ESSCI
Skilling India in Electronics

Participant Handbook

Sector
Electronics

Sub-Sector
Industrial Automation

Occupation
Engineering- I & A

Reference ID: **ELE/Q7106, Version 1.0**

NSQF Level 7

Robotics Automation Lead

QR code

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> **Skilling is building a better India. If we have to move India towards development then Skill Development should be our mission.**

Shri Narendra Modi
Prime Minister of India

Certificate

COMPLIANCE TO
QUALIFICATION PACK – NATIONAL OCCUPATIONAL STANDARDS

is hereby issued by the

ROBOTICS AUTOMATION LEAD

for

SKILLING CONTENT : PARTICIPANT HANDBOOK

Complying to National Occupational Standards of

Job Role/Qualification Pack

"Robotics Automation Lead"   QP No. **"ELE/Q7106, NSQF Level: 7"**

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 'Valid up to' date mentioned above (whichever is earlier)

Authorized Signatory
Electronics Sector Skill Council of India

Acknowledgment

About this book

This participat handbook has been designed to serve as a guide for participants who aim to obtain the required knowledge and skills to undertake various activities as a Robotics Automation Lead.
Its content has been aligned with the latest Qualification Pack (QP) prepared for the job role. With a qualified trainer's guidance, the participants will be equipped with the following for working efficiently in the job role:

- **Knowledge and Understanding:** The relevant operational knowledge and understanding to perform the required tasks.

- **Performance Criteria:** The essential skills through hands-on training to perform the required operations to the applicable quality standards.

- **Professional Skills:** The Ability to make appropriate operational decisions about the filed of work. The handbook details the relevant activities to be carried out by a Robotics Automation Lead. Afer studying this handbook, job holders will be adequately skilled to carry out their duties efficiently according to the applicable quality standards, with minimum supervision. The content in this handbook is aligned with the following National Occupational Standards (NOS) as given in the latest version of the Robotics Automation.

- ELE/N7117: Use the appropriate Robotic Process Automation (RPA) software
- ELE/N7118: Integrate robot manipulators with process components
- ELE/N7119: Perform source control integration in the RPA software
- ELE/N7120: Use REFramework in the RPA software
- ELE/N7121: Use the robot sensing and machine vision technologies
- ELE/N9905: Work effectively at the workplace
- ELE/N1002: Apply health and safety practices at the workplace

The handbook has been divided into an appropriate number of units and sub-units based on the content of the relevant QP. We hope it will facilitate easy and structured learning for the participants. We sincerely hope that participants will obtain enhanced knowledge and skills are studying this handbook and make career progress in the relevant and senior job roles.

Symbols Used

Key Learning Outcomes	Exercise	Steps	Tips	Notes	Unit Objectives

Contents

1. Introduction to the role of a Robotics Automation Lead

ESSCI

Skilling India in Electronics

Key Learning Outcomes

By the end of this module, participants will be able to:

- Describe the job role of a Robotics Automation Lead.

Unit 1.1 Overview of the Electronic Industry

Unit Objectives

By the end of this unit, participants will be able to:

- Describe the size and scope of the Electronic industry and its sub-sectors.

1.1.1 Definition of Electronics

Electronics is a branch of physics that studies the electrons' flow, control, and behaviour and their effects on vacuums, gases, semiconductors, and devices using such electrons.

The electrons are controlled by devices (electronic components) that resist, carry, select, steer, switch, store, manipulate, and exploit them.

1.1.2 Electronic Industry

The electronics industry comprises companies that manufacture, design, manufacture, assemble, and electronic service products. To perform their primary functions, electronic products rely on electronic principles. It consists of materials, parts, components, subassemblies, and equipment that use electronics principles.

1.1.3 Profile of Electronic Sector of India

- Globally, electronics is one of the fastest-growing industries.

- The Indian market is predicted to be second only to China's, followed by Vietnam, South Korea and Taiwan.

- The Indian government focuses on manufacturing electronics hardware at the domestic level, which appears to be the conceptual foundation of the Make in India and Digital India programmes.

- These initiatives seek to attain a market size of US$ 251 billion by 2023 by encouraging local production and exports across the electronics system design and manufacturing (ESDM) value chain.

- The seven key segments of the Indian electronics industry are industrial electronics, consumer electronics, communications and broadcasting electronics, strategic electronics, electronic components, computer hardware, and LED products.

- The Electronics Development Fund (EDF), the Phased Manufacturing Program (PMP), the Modified Special Incentive Package Scheme (MSIPS), Preferential Market Access (PMA), and a reduction in tariff structure have all been used by the Indian government to support the sector.

1.1.4 Size of Electronic Sector in India

- The electronics sector of India contributes around 3.4% of the country's Gross Domestic Product (GDP).
- The IT sector in India is one of the most significant contributors, with a 9% contribution to Gross Domestic Product (GDP).
- The industry is around US$ 194 billion and is expected to surpass US$ 300-350 billion by 2025.

1.1.5 Key drivers

The following are some of the electronic industry's most important growth drivers:

- **Economic growth:** India has one of the world's fastest-growing economies, with GDP forecast to rise consistently. Demand in the industry and strategic electronics domains has been positively driven by rising economic activity and implementation of the newest automation technology across many industries.

- **Rapid urbanization and income growth:** Rapid urbanization, combined with rising incomes, has made items more affordable, resulting in increased demand for mobile phones, tablets, and other household gadgets.

- **Government initiatives:** The GST, Make in India, and other policies like Preferential Market Access have improved the business climate for domestic manufacturing. Demand for electronic items is also boosted by government flagship programmes such as Smart Cities and Digital India. The government announced three further plans in April 2020, which were notified by the Ministry of Electronics and Information Technology (MeitY), giving a total of 500 billion (US$ 7.2 billion) in incentives under the schemes. These incentives will boost domestic electronics output and encourage anchor firms in India's key electronics clusters.

  Production Linked Incentives (PLI), Modified Electronics Manufacturing Clusters (EMC 2.0), and Scheme for the promotion of manufacturing of components and semiconductors (SPECS) are the three essential schemes.

- **Evolving technology and innovation:** Rapid technological advancements and newer items with enhanced technologies have resulted in shorter product life cycles for electrical products. Customers may also replace their old electronic equipment with newer items thanks to shifting customer attitudes and consumer-to-consumer websites like Olx and Quikr.

  Demand for high-speed Internet has also fueled the growth of high-end smartphone sales. In addition, consumer electronics has seen tremendous innovation due to this increased demand for high technological items. In the industrial and strategic electronics area, new technologies such as artificial intelligence (AI), the Internet of Things (IoT), robotics, and analytics have contributed to the overall expansion of various electronic items, boosting local demand.

1.1.6 Scope of Electronic Industry

The electronic industry has scope in the following sector:

Telecommunication	Mobile Communication (2G, 3G, 4G or 5G)	Automotive Industry	Consumer electronics manufacture
	IT Industries	Petroleum and Chemical Industry	Health care equipment manufacturing
	Power Electronics	Steel Industry	

Fig. 1.1.1 Scope of the electronic industry

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Scope of Electronic Industry

Unit 1.2 Introduction to Robotics

Unit Objectives ◎

By the end of this unit, participants will be able to:
- Define Robotics.
- Explain the type of robots.
- Explain the main components of a robot.

1.2.1. What is Robotics?

Robotics is a multidisciplinary scientific, engineering, and technology area. It entails the design, manufacture, operation, and usage of machines known as robots to do tasks traditionally performed by humans or to replace human actions.

The main purpose of robotics is to create machines that can aid and support people.
Mechanical engineering, electrical engineering, information engineering, mechatronics, electronics, bioengineering, computer engineering, control engineering, software engineering, and mathematics are a few of the subjects it encompasses.

1.2.2 What is a Robot?

A robot is built by the robotics sector, which develops programmed devices to aid people or emulate human behaviours. Robots were initially designed to do tedious activities (such as automobile manufacturing lines) but have evolved to accomplish duties such as cleaning houses, fighting fires, and aiding with extremely complex procedures. Each robot has a different amount of autonomy, ranging from human-controlled bots that do activities over which a person has complete control to completely autonomous bots that accomplish tasks without any external influences.

1.2.3 Types of Robots

Robots are of various shapes and sizes to carry out the task they are designed for. Generally, there are five types of robots:

1. Pre-programmed Robots: Pre-programmed robots do simple, monotonous activities in a controlled setting. A pre-programmed robot is an example of a mechanical arm in an assembly line. The arm has one purpose — weld a door, put a part into the engine, etc. — and its goal is to execute it longer, quicker, and more efficiently than a person.

2. Humanoid Robots: Robots that mirror human behaviour or resemble humans are called humanoid robots. These robots frequently carry out actions associated with humans (such as running, leaping, and carrying goods), and occasionally they are created to resemble people, even having human features and attitudes. The Sophia robot from Hanson Robotics (seen in the video above) and the Atlas robot from Boston Dynamics are two of the most well-known humanoid robots.

3. Autonomous Robots: Robots with autonomous work without the assistance of human operators. These robots are often made to complete duties in public spaces without human supervision. Their decision-making mechanisms (often a computer) to determine the best course of action based on their data and goal make them extremely distinctive. They detect their environment using sensors, which makes them quite unusual. The Roomba vacuum cleaner, which uses sensors to move about a house at will, is an example of an autonomous robot.

4. Teleported Robots: Robots that a person can remotely control from a safe distance are known as teleoperated robots. These robots often operate under harsh environmental factors such as weather, geography, and other factors. Teleoperated robots include, for instance, the human-controlled submarines used to repair undersea pipe breaks during the BP oil spill or drones used to find landmines in a war zone.

5. Augmenting Robots: Robotic augmentation either improves human capabilities already present or replaces lost human abilities. Science fiction might soon become a reality in robotics for human enhancement, where robots with the power to make people quicker and stronger could completely rewrite what it means to be human. Robotic exoskeletons or prosthetic limbs are two examples of modern augmenting robots that can carry heavy objects.

1.2.4 Main Components

The main components of a robot are:
- Control system
- Sensors
- Actuators
- Power Supply
- End Effectors

Control System: All parts that make up a robot's central processing unit, also known as its control system, are considered part of the computation. Like how the human brain transmits signals throughout the body, control systems are built to instruct a robot on how to use particular components to carry out a given task. These robotic jobs might include everything from minimally invasive surgery to assembly line packaging.

Sensors: Robots can interact with the outside environment due to sensors, which offer stimuli in the form of electrical impulses that the controller analyzes. Robots frequently have photoresistors, which act as the robots' eyes, video cameras, and microphones, which act as the robots' hearing. These sensors enable the robot to observe its surroundings, evaluate the most logical conclusion given the circumstances, and transmit orders to the other parts via the controller.

Actuators: A gadget may only be categorized as a robot if it includes a moveable body or frame, as was previously established. The components causing this movement are called actuators. These parts consist of motors that take commands from the control system and work together to make the movements required to finish the task. Actuators come in several formats to best perform their particular duties. They can be built of various materials, such as metal or elastic, and are often driven by compressed air (pneumatic actuators) or oil (hydraulic actuators).

Power Supply: Robots typically operate using an internal battery; however, stationary robots used in factories may also function on AC power through a wall socket. Most robots use lead-acid batteries because of their durability and safety, while some may use the more portable but more costly silver-cadmium variant. Designing a robot's power supply requires considering many essential criteria, including weight, safety, replaceability, and lifetime.

Pneumatic power from compressed gases, solar power, hydraulic power, flywheel energy storage organic waste through anaerobic digestion, and nuclear power are other possible power sources for future robotic advancement.

End Effectors: End effectors are the physical, usually external components that enable robots to complete their tasks. Robots used in manufacturing frequently include interchangeable tools like paint sprayers and drills, robots used in surgery may have scalpels, and other robot types may be constructed with grasping claws or even hands for activities like delivery, packing, bomb dispersion, and other things.

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What is Robotics?

Unit 1.3 Role and Responsibilities of a Robotics Automation Lead

Unit Objectives ⊚

By the end of this unit, participants will be able to:
- Discuss the role and responsibilities of a Robotics Automation Lead.
- Discuss various employment opportunities for a Robotics Automation Lead in the Electronics industry.
- State the organizational policies on incentives, personnel management reporting structure, etc.

1.3.1 Robotics Automation Lead

A Robotics Automation Lead is responsible for designing and monitoring all computer-controlled systems and robotic devices used in industrial and commercial facilities to minimize human interaction and maximize productivity. The person aids manufacturing, mechanical, and electronics engineers in all areas of process design, development, production, testing, robot installation, and operations.

1.3.2 Job Responsibilities of Robotics Automation Lead

The key responsibilities of a Robotics Automation Lead are
- Identifying and creating automated business processes
- Creating, testing, and monitoring automated workflows to guarantee that business operations run efficiently and without mistakes
- Monitoring and maintaining automation after deployment and resolving any possible concerns to guarantee that company activities run smoothly.
- Creating process documentation in order to highlight failures and triumphs and enhance procedures in the future
- Using Quality Assurance (QA) techniques to ensure quality automation and avoid any possible issues

1.3.3 Career Opportunities

The following are some of the most standard job descriptions for robotics and industrial automation:
- Robotics Technician
- Automation Technician
- Engineering Technician
- Instrumentation Technician
- Maintenance Technician
- Manufacturing Production Technician
- Manufacturing Engineering Technologist
- Electro-Mechanical Technician

1.3.4 Organizational Policies on incentives, Personnel Management and Reporting Structure

The organizational policies on incentives, personnel management, and reporting structure depend on the organization the individual joins. These vary across organizations.

For example, a public sector company may offer different incentives for work performance compared to a private company. The same is the case with the reporting structure.

Personnel management policies also tend to differ from organization to organization. Therefore, the individual should conduct proper research before interviewing for a job at a particular company to ensure that they are satisfied with the company policies on remuneration, human resource management, career progression, etc.

Exercise

1. Explain any 2 key drivers of electronic industry.

2. State 5 roles and responsibilities of a Robotics Automation Lead.

3. Define robotics.

4. State in brief about types of robots.

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Job Responsibilities of Robotics Automation Lead

2. Process of using the appropriate Robotic Process Automation (RPA) software

Unit 2.1 Implementation of Robotic Process Automation (RPA)

Unit 2.2 Control System and Cybersecurity in Robotic Process Automation (RPA)

Key Learning Outcomes

By the end of this module, participants will be able to:

- Describe the process of implementing RPA.

- Demonstrate the process of setting up the RPA software for use.

- Describe the process of dealing with cybersecurity attacks in robotics.

Unit 2.1 Implementation of Robotic Process Automation (RPA)

Unit Objectives ◎

By the end of this unit, participants will be able to:

- Explain the importance and use of debugging tools in RPA.

- Explain the benefits and applications of RPA.

- Explain the difference between RPA and traditional automation.

- Explain different types of bots.

- Describe the RPA development methodology and key considerations.

- Explain the use of various RPA tools.

- Explain different types of RPA software and its components.

- Explain how to install RPA software.

- Explain different workflow files in the RPA software.

2.1.1 Robotic Process Automation (RPA)

Robotic process automation (RPA) is the use of software with artificial intelligence (AI) and machine learning (ML) capabilities to handle repetitive, high-volume operations that traditionally needed human labour. A few of these tasks are:

- Answering queries
- performing calculations
- maintaining records
- conducting transactions

There is a widespread misperception that automation and robotic process automation are interchangeable, however, this is inaccurate since classical automation and RPA vary in many ways.

Application programming interfaces (APIs) and integration tools are programmed in traditional automation in order to combine various systems. The target system must be well-known to the RPA developer.

On the other side, robotic process automation imitates user interface (UI) level user behaviour. As long as the bot can adhere to the instructions, the developer need not worry about the complexity at work.

Take into account the procedure a firm uses to integrate a new hire. To create a new user account, email address, access privileges, document retrieval, etc., data from many systems must be coordinated. The user account can automatically activate a template for the onboarding processes using robotic process automation.

2.1.2 RPA vs. Traditional Automation

Robotic Process Automation (RPA) software is used to automate a large number of routine, rule-based processes. Users using RPA technologies may create and employ software robots that can imitate human behaviour. These tools may also autonomously carry out a variety of jobs, transactions, and processes across software systems by using pre-defined activities and business rules. RPA may provide the required outcome without involving any human beings.

The automation of any repetitive operations is known as traditional automation, on the other hand. It combines database or infrastructure-level application integration. Only minimum human involvement is needed.

Fig. 2.1.1 Traditional Automation and RPA

The key differences are:

Robotic Process Automation	Traditional Automation
It doesn't require changing the infrastructure or processes that are already in place.	It requires certain modifications to the current IT architecture.
It is capable of automating routine, rule-based processes. To do the duties, it imitates human activities.	It excludes the capacity to imitate human behaviour. It solely carries out the pre-programmed instructions.
RPA may be used without any prior programming experience. Automation is made possible by RPA and its simple flowchart illustration. Users do not need to remember language syntax or scripting as a result. They merely need to concentrate on the automation's provided features.	Users must possess programming knowledge in order to employ traditional automation to automate operations. The type of automation instrument determines the necessary programming language. Users must keep in mind scripting and language syntax.

RPA offers rapid and simple installation. RPA software is process-driven, thus it takes less time.	Implementation of traditional automation might take many months. It takes longer to create tests and conduct feasibility studies.
RPA enables customers to distribute work among thousands or hundreds of virtual computers, allowing the assigned tasks to be completed without the need for real equipment.	Traditional Automation, on the other hand, makes use of several programming approaches to provide scalability or parallel execution. Parallel execution requires the use of physical machines. These actual devices ought to be able to process information quickly.
RPA can be set up to accommodate a specific user's needs. It may be used in conjunction with a number of programmes (such as calendar, email, ERP, CRM, etc.) to synchronise data and generate automatic responses.	Traditional Automation is viewed as a vital and sophisticated technology in comparison to RPA when it comes to customisation. Due to APIs' restrictions, integrating various systems with Traditional Automation might be difficult.
RPA might be quite expensive in the beginning. However, in the long term, it saves a tonne of time, money, and effort.	In the beginning, traditional automation is less expensive. Long-term expenses, however, end up being far higher.
RPA is a more effective choice since it can make changes right away.	Traditional automation demands a sizable team, additional time, and effort.
Due to RPA's simplicity, users can quickly adapt to any business flow.	Traditional Automation, on the other hand, could require users to modify multiple scripts. As a result, maintaining and updating this technology could be challenging.

Table 2.1.2 RPA vs. Traditional Automation

2.1.3 Features of Robotic Process Automation (RPA)

- **Rich analytical suite:** The automated functions are managed and monitored by RPA from a central console. This console is accessible from anywhere and offers basic metrics on robots, workflows, servers, and more.

- **Simple creation of bots:** RPA allows quick creation of bots by capturing keystrokes and mouse clicks with built-in screen recorders.

- **Scriptless automation:** RPA tools allow one to automate any application across any department without coding. An intuitive GUI allows users without programming skills to create bots.

- **Security:** In RPA tools, encryption capabilities can be configured and customized to protect certain data types against network interruptions.

- **Hosting and deployment:** RPA systems can automatically create bots in groups of hundreds. Therefore, RPA bots can be installed on desktops and deployed on servers to access data.

- **Debugging:** RPA tools can be debugged dynamically or by stopping them from running and correcting the errors. Process automation is one of RPA's most powerful features. Process automation is one of RPA's most powerful features.

2.1.4 Benefits of Robotic Process Automation (RPA)

- **Reduces cost:** RPA is helpful in reducing the cost by automating the tasks. Any organization can save up to 30 per cent of their total costs as software robots also cost less than a full-time employee.

- **Reduces operational risks:** Many companies tend to outsource the work to third-party organizations, and there is a chance of risk of human errors and inefficiency. With the help of RPA, the work can stay in-house, and there is less operational risk.

- **Quality and accuracy:** Human error-prone processes can be automated using RPA. These bots are consistent, reliable, and can work tirelessly.

- **Scalability:** With the use of RPA, organizations can simply scale up or down operations as necessary and may make modifications depending on other important aspects.

- **Reduced workload:** Automating tasks like report-making can significantly reduce the workload on employees, allowing them to focus on other critical tasks.

- **Improved customer satisfaction:** Since accuracy is maintained and operational risk is minimal, customers are provided with quality content.

- **Improved business results:** As employees are focused on the activities that are more valuable to the company, RPA improves results that can be automated.

2.1.5 Debugging & its tools

The testing, upgrading, troubleshooting, and maintenance of software programmes is extensive during the development phase. The programme typically has problems and mistakes, which are often fixed. A software issue is fixed through the process of debugging.

It refers to identifying, analyzing and removing errors. This procedure starts when the programme doesn't work as intended and ends after the issue has been fixed and the software has been tested successfully. As faults should be fixed at every level of debugging, it is seen as a very difficult and time-consuming operation.

The phases in the debugging process are as follows:

Fig. 2.1.2 Steps of Debugging

Step 1: Identify the Error
Time spent developing might be lost due to poor mistake detection. It is common for production mistakes reported by users to be difficult to decipher, and occasionally the data we get is inaccurate. Finding the real mistake is crucial.

Step 2: Find the Error Location
After correctly identifying the error, one needs to go through the code to find the exact spot where the error is located. In this stage, one needs to focus on finding the error instead of understanding it.

Step 3: Analyze the Error
The third stage requires users to start from the error location and evaluate the code from the bottom up. This aids in the comprehension of the mistake. There are two basic objectives when evaluating a bug: to determine the probability of introducing any collateral harm into the remedy and to search for more mistakes that may exist.

Step 4: Prove the Analysis
After examining the original problem, one must look for a few other mistakes that could occur in the programme. Using a test framework, write automated tests for these sections in this stage.

Step 5: Cover Lateral Damage
For the code that users want to edit, all of the unit tests must be written or compiled at this stage. Now, if users run it, all of these unit tests must succeed.

Step 6: Fix & Validate
The last step is to fix any errors and run each test script to check if it succeeds.

Debugging Tools

A debugging tool is a software program that is used to test and fix other programmes. One may use a variety of free applications for debugging, such as gdb and dbx. Additionally, they provide command-line interfaces based on consoles. Code-based tracers, profilers, interpreters, and other tools for automated debugging are some examples.

Some widely used debuggers are:
- Radare2
- WinDbg
- Valgrind

2.1.6 Working of Robotic Process Automation (RPA)

An RPA solution automates the day-to-day manual tasks performed by configuration analysts. Manual tasks include data entry, application configuration, validation of client files, data loads, creation of test data, and report generation. RPA solution uses the following components:

- Cognitive Automation Platform (CAP) and
- Unified Test Management Solution (UTMS).

The cognitive automation platform can generate meaningful data from any format of unstructured data fed to it if powered by machine learning and predictive capabilities while the UTMS enabled by bots can improve productivity and efficiency by taking over labour-intensive and repetitive tasks.

2.1.7 Types of Robotic Process Automation (RPA)

There are three major types of RPA:

1. Attended Automation: Attended Automation refers to automated systems that are operated under human control. These work best when used with smaller, more detailed tasks. For instance, submitting an expenditure report is an activity that is amenable to automation. The user enters their login information into the system, after which the automation completes the required fields, adds any necessary attachments, and submits the report on their behalf.

2. Unattended Automation: Unattended Automations are automations designed for more difficult, repetitive operations that must often be carried out in batches and can be determined based on a specified rule. Unattended automations are also appropriate for processes that execute privileged operations and need access to privileged resources.

The approval of expenditure reports would be one such task from the aforementioned scenario. Without a human user present, the automation would log into the required system, process any submitted expense reports, and, if they meet a predetermined rule (for example, fall within a certain amount), automatically approve them.

3. Hybrid RPA: Combining attended and unattended RPA processes to enable automation for both back and front office tasks are known as hybrid RPA. This makes it possible to automate the entire procedure.

2.1.8 Tools of Robotic Process Automation (RPA)

To know the automation tools for the project it is essential to know which type to use. There are 3 types of RPA tools which can be used:

1. Macros: Macros are the oldest tools in automation which automate processes that are in a single system. Macros can be used in simple processes which require a single tool. Macros can be used to make calculations, organize data, etc.

2. IT Process Automation: IP Process Automation are function-specific automation tools which are helpful in automating complex multi-system-dependent processes. These are able to handle complex tasks like prioritising action plans, alerts from multiple sources, and deployment of the defined possible action plans. These can notify key members of the team that require notifications of the activity before closing the ticket.

3. Cognitive Automation: These bots can exploit a desktop to do activities requiring numerous systems due to their screen scraping skills. They are simple to use and less accurate than ITPA instruments. They are enhanced with artificial intelligence characteristics that allow them to learn from prior instances using a straightforward drag-and-drop programming interface. They can also be referred to as intelligent or cognitive bots since they employ natural language processing.

2.1.9 Components of Robotic Process Automation (RPA)

The following are the main elements of robotic process automation:

- Recorder
- Development Studio
- Plugin/Extension
- Bot Runner
- Control Centre

Fig. 2.1.3 Components of Robotic Process Automation (RPA)

Recorder: The recorder has the ability to automate desktop, web, and mainframe applications without the need for any programming, coding or scripting.

An object recording approach is used as the primary recording mode. RPA bots automatically record object attributes, such as the values of active elements. As soon as the recording is complete, RPA bots locate the same elements and repeat the recording process. While executing scripts, RPA robots perform actions such as clicking, hovering, dragging, or scrolling on the same features. RPA recorder also allows modifying the workflow and manually adding system actions. The actions may include opening applications, switching windows, manipulating Excel files, or using a clipboard.

Development Studio: Development Studio is one of the primary components of almost all RPA tools. Workflows for intelligent process automation can be created or developed using the development studio. It enables the users to take complete control of the automation. Additionally, it enables the installation of activity packages, wizards, recorders, and individual plugins.

Some key features of RPA Developer Studio are:

- Dashboard with GUI (Graphical User Interface).

- Integration support with OCR (Optical Character Reader).

- Logging and Exception Handling.

- Different types of Recorders.

- Collection of pre-built, drag-and-drop templates.

- The automation resources such as activities, libraries, and projects can be searched using the universal search option.

Plugin/ Extension: Most RPA platforms feature several plugins and extensions to facilitate development and execution. A set of programs known as RPA plugins can be installed along with the RPA tool. These plugins can extract data from invoices, manipulate dates in different databases, and transcribe speech. The advantages of RPA plugins include the reduction of development efforts, error rates, and implementation time. Following their installation along with the RPA tool, they can be directly used.

Bot Runners: Bot Runners help execute the developed software bots and are the machines on which bots run or execute. Multiple bots can be assembled in parallel for faster execution. 'Run License' is required to run these bots. The bots also connect with the control centre about the execution status (e.g., execution logs, pass or fail, etc.). The control room schedules and runs the software bots on the bot runner after a developer develops a software bot or task and changes the status within. The order in which a bot executes often relies on the priorities or needs.

Control Center: The control center is a web-based platform for controlling software bots. These are developed by the Bot Creator. Users can schedule, manage, control, and scale a vast amount of digital workforce activity. Various features such as centralized user management, deployment automation, source control, and dashboards are included as well.

2.1.10 Bots and Types

A bot is a computer programme that executes other programmes' commands. A bot is an automated program. The processes are carried out as programmed instructions without any human intervention. The bots are designed to perform human tasks in a similar manner to humans. In short, bots replicate human behaviour and actions. Normally bots are built to perform repetitive tasks. The speed of the tasks performed by bots is much better than human speed.

Types of Bots
A few types of Bots are:

1. Spider Bot: The Spider Bot is an internet bot that has been designed to search through and download pages from various websites before indexing their information. When searching, the data may be retrieved thanks to this indexing. Web crawlers are another name for spider bots. When people access the website pages, they use resources. The crawlers almost never have permission to access these websites. Websites that do not want web spiders on them include a robots.txt file. The text file defines the pages of the website that can be indexed by the bots.
The use of spider bots in search engines is a well-known illustration. When the internet first came up in 2000, search engines found it difficult to provide relevant search results. These bots now help to effectively provide matched results.

2. Scraper Bots: Scraper bots are designed to read information from websites and preserve it for offline use. One could use the saved material again. Scraping is the process of reading a website's page's content in part or in its entirety. In e-commerce websites, the data read may include names, pricing, and product information.
Scraping is not entirely legal. The website's proprietors occasionally allow data reading. Scraper bots have been known to access sensitive data, including copyrighted content, in some circumstances. This is an evil bot.

3. Spam Bots: Spam Bots are designed to gather email addresses from spam mailing lists. The bot can gather email addresses from social networking platforms, websites, and businesses. Once a sizable collection of email addresses has been amassed, spam bot programmers can use it to deliver spam or for any of their malevolent objectives, such as credential cracking and form spam.
In credential cracking, email addresses are combined with frequently used passwords to gain illegal access to accounts. In the form of spam, the bots post spam-like malware URLs into well-known websites' comments or feedback areas.

4. Social Media Bots: Social Media Bots are bots that have been designed to post messages on social media. They follow user behaviour and are programmed to support ideas. These bots are employed to set up phoney accounts in an effort to gain more followers. Social bots make up between 9 and 15 per cent of Twitter accounts, according to research.

5. Download Bots: The Download Bots are designed to download mobile apps or software automatically. The download numbers are boosted through the usage of bots. In order to help new apps get to the top of the charts, these bots are utilized to obtain a sizable number of downloads on well-known app stores. As the first stage of the DoS (Denial of Service) assault, the bots are also utilized to generate a number of fictitious downloads.

6. Ticketing Bots: The bots are set up to purchase tickets for popular events. The tickets will be resold with the goal of making a profit. The bots are made to act like people buying tickets, mimicking human behaviour. According to estimates, automated bots purchase between 40% and 95% of the tickets. Although it is not against the law, several nations consider this type of ticket purchasing to be unlawful.

2.1.12 Installation of Robotic Process Automation (RPA)

There are various software using Robotic Process Automation (RPA) technology. The steps for installation of one such software 'UiPath' are:

Steps	Images
Step1: Go to the official UiPath website "uipath.com". Click on "try UiPath for free".	
Step 2: Sign up using the Email ID. If user already have an existing account, then sign in.	

Step 3: After sign-in, click on "download studio". Once the file is downloaded, run the setup file and install it.	
Step 4: It will ask for a license, select a community license, which is fre`e.	

Steps	Images
Step 5: Choose the profile as UiPath studio pro community. • Profiles in UiPath • Specialized developers normally use UiPath studio pro. In this profile, the developer can automate with AI, use advanced RPA features, testing tools, and sophisticated coding services. • UiPath studio - This is specifically for RPA Developers In this profile, the developer can build complex automation that is run by attended or unattended robots • UiPath studioX - This is used by business users. If users are not a developer, but if they want to automate a simple task. Then it is convenient to use studioX.	
Step 6: Choose the update channel as 'Preview' to get the latest updates from UiPath.	

Steps	Images
Step 7: Choose the control supports. Click on continue.	
Step 8: UiPath path provides a brief introduction and tutorial video with instructions for beginners to understand easily. UiPath Studio is successfully installed and is ready to get started.	

2.1.13 Workflow

RPA enables virtual robots to carry out automated tasks precisely. RPA transactions are frequently carried out in a repeated and massive volume. RPA automates business processes or workflows by simulating human behaviour without requiring human involvement.

RPA is similar to the scripting tool that forms the basis of all of the favourite movies. A movie script develops a series of incidents to tell a story or add to a bigger picture. There are characters in the screenplay who converse with one another.

The screenplay specifies the action each character will do, when they will take it, and who will take it. Each action in a script has an associated result. RPA may be seen in a similar sense, where the characters represent the elements or processes of an automated workflow and the script is that workflow.

2.1.14 Need for Robotics in the Automation Process

Robots can play an essential part in the future of nearly every industry:
• Robots help manufacturers reduce expenses and reintroduce tasks that were previously outsourced.
• Robots assist close the skills gap by taking on the demanding duties that make it impossible to fill some occupations.
• By doing boring, repetitive, and hazardous tasks, robots are revolutionizing the manufacturing industry.
• As a result, more intriguing, demanding, and lucrative roles are required. Robots help with employee retention and can save personnel expenses for recruitment, hiring, and training by fostering a safer, more enjoyable work environment.

2.1.15 RPA integration with existing systems

RPA provides a less expensive and faster solution to the same problem that integration seeks to solve. RPA's competitive advantage arises from the solution's light structure, which enables the technology to be implemented without requiring changes to the organization's current IT systems. Due to the significant cost and operational effect of rethinking their outdated, poorly integrated IT, many system-heavy firms struggle to improve their operations.

Notes 📝

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Scan the QR Code to watch the related videos

https://youtu.be/9URSbTOE4YI
Robotic Process Automation (RPA)

Unit 2.2 Control System and Cybersecurity in Robotic Process Automation (RPA)

Unit Objectives 🎯

By the end of this unit, participants will be able to:
- Explain the concept of a control system and its process.
- Describe the authentication process for accessing the robotics program.
- Explain intelligent autonomous robots.
- Explain how to mitigate cybersecurity attacks on robotic systems.
- Explain the use of artificial intelligence, screen scraping, and workflow automation in the RPA process.
- Explain how the combination of RPA solutions is used with intelligent technologies in different industries.
- Explain the functioning of intelligent agents and autonomous robots.
- Describe the process of digitizing, auditing and processing data using RPA.

Explain how to identify cybersecurity attacks in robotics programming.

2.2.1 Robot Control System

Robot control systems regulate and direct the robot's operations to produce the intended outcome. The robot itself is an independent device with three primary components that all function well together. The controller, actuator, and sensors make up the three essential components. The controller, which we just spoke about, uses a feedback control system that is controlled by a computer programme to direct all of the robot's motions.

The robotics control employs a closed loop control system that leverages sensor feedback to reach high levels of performance.

The five fundamental parts of a feedback control system are as follows:
1. Input;
2. Process being controlled;
3. Output;
4. Sensing elements;
5. Controller and actuating devices;

2.2.2 Robot Authentication

Robots tend to share files wirelessly with one another and with a file server, either directly or indirectly. The server and robots together with the network connections constitute a subnet with local IP addresses, whereas the router has a static IP address that is accessible to the outside world. But frequently, every robot has a unique static IP address. Depending on the functionality and complexity of the robot, each one also has various hardware IDs, a NIC card, a distinct NIC address, and other hardware components. The non-electronic component of a robot's hardware often comprises established, long-understood technology.

The electronic hardware has evolved to the point that the embedded software can provide the needed intelligence for the robot to perform sophisticated tasks previously performed by one or more human beings. However, in previous research emphasis has been placed on the tasks performed by the robots, neglecting any security issues or liabilities that may arise due to lack of security.

2.2.3 Robot Autonomous

An autonomous robot is one that has been developed and manufactured to function for lengthy periods of time without the assistance of a human. Autonomous robots frequently include advanced characteristics that can aid in their understanding of their physical surroundings and automate tasks that were earlier performed by human hands in terms of maintenance and control.

Autonomous cleaning robots such as Roombas, medical delivery robots, and other robots that move freely throughout a physical place without being physically led by humans are examples of autonomous robots. Many people associate robots with manufacturing robots or others at a fixed workstation, or with those controlled by human users.

Autonomous robots often function without human involvement unless it is required as part of their mission. Many of these robots are equipped with sensors and other useful equipment that enables them to notice any obstacles in their path and move about in spaces like rooms, corridors, or other environments. Complex delivery robots can even be taught to operate elevators and navigate autonomously across a multi-story structure. However, physical maintenance is still required for autonomous robots.

2.2.4 Intelligent Agents

An intelligent agent is a software that can make decisions or provide a service depending on its surroundings, human input, and past experiences. These applications can be used to gather information autonomously on a regular, pre-programmed schedule or when requested by the user in real time. Intelligent agents are also known as bots, which is short for robots.

Typically, an agent software searches the internet using criteria specified by the user, accumulates information of interest to the user, and provides it to them on a periodic or requested basis. Any specific information, such as contained keywords or publication date, may be extracted by data intelligent agents. In artificial intelligence (AI) agents, user input is received via sensors such as microphones or cameras, while agent output is provided via actuators such as speakers or displays. Push technology refers to the technique of having information delivered to a user via an agent.

Intelligent agents share traits such as experience-based adaptation, real-time problem solving, error or success rate analysis, and the usage of memory-based storage and retrieval.
Intelligent agents may be utilised in data mining, data analytics, and customer care and support (CSS) applications for businesses. Intelligent agents may also compare the pricing of similar goods and alert the user when a website change happens.

Intelligent agents are related to software agents, which are self-contained computer programmes.

Types of intelligent agents

Intelligent agents are classified according to their capabilities and level of intelligence:

Reflex agents: These agents operate in the present, ignoring previous events. Responses are based on the event-condition-action rule (ECA rule), in which a user initiates an event and the agent refers to a list of pre-set rules and pre-programmed outcomes.

Model-based agents: These agents make the same decision as reflex agents, but they have a broader perspective of their surroundings. The internal system has a world model that integrates the agent's past.

Goal-based agents: These agents supplement the information stored by model-based agents by storing goal information, or knowledge about ideal scenarios.

Utility-based agents: These agents are comparable to goal-based agents, but they also offer an additional utility measurement that ranks each potential scenario according to the intended outcome and selects the course of action that maximises the result. Rating criteria examples could be the probability of success or the resources required.

Learning agents: Through an added learning component, these agents have the capacity to progressively advance and learn more about a given environment over time. Feedback will be used by the learning component to decide how to adjust performance components for a steady improvement.

2.2.5 Execution of RPA

RPA Execution Procedures

RPA implementation into an entity's infrastructure happens in four steps:

1. Selection and Approval: The selection phase involves selecting appropriate processes for automation. RPA processes that are appropriate are structured, constant, rule-based, and have a large number of transactions. However, even if a work doesn't require a lot of transactions per second, rule-based activities can still be automated.

2. Developer Design: The RPA design step entails selecting the best software solutions for the user's stated tasks. For instance, if a user wishes to employ RPA automation for payroll, they need take into account the cost, functionality, quality, and implementation time required for robot software for this activity. When comparing RPA technologies for payroll to other available options, a user may find that they don't get the best results. The typical RPA difficulties should be addressed, results should be determined for the short- and long-term, and roles and responsibilities for individuals participating should be established during this phase.

3. Scripts, Build, Test: Building and rewriting scripts for the automation technologies chosen during the design stage is the third stage of putting RPA into action. The scriptwriting stage needs some understanding of programming and configuration, depending on the desired objective. The configurations must also be written, which is normally the job of an RPA developer or an IT professional. The user interface of each tool varies. For instance, some may need little to no coding, but others require a new script. Creating a space for the RPA tools to build, test, and deploy is also essential during this step.

4. Execute: Executing the automation tools comes after each step has been finished. It is crucial to keep an eye out for software robot faults and to have a competent quality human resources that are well-versed in this field. Many businesses should think about using outside assistance for their RPA deployment process and setting up a capable team to watch the programme throughout the execution phase.

2.2.6 Artificial Intelligence

Robotic process automation (RPA) robots that have artificial intelligence built into them will work on any application as long as it is explicitly written into their cores with the rules they must follow. This does not only imply that RPA is not appropriate for non-rule-based processes; as we previously discovered with AI, RPA is capable of handling tasks without these rules.

This means that the environments with the highest levels of transaction volume, standardisation, well-defined implicit logic, and security are those where AI service-based RPA is most effectively used. While security protects the automated operations, automating vast volumes of repetitive, menial tasks can result in significant cost savings and time reductions. Following are a few typical applications for RPA powered by artificial intelligence:

- **Low cognitive requirements:** While complicated processes with a number of diverse, complex tasks are tougher to handle with RPA, they are excellent candidates for AI-based RPA applications. example: Chatbot interactions with customers.

- **Access to multiple systems is not required:** RPA is implemented on top of already-existing applications, although it usually automates actions taking place within a single application or information system. For example, Internet of Things services.

- **High volume:** Processes and tasks that are carried out on a regular basis make suitable candidates for RPA implementation.

- **High probability of a human error:** The first preference when choosing processes for RPA deployment should be tasks that are generally carried out by operators and where there is a high risk of a human error (as shown by historical data records).

- **Limited exception handling:** The processes that are most likely to be automated for RPA application are those that do not have many opportunities for some exceptions.

2.2.7 Screen Scrapping

Screen scraping, a subset of data scraping, is the automated collection of data from a screen (whether it be an application, web page, terminal, or document), for use in another system's display or use. Modern apps may often retrieve data from outdated systems that don't have an API or other practical source data access methods using screen scraping.

Any circumstance where it is difficult or impossible to directly access the underlying data can be used by organisations to scrape it off screens. Screen scraping allows data to be extracted from user interfaces (UI) and is compatible with almost every UI, from the DOS terminal, Win32, and FoxPro programmes of the 1990s to the Java and .Net WinForm apps of the early 2000s. Of course, it also works on modern WPF programmes and web browsers.

Screen scraping has developed into a useful technique for updating current manual procedures and allowing novel applications that need data that is not easily available. There are several use cases for it in the banking, travel, retail, and e-commerce sectors.

2.2.8 Workflow Automation

Workflow automation is an advanced form of automation tool since it has been used successfully for a long time. It automates particular operations within a company process or workflow, ranging from order management to HR duties. Processing invoices, customer relationship management (CRM), and enterprise resource planning are a few typical job sequences (ERP).

RPA has a wider reach since it may automate complete workflows from beginning to end, in contrast to workflow automation, which automates certain activities within a business process or workflow.

Tasks inside a business process or workflow are carried out through workflow automation.

RPA (Robotic Process Automation) automates whole operations according to business-set rules.

Keep in mind that RPA is more adaptable than both forms of software automation technologies and that their uses and applications differ. Depending on the requirements of the particular work, user should only select one or the other.

2.2.9 Three Core Technologies in RPA

Workflow automation, screen scraping, and artificial intelligence (AI) comprise the three core technologies that make up robotic process automation (RPA). By combining these three distinct technologies, RPA is able to address a productivity issue with manual desktop jobs that would otherwise have a weak return on investment (ROI).

RPA first gave off the idea that it was merely screen scraping technology. In a way, that's not incorrect; RPA is a progression of screen scraping with greater use of various technologies like screen help, more sophisticated parsing of UI data (e.g., native Windows controls, Web browser DOM model), and a more scalable approach of handling several robots at once.

Before RPA was widely used, workflow automation could be divided into three general categories: entirely manual, semi-automated human-centric, and fully automated straight-through process. The majority of automation initiatives aim to increase the proportion of completely automated straight-through operations compared to totally manual procedures. The API economy was fueled by the need for as many straight-through procedures as possible since every service had to be API accessible and engineered to avoid any human intervention:

The problem is that straight-through processes and human-centric processes demand an investment, and occasionally the expenditure is far higher than the advantages. As a result, we will observe that many first automation efforts are concentrated on business-critical procedures where the ROI would be higher. These groups of key business processes frequently account for just 10% of the activities in the firm, and the bulk of the remainder are what we term "long-tail processes" and human-centric, but they are not big enough to warrant the effort necessary to establish a new API or re-engineering procedures.

This is where RPA makes sense and is useful. Without adequate API integration, it would be difficult and time-consuming to automate a variety of repetitive desktop chores. RPA is adept at doing this. Users may create the solution even more quickly and easily because many RPA systems (including IBM Robotic Process Automation) offer low-code writing tools together with screen capture and advanced vision technologies.

This results in a hybrid strategy employing humans, robots, and API to drive automation, which bridges the gap between human-centric and straight-through processes:

2.2.10 RPA in Cyber Security

Robotic process automation (RPA) is beginning to be used in many different sectors and areas. Cybersecurity is one field in particular where RPA has yielded enormous benefits. Whatever a company performs, it is trusted with a lot of sensitive and confidential information. Healthcare organisations, Fortune 500 finance departments, and financial institutions all have the duty to make sure that fraudsters do not get critical data. Companies can then decide to deploy RPA to assist defend against upcoming threats at that point.

What is Cybersecurity Automation?
Automation in cyber security helps to lower the number of risks and enables quicker prevention of brand-new and undiscovered attacks. Both technology and automation techniques are constantly evolving. Likewise, cybercriminals are honing their methods, particularly with regard to intrusions into financial systems. New automation technologies are referred to as Security Orchestration Automation and Response (SOAR) solutions by industry insiders. RPA, bespoke software, and code that automates processes and conducts analysis make up SOAR products.

In order to counter recognised cyber threats, SOAR solutions perform particular duties in conjunction with other security technologies. A greater range of processes may be automated with RPA technologies. Every analysis may be automated with specially written software and code, which is frequently utilised to address a particular problem inside an organisation.

Data intelligence is gathered, analysed, and either automatic action is taken or an employee is alerted to take additional action through SOAR, RPA, and specially built software.

Benefits of RPA for Cybersecurity

RPA has been used or is being invested in by businesses of all sizes to help safeguard their cybersecurity, reduce risk, and adhere to legal requirements. The organization's cybersecurity personnel may concentrate on more difficult duties by implementing automation. The cybersecurity team may concentrate on resolving the major and technical issues that will result in decreasing organisational risks while the bots can do the mundane and repeated job.

Some examples include:

Engineering and Architecture: With RPA's assistance, the cybersecurity team will be able to concentrate on developing and implementing cybersecurity solutions (like zero-trust) across the company.
Automation Development and Engineering: RPA will be a crucial tool for the cybersecurity team to utilise in initiatives that need their own resources for automation design and execution.

Remediation Activities: RPA will help the technical team by pointing up flaws and offering perceptions into the business, which will reduce vulnerabilities.

Utility-based agents: These agents are comparable to goal-based agents, but they also offer an additional utility measurement that ranks each potential scenario according to the intended outcome and selects the course of action that maximises the result. Rating criteria examples could be the probability of success or the resources required.

Learning agents: Through an added learning component, these agents have the capacity to progressively advance and learn more about a given environment over time. Feedback will be used by the learning component to decide how to adjust performance components for a steady improvement.

RPA The Future of Cybersecurity
Businesses are expanding their use of systems, technologies, programmes, and networks, thus there must be more safeguards in place to secure them. Securing all of that sensitive data is more crucial than ever, especially considering how much information we exchange every day. Here are some ways that RPA will be used in the future to improve cybersecurity protection and aid to lower cybersecurity risks.

1. Minimizing the Number of Potential Cyberattacks
RPA uses stronger data encryption to thwart and lessen cyberattacks. Although it is cautioned that this is not a permanent solution, it is helpful in the meantime. Keep in mind that RPA needs to be checked continually to prevent unauthorised individuals from accessing sensitive information.
Why is RPA so highly regarded by businesses? Eliminating the danger of human variables is the solution. Unintentional mistakes can be a result of human circumstances. Better and quicker production of work results from fewer errors and blunders.

The RPA Center of Excellence (CoE) and a committed staff that oversees planned tasks are two further reasons why RPA is valued. The staff makes sure that viruses and malware are protected. Additionally, they safeguard and reinforce regulations that lower corporate risks.

2. Safeguarding from Unwanted Attacks

Monitoring and protecting against unauthorised assaults may be made easier using RPA. For instance, if a worker accidentally hits a strange link, RPA will intervene to safeguard them if the connection contains a virus. The bots are able to prevent the virus from entering and spreading throughout the whole organization's computer network.

RPA can quickly analyse malware alerts and choose the most pertinent information to help decide when and how to respond to each threat. In the event that a human error occurs, RPA functions similarly to a digital bodyguard.

3. Assisting the Cybersecurity team

RPA aids the cybersecurity team of the company so that the human employees may concentrate on more important responsibilities. While RPA bots handle regular audits and provide daily or weekly reports, human employees may concentrate on high-value tasks. RPA makes it possible to complete repetitive jobs more quickly and accurately than a human worker. Then, human workers may focus on strategic and analytical duties to assist increase production.

4. Eliminating Unauthorized Access

Protection from unanticipated cyber assaults or staff mistakes is crucial. RPA is ideal for limiting unauthorised people' access to and management of private data. These RPA bots can allow access to particular individuals who have the necessary credentials to access private data. To assist stop outside attacks on the company, these bots can increase the encryption layer for more secure data consumption.

5. Securing the Safety of Sensitive Data

Consider RPA as an extremely sophisticated assistant that collaborates with every member of the team. RPA can make sure the business complies with laws like the Payment Card Industry Data Security Standards and the EU's General Data Protection Regulation (GDPR) (PCI DSS). RPA bots can create backup copies of key processes in the event that the company's system breaks or has to be restarted. The bots can easily backup data and swiftly retrieve information from locations off-site.

6. The Speed of Identifying a Cyber Attack

Automation and robots are faster at detecting cyberattacks than people. An oncoming attack can be halted more quickly if it is recognised as such. RPA can assist lessen the effects of a cyber assault by reducing its risks. RPA can help perform forensics and develop new defences to stop future assaults.

2.2.11 RPA in Auditing

There are several advantages that RPA in audit and compliance can offer the auditing process, including:

Faster And More Accurate Data Collection

Data collecting is a major source of auditing hardship. This may take a while and be error-prone, especially if data is dispersed across several platforms. The whole audit may be flawed if the information is incorrect.

RPA has the ability to automate the consolidation of data from numerous sources into a single system for further analysis. This not only saves time but also lowers the possibility of mistakes.

Improved Efficiency
RPA in audit can automate routine, manual processes involved in the audit process, giving auditors more time to concentrate on higher-value duties.

RPA can, among other things, create documents, send emails, update information, and generate standard reports. This not only makes the task of auditors simpler but also lowers the possibility of human error.

Increased Quality
Through the use of a standardised and repeatable procedure, RPA in audits can assist to raise the quality of audits. Auditors may ensure that important processes are completed correctly and that no stages are overlooked by automating them.

Additionally, robotic process automation in audits may offer real-time feedback on the status of an audit, which can aid in spotting possible issues before they become serious.

Higher Customer Satisfaction
Audits can be a pain point for both auditors and those being audited. The audit process involves several regulations and compliance criteria that must be strictly followed. This criterion takes a long time to perform manually. So employing an RPA in audit software to automate the operations is advantageous.

RPA in audit and compliance can aid in streamlining the procedure and making it more effective, improving satisfaction from all parties involved.

Elevated Client Service
In order to perform an audit, auditors frequently need to gather data from clients. This procedure may be automated by RPA in audit by sending emails, scheduling meetings, and issuing reminders. This can assist to enhance customer service and streamline the audit process for all parties.

Faster turnaround times for reports and other deliverables made possible by RPA can also assist to enhance client service.

Fraud Detection
RPA can assist in the detection of fraud by seeing data trends that can point to fraudulent conduct.

Robotic process automation, for instance, may compare data from several systems to check for inconsistencies in audit and compliance. This can assist in identifying cases of fraud so they can be looked into further.

2.2.11 Digital Transformation

RPA can help development teams and business users with changing demands for digital transformation and internal process changes. It's even plausible that RPA will affect all tasks, from data protection to the creation and deployment of low-code applications, spanning practically every imaginable business. RPA also makes it easier for teams to collaborate more effectively, which is crucial for solving operational problems.

RPA will ultimately help save a lot of time. Following the COVID-19 epidemic, it is more crucial than ever for a company or product owner to use big data analytics to identify flaws and create significant process improvements that will benefit both the company and the customer. Ultimately, these improvements fall under the purview of RPA and make the digital transformation process reasonably swift and virtually error-free. As a result, one can train these software robots to imitate employee behaviour and use normal language. The software robot replication version might contain everything from straightforward copy-and-paste activities to more involved procedures like digitising personal information or billing.

Various usage situations have different effects on each sector. RPA and digital transformation are an enticing pair that may provide significant process silo benefits whether they are a member of a team of healthcare practitioners, a corporate recruiter, a product owner, or a chatbot enthusiast.

2.2.12 RPA in Data Entry Process

RPA enhances data input in the following ways:

- Enhances accuracy in the balance sheet through access disparity, task allocation, streamlined workflows, and greater visibility.
- Reduces the probability of fraud through greater transparency.
- Advances data collation capabilities by handling data from different sources through a single format.
- Works with the staff to eliminate human errors and maintain data quality and consistency.
- It saves time and money by diminishing the need for paperwork management. An ISG study states that RPA implementation saves 37 per cent of the money.
- Cleanses, extracts, and processes data effectively.
- Automates a few workflow processes

Exercise

1. Explain RPA in brief.

2. Name the three core technologies in RPA.

3. Name types of Bots.

4. What do you understand by Artificial Intelligence?

5. What is Robot Control System?

6. Name the tools of RPA.

Notes

Scan the QR Code to watch the related videos

https://youtu.be/xd-nY4GslvQ
Robot Control System

https://youtu.be/ad79nYk2keg
Artificial Intelligence

3. Process of Integrating Robot Manipulators with Process Components

Unit 3.1 Setting up Process Components

Unit 3.2 Robotics Manipulators

ELE/N7118

Key Learning Outcomes 💡

By the end of this module, participants will be able to:

- Demonstrate the process of setting up process components.
- Demonstrate the process of integrating robot manipulators.

Unit 3.1 Setting up Process Components

Unit Objectives ◎

By the end of this unit, participants will be able to:

- Explain the User Interface (UI) automation process.

- Explain applicable system activities and variables.

- Explain how to import panel data.

- Describe the application of robotics systems in the automation industry.

- Explain how to create standalone automation projects.

- Explain different types of variables used in UI.

- Explain how to use an argument in automation with an invoke workflow file activity.

- Describe the process of creating arguments and making changes to them in the arguments panel.

- Explain how to rename an argument in a panel.

3.1.1 User Interface (UI) Automation

The technique of interacting with graphical components within programmes by emulating mouse and keyboard commands is known as the user interface, also known as graphical user interface automation (UI Automation).

RPA Developers may set up UiPathRobots in various software to carry out the same operations more quickly and accurately than human users do by clicking, typing, or choosing the text.

All major GUI frameworks, including Win32, WPF, HTML, and Java, are deeply integrated with RPA software, enabling RPA developers to quickly automate any sort of desktop application.

This RPA software provides a single GUI automation API that operates uniformly across all platforms and detects graphical items based on their own platform-specific attributes.

RPA Developers must set up each step in a logical, sequential route since robots will carry out activities in application user interfaces (UIs) similarly as humans would.

3.1.2 Concepts of UI Automation

UI Automation is built upon seven key concepts. These are:

Fig. 3.1.1 Concepts of UI Automation

UI Automation activities

Developers may easily write instructions for the Robot to interact with the interfaces of multiple apps using UI Automation activities. These activities can be divided into the following categories:

- **Containers:** These are the activities that determine which web browsers or mobile applications the procedure will use. A Container contains activities that all run on the same application. Open Browser, Attach Browser, Open Application, and Use Application/Browser are a few examples.

- **Input Activities:** These actions provide input to UI components. Clicking, checking, typing, sending hotkeys, and other actions are all possible with them.

- **Output Activities:** These actions rely on GUI Elements for their information. They can give the Robot instructions to obtain text using a variety of techniques, structured data, or UiElements with graphics.

- **Synchronization Activities:** They assist in the creation of triggers based on UI behaviour, allowing the Robot to carry out certain operations in response to particular machine events.

Activity Property

Depending on the kind of activity, different sets of properties relate to UI Automation activities.

Property	What it does
Delay After/Delay Before	How many milliseconds the Robot waits before or after executing the activity.
Continue On Error	Will an exception encountered while executing the activity be thrown or ignored. For example, if the element is not found, will the Robot throw an error and stop the execution, or will it ignore and continue?)
Target	Provides several properties related to identifying the target UI Element.
Timeout (milliseconds)	How many milliseconds will the Robot try to perform an action on an UI element?
Send Windows Messages/Simulate Type	What input method do we use for input activities.
Output	It Stores the output of the activity in the form of variables.

Table 3.1.1 Activity Property of UI Automation

Targeting methods

Properties is divided into targeting techniques. They offer several means of locating the UI component that the Robot will be interacting with.

The key targeting methods are:
- Selectors
- Fuzzy Selectors
- Image
- Native Text

Input and Output Methods

Input actions are carried out each time we give a command to a system to make a change (or to keep going), as already described, or whenever users insert data into an application. Data is extracted from a UI element via output actions, which often take the form of text. The ability of output actions to extract data from UI components is made possible by output methods.

Recorders and Scraping Wizards

When automating the business operations, the recording feature can help save a massive amount of time. With the help of this technology, users can quickly record the on-screen activities and turn them into sequences. These projects can be readily replayed and reused in as many additional processes as users require by changing and parameterizing them.

With the use of scraping wizards, structured data may be extracted from the browser, application, or document and stored in a database, Excel spreadsheet or a .csv file.

The object repository
The management, reuse, and dependability of UI components are ensured by the object repository by storing them as objects in a repository that can be shared between projects. It enables the development and sharing of UI taxonomies inside and across automation projects. We will learn more about this more sophisticated feature later.

AI Computer Vision
Refactored basic UI Automation activities like Click, Type Into, and Get Text are included in the AI Computer Vision activity package. The utilisation of the internal Computer Vision neural network created by our Machine Learning team distinguishes the CV activities from their rivals. Without using selectors, the neural network can recognise UI components like buttons, text input fields, and check boxes. We will learn more about this sophisticated feature later.

3.1.3 Workflow Files

The four diagrams for creating a workflow file that incorporates activities into a working structure are:
- Flowchart
- Sequence
- State Machine
    - Global Exception Handler

Sequence
Sequences are best used in straightforward settings where actions naturally follow one another since they have a straightforward linear representation that runs from top to bottom. They are helpful in UI automation, for instance, when navigation and typing are done one click or keystroke at a time. Sequences are the most common form for processes since they are simple to put together and comprehend.

Flowchart
Flowcharts prefer to lay out a workflow in a simple two-dimensional manner and allow more freedom for connecting operations. Flowcharts work well for displaying decision points in a process due to their flexibility and aesthetic appeal. Large processes are susceptible to uncontrolled activity intertwining because arrows that can point anywhere closely resemble the unstructured GoTo programming statement.

State Machine
A state machine is a complicated structure that resembles a flowchart with transitions, or conditional arrows. We discovered that it is appropriate for a typical high-level process diagram of transactional business process templates because it allows for a more condensed depiction of logic.

Global Exception Handler
The Exception Handler is intended to be used in both small and big automation projects, and is particularly useful for locating execution failures and, more crucially, figuring out what will happen to the process when one happens. The Global Exception Handler may be configured to intervene in the event of an execution fault while debugging and allow one to examine the workflow's behaviour in light of the settings previously made in the Exception Handler.

Choices
Workflow decisions must be made in order for the Robot to respond differently to various data processing and application interaction scenarios. The visual organisation and readability of a process are significantly impacted by choosing the most effective depiction of a condition and its following branches.

If Activity

The If activity divide a sequence vertically and is perfect for short balanced linear branches. The difficulty arises when more criteria must be linked in an If… Otherwise, especially when the breadth or height of the branches exceeds the size of the screen that is available. Nested If statements should generally be avoided in order to maintain a straightforward, linear process.

Fig. 3.1.2 If Activity

Flow Decision

Flowchart layouts are good for showcasing important business logic and related conditions like nested **If** statements or **If… Else If** constructs. There are situations where a Flowchart may look good even inside a Sequence.

Fig. 3.1.3 Flow Decision

IIf Operator

The VB If operator may sometimes simplify an entire block to a single operation and is especially helpful for small-scale local conditions or data processing.

Fig. 3.1.4 If Operator

Switch Activity

In order to simplify and condense an If, the Switch activity may occasionally be utilised in convergence with the If operator. If not, a cascade of separate criteria and actions is performed for each branch.

Fig. 3.1.5 Switch Activity

IIFlow Switch
The procedural Switch activity in flowcharts is analogous to the Flow Switch activity in that both choose the next node based on the value of an expression. By establishing additional connections from the same switch node, it can match more than 12 situations.

Fig. 3.1.6 Flow Switch

Data
When it comes to visibility and life cycle, data comes in two varieties: arguments and variables. Variables are connected to a container inside a single workflow file and may only be utilised locally, unlike arguments, which are used to transport data from one process to another.

Variable Scope
Variables are exclusively visible inside the container where they are specified, or scope, as opposed to arguments, which are accessible elsewhere in a workflow file.
In order to keep the Variables panel from becoming cluttered and to limit what appears in autocomplete at each stage of the process, variables should be maintained in the innermost scope.

Arguments
It is important to remember that only serializable types may be used as parameters to pass data across processes when launching workflows with the Isolated option, which launches the workflow in a separate system process. For instance, it is unsafe for objects like SecureString, Browser, and Terminal Connection to pass across processes.

Default Values
It is possible to initialise variables and input arguments with predefined static default values. This is highly helpful when testing processes separately since it avoids the need for actual input data from calling workflows or other external sources.

Fig. 3.1.7 Default Values

Naming Conventions

Workflow files, actions, arguments, and variables should be given meaningful names in order to appropriately reflect their usage throughout the project.

Project descriptions should be informative because they are presented in the Orchestrator user interface and may be useful in situations with many users.

Variable and argument names should also follow a naming standard to increase readability:
- Snake case: First1_Name2, first_name2,
  - Upper or lower Camel case: FirstName, lastName,
  - Pascal case: First1Name2, First1Name,
  - Kebab case: First-Name, First-Name1.

Argument prefixes, such as in DefaultTimeout, in FileName, out TextResult, and io RetryNumber, should be present before the argument name.

Activities should have labels that succinctly describe the activity done, such Click the Save Button. Continually use the action-descriptive portion of the title (Click, Type Into, Element Exists, etc.).

All workflow titles, with the exception of Main, should include a verb that expresses what the process performs, such as GetTransactionData, ProcessTransaction, or TakeScreenshot.

Comments and Annotation

To go into further depth about a method or the specifics of a particular interaction or application behaviour, utilise the Comment activity and Annotations. Remember that other people could come across a robotic project at some time, and one might strive to make the process easier for them to grasp.

Fig. 3.1.8 Comments and Annotation

3.1.4 Managing Variables

Various kinds of data are stored in variables. The ability of variables to change value allows user to, for example, manage how frequently the body of a loop is run.

Users may add new variables and edit existing ones using the Variables panel. When a variable is renamed in this panel, it affects every instance of it in the current file.

Fig. 3.1.9 Variable Panel

3.1.5 Managing Arguments
Arguments are used to transfer data from one project to another. They resemble variables in the broadest sense since they dynamically store and transmit data. While arguments transfer data between automation, variables pass data between activities. They thereby make it possible for users to repeatedly reuse particular projects.

Creating Arguments
Argument names should be in upper CamelCase with a prefix stating the argument direction, such as in_DefaultTimeout, in_FileName, out_TextResult, io_RetryNumber.

Removing Arguments
To remove an argument, in the Arguments panel, either right-click the argument and select Delete, or select the argument and press the Delete key.

Fig. 3.1.10 Removing Arguments

Choose Remove Unused > Arguments from the Studio ribbon to get rid of all the arguments that aren't being used anywhere in the current file.

Arguments Panel
The Arguments panel allows users to create and modify arguments. In this panel, renaming one parameter affects all instances of that argument across the current file.

The attributes that can be used as arguments are listed in the following table:

Property	Description
Name	Mandatory. The name of user's argument. If user do not add a name to an argument, one is automatically generated.
Direction	Mandatory. Select a direction for user argument. The following options are available: In: the argument can only be used within the given project. Out: the argument can be used to pass data outside of a given project. In/Out: the arguments can be used both within and outside of a given project. Property: not currently used.
Argument Type	Mandatory. Choose the value type user want their argument to store. The following options are available: • Boolean • Int32 • String • Object • System.Data.DataTable • Array of [T] • Browse for Types If one select a .Net type from the Browse and Select a .Net Type window, it is added to the Argument Type drop-down list.
Default Value	Optional. the argument's default value. The variable has no default value if this field is left empty. Please be aware that regardless of the RPA software interface language, default values for parameters must be specified in English.
IsRequired	If selected, marks the argument as mandatory. Note: This property is available in the Properties panel.

Table 3.1.2 Arguments

3.1.6 Import Panel

Imported Namespaces
RPA software uses VB.NET namespaces as containers for storing various kinds of data. They make it simple for users to specify the scope of their expressions, variables, and arguments.

For instance, if the System.Data namespace has been imported, users may utilise the classes accessible there, such as DataTable, DataView, DataColumn, and DataRow, without having to type System every time. Data.DataTable, etc.

The Imports panel shows all imported namespaces. Keep in mind that when user browse for a variable or argument of the.Net type, some namespaces are automatically imported.
To open this panel, click Imports in the Designer panel.

Fig. 3.1.11 Import Panel

Managing Namespaces

From the Imports Panel

1. Open the **Imports** panel.
2. In the **Enter or Select namespace** field, start typing the namespace that interests the user. Note that suggestions are provided while they type, in case user are not exactly sure what they are looking for.

Fig. 3.1.12 Importing Namespaces

1. **(Optional)** Click the drop-down arrow to view and browse all available namespaces.
   2.Select the desired namespace. The namespace is added to the **Imported Namespaces** list.

3.1.7 Standalone Automation

A smart system that doesn't employ a personal computer as its controller is known as a standalone automation system. However, some of its components' characteristics may be programmed into a personal computer. These days, independent home automation systems may match the functions and features of a PC-based system. To get started on the path to having a smart home, MediaComs may assist the user with designing a stand-alone system.

Characteristics of a Standalone Automation System

1. Features: Standalone systems have practically all the functions that PC-based systems have. A PC-based system only outperforms other systems in terms of telephone and internet access. To alert users if there is a problem with the robots, like as a potential water leak or unwanted access, some independent systems may send SMS messages. However, keep in mind that the software for these system's components is often built-in when they are made, so there may be complications if user wish to upgrade the components.

2. Costs: Inherently, standalone systems are less expensive than PC-based ones. Sometimes, all the components of a RPA system may be controlled by a single controller device. Users should give installing using one of the beginner kits that are available seriously if they are just getting started with standalone automation. By doing this, users may keep the cost of the initial investment low and later improve the system by adding more components.

3. Power Consumption: Here, a standalone system outperforms every other type of automation system. They use modern components and compact modules, which take so little power that they barely increase the electricity cost. Some modules can run effectively on as low as 1 watt. The controller devices frequently use just 5–6 watts of power.

4. Noise: The ventilation system does not require fans, therefore it operates quietly. The only sound users might hear is the clicking of a relay switch in operation. Due to their natural size, the components for this system also don't take up much space.

5. Reliability: In this respect, standalone automation systems excel above PC-based ones. The dependability problems associated with PC-based systems are often avoided by this technology. While power outages can have an impact on solitary system components, the majority resume operation almost soon when the power is restored. Since UPS devices use relatively little power, they may even be used to power crucial components, including those involved in security.

3.1.8 Robotics Application

Robotics is the branch of engineering that deals with the ideation, creation, control, and construction of robots. Robotics integrates software, hardware, and electronics.

Robots are used for dirty, dull, and risky jobs. Today, robots have a wide range of applications. Among them are:

Outer Space Applications: For the purpose of space exploration, robots are essential. The key to studying the stars, planets, and other celestial bodies is the robotic, unmanned spaceship.

3.1.13 Mars Rovers

The NASA Mars rovers are the most well-known robots employed in space applications. The Pathfinder Mission touched down on Mars in 1997. In the first week of July, its robotic rover Sojourner slid down a ramp and landed on Mars. Up until September, it was ransmitting data from the Martian surface.

As a component of the Mars Pathfinder project, Sojourner operated remotely on the surface of Mars and had an obstacle avoidance system. Sojourner was capable of devising and following pathways for exploring the planet's surface. Sojourner's capacity to manoeuvre while having limited information about its surrounds and immediate area enables the robot to respond to unforeseen occurrences and things.

After Sojourner's mission, between June 10 and July 23, 2003, NASA dispatched the identical Spirit and Opportunity robots to Mars. On January 4 and January 25, 2004, respectively, Spirit and Opportunity touched down on Mars.
The solar-powered robots Spirit and Opportunity have six wheels with built-in motors. Both Mars Rovers measure 1,5 m in height, 2,3 m in width, and 1,6 m in length. They each weigh 180 kg.

3.1.14 Sojourner

Numerous scientific tools are used by Spirit and Opportunity to carry out their missions on Mars. They have a robot arm with a Mössbauer spectrometer to study the mineralogy of the rocks and soils of Mars, an Alpha particle X-ray spectrometer to analyse the elements contained in the rocks and soils, and a rock abrasion tool to reveal the composition of the rocks.

The twin Mars Rovers are equipped with a panoramic camera for examining the local terrain's texture, colour, mineralogy, and structure, as well as a small thermal emission spectrometer for identifying prospective rocks and soils and figuring out how they were formed. On both Mars rovers, there is a navigation camera that captures views with a larger field of view but poorer resolution for driving and navigation.

3.1.15 Twin Mars Rover

The Phoenix Mars Rover arrived on the Red Planet on May 25, 2008, after being launched there on August 4, 2007. The Phoenix's purpose was to discover whether there was water and whether there was a suitable environment for life on Mars..

Military Applications: Robotics is a key component that is being studied and improved daily in the contemporary army. Unmanned aerial vehicles like the Predator drone, which are able to take surveillance photos and even successfully deliver missiles at ground targets without a pilot, have already achieved incredible success.

Intelligent Home Applications: Intelligent robotic home systems allow us to keep an eye on things like energy use, environmental conditions, and home security. Appliances like lighting and air conditioning can be pre-programmed to turn on, and doors and windows can open automatically. This supports users regardless of their level of movement.

Industry: Robotics and automation became the most significant aspect of production from the start of the industrial revolution. Fabrics are handled by robotic arms that are capable of welding, cutting, lifting, sorting, and bending.
The industrial robots' most common configurations are as follows:

3.1.16 Industry Robotics

Articulated Robots: A robot that employs rotational joints to reach its workspace is said to be articulated. Simple two-jointed robots to complex systems with ten or more interacting joints are all examples of articulated robots. The most adaptable industrial robot that offers a great degree of flexibility is the six-axis articulated robot.

Cylindirical Coordinate Robots: With a cylindrical work environment and three degrees of freedom, these robots can only move linearly along the Y and Z axes.

Scara Robots: It stands for Selective Compliant Assembly Robot Arm or Selective Compliant Articulated Robot Arm. SCARA robots usually have four axes as any X-Y-Z coordinate within their work envelope and a fourth axis of motion which is the wrist rotate (Theta-Z).

3.1.17 Scara Robots

Spherical Coordinate Robots: The sperical arm, also known as polar coordinate robot arm, has one sliding motion and two rotational, around the vertical post and around a shoulder joint.

Cartesian Coordinate Robots: Rectangular arms are sometimes called "Cartesian" because the arm´s axes can be described by using the X, Y, and Z coordinate system. It is claimed that the cartesian design will produce the most accurate movements.

Delta Robots: Three arms are attached to universal joints at the base of a delta robot's body. The essential design aspect is the usage of parallelograms in the arms, which preserves the alignment of the end effector. In industries, the Delta robot is frequently used for selecting and packing.

3.1.18 Delta Robots

Health Service: A robotic suit that will allow nurses to lift patients without hurting their backs is currently being developed. Japanese researchers have created a power-assisted outfit that will provide nurses with the extra strength they need to lift patients and prevent back problems.

Notes 📝

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Scan the QR Code to watch the related videos

https://youtu.be/YumuVPxp-cw
User Interface (UI) Automation

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Standalone Automation

https://youtu.be/pIcxOGo7ieU
Robotics Application

Unit 3.2 Robotics Manipulators

Unit Objectives ⊚

By the end of this unit, participants will be able to:

- Explain the working of forwarding and inverse kinematics.
- Explain the function of manipulators.
- Explain how to control flexible joint robotic systems, feedback, force control, and stability, and drive train dynamics.
- Explain multi-finger grasping, walking mechanisms, and motion planning.
- Describe the process of geometrical modelling and map building.
- Describe the process of object manipulation and grasping.
- Explain the joint torque and recursive Newton-Euler formulation.
- Explain the gravity torque and inertia with robot configuration multi-finger grasping, walking mechanisms, and motion planning in robotics.
- Explain how to integrate all the data collected by robots for map building.

3.2.1 Robotics Manipulators

The position of things in three-dimensional space is a continual topic in the study of robotics. These items include the manipulator's linkages, the tools and parts it uses, and other items found in the manipulator's surroundings. These objects may be crudely yet effectively characterised by just two characteristics: location and orientation. Naturally, one area of obvious interest is how we express and work with these quantities numerically. We always rigorously connect a coordinate system, or frame, to an item in order to characterise its location and orientation in space. The position and orientation of this frame with respect to a reference coordinate system are then described.

It is frequently considered to shift or switch the description of these characteristics of a body from one frame to another since any frame might serve as a reference system within which to represent the position and orientation of a body.

3.1.18 Delta Robots

Links and joints are assembled to form manipulators. The rigid parts of the mechanism are referred to as links, and joints are the joining points between two links. The end-effector is the component linked to the manipulator that interacts with its surroundings to carry out tasks.

Functioning

A manipulator in robotics is a tool used to move materials without the user making any direct physical touch. Originally, the applications were employed inaccessibly or to handle radioactive or biohazardous objects using robotic arms. In more recent advances, they have been employed in a variety of applications, including robotic surgery, welding automation, and space travel. It is an arm-like device made up of many sliding or jointed segments known as cross-slides that can grip and move items with a variety of degrees of freedom.

Types of Joints

Name of Joint	Representation	Description
Revolute		Allows rotation with relation to one axis.
Cylindrical		Allows rotation and translation about a single axis.
Prismatic		Allows angular translation in relation to one axis.
Spherical		Allows for three degrees of rotational flexibility about the joint's centre. Additionally called a ball-and-socket joint.
Planar		Allows relative rotation around a plane's axis and relative translation on that plane's axis.

Table 3.2.1 Types of Joints in Robotics

Classification of Manipulators

Manipulators can be classified according to the following criteria:

A. By Motion Characteristics
- **Planar manipulator:** If all the moving connections move in planes that are parallel to one another, the manipulator is referred to as a planar manipulator.
- **Spherical manipulator:** A manipulator is referred to as a spherical manipulator if all of its linkages rotate in circles around a single fixed point.
- **Spatial manipulator:** If at least one of the mechanism's links demonstrates a general spatial motion, the manipulator is referred to as a spatial manipulator.

B. By Kinematic Structure
- **Open-loop manipulator (or serial robot):** A manipulator is referred to be an open-loop manipulator if a chain of open-loop connections connects its links.
- **Parallel manipulator:** If a manipulator consists of a closed-loop chain, it is referred to as a parallel manipulator.
- **Hybrid manipulator:** If a manipulator has both open loop and closed loop chains, it is referred to as a hybrid manipulator.

3.2.2 Forward kinematics of manipulators
The study of motion without taking into account the forces causing it is known as kinematics. Position, velocity, acceleration, and any higher order derivatives of the position variables (with respect to time or any other variable(s)) are all studied in the field of kinematics. As a result, the study of the kinematics of manipulators encompasses all the motion's geometrical and temporal characteristics.

Fig. 3.2.2 Coordinate systems attached to the manipulator

Manipulators are made up of virtually rigid links that are joined together by joints that permit the relative mobility of adjacent links. These joints are typically equipped with position sensors, allowing for the measurement of the relative position of adjacent links. These displacements are known as joint angles when they pertain to rotary or revolute joints. Some manipulators have sliding (or prismatic) joints, where the translation between links' relative displacements is frequently referred to as the joint offset.

The number of independent position variables that must be given in order to find every component of the mechanism is the number of degrees of freedom that a manipulator possesses. Any mechanism can be referred to by this generic word. A four-bar connector, for instance, has just one degree of freedom (even though there are three moving members). The number of joints and degrees of freedom are equal in typical industrial robots since a manipulator is often an open kinematic chain and each joint position is typically determined by a single variable. The end effector is the free end of the chain of links that makes up the manipulator.

The end-effector may be a gripper, a welding torch, an electromagnet, or another device, depending on the robot's intended use. In general, we characterise the position of the manipulator by describing the relationship between the base frame, which is coupled to the manipulator's stationary base, and the tool frame, which is attached to the end-effector. Forward kinematics is a very fundamental issue in the study of mechanical manipulation. Computing the location and orientation of the manipulator's end-effector is a static geometrical issue. The forward kinematic issue is to determine the location and orientation of the tool frame with respect to the base frame given a set of joint angles.

Fig. 3.2.3 Kinematic equations describe the tool frame relative to the base frame as a function of the joint variables

3.2.3 Inverse kinematics of manipulators

The goal of an inverse kinematics task is to identify all potential configurations of angular or linear joint displacements (configuration coordinates) that let the manipulator's end-effector (gripper or tool) to adopt a certain position and/or orientation. When certain configuration coordinates must be determined to have the end-effector conduct a specified motion, this is a basic difficulty in the programming and control of manipulator motion.

For instance, the beginning and final positions of the end-effector are provided as the time required to travel between those two points in the simplest positioning operation, "take and put." Finding the values of the configuration coordinates that correspond to these points is required for the inverse kinematics solution.

It is feasible to locate the inverse kinematics solution in a closed form for specific types of manipulators with five and six degrees of freedom. Pieper has demonstrated that the fact that the axes of the three succeeding joints cross in a single location is a necessary and sufficient condition for the existence of a solution in a closed form.

The issue can be resolved using a matrix, a vector, or a numerical approach.
The analytical approach and the numerical method are the two methods that are often employed to address inverse kinematics issues in general (iterative optimization). Algebraic and geometric techniques are used in analytical processes. However, for more complicated kinematics issues, this method becomes challenging and time-consuming. The iterative technique approach might offer a superior result in terms of numbers.

Inverse kinematics issues may be solved numerically using a variety of techniques, the most prominent of which being Jacobian invers and Cyclic Coordinate Descent (CCD). The CCD heuristic approach is quick to compute but prone to redundancy and singularity. It does not manipulate matrices. CCD can only use serial kinematics.

The inverse Jacobian provides a solution by linearly simulating the ultimate effector motion in relation to the instantaneous change in joint angles. The Jacobian Transpose, Pseudo Inverse, Damped Least Squares (DLS), Damped Least Squares with Singular Value Decomposition (SVD-DLS), and Selectively Damped Least Squares are some of the methods that have been developed to calculate the inverse Jacobian (SDLS).

3.2.4 Statics Manipulator

Generally, there is a separate drive for each of the manipulator joints. The manipulator linkages transfer drive forces and torques acting in joints to the end-effector (gripper), where the environment also applies a force and torque. The foundation of a control system is the connection between input (drive) and output (acting on the end-effector) forces and torques.

1he vector quantities of forces and torques are described in a particular coordinate system. The letters F and M stand for force and torque vectors, respectively. The origin of the coordinate system is supposed to be where force vectors are coupled.

If there is a torque and a force applied at the origin of a certain coordinate system attached to a link, it is possible to find an equivalent force and torque described in a different coordinate system, attached to this link as well. To solve this kind of problem we use the principle of virtual work. We consider the force and torque applied to a link that cause a differential, so-called virtual displacement, and performing virtual work. Since the displacement is infinitesimal and does not change the total energy of the mechanical system, the sum of the virtual work of all the forces acting on the link is equal to zero.

The virtual work, done by force *F,* is defined as

$$\delta W = F^T D \qquad \text{........................(5.1)}$$

Where,

$$F^T = [F_x \ F_y \ F_z \ M_x \ M_y \ M_z]$$
$$D = [d_x \ d_y \ d_z \ \delta_x \ \delta_y \ \delta_z]^T \qquad \text{............(5.1a)}$$

and *D* is a differential displacement vector, consisting of a translation vector *d* and a rotation vector *8.* The same displacement *D1* of the *i* link may result from load *Fj,* that is a torque and a force exerted at a different point of this link and described in the *j* link system, performing the same virtual work

$$F_i^T D_i = F_j^T D_j \qquad \text{......................(5.2)}$$

As the virtual displacement *D1* in *j* system is equivalent to the virtual displacement *D;* in *i* system, we have

$$D_j = J D_i \qquad \text{.........................(5.3)}$$

where *J* is the Jacobian describing the transformation of an infinitesimal displacement in the *i* system into *the}* system. Substituting (5.3) in (5.2) and ordering, we obtain:

$$F_i = J^T F_j \quad \text{or} \quad F_i^T = F_j^T J \qquad \text{..............(5.4)}$$

If the relative orientation and position of the *i* and *j* systems is described by means of a matrix:

$$T_{i,j} = \begin{bmatrix} l & m & n & p \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad \text{.......................(5.5)}$$

then, considering (5.1a), the relationship (5.4) can be converted into

$$M_{j,x} = l \cdot [(F_i \times p) + M_i]$$
$$M_{j,y} = m \cdot [(F_i \times p) + M_i]$$
$$M_{j,z} = n \cdot [(F_i \times p) + M_i] \qquad \text{.........................(5.5a)}$$
$$F_{j,x} = l \cdot F_i$$
$$F_{j,y} = m \cdot F_i$$
$$F_{j,z} = n \cdot F_i$$

3.2.5 Geometrical Modeling

The study of techniques and algorithms for the mathematical representation of forms falls under the umbrella of geometric modelling, an area of applied mathematics and computational geometry.

Although many of its techniques and ideas may be applied to sets of any finite dimension, the forms explored in geometric modelling are typically two- or three-dimensional. Today, computer-based programmes are used to perform the majority of geometric modelling. In technical drawing and computerised typesetting, two-dimensional models are crucial. In many applicable technical domains, including civil and mechanical engineering, architecture, geology, and medical image processing, three-dimensional models are essential to computer-aided design and manufacture (CAD/CAM).

Procedural and object-oriented models, which describe the form implicitly by an opaque method that creates its appearance, are often distinguished from geometric models. They are also compared with fractal models, which provide an eternally recursive definition of the shape, and volumetric models, which depict the shape as a subset of a fine regular division of space. These differences, however, are sometimes muddled. For instance, a digital picture could be seen as a collection of coloured squares, while geometric forms like circles are typically determined by implicit mathematical equations. Additionally, when a fractal model's recursive specification is cut off at a finite depth, a parametric or implicit model is produced.

3.2.6 Map Building

Since the environment is unknown at the beginning, the robot must be able to build a map as it explores the environment to avoid visiting the same place more than once. Thus the search for emergency exit is more efficient, and we can ensure that the robot explores the whole environment, if necessary, until finding the exit. The mapping is comprised of two modules: "Kinect to Laser" and "SLAM"

The "Kinect to Laser" module takes a horizontal region ([−020 080] of height) of the depth image from a RGBD camera and transforms these data into format of a laser. It determines the shortest depth for each angle of that horizontal region. Due to the limitations of RGBD camera, this virtual laser only covers about 60◦ and only sees obstacles between [06 60] (see Figure 6.17). This is a major limitation because the robot cannot see nearby obstacles (60), so it may collide with objects that come suddenly into this blind region. The method can be summarized by the following four steps:

1. Sampling: The next generation of particles is obtained from the past generation by sampling from a proposal probability distribution.

2. Importance Weighting: An individual importance weight is assigned to each particle according to the importance sampling principle.

3. Resampling: According to their importance weight, replacement is applied to the drawing of the particles. All of the particles have the same weight upon resampling.

4. Map Estimation: Based on the trajectory of the sample and the history of observations, the associated map estimate for each particle is calculated.

3.2.7 Walking Mechanism

A mechanical system known as a leg mechanism, also known as a walking mechanism, is created to deliver a propulsive force by sporadic frictional contact with the ground. Wheels or continuous tracks, on the other hand, are designed to keep constant frictional contact with the ground. Mechanical legs are links that may conduct basic planar motion or sophisticated motion and can include one or more actuators. A leg system, which can step over obstacles, would be better suited to uneven terrain than a wheel.

At the Exposition Universelle, Pafnuty Chebyshev displayed an early prototype of a leg mechanism known as the Plantigrade Machine (1878). This leg mechanism's original engravings are available.

The 1988 book Machines that Walk describes the design of the leg mechanism for the Ohio State Adaptive Suspension Vehicle (ASV).   W-B. Shieh provided a design approach for leg mechanics in 1996. Theo Jansen's artwork, see Jansen's linkage, as well as the Klann patent, which served as the inspiration for the Mondo Spider's leg mechanism, have both been major design influences.

3.2.8 Motion Planning

In robotics, the act of breaking down a desired movement job into discrete movements that fulfil movement limitations and maybe maximise some component of the movement is known as motion planning.

For example, consider a mobile robot navigating inside a building to a distant waypoint. It must complete this assignment without running into walls or tumbling downstairs. An algorithm for motion planning would use a description of these activities as input to generate the turning and speed orders for the robot's wheels. Motion planning algorithms may take into account robots with more joints (such as industrial manipulators), more difficult jobs (such as item manipulation), various limitations (such as a car that can only go forward), and uncertainty (e.g. imperfect models of the environment or robot).

Another example would be controlling one or more unmanned aircraft or drones in a crowded space, either indoors or outdoors. In a 3D space with environmental disturbances like wind and severe weather, the same motion planning algorithms can still be used.

Motion planning has several uses in robotics, including autonomy, automation, and robot design in CAD software. It also has uses in other industries, including video games, robotic surgery, robotic architecture, and the study of biological molecules.

3.1.9 Object Manipulation

Manipulation of things independently and in unstructured contexts is one of the fundamental abilities required for robots to assist people in their daily lives outside of industrial cages. The study of autonomous manipulation in robotics attempts to impart human-like perceptual skills to robots such that, when paired with cutting-edge control techniques, they can perform similarly in handling things.

Autonomous manipulation is one of the open challenges in robotics that has generated significant interest in the community in recent years due to its extreme complexity. Traditional techniques try to recreate the world using 3D vision and calculate grasping positions that meet force closure restrictions, or by accessing a database of precomputed or learned poses. Recently, grasping has been addressed utilising end-to-end learning approaches that have demonstrated excellent performance.

3.1.10 Grasping

Grasping addresses the issue of holding down an object using a robotic hand or gripper. Choosing the location and pressures to apply to the item to be grabbed to assure specific features, such as the capacity to withstand external disturbances, is one of the biggest challenges in grasping.

Multi Fingered Grasp
Given a friction model, the type of constraint that the multi-fingered grip will achieve may be explicitly stated using a representation. When there are nc contact points between the fingers and the body, just specifying their coordinates $c_1, \ldots, c_{nc}$ is insufficient since the forces exchanged through the contacts must also be considered, as well as how the fingers can be manipulated to apply these forces. This data is represented by two matrices: the hand Jacobian J and the grip map G. The hand Jacobian J is the most well-known Jacobian matrix in robot kinematics. Let qh represent the hand's h degrees of freedom. The location of the fingertips may then be established using forward kinematics. The function FK: $R^{h} \dashrightarrow R^{6nc}$ then maps the h degrees of freedom qh into the frames connected to the fingertips[4].

Fig. 3.1.4 Multi-fingered grasp with frictional contact points.

Note that we assumed there are nc fingers to use the same symbol utilized for the number of contact points. The hand Jacobian J can be mapped from joint velocities q into frame velocities using the relationship J_q. While J is utilised to illustrate velocity connections, the grab matrix G determines how forces applied at contact sites are translated into wrenches. G is described using a friction model that incorporates the object's forces and moments.

3.1.11 Flexible Joint Control

Flexible joint robots (FJR) control is the robot joints' flexibility due to flexible mechanisms, including harmonic drives, belt-pully transmission, and series elastic actuators. The control of FJR is becoming one of the most crucial subjects because of the diversity of robotic fields.

The primary goal of this study is to provide a reliable controller that can decouple disturbances in FJR. There are usual robust control methods such as H_∞ ccontrol, disturbance observer (DOB), adaptive control and sliding mode control (SMC). Among these, sliding mode control virtually totally decouples disturbances using the sliding mode. Therefore, using SMC to regulate FJRs with disturbances is preferred. FJR does not meet the matching criterion, which is necessary for the application of SMC.

Backstepping control method combined with SMC is utilised to get over this problem. Link side and motor side are thought of as separate models for the FJR. The motor side angle position is regarded as a virtual controller for the link side system in the FJR backstepping control, and actual control input in the motor side is intended to accomplish the required motor side angle position. Some findings that have already been published employ backstepping control for FJR, but they do not take SMC and backstepping into account.

The control performance of the FJR must be taken into account in addition to robustness. In the realm of robotics, having an acceptable impedance is one of the often considered control performances.

This combined control performance and resilience is made achievable by integral sliding mode control. An integrated sliding surface may incorporate the dynamic characteristics of the intended impedance. Selecting the starting virtual state in the integral sliding surface naturally eliminates the reaching phase problem. The overall impedance of the FJR is decided upon as being the link side impedance, and the motor side impedance is determined to be sufficiently high.

3.1.12 Moment Arm

Identifying the moment arm is the first step in comprehending and estimating torque. The distance from an axis to the line of action of a force is known as the moment arm (or lever arm) of a force system. In other words, the quality of the torque is determined by the moment arm. The moment arm changing with the force's application angle is a crucial idea to keep in mind (angle of insertion).

Fig. 3.1.5 Moment Arm in a Force System

3.1.13 Torque

The ability of a force to generate rotation on a lever is known as torque (moment of force). A force delivered over a distance (lever arm) that induces rotation around a fulcrum is the more precise definition of torque (axis of rotation).

Torque is Dependent on 3 Variables:

1. Amount of force
2. Angle of application of force
3. Length of the moment arm

Drawing a thorough free-body diagram of the force system that includes each force component is a prerequisite for doing the calculation of force. The following calculations can then be used to determine torque:

- Torque =Lever Arm x Fy (or Force sin(   ))
- Torque = Force (Fm) x Moment Arm

Fig. 3.1.6 Force System

Movement in a biomechanical system is produced by torque. It is what causes the lever system to move (bones). It is crucial to comprehend this. A muscle may be strengthened to its fullest potential by being able to produce as much torque as possible. A muscle's ability to generate torque determines how much movement it can generate on the body's levers. To enhance the effectiveness of the muscles in moving the body part, one can alter the torque variables if their treatment objective is to increase movement.

This is best illustrated by the barbell biceps curl exercise. When the elbows are completely extended compared to when they are at 90°, it is considerably more difficult to move the bar. This is due to the connection between angle and torque. The highest torque in this relationship always occurs when the force is applied at a 90° angle to its lever.

The opposite objective can likewise be achieved using this idea. One may vary the force vector components and boost the compressive force by modifying the angle of application and moment arm. When trying to optimise stability, the objective is frequently to increase the compressive force. This kind of force vector is seen in the rotator cuff when the muscles work in concert to produce a compressive force couple that stabilises the humeral head in the glenoid fossa.

It is crucial to understand that the joint ROM and the amount of torque a muscle can produce are not necessarily correlated when trying to modify torque. Joint range of motion has no bearing on the insertion angle. Numerous muscles cross joints and have a wide variety of insertions. The line of pull in reference to the lever arms and joint axis must be assessed in order to identify the force vectors (torque and compression) of a muscle.

The influence of the patella on quadriceps torque is a typical illustration of the relationship between moment arm and application angle and torque. As you can see in the image below, the patella bone raises the angle at which the quadriceps tendon and, consequently, the moment arm are applied, increasing the torque that the quadriceps can produce. Most of the quadriceps effort would produce a compression/joint stability moment without the patella.

Fig 3.1.7 Torque of Quadriceps

Joint Torque

A joint torque is the total of passive and active torques. Tension that forms as muscle tissue, tendons, and ligaments are stretched causes passive torques to occur. Exponential equations have previously been used to represent passive torque-angle interactions.

Gravity Torque

The gravitational torque or moment is the result of the force and the perpendicular distance from the centre of gravity for an open object or from the pivot for a closed item to the pivot. In the same way that a force causes a translation, a torque, which is also a vector variable, causes a rotation.

Recursive Newton-Euler Formulation

In classical mechanics, the Newton–Euler equations describe the combined translational and rotational dynamics of a rigid body. Traditionally the Newton–Euler equations is the grouping together of Euler's two laws of motion for a rigid body into a single equation with 6 components, using column vectors and matrices.

$$\mathbf{v}_i = \mathbf{v}_{i-1} + \mathbf{S}_i \dot{q}_i \qquad \cdots \cdots \text{ (a)}$$

$$\mathbf{a}_i = \mathbf{a}_{i-1} + \mathbf{S}_i \ddot{q}_i + \dot{\mathbf{S}}_i \dot{q}_i \qquad \cdots \cdots \text{ (b)}$$

$$\mathbf{f}_i^B = \mathbf{I}_i \mathbf{a}_i + \mathbf{v}_i \times^* \mathbf{I}_i \mathbf{v}_i \qquad \cdots \cdots \text{ (c)}$$

$$\mathbf{f}_i = \mathbf{f}_i^B - \mathbf{f}_i^e + \mathbf{f}_{i-1} \qquad \cdots \cdots \text{ (d)}$$

$$\boldsymbol{\tau}_i = \mathbf{S}_i^T \mathbf{f}_i \qquad \cdots \cdots \text{ (e)}$$

$\mathbf{v}_i$: Velocity vector of body i (6 components)

$\mathbf{a}_i$: Acceleration vector of body i (6 components)

q_i : Generalized coordinate (joint values)

$\mathbf{S}_i$: Velocity transformation matrix

$\mathbf{I}_i$: Mass and mass moment of inertia of body i

$\mathbf{f}_i^B$: Resultant force exerted on body i

$\mathbf{f}_i^e$: External force exerted on body i

$\mathbf{f}_i$: Force exerted on the joint i which is on body i

$\boldsymbol{\tau}_i$: Force generated by joint i

Fig 3.1.8 Equation of Motion using Recursive Newton-Euler Formulation

Exercise

1. Explain UI Automation.

2. What is Argument Panel?

3. Explain Standalone Automation.

4. What do you mean by Robotics Manipulators?

5. Name types of joints.

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Scan the QR Code to watch the related videos

https://youtu.be/fcaPj7_4oRI
Robotics Manipulators

https://youtu.be/NBgLTCbUSkY
Geometrical Modeling

4. Process of performing source control integration in the RPA software

![ESSCI - Skilling India in Electronics]

Unit 4.1 Carrying out app integration, recording and scraping

Unit 4.2 Carrying out data manipulation and PDF automation

Unit 4.3 Carrying out programming, debugging and logging

ELE/N7119

Key Learning Outcomes

By the end of this module, participants will be able to:

- Demonstrate the process of carrying out app integration, recording and scraping.

- Demonstrate the process of carrying out data manipulation and PDF automation.

- Demonstrate the process of carrying out programming, debugging and logging.

Unit 4.1 Carrying out app integration, recording and scraping

Unit Objectives ⊚

By the end of this unit, participants will be able to:

- Describe the process of app integration

- Demonstrate how to integrate all the data in the RPA software

- Explain the functions of recording in RPA

- Demonstrate the use of the recording function to detect the fault in jobs

- Demonstrate the use of a screen scraping wizard

4.1.1 App Integration

App Integration is the process of enabling individual applications to work with one another. These applications are designed for their specific purpose, i.e. they are independently designed. Organizations can achieve connections that modernise their infrastructures and enable agile business operations by combining and streamlining data and workflows between various software applications.

It can also be defined as a tool that makes it possible to connect applications by removing the need for manual processes to obtain data from one application and enter it into another.

App Integration Process
The app integration process depends upon the number of applications integrated, their architecture, the complexity of security and compliance requirements and the chosen integration approach.

Step 1: Integration scoping and planning: It includes describing business requirements and planning of execution of integration. Planning includes integrated systems/ processes, the kind of data to be shared, and infrastructural capabilities and constraints.

Step 2: Integrated system design: In this, the integrated system and security requirements are described, and the decision is taken on an appropriate app integration approach.

Step 3: Selection, Evaluation & comparison of tech stacks for the selected integrated approach: For the selected integrated approach, the solution architect selects the top 2-3 tech stacks and evaluates each option after comparing each other to decide which is more strategically advantageous.

Step 4: App Integration implementation and testing: The last step is to get QA team validation on the app integration. This includes approving the work failover mechanisms and performing security tests.

| Scoping and planning | Integrated system design | Tech stack selection, evaluation and comparison | Implementation and testing |

Fig 4.1.1 App integration process

4.1.2 Integrating Data in the RPA Software

Integrating data in the RPA Software includes building a process that logs into an application, navigates to a specific window, query an invoice. It completes the information with the data collected from other sources, connecting them to the target application and entering the invoice with the information collected from different sources.

App integration is considered to be efficient for integrations that require a small volume of data. This is an important alternative, especially for organizations already using RPA technology.

It takes a variety of technologies to create sophisticated interfaces and integration processes when creating a programmatic integration to connect to apps. There are numerous options, ranging from straightforward text file sharing to intricate SOA-based architectures. Each of them demands a sizable amount of development work but offers substantial gains in terms of processing speed, dependability, etc.

The classic integration strategy is the most suitable when there is a large amount of information to integrate. However, RPA might be useful for connecting applications when integrated data is not regularly changed.

Steps to ensure smooth integration of data in the RPA Software are as follows:-

- **Identify the role of RPA**: Before thinking of data integration, the role of robotic automation within the overall business process needs to be identified. App integration in the RPA software is most beneficial when utilized for high volume but repetitively. Each bot contribution should contribute to the broader process rather than being an isolated addition. Post defining the clear purpose of RPA, an evaluation of the evolving role of humans should be done.

- **Reconfigure the humans' involvement in remaining roles**: RPA cannot perform all the activities; there are still chances of other roles that can only be taken care of by human beings. Those new roles within the business process should be noted and prepared to emphasize the value of these new jobs.

- **Define roles amongst employees**: It is essential to explain to the human workers about their work in conjunction with Robotic workers so that vision can be created amongst them and they will be able to understand the work expected from them.

- **Prepare Workforce for the changes to come**: In order to incite enthusiasm amongst employees in their new roles, support programs are to be introduced. Cross training or Up Skilling can be considered as one option for displaced employees. Collective success stories are to be shared with employees to motivate and convince them of the change.

4.1.3 Process Recorder Function

In order to keep pace with a changing digital landscape, Robotic Process Automation has been implemented. There are two ways to get the recording done. First is to use the RPA process recorder function and the other option is to build the automation from scratch and make design base automation.

RPA's process recorder function is one technique to speed up the process of recording a process's phases before automating it. It can be helpful for several straightforward automation. However, there are significant difficulties, and software vendors will take some time to get over some of them.

To put it simply, a process recorder in RPA takes the actions taken by a user and converts them into an automation-ready workflow that is intended to duplicate those actions. The recorder will record the precise coordinates of a site if the user clicks on it (and the time between clicks). A business analyst would typically need to review the workflow to ensure it is as precise and efficient as possible because the recorder lacks the functionality to analyse the process.

Remember that many jobs and processes are carried out in a specific way to make them simple for a human worker to follow; hence, a robot may not always require all the steps a human worker would. A recorded process may be just as inefficient as the previous manual without a business analyst refining it. In light of this, some organisations choose not to use the recorder feature and instead have the business analyst evaluate the process before completely redesigning it.

Additionally, it is unable to comprehend the commercial justifications for the automation's chosen course. Process recording also does not support best practices of reusing modules and sub-processes and is not as flexible as the layered design process. Design-based automation will therefore continue to be crucial for the time being.

To put it simply, a process recorder in RPA takes the actions taken by a user and converts them into an automation-ready workflow that is intended to duplicate those actions.

Fig 4.1.2 Recording of various functions in RPA

Merits & demerits of recording

Taking screenshots of various chores that appear on computer screens is nothing new. The idea of an RPA recorder function will not be strange if we are seasoned Word or Excel users. The capability of macros to incorporate built-in productivity tools is constantly expanding.

To count a few advantages, the process recorder function is one way to speed up the process of capturing the steps in a process and then automating them.

On the opposite side, software vendors take a while to overcome some disadvantages. The recorder does not have the functionality to analyse the process; a business analyst will probably have to look at the workflow to ensure that it is efficient and accurate as it should be.

All automation's goal, whether robotic, desktop, attended, or unattended, is to take a workflow and delegate at least some of it to a software robot. However, for the time being, most businesses will still require human monitoring to get the most out of the RPA automation they develop. Process recorder capabilities in RPA can help this purpose.

Uses of recording function
RPA can be used to automate repetitive processes that call for human involvement in the front office and the back office. Data input, data extraction, and invoice processing automation are some typical RPA applications and use cases we come across. Additional instances of RPA use cases automating jobs may be found in other company departments and industries, including sales, human resources, and operations (banking, retail, manufacturing, etc.).

The uses of the recording function are as follows:

a) **Customer Service**: The recording function can check and detect customer onboarding records.
b) **Accounting**: Data Validation related faults can be cross-verified.
c) **Financial Services:** Report preparation and dissemination can be recorded and checked for faults.
d) **Healthcare**: Book health appointments, Account settlement and claims management can be taken care of by the recording function.
e) **Human Resources**: Absence management in HR can be taken care of well by recording the function of RPA
f) **Supply Chain Management**: Creating invoices and updating CRM can be performed using the recording function, and faults can be easily captured.

Fig 4.1.3 Use of the recording function to detect faults (RPA)

4.1.4 Screen Scraping Wizard

Screen Scraping is copying data from documents, PDFs, and websites to be used for another purpose. On-screen items, such as text or images on the desktop, in an application, or on a website, can capture visual data in raw text.

Screen Scraping is commonly used to work with application interfaces that cannot be directly accessed through available UI frameworks. It is a compelling method for extracting text.

Screen scraping is an essential component of the RPA toolkit; it is used to capture bitmap data from the screen and cross-verify it with the stored information to read the desired information, which can extract the text using the screen scraper wizard. The screen scraping wizard reflects right next to the record radio button.

Fig 4.1.4 Screen Scraping wizard in RPA Toolkit

Screen scraping Process
The process first highlights the region to be scrapped, which will open the Screen Scraping Window with the extracted data. It focuses on application components that are not reachable through code. Optical character recognition (OCR) makes it feasible to digitise text. It is largely accurate and simple to use. The Screen Scraper Wizard has three different methods to perform screen scraping –

- Full text: the scrapping of all UI objects' visible objects
- Native scrapes text and records its position, colour, and font style.
- OCR: scraping in Citrix applications and virtual desktops

This is a simple application of **Robotic Process Automation** in which data is taken from a website, written down and stored in an Excel sheet, and then the file is emailed to the desired email address. RPA is used to automate the process entirely. The detailed process is as follows:-

Step 1: Select the Process tab to start a new process.
Step 2: Name the Process and give a short explanation of it
Step 3: In the activities panel, flowchart activity can be searched. Drag & drop it in the designer window
Step 4: Now, look for the Open Browser activity in the activities panel. Include it in the order. Double-click it and type the URL inside quotation marks.
Step 5: Click on the Data Scraping icon in the design tab, and then the Extract Wizard window will open.
Step 6: Next, look in the Activities section for message box activity. Drag and drop it in the designer window. By double-clicking the phrase "Data extraction Completed," one can pass it.
Step 7: Search for **Excel Application Scope** activity in the activity panel. Drag and drop it in the designer window. The location of the Excel file created earlier can be passed in quotes.

Step 8: Now, search for **message box** activity in the Activities panel. Drag and drop it in the designer window. Double-click and pass the message on it "Data writing process Completed".

Step 9: Next is to search for Send SMTP Mail Message activity in the Activities panel. Drag and drop it in the designer window.

Enter the recipient's email address in the "To" field if the excel file is to be sent to them automatically.
Write the desired subject, such as "Covid 19 Report," in the "subject" field.
Write the message, for instance, "Hi, please find the attachment report," in the "body" area.

Step 10: Search for **close tab** activity in the Activities panel. Drag and drop it in the designer window. Click on this activity, and in the properties panel under the input section, pass the browser variable browserVar.

Fig: 4.1.5 Stepwise Process of Screen Scraping Process

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Unit 4.2 Carrying out data manipulation and PDF automation

Unit Objectives ⊚

By the end of this unit, participants will be able to:
- Describe the process of data manipulation.
- Describe the process of text, image and PDF automation in RPA.
- Explain how a modular server product provides a rich set of PDF processing functions for different.
- Explain how to extract data from a specific UI element or document.
- Explain how to automate specific actions in the user interface.
- Explain how to automate a sequence and summarise the collected data.
- Explain how to manipulate data in robotics software.
- Demonstrate the use of Word Application Scope in the RPA software.
- Demonstrate how to summarise the collected data and program it in the robotics software.
- Explain how to enable image and text-based process automation

4.2.1 Data Manipulation

Data Manupulation is the process of adjusting data to make it more readable and organised. The purpose of data manipulation is to improve readability by altering it. For this, data manipulation language is used, which modifies the data in a database by inserting, deleting and adjusting it so that it can be mapped wherever the user desires.

RPA works best when the source data is highly organised for automated data entry. RPA bots perform best with 100% predictable data because they are made to automate highly repetitive, time-consuming, and laborious jobs.

Data Manipulation Process
Data manipulation is the process of how to alter data to make it more readable and structured. Combined with automation, data processing gives people access to what they like or need the most and depends on their individual needs and preferences. The data manipulation is based on three of the most common collection data types: Strings, lists and dictionaries.
The process of data manipulation carries following steps:-

1. **Create a database**: The first process is to create a database comprised of different data sources. A data source may be the initial location where the data is born or where physical information is first digitized. Few examples are flat files (Excel files), databases (SQL, Oracle, MS Access, web services)

2. **Fine-tune database**: Read the text from a Word file, write it into another document, add a picture, and convert it from Word to PDF using Word Application Scope in the RPA software. Further data should be reorganized and rearranged in terms of its usage. Data cleansing is required to ensure that data is correct and there are no errors.

3. **Build a readable database**: Data should be made readable with the help of building tables, forms, reports and other database objects. The purpose is to summarise and program the collected data in the robotics software.

1.   **Combine/merge/remove redundant information:** When we filter data, the need to remove or merge redundant information arises. It is done to make the information more useful for readers.

2.   **Conduct Data Analysis:** Lastly, data is analysed to develop useful insights that can further guide the decision-making process of end users.

Fig 4.2.1 Data Manipulation

Data manipulation and RPA help execute transactions within systems like ERP, CRM, etc. It is also helpful in reporting information periodically to the indicated people, either external or internal

4.2.2 Text, Image and PDF Automation Process in RPA

While uploading records and other important documents, we need to scan and store the data (text and images) as PDF Files. The text from the scanned document must be read and then saved as a word or excel document. We may automate these procedures using the RPA (Robotic Process Automation) idea.

The file type known as Portable Document Format (PDF) allows for the accurate capture and transmission of electronic documents. PDF files significantly affect daily tasks and processes in every industry.

PDF automation is a server product that offers various PDF processing features for various settings. In PDF automation, text files are extracted from PDFs, form fields are extracted from PDFs, PDFs are converted to jpg images, and text is converted to PDFs. We can read PDF and Excel files from various sources, such as the FTP server, email server, and unstructured systems, thanks to PDF automation.

The Process of text, image and PDF automation in RPA is as follows:

Steps	Images
Step1: Create a new process by clicking the process option under the new project.	
Step 2: After clicking it, a dialogue box gets open. In that, enter the name for the process and location of the process and the description for that. Then click the create button.	
Step 3: At the design page, click the Open Main Workflow option.	

Step 4: Design page gets open. There add a flow chart by clicking New, Flowchart.	
Step 5: Then a dialogue box with the information for the new flow chart gets opened. There we can enter the flow name and the location for the flowchart. Then click the create button. A new flowchart page gets created.	
Step 6: Create new sequence inside the flowchart by dragging and drop from the activities panel	

Step 7: Make sure that some dependencies are installed in the tool. We can see it or add it in the management package option.	
Step 8: Adding activities to the Sequence for reading (read pdf with OCR), writing text (write text file activity) and displaying it further in PDF (using message box activity)	
Step 9: Running the flowchart: run the flow by clicking the Debug File button for debugging and running.	

SStep 10: After running, it will display the text from the PDF as output in a message box and a text file will be stored with the PDF content. Hence, the flow runs successfully.

Table 4.2.1 Stepwise Process of text, image and PDF automation in RPA

(Source: https://www.c-sharpcorner.com/article/reading-and-writing-the-text-from-a-scanned-pdf-using-rpa/**)**

4.2.3 Modular Server Product

A versatile server package called PDF Automation Server offers a wide range of PDF processing capabilities.PDF automation server offers a full range of PDF processing and conversion capabilities. It is simple to incorporate into our current document process enable with third-third-party. Modular Server Product is essential for the following:

1) **Easy to set up**: PDF Automation Server is a server product which is easy to set up and affordable. It does not require any programming and can run in a few minutes.

2) **Reliable:** This software does intelligent error handling and recovery at multiple levels in the software so that server can recover from errors side by side. It has been produced and tested with the utmost care and caution. It helps in making documents reliable.

3) **Multiple Destinations:** The PDF automation server can deliver the documents to multiple destinations after processing documents. Each process can send the resulting document to multiple destinations, and different processes can send output to unique destinations.

4) **Platform Independence**: It is a platform that is independent and can run on windows, UNIX, Linux etc.

5) **Event Logging**: This product keeps a complete log of events in the server, which help users to track document processing and pinpoint causes of problems.

4.2.3 Data Extraction from a Specific UI Element

Activities that enable us to extract data from a specified UI element or document, such as a pdf file, are known as output or screen scraping methods. The 3 types of scraping methods are used, i.e. Full Text, Native and OCR. There is a prescribed procedure that must be followed, and it is as follows:

- **Double click text/click text**: This activity is used to click the text inside a UI Element. A Target, which can be a string variable, a region variable, a UIElement variable, or a selector, is provided as input to these activities and indicates the coordinates at which the action has to be done.

Fig 4.2.2 Double Click Text

- **Find text position:** This activity searches for a given string in a specified target and returns a UIElement variable with the clipping region set to the screen position of that string. It can be useful in locating UI elements to text on the screen when there is no other way of locating them.

Fig 4.2.3 Find text position

- **Get full text:** It helps extract string and its information from an incidated UI Element using the full-text screen scraping method.

Fig 4.2.4 Get full text

- **Get visible text:** This activity receives a target which can be either a region variable that helps to identify what is to be automated and where the actions must be performed. This is done using Native Screen Scraping Method.

Fig 4.2.5 Get visible text

- **Extract structured data**: It is used to extract data from the structured table. We can specify what information to be extracted and what all properties need to be set. This is done by using a data scraping wizard.

Fig 4.2.6 Extract structured data

- **Text exists**: This activity is helpful in all types of text-based automation and allows us to make decisions based on whether or not a given string is displayed, or it can be used in the retry scope activity.

Fig 4.2.7 Text exists

4.2.3 Automation of Specific Actions in the User Interface

All User Interface elements consist of selectors that pinpoint the order of activities of the structure. When creating a UI element of an application window, its sector always has a root element named: desktop.

To help users engage with Windows and desktop apps, Power Automate offers a variety of UI automation options. In order to specify the UI element to handle, one must set specific UI automation actions parameters.

Choose Add UI element from the deployed UI automation action or the UI elements tab of the flow designer to add a new UI element.

https://docs.microsoft.com/en-us/power-automate/desktop-flows/actions-reference/uiautomation

4.2.6. Sequence and Summarising Automation

Data capturing is the process of classifying data according to the priority and ease of access. Data automation is a software-based solution that can optimize data entry by eliminating or reducing manual processes. Such software can typically extract data from documents, images, e-mails and PDF's. After data extraction, it is processed as per the requirement and summarised. The steps to be taken are listed below:

1. Create the test plan to be followed
2. Design the data set to allow automation of data
3. Create a clear file naming system
4. Store the resulting data files in a specific folder and name it
5. Analyse the results of every test
6. Error checking options to be included
7. Store the data logically

4.2.7 Manipulating data in robotics software

Data manipulation in robotics software includes how robots interact with the objects around them. A few examples are opening a door, packing an order, folding laundry, grasping an object etc. A set of coded commands or instructions are given to a mechanical device, and electronic system, known together as a robot. It is a model in which humans co-work with robots after manipulating all essential instructions. A Robot follows all the instructions and acts accordingly.

Few activities are performed in manipulating data in robotic software. Few are explained as below:-

1. **Algorithms for manipulation planning:** Intelligent algorithms are to be developed for robots to enable them to do perform that activity. For e.g. opening the refrigerator to get a water bottle.

2. **Kinematics of prehension**: Prehension is the ability to grasp and manipulate objects, which is considered the most fundamental human activity. Simulations are created that allow to generate human like movements in robots based on clear control signals. These control signals can then be used to control arms of robots.

3. **Human-Robot Collaborative Manipulation**: Instructions are given to robots that comprise of human-computer interaction, artificial intelligence, process design and psychology

4. **Multi-Robot Collaboration**: It is an efficient scheduling algorithm for multi-robot tasks so it can assist human beings in multiple tasks.

4.2.8 Use of word application scope in the RPA software

Word application in the RPA software is beneficial and provides a scope of other word activities in the RPA software. UI automation activities can be added directly to the word application scope activity to automate the interface of word quickly. For this, only MS Word documents should be available and opened in the operator's machine.

Steps in word Application in RPA Software		
1	**Setting up the word macro** The first step is to set up and define macros. A few examples are dropping a company letterhead onto a document, Inserting pre-designed tables, Creating custom book formats etc. Activities are: • Select the View tab, then click *Macros > Record Macro* • In the Record Macro dialogue box, enter a macro name and description • choose All Documents to run this macro in all of the Word documents • Next, in the Assign Macro To panel, click Button or Keyboard (shortcut) for the method used to access and run the macro.	

2	**Adding a macro button to the quick access toolbar** If one have button for the macro that they want to add to the quick access toolbar, directly right-click on it. **Activities are:** • Click *Button ,* and the Word Options/Customize Quick Access Toolbar screen opens. • Click *Modify*, choose an icon to represent the macro button, then click *OK* When finished, click *OK* again to exit.	
3	**Recording the macro** It can include typing text or numbers, clicking on menus, Formatting cells, rows or columns or importing data from any external source.	
4	**Enter the keystrokes** Keystrokes to be entered, which are required to be recorded in macros. We can use the macro recorder to record the macro or write their own macro script in VBA.	

5	**Stop recording** When finished, select the View tab again, then click *Stop Recording*	

Table 4.2.2 Word Application Scope with steps in the RPA software

4.2.9 Summarising the collected data and programming

Data, once collected, needs to be programmed in the robotic software. The robot's data collection is the same no matter what source the robot pointed at without transposing numbers or misplacing any decimals. Most robots are programmed using one of two ways: either learning from demonstration, where they see a task being performed and then copy it or motion-planning techniques like optimization or sampling, where a programmer must explicitly state a task's objectives and restrictions.

Robot programming is creating a control strategy for how a machine will interact with its surroundings and accomplish its objectives. A programming language and some familiarity with mathematics are typically needed. It can also be defined as giving a machine the ability to sense its surroundings, make decisions, and carry out tasks by creating computer programmes.

The basic elements for programming data in robotics software are as follows:

Input: The first step is to collect the data and commands it into the computer

Output: Next is to get the results out of the computer

Arithmetic: Performing mathematical calculations on the data

Looping: Testing whether a condition is true or false and iterating through a sequence of instructions until a condition is satisfied are conditional and looping.

Data programming can be done using a few computer programming languages such as python, Java, C++, Haskell etc. Teaching pendant and lead through programming are the two most used techniques in the online programming category. The most popular way of programming industrial robots is to teach pendant programming. It is believed that teaching pendants programme around 90% of industrial robots. Most robots are taught either through motion-planning techniques like optimization or sampling, which require a programmer to state a task's goals and restrictions explicitly or by learning from demonstration, in which they observe a task being performed and subsequently repeat it.

4.2.10 Different Programming methods

Low-level coding has given chief place to more user-friendly techniques in robot programming. Robot makers are not necessarily the ideal persons to programme a particular task, and robot operators are not always robot makers. Here are the top 3 robotic programming techniques:

1. **Teaching Pendant**: The robot is programmed by the operator, moving it from location to location while separately saving each position with the buttons on the necklace. The robot can replay the points at full speed once the entire programme has been learnt.

2. **Simulation/ Offline Programming**: It is most often used in robotics research to ensure the correct working of algorithms before moving to real robots. Offline programming allows the robot to be programmed using a virtual mock of the task and the robot.

3. **Teaching by demonstration**: It is considered as an addition to the classic teach pendant. This involves moving the robot around either by a sensor or a joystick attached to the robot's wrist.

Each method has its advantages and disadvantages. The best method will depend on the type of task, robot type and requirements.

4.2.11 Enabling image and text-based process automation

Image enabling is the art of searching one image within another image. One can have two images: one that is predetermined at design time and one that is a screenshot of the actual application while the automation flow is in operation. To enable automation of text- and image-based processes, activities are introduced that stimulate keyboard and mouse input, such as clicking, typing, text recognition and Optical Card Reader (OCR) that use screen scraping to identify UI elements.

Image recognition compares a matrix of numbers with another matrix of numbers. Image and Text automation is functional when UI automations do not work. For example, virtual machine environments where selectors cannot be found using standard methods.

Image and text automation can be helpful when UI automation is ineffective, such as in virtual machine environments where selectors cannot be located using standard techniques.

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Data Manipulation

Unit 4.3 Carrying out programming, debugging and logging

Unit Objectives ◎

By the end of this unit, participants will be able to:

- Explain the basics of programming

- Describe the process of auto-health checking

- Explain the power-on self-diagnosing

- Explain how self-testing takes place and the steps involved in error checking.

- Describe the project organisation process

- Describe the process of storing the attributes of a graphical user interface element

- Describe the process of using a VM software to connect virtually and remotely to the client's applications

- Describe the process of using computers to gain a high-level understanding of digital images or videos.

- Explain the importance of ensuring an integrated development environment for developers.

- Describe the process of debugging and its functionality in various projects.

- Describe different methods of error handling in the RPA software.

- Describe the process of separation of Orchestrator components within tenants for assigned users.

4.3.1 Basics of Programming

The process of writing a set of instructions that instructs a computer on how to carry out a task is known as programming. Numerous languages can be used for programming. The purpose of programming is to find a sequence of instructions that will systematise the performance of a task on a computer for solving a given problem.

Programs are executed by the processor, whereas scripts are always interpreted. There are three types of programming languages available, i.e. machine language, high-level language and assembly language.

Programming languages include JavaScript, Python, and C++. Undoubtedly, Python and JavaScript are among the most recommended programming languages for beginners because of their easy syntax and wide range of applications.

4.3.2 Importance of Programming

Programming languages utilise classes and functions to handle commands. Programming tells a computer to carry out these instructions regularly so that people do not have to repeat the process by hand, which is why it is crucial. Instead, the computer programme can complete it precisely and automatically. Any web application is built using computer programming. Each of the applications uses a variety of languages, some of which are relatively similar and others very different. Furthermore, specific programming languages generate products that run covertly without our knowledge. By mastering computer programming languages, anyone can develop into a versatile programmer.

1. Programming is essential for learning to innovate

2. It helps in creating eco-friendly solutions for global problems

3. It is essential for speeding up the input and output processes in a machine

4. It helps in data analysis and interpretation

5. It is helpful in 5 categories like Information Technology, Data Analysis, Artists & designers, Engineers and Scientists

4.3.3 Auto-Health Checking Process

Health checking is an automated technology that uses software to identify the problems in the system and shows suggestions to fix them. In a robotic framework, three types of functional tests are commonly used, i.e. unit tests, integration tests and regression tests. These tests can be used to confirm and validate the robotic software's resilience.

A robot system can be affected by faults and failures in a variety of ways which can affect the robot's performance, such as accuracy, velocity, force and torque. These factors are commonly identified as critical indicators of the system's health. A tool centre accuracy measurement can be used to evaluate an industrial robot's condition.

4.3.4 Power-On Self-Diagnosing

It is a process performed by software immediately after it is powered on. It helps to report the error after making the health check. Only properly functioning hardware will allow the operation to continue; otherwise, the BIOS (Basic Input Output Software) would generate an error message. The POST sequence is handled by the system BIOS regardless of the operating system. The POST typically beeps the OS when the checks pass. However, the precise amount of beeps can vary from system to system.

This process happens within the first few seconds during a system's start-up and is considered very important. It alerts if there is any hardware issue or any software issue. This process has probably saved users many times, and they may not have even noticed.

If the power-on self-diagnosing test is unsuccessful, it generates a beep code to indicate the error, and the computer will not boot up.

4.3.5 Self-Diagnosing Errors

Almost all potential errors that could stop the computer from continuing to boot will display some sort of error message. As POST codes, beep codes, and on-screen power-on self-test fault messages, errors can appear as flashing LEDs, audible beeps, or error messages on display. The meanings of beeps are represented in the following chart:

Beeps	Meaning
1 short beep	Normal POST – the system is OK
2 short beeps	POST error – error code is shown on screen
No beep	Power supply, system board problem, disconnected CPU, or disconnected speaker
Continuous beep	Power supply, system board, or maybe RAM problem, keyboard problem
Repeating short beeps	Power supply or system board problem or keyboard
1 long, 1 short beep	System board problem
1 long, 2 short beeps	Display adapter problem (MDA, CGA)
1 long, 3 short beeps	Enhanced Graphics Adapter (EGA)
3 long beeps	3270 keyboard card

Fig. 4.3.1 Different types of errors on self-testing

Steps for Checking Errors

The purpose of error handling testing, a software testing, is to determine whether the system can handle potential future mistakes. Generally speaking, testers and developers work together to carry out this kind of testing. Testing for error handling places equal emphasis on identifying errors and addressing exceptions.

The steps involved in the error checking tests are as follows:

1. **Test Environment Set Up:**
    To ensure a seamless testing process, test environments are set up following software testing techniques. The preparation for the test is a part of this process. It is ensured that the system being tested has less important data because a system crash during testing is possible.

1. **Test Case Generation:**
    It includes making different test cases which may cause an error. Since test cases cannot be created without knowledge of the internal code, the development team is involved in test case generation.

1.   **Result and Analysis:**

The test case's output is analysed after execution. It also includes examining any discrepancies between the created test case's intended output and actual result. The possibility of the programme entering an infinite loop, which could result in software failure, exists.

2.   **Re-test:**

The system is tested again if the testing is unsuccessful, following another round of analysis. It also includes evaluating the system using newly created test cases..

Fig 4.3.2 Steps involved in error checking

4.3.6 Attributes Storing Process

Users interact with electronic devices via visual indicators using graphical user interfaces. The GUI process lets us click or point to a small picture, known as an icon or widget, and open a command or function on the devices, such as tabs, buttons, scroll bars, menus, icons, pointers and windows. It is now the standard for user-centred design in software application programming.

A GUI-based application is designed using graphical features such as windows, menus, dialogue boxes and features that make the application easy to use. GUI is incredibly user-friendly and visually appealing to the user. It is an interface for using laptops, PCs, tablets and other devices. It is a translator that communicates between human beings and machines. Without GUI, we cannot control programs and applications by just typing instructions into the command line.

GUI stands for Graphical User Interface and refers to computer programs that provide a visual means for users to interact with an underlying application or system.

4.3.7 Process of using VM software to connect virtually to the client's applications

A virtual machine, sometimes abbreviated as just VM, is an actual computer like a laptop, smartphone, or server. It is equipped with a CPU, RAM, discs for file storage, and an internet connection in case that is required. VMs are frequently considered virtual computers or software-defined computers inside real servers, although hardware is actual, physical, and exists solely as code.

Software that was not designed for specific operating systems is frequently executed on those platforms using virtual machines. Additionally, virtual machines are used to access virus-infected data, quickly install software with an image, and test different operating systems.

Here are a few ways virtual machines are used:

- Creating and deploying cloud-based apps
- Evaluating beta releases of new operating systems (OS)
- Creating a fresh environment to enable running development-test scenarios for developers easier and faster
- Back up the current OS
- Installing an outdated OS and using it to access virus-infected data or run an outdated programme
- Running applications or software on platforms for which they were not designed

Oracle created the open-source virtual machine software called Virtual Box. It enables users to virtually install various operating systems, including Windows, BSD, Linux, Solaris, and more, on virtual discs. Process of using VM software to connect virtually and remotely to the client's applications are as follows:

1. Start with downloading and installing Virtual Box/ Virtual Machine
2. Once user have Virtual Box running, click the "New" button
3. The OS user intend to install must then be selected. Enter the name of the OS user wish to install in the "Name" box. If user write in a name, Virtual Box will infer the kind and version; however, one can modify these parameters if necessary.
4. Next, start the virtual machine user just created by clicking "Start".
5. Choose the .iso image file user want to utilise after the virtual machine has started.
6. The chosen operating system will now be loaded into the virtual machine. The operating system may need some configuration, but it will be the same configuration needed if user had installed it on a typical machine.

4.3.8 Information Extraction

The practice of moving through unstructured data to extract meaningful information into more editable and organised data forms is known as information extraction. Managing a large amount of text data can be difficult and time-consuming. Process of Information Extraction (IE) is used to extract useful information from semi-structured data.

4.3.9 Automating the Appropriate Sequence

Data extraction is the first step in automating the appropriate sequence. It helps organisations and companies solidate all types of data into a common format an and The procedure consists of these three steps:

1. **Extraction**: One or more sources or systems are used to gather the data. Relevant data is located and identified during the extraction phase, and prepared for processing or transformation. Extraction makes it possible to mix various data types and eventually mine them for business knowledge.

2. **Transformation:** In this phase, extracted data is sorted, organised and cleansed. In this, all duplicate entries will be deleted, missing values will be removed, and audits will be performed to produce data.

3. **Loading:** The highly-quality data changed is then sent to a single, unified target place for storage and analysis.

Automate Document Data Extraction refers to using Artificial Intelligence to extract the data. The complete process of using intelligent tools to extract data from documents and processing it to derive meaningful information.

4.3.9 Analysis of Digital Images or Videos

In order to properly analyse the input images or videos and anticipate the visual input like the human brain, computer vision is primarily concerned with extracting information from them. Computer vision is using computers to comprehend digital images and movies at a deep level. It includes a set of Artificial Intelligence techniques and allows a computer to have a human-like vision that extracts information from the visual world.

Computer vision can be used for object classification, identification and tracking. This technology tends to imitate the way the human brain works. The algorithms for computer vision we use today are based on pattern recognition. Users use a tonne of visual data to train computers, process photos, identify the things in them, and look for patterns.

Two essential technologies are used to train computers to gain an understanding of digital images or videos, i.e. machine learning, which is also known as deep learning, and a Convolutional Neural Network (CNN).

Machine Learning uses algorithms that allow the computer to learn by itself rather than needing to be programmed. The computer will learn to distinguish one image from another if enough data is fed.

Using Convolutional Neural Networks (CNNs), a machine learning model can see an image by breaking it down into tagged pixels. It uses labels to perform a twist, i.e. a mathematical function that combines two signals to form a third one. Much like a human making out an image at a distance, CNN first recognises and checks the accuracy of its predictions in a series of iterations until the predictions come true and similar to humans.

In a manner similar to this, recurrent neural networks (RNNs) are employed in video applications to assist computers in comprehending the relationships between the images in a sequence of frames.

4.3.10 Integrated Development Environment

Integrated development environment is a software application that combines all the tools needed for developing software. It provides interfaces for users to write code, organize text groups and automate the repetition of programming. An IDE provides an editor, debugger, and compiler and usually performs a task like code completion and generic code management. Few IDE's have advanced features like data visualisation, cross-referencing or tracing data.

The value of an integrated development environment for developers is summed up as follows:

a) **Increase programmer productivity**
    It increases the ability of an individual programmer to build and evolve software systems. It helps focus on the most important tasks and cultivate consistent work.

b) **Supports Collaboration**
    The IDE facilitates collaboration among programmers by allowing them to work together effortlessly. They can use each other's ideas or edit each other's codes.

c) **Translation ability**
    At the compile or build stage, IDEs can translate code from high-level languages to the object code of the targeted platform.

d) **Ability to correct**
    The IDE can repair grammatical errors, alert the user to memory leaks, help with code quality, etc. Also, it helps to manage resources like library files, header files etc at a specific location.

e) **Creation of database applications**
    Integrated Development Environment offers services for the database's data sorting, searching, retrieval, and processing. At the compile or build stage, IDEs can translate code from high-level languages to the object code of the targeted platform.

4.3.10 Process of debugging

The process of debugging involves finding and fixing flaws or mistakes in computer hardware or software. It involves a number of processes, including identifying the issue, tracking out the cause, and either fixing the issue directly or finding a means to go around it. Testing must be completed prior to debugging or rectification in order to identify a problem.

4.3.11 Functionality of debugging

As its name suggests, debugging is used to test and debug the programs. It is a step-by-step process and allows the user to inspect the registers and the memory locations post execution of a program. It provides a range of services, some of which are listed below:

Query Processor
It processes queries on various data storage architectures. Debugging carries out the query translation process into low-level instructions, query optimization and evaluation, and data extraction from the database.

An expression interpreter
Evaluating an algebraic expression involves determining its value when a particular integer is substituted for a variable. To evaluate an expression, the debugger substitutes the given number for the variable in the expression and then simplifies the expression using the order of operations.

Software cracking tool
Debugging is considered a software cracking tool to evade copy protection. It is considered a popular extension to debugger engines.

Digital rights management
By using various techniques to regulate or obstruct the sharing of digital copies through computer networks, debugging aids in protecting copy-written works.

4.3.12 Methods of error handling

The response and recovery processes from error circumstances present in a software application are referred to as error handling. In other terms, it is a procedure for anticipating, detecting, and fixing programming faults, communication errors, or application errors.

An RPA robot may run across **two types of errors: business exceptions and application exceptions**.

A business exception is associated with the process's nature. This is a business exception when a software bot cannot complete a transaction because of its pre-programmed instructions. In other words, the code for the automation contains the business exception. When the RPA bot runs into a circumstance it was not designed to handle; it will stall. This could be due to known factors like security or access restrictions, or it could be due to unforeseen factors like incomplete or inaccurate data.

On the other hand, when a robot runs into a technical problem, such as a server crash, a malfunction, or a change in the technology environment that necessitates interaction with a new application, programme, or website, this is known as an **application exception**. Application exceptions are best handled by the bot just trying again; occasionally, these mistakes are incidental and can be fixed by repeating a specific scope of the procedure.

4.3.13 Separation of Orchestrator components

Orchestrator is a single control room that allows us to schedule and launch bots on virtual machines and desktops. It helps build sequences, control bot status and analyse the results of their work. This platform helps manage the bots by helping with scheduling, tracking, and termination.

The orchestrator is made up of a variety of parts, including the following:

- The task
- The job
- The scheduler
- The manager
- The cluster
- The CLI

Tenant is automatically created when installing the orchestrator as our first tenant. Tenant admins are created as local users with the Administrator role for each tenant. The tenant admin cannot be deleted, but we can edit its information on the Users page. Few Orchestrator entities are Robots, Assets, Queues, etc. Tenants are designed for the purpose of complete separation of all Orchestrator entities between these segregated instances of deployment without maintaining multiple orchestrators.

Here are a few instances of how to divide Orchestrator into tenants:

1. Maintaining many testing and development environments
2. Isolating delicate information, such as payroll procedures or private projects.
3. A tenant for each of the company's regional or overseas offices, as users from each country have automation unique to the regional laws and regulations

Thus, tenants work best when we want authorised tenant administrators to independ ently manage all users, resources, and settings for automation systems.

Exercise

1. Describe the process of app integration.

2. Explain the screen scraping wizard.

3. What do you understand by data manipulation?

4. Explain the basics of programming.

5. State the steps for checking errors.

Notes

5. Process of using Re-Framework in the RPA software

Unit 5.1 RPA Tools

Unit 5.2 Robotic Enterprise Framework

Key Learning Outcomes 💡

By the end of this module, participants will be able to:

- Demonstrate the process of using the relevant RPA tools.

- Demonstrate the process of implementing the Robotic Enterprise Framework.

Unit 5.1 RPA Tools

Unit Objectives ◎

By the end of this unit, participants will be able to:

- Explain the benefits and uses of different RPA tools.
- Explain the use of relevant RPA tools for a centralized bot management hub for learning and testing purposes.

Demonstrate the use of the relevant RPA tool to manage the creation, monitoring, and deployment of resources in the life cycle of the network.

5.1.1 Robotic Process Automation (RPA) Tools

Robotic process automation (RPA) makes it simple to create, use, and manage software robots that mimic how people interact with computers and software. RPA tools can integrate with the applications in a variety of ways. Connecting to databases and online business services in the backend is one possibility. Another is through desktop or front-end connections, which can be made in many ways.

The most beneficial RPA tool uses bots to automate business processes. An intelligent cloud platform for automation for businesses is called Work Fusion. It identifies processes that can be automated and uses analytics and intelligent bots to do it.

Several tools are currently available for robotic process automation. RPA enables businesses to speed up operations while cutting costs, ensuring they are prepared to handle upheaval and change.

5.1.2. Types of RPA Tools:-

All the RPA tools can be segregated into different tools built as extensions of the previous generation of robots. Various Tools available are as follows:

Fig. 5.1.1 RPA Tools

- **Blue Prism**: It has the capacity for a software-powered virtual workforce. This enables businesses to automate business processes in a flexible and economical way. The programme is built on Java and provides a visual designer with drag-and-drop capabilities. The Blue Prism is related to the unattended robot modes, whereas the RPA UI route is designed for the attended robot modes.

- **Inflectra Rapise**: It is an automated testing solution that provides businesses with tools to conduct tests and assess the performance of API's and web, mobile or desktop applications.

- **UiPath:** It allows IT departments to set up software robots that collect and interpret data in various applications to automate routine tasks.

- **Automation Anywhere:** It is a high performance tool that allows any organization to implement RPA technology into their existing processes.

- **Pega:** It adds the ability to automate tasks using the user interface of existing applications. Automations are created in Pega Robotic Studio.

- **Nice System:** It provides an extensive framework for advanced process automation (APA). It offers both attended real-time employee support and unsupervised robotic process automation (RPA).

- **Kryon**: This tool lets one automate manual processes on citrix environments with unmatched speed, ease, and accuracy. This technology enables enterprises to automate processes on any application and desktop virtualization technology.

Linx: It is the tool used for visual process automation, screen scrapping and web scrapping.

5.1.3 Uses of RPA Tools

In every organization, many tasks get repeated and are time-consuming. There is a huge probability of errors in this activity. So, to reduce this risk, RPA tools can be used for learning and testing purposes. The uses are mentioned as below:-

- **Customer Service**: RPA tools helps to provide excellent customer service including installation, servicing and emergency work to be taken care immediately.

- **Boosts Productivity:** These tools help to boost the productivity which will further help to take care of multiple tasks at once.

- **Invoice Processing**: Processes related to finance are crucially important to the everyday functions of any company. RPA tools uses Artificial Intelligence (AI), Natural Language Processing (NLP), Machine Learning and intelligent document processing to automate routine business processes.

- **Payroll Management**: Since the payroll process is also repetitive in nature, RPA tools are useful and effective in calculating payroll. The input to the Process is the data of the employees, tax figures, and a way to calculate the number of hours worked etc.

- **Storing Information**: RPA brings in automation and stores data to reduce unnecessary tasks that human beings have to perform repetitively without using their cognitive skills.

5.1.4 RPA Tools for a centralized Bot Management Hub

Adopting robotic process automation into routine corporate operations is one of the best strategies to increase business efficiency. Bots are typically employed to automate a specific set of operations because they can work independently without human intervention. Any repetitious task that exists can be replaced with a bot.

A bot should be able to make judgments, carry out the tasks that are given to it, and interface with other systems through screen scraping or other API interactions. RPA solutions for a centralized bot management hub are chosen based on inputs obtained from other systems.

RPA tools that are considered relevant for a centralized bot management hub are:-

a) RPA blue prism

b) UiPath

c) Automation Anywhere

d) NICE

5.1.5 RPA tool in the Network Life Cycle

Robotic process automation is the practice of automating workflows with robot assistance to minimize human involvement.

The RPA Lifecycle primarily consists of 5 steps, plus an additional stage where the built-in bot is executed. See the illustration below:

Fig. 5.1.2 RPA Lifecycle

Discovery Phase: The Process Architect examines the client's needs during this phase. Whether or not the procedure can be automated depends on the requirements provided by the client. The complexity of the process is examined to if it can be automated. Finally, the advantages of automation are listed.

Solution Design Phase: The process of automating a task is designed during this stage. A Process Definition Document (PDD), created by the Technical Architect and Process Architect together, contains detailed information about every process and stage**.**

Development Phase: The Automation Developer writes Automation Scripts in the selected RPA Tool during the Development Phase. The tool might be any of the countless tools that are available on the market.

UAT (User Acceptance Tests): In this phase, Either the testing team or the development team itself tests the developed bot. The bot is tested in a pre-production setting to see how users would be able to utilize it to automate a particular task. If the testing is successful, the bot advances to the following stage; however, if the testing is unsuccessful, it returns to the development phase, where the issues identified in the testing phase are fixed, and the bot is tested once more.

Deployment & Maintenance Phase: The production environment is where a bot is deployed after development and testing. Following its introduction, the bot is now accessible to users. However, the bot returns to the Development & Testing teams for further troubleshooting if there are any problems.
The three Best Robotic Process Automation Tools used to manage the creation, monitoring and deployment of resources in the lifecycle of the network are:

1.   Automation Anywhere

2.   Blue Prism

3.   UiPath

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https://youtu.be/dJ6qJx9DvcQ
Robotic Process Automation (RPA) Tools
Types of RPA Tools
Uses of RPA Tools

Unit 5.2 Robotic Enterprise Framework

Unit Objectives ⊚

By the end of this unit, participants will be able to:

- Explain the use of the Re-Framework and its architecture.

- Demonstrate the process of implementing the Robotic Enterprise Framework.

- Explain different workflows available in Re-Framework.

- Describe the process of exception handling and logging.

- Explain the three components of the business process.

- Demonstrate the process of implementing the Robotic Enterprise Framework.

- Explain the applicable rules for developing a process using RE Framework.

- Explain how to create automated e-mail login and remote data entry applications.

- Demonstrate how to create Robotic Enterprise Framework (RE Framework) for logging in, exception handling, application and initialization

- Demonstrate the use of Re-Framework to tackle complex business scenarios.

5.2.1 Robotic Enterprise (Re) Framework

Robotic Enterprise (Re) Framework is a template to design automation workflows in a favourable approach for large-scale deployments. It is created in a particular manner to fit all of the best practices regarding logging, exception handling and application initialization. For example, retrying unsuccessful transactions is possible using the Robotic Enterprise Framework. Re-initialize applications and handling exceptions appropriately without the need for human interaction is also possible in this framework. A few examples are web scraping, inventory management, customer onboarding etc.

5.2.2 Use of Re-Framework

In order to handle a complicated business scenario, it is designed to adhere to all best practices for logging, handling exceptions, application setup, and other areas. Any form of business procedure can use it. A framework is designed to assist developers in creating RPA procedures that are both quick and efficient. Additionally, it records all completed, unsuccessful, and successful transactions. As a result, the RE Framework is used by the UiPath development to produce a robust and efficient approach.

5.2.2 Use of Re-Framework

A "Main.Xaml file" that uses the State machine process is present in every project in Re-Framework. This file is used to improve the process flow's aesthetic appeal. Included are three state activities, one last state activity, and seven transitions. Additionally, each stage has transitions that have been developed.

Four states are basically used in the Robotic Enterprise Framework:-

- Init State

- Get the status of a transaction

- Complete the transaction state

- State of the process at the End

*Fig. 5.2.1 Re-Framework Architectur*e

The 4 states of Re-Framework are as follows:-

o **Init State**: Every project using RPA (Robotic Process Automation) starts out in the init stage. The bot launches the programme after reading the initial project settings. This state advances to the next state: Get Transaction Data. It is useful to read and store the configured data with the dictionary. It closes all the unimportant applications and opens the required one only. Users can start all the important applications within the init state. Later, the robot will move forward with transaction processing if the built conditions are met.

o **Get Transaction:** It is possible to retrieve the transaction from the queue, folder, data table, and other sources using this recovery state. The robot requires all the applications required for a process after it has successfully started. As a result, it concentrates on any transaction items waiting in line to be processed.

o **Process Transaction:** The process transaction is the state where the transactions are fetched from the earlier state. All the tasks required to attach the document will be activated within the Process State. Re-Framework includes prebuilt Set Transaction Status workflow useful to set the Transaction Status of an item.

o **End Process:** This framework's final stage stops the bot successfully and closes all the applications. The robot will log out of itself once it has processed all of the transaction items in the queue. Regardless of whether the deal is successful or not, it will leave.

5.2.3 Re-Framework Implementation Process

Robotic process automation is a disruptive technology to automate already digital yet manual tasks and sub-processes as well as whole business processes rapidly. Robotic process automation is lightweight and only accesses the presentation layer of IT systems to mimic human behaviour.

A framework for implementing robotic process automation...

Awareness	Data Collection and suggestion	Development	Evaluation and conclusion
• Problem indentification and abstraction • Definition of Research goal	• Structured literature review • Interview study • Data coding • Meta-synthesis • Workshopa	• Consolidation of finding from data • Definition and refinement of RPA implementation framework	• Demonstration of frame work • Evaluation based on expert feedback • Envaluation based on workshops

Fig. 5.2.2 Implementation of Robotic Process Automation

The process contains four phases: Awareness, Data Collection and suggestion, Development, evaluation and conclusion. All phases are successive but have been joined until a consolidated framework emerges. For a better understanding, each phase is elaborated as below:

i.   **Awareness**: This phase includes identifying the problem and profoundly studying the possible solutions to reach the ultimate goal. Herein, the development of design, and evolution of RPA implementations are to be considered and accordingly, work has been started and deployed.

ii.   **Data collection and suggestion**: In order to examine the current state of the art and provide resolution systematic literature review has to be conducted. In second iteration, semi-structured interviews will be undertaken in order to validate the framework's initial iteration and modify it in response to input received from the interviewees. Further, interviews are coded in terms of transcripts and analysis to be performed by multiple authors. The systematic review and integration of findings from qualitative studies are taken care in various workshops using different methods.

iii.   **Development**: Using the results of the structured literature analysis and the interview stages as a basis, identification is done of all stages and phases. Only those stages which are identified will be considered and added to the framework. Visited and slightly adapted the framework to its final form to pro- vide our second contribution.

Evaluation & Conclusion: After evaluation of the study based on the feedback of experts and of workshops, the conclusion is drawn and shared. This conclusion further becomes the base for the implementation of the process of the Robotic Enterprise Framework.

5.2.4 Re-Framework Workflows

Workflows are created to fit all best practices regarding exception handling, logging and application initialization etc. Below is the template which is primarily used across the globe. The process starts by initializing the process, gathering transaction data, processing the transaction and then ending the process after drawing conclusions and feedback.

Fig. 5.2.3 Workflows in Re-Framework

- **Initialization Process:** It includes entering the data that needs to be processed through the Robotic Enterprise Framework, and conclusions ar**e drawn upon it.**

- **Transaction Processing:** This process includes retrieving the initiated data and putting it into the transaction flowchart for processing. The output of this leads to the end process.

- **End Process:** In this, all the processes are ended up, and conclusions are drawn on it and shared further for inference.

5.2.5. Process of Exception Handling, Logging, Application and Initialization

Robots are carrying out the tasks (automation requests) following how the process has been set up. There is a chance that the robot will not be able to accomplish a given assignment in its entirety. There might be numerous reasons possible for such fallout, for example, issues with Underlying applications (slow / non-responsive applications which have been automated), infrastructural issues (unresponsive/overloaded machines or robots), and business issues (the scenarios which are not handled during process configuration, hence the robot does not know what to do when such scenarios occur) etc.

RPA tools give users a variety of options for handling these issues. Exception handling ensures that problems can be automatically resolved or easily identifiable and repairable by system administrators for human completion where appropriate. The exception handling process should be well implemented during development. Exceptions occur when established rules are broken. They happen when data/inputs do not conform to application criteria.

 Despite RPA software's benefits, choosing the right RPA technology is not always necessary to implement enterprise-level exception handling. Having a defined approach put forth by the developers who closely collaborate to follow an organization's existing processes is necessary for successful exception handling. Having established standards of managing exceptions is the key to high-performing unassisted automation that operates safely and efficiently.

5.2.6 Business Processes Components

The 3 types of business processes are followed in the Robotic Enterprise Framework:-

a) **Operational Process:** In robotic processing operations, the robot manipulates a tool to perform a process on the work part.

b) **Supporting Process:** These are the processes that make it possible for the operational processes to be carried out effectively and are either strategically important or necessary.

c) **Management Process:** This is where both of the above processes occur. This involves planning and monitoring. It also means identifying possible threats or opportunities.

5.2.7 Creating Automated Email Login

The Robotic Enterprise Framework is configured and optimized to get the input data from a list of e-mails. The Generic Re-Framework has been modified to create this framework. A set template has to be used to automate processes where the input data comes from an e-mail account. The code here works with a regular e-mail account but can also work with a shared e-mail account if configured correctly.

Pre-requisite:
The user should create a folder e-mail account, where the successfully processed e-mails are moved, and configure the processed e-mails/ folder in the configured .xls file format.

Following are the steps:
One can process a list of e-mails using this RE Framework. MailMessage is the datatype of the TransactionItem, and ListMailMessage> is the data type of the TransactionData. By default, Exchange Server is used to retrieve e-mails, one can also use other providers and modify the framework to operate with them.

The primary adjustment is that the list of e-mails is now marked as read at the End Process step rather than in the Init stage.

The other significant change brought about by this is that if the robot crashes in the middle of the operation, the unread e-mails that have not been processed will still be found if the robot is rerun.

Init: The "GetEmails.xaml" process is called from within the "GetInitialData.xaml" workflow. The list of unread emails gets expanded, but none of the emails are marked as read.

* 'GetAppCredentials.xaml' is called from within the GetEmails.xaml file. This is used to authenticate users on the Exchange server. One don't need that if they are working with Integrated Outlook.

Process: In addition to the code that any developer can add, the final step is to execute "MoveProcessedEmail.xaml," which, if the transaction was successful, moves the transaction item that was just processed into the processed emails folder (the one that was previously created and configured in the ProcessedEmailsMailFolder parameter in the Config.xlsx file).

End Process: All emails present in the folder the user previously created for the processed emails to be relocated are first marked as read before the workflow "MarkAsReadAllEmails.xaml" is invoked, which closes all open applications.

This modified Re-Framework is compatible with both standard email accounts and shared email accounts; however, for shared email, the developer must provide the necessary data to the Exchange activities used for reading, moving, and marking as read emails.

Exercise

1. Name the types of RPA tools.

2. What are the uses of RPA Tools?

3. Explain Robotic Enterprise (Re) Framework.

4. Describe Re-Framework Implementation Process.

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Robotic Enterprise (Re) Framework
Use of Re-Framework
Use of Re-Framework
Re-Framework Implementation Process
Re-Framework Workflows

6. Process of using the Robot Sensing and Machine Vision Technologies

Unit 6.1 Robotic Sensing System

Unit 6.2 Machine Vision System

ELE/N7121

Key Learning Outcomes 💡

By the end of this module, participants will be able to:
- Demonstrate the process of using robot sensing and machine vision system.

Unit 6.1 Robotic Sensing System

Unit Objectives 🎯

By the end of this unit, participants will be able to:

- Explain the use of sensors and sensor-based systems in robotics.

- Explain sensing, digitizing, image processing and analysis.

- Explain the use of robotic assembly sensors and intelligent sensors.

- Explain the difference between the contact and non-contact sensors.

- Explain different types of sensors used in robotics such as active, passive, contact and non-contact sensors.

6.1.1 Robotic Sensors

A robotic sensor assures that it runs without any problem. These sensors enable robots to respond to orders. These sensors contribute to the development of its "feel-and-see" characteristic, which enables the quick completion of a variety of activities. A robot can operate appropriately by determining its surroundings' temperature, object proximity, sound, and chemical reaction.

One needs to include numerous sensors in robots to provide dependable, efficient quality, quick response, accurate, and cost-effective solutions.

Sensors/Detectors/Transducers are electrical, optoelectrical, or electronic devices that use specialized electronics or other sensitive materials to determine if a particular entity or function is present. Sensors, detectors, and transducers for sensing a physical presence, such as flame, metals, leaks, levels, or gas and chemicals, are among the wide varieties available. Some are designed to detect physical elements like temperature, pressure, or radiation, while others are designed to detect motion or proximity. They can operate in a variety of methods, depending on the application, including employing optical or electromagnetic fields, among other things. Various types of sensors, detectors, and transducers are utilised in a wide range of applications in a wide range of sectors to test, measure, and control a wide range of processes and machine operations.

6.1.2 Need for Robotic Sensors

A robot sensor is used to assess the state of the robot and its surroundings. Robots use sensors to transmit electronic impulses so that they may carry out specified tasks. Robots require appropriate sensors to aid in self-control.

A robot sensor makes sure that it runs without a hitch. These sensors enable robots to respond to orders. They develop a feel-and-see ability thanks to these sensors, making a variety of activities simple to do. A robot can operate appropriately by determining its surroundings' temperature, item proximity, sound, and chemical response.

Robots need to include numerous sensors to provide dependable, efficient quality, rapid reaction, accurate, and cost-effective solutions.

6.1.3 Robotic Sensing

Robotic sensing is a branch of robotics research that offers robots the capacity to sense their surroundings to make them more like humans. Robotic sensing primarily allows robots to see, touch, hear, and move and employs algorithms that depend on environmental feedback.

Sensing & Digitizing Image Data
A camera is employed to sense and digitize data and examine the images. It will utilize unique lighting techniques to improve picture contrast. These pictures are converted to digital form, which is referred to as the vision data frame. A frame grabber is included for capturing digital images constantly at 30 frames per second. Every frame is separated into a matrix rather than shown as a scene. The number of pixels in the image may be determined by sampling.

A pixel is reduced to a size appropriate for sensing light intensity. Consequently, every pixel's intensity is converted into a digital value and saved in the computer's memory.

Processing and analysis of images:
The methods for data reduction and image interpretation are carried out in this function. An image frame's threshold is created as a binary picture to lower the data. Data reduction will transform the frame from raw picture data to feature value data. Computer programming may be used to calculate the feature value data. This is accomplished by comparing image characteristics- size and appearance—with the previously created computer data.

6.1.4 Intelligent Sensors

In 1979, NASA introduced the concept of intelligent sensors in developing a spaceship. The ground or spacecraft needs many sensors to receive data, such as temperature, position, velocity, and attitude, even though a large computer would be unable to process such massive data simultaneously. Moreover, the computer must be contained within a spacecraft due to its weight and size restrictions. When the sensor is combined with a microprocessor, the intelligent sensor should appear when it has an information processing function.

The intelligent sensor is a kind of function that can sense and detect information about a certain object, learn, judge, and process signals, and has a new kind of sensor with management and communication capabilities. The intelligent sensor can automatically calibrate, calibrate, compensate, and collect data. The capability of an intelligent sensor determines its accuracy, resolution, stability, and adaptability. Compared to traditional sensors, it has a high price-performance ratio.

Fig. 6.1.1 Intelligent Sensor in Ecobee Thermostat

Microprocessors operate intelligent sensors by converting the output signal from the sensor to the input signal of the microprocessor. The intelligent sensor mainly focused on microprocessors in the 80s and integrated the sensor signal conditioning circuit, microprocessor memory, and interface circuit into a chip, so it had AI capabilities. Intelligent measurement technology has been further improved in the 90s, such that the sensor can achieve miniaturization, integration, array, digital structure, convenient use, simple operation, and has self-diagnosis, memory and information processing functions, data storage functions, measurements of multiple parameters, networking functions, logical thinking, and judging functions.

6.1.5 Sensor Assembly

A sensor assembly is a device with an electric field sensor designed to detect the presence of a substance (other than a human touch input). Assembled Flexible Substrates, connections, housing and/or mounting mechanisms for the Sensor Assembly, Touch Sensor Technology, and, if applicable, an output device, such as a display or other audio/visual indication, are all possible components of the Sensor Assembly.

6.1.6 Contact and Non-Contact Sensors

Contact Sensors: Contact sensors are any sensing device that uses physical touch or contact between the sensor and the thing being viewed or monitored to identify a condition. Alarm systems employ an essential sort of touch sensor to monitor doors, windows, and other entry points. A magnetic switch sends an indicator to the alarm control unit when the door or window is closed, allowing the status of that entry point to be known.

When a door or window is opened, the contact sensor signals the alarm controller, which may cause an action such as activating an audio siren. Contact sensors may be used for various purposes, including temperature monitoring and proximity sensors in robotics applications and automated machinery.

Fig 6.1.2 Contact Sensors

Non-contact sensors: Non-contact sensors do not require physical contact between the sensor and the monitored item to function. The motion detector in security lights is an example of this sort of sensor. Objects within a motion detector's range are detected using non-mechanical or non-physical methods, such as passive infrared radiation, microwave energy, ultrasonic waves, etc. Another type of non-contact sensor is radar guns, which law enforcement employs to monitor vehicle speeds. Inductive sensors, Hall-effect sensors, Eddy current sensors, LVDTs (linear variable differential transformers), and RVDTs (rotary variable differential transformers) are only a few examples of non-contact sensors.

Fig 6.1.3 Non-Contact Sensors

Difference between Contact and Non-Contact Sensors
Direct physical contact or indirect sensing are viable options for measuring, monitoring, or detecting a certain condition or state. A sensor is referred to be a contact sensor if direct physical contact is made with it. Examples of touch sensors are a straightforward thermometer placed in a swimming pool to detect the water's temperature or a float placed within a tank and used to power a gauge that shows the quantity of fluid inside the tank. For any sensor to work, the measured item or substance must be in direct physical contact with the detecting device.

Non-contact sensors, on the other hand, are those that can operate without having to touch the thing being monitored physically. For instance, a nurse or doctor may use an infrared thermometer to take a patient's temperature rather than an oral thermometer, which must be physically inserted in the patient's mouth so that the thermometer bulb may make contact. This kind of thermometer employs infrared radiation to determine a temperature measurement rather than making direct physical touch, which is an example of non-contact sensor technology.

Therefore, non-contact sensors typically use technologies based on electrical, magnetic, optical, acoustic, or other principles to get readings rather than relying on physical touch or mechanical movement. In order to detect a state without physical touch, the sensors frequently release an energy form like radiation. The target is often used to refer to the thing that is being felt or detected.

6.1.7 Passive and Active Sensorsy

Passive Sensors: A passive sensor is a microwave device created to detect and quantify the natural emissions emitted by the surface and atmosphere of the Earth. The surface composition, physical temperature, surface roughness, and other physical features of the Earth all affect the power that passive sensors monitor. The measuring substance's fixed physical characteristics (molecular resonance) establish the frequency ranges for passive sensor readings. Information cannot be reproduced in other frequency ranges since these frequencies are constant.

In order to detect very low power emissions, passive sensors are modelled after radio astronomy devices. They are extremely sensitive to cumulative radiation from several ground-based emitters, both within the measuring frequency band and from out-of-band. The capacity to collect worldwide measurements of the Earth and its atmosphere in all weather conditions, day and night, is made possible by space-based passive sensors. These satellite-based passive sensors function in frequency ranges designated for the Earth Exploration Satellite Service or the Space Research Service.

Fig 6.1.4 Passive and Active Sensors

Active Sensors: A radar device that measures signals that were transmitted by the sensor but were reflected, refracted, or scattered by the Earth's surface or atmosphere is known as an active sensor. There are several uses for space-based active sensors in meteorology and the study of the Earth's surface and atmosphere. Examples include cloud profile radars, which measure the radar echo return from clouds to provide a three-dimensional profile of cloud reflectivity over the Earth's surface, and precipitation radars, which measure the radar echo from rainfall to determine the rate of rainfall over the Earth's surface
.
Active space-based sensors work for either the Space Research Service or the Earth Exploration-Satellite Service. Since other radar systems are typically able to operate in harmony with active sensor operation, active sensor frequency allocations are frequently shared with these systems.

6.1.8 Other Robotic Sensorsa

The types of sensors are:

1. Vision and Imaging Sensors: Electronic devices that detect the presence of objects or colours inside their fields of view and transform this information into a visual picture for display are known as vision and imaging sensors/detectors. Sensor type and intended application, as well as any special transducer properties, are essential parameters.

Fig 6.1.5 Vision and Imaging Sensors

2. Temperature sensors: Temperature sensors, detectors, and transducers are electrical devices that detect thermal characteristics and provide signals to control and display devices' inputs. An RTD or thermistor is used in most temperature sensors to monitor temperature and convert it to an output voltage. Sensor/detector type, maximum and lowest measurable temperatures, and diameter and length parameters are essential. The thermal characteristics of liquids, gases, and solids in many process industries are measured by temperature sensors and configured for general and special purposes.

Fig 6.1.6 Temperature Sensors

3. Proximity Sensors: Proximity sensors are electrical devices that employ non-contact methods to detect the presence of surrounding objects. A proximity sensor may detect the presence of objects at a range of up to several millimetres and provide a dc output signal to a controller as a result. In many industrial operations, these sensors detect the presence of goods and machine components. Sensor type, maximum sensing distance, minimum and maximum working temperatures, and diameter and length measurements are all essential characteristics. Proximity sensors are typically short-range devices; however, variants that can detect things up to several inches away are also available. A capacitive proximity sensor is a type of proximity sensor that is extensively utilized.

This gadget determines the motion and location of the item from the sensor by measuring the change in capacitance caused by a reduction in the separation distance between the plates of a capacitor, one of which is attached to the object being viewed.

Fig 6.1.7 Proximity Sensors

4. Position Sensors: Position Sensors/Detectors/Transducers are electronic devices that sense the positions of valves, doors, throttles, and other similar devices and send signals to control or display devices' inputs. Sensor type, sensor function, measurement range, and sensor-specific properties are essential. Position sensors are utilized in various control applications where positioning information is required. A string-pot, sometimes known as a string potentiometer, is a typical position transducer.

Fig 6.1.8 Position Sensors

5. Motion Sensors: Motion Sensors/Detectors/Transducers are electrical devices that detect the movement or stopping of components, people, or other objects and provide signals to control or display devices' inputs. Motion detection is commonly used to detect the stalling of conveyors or the seizing of bearings. The intended application, sensor type, function, and minimum and maximum speeds are all important characteristics.

Fig 6.1.9 Motion Sensors

6. Force Sensors: Force Sensors/Transducers are electronic devices that measure numerous characteristics linked to forces, such as load, weight, torque, etc., and provide signals to control or display devices' inputs. In force sensors, a load cell is a piezoelectric device whose resistance fluctuates owing to deforming stresses. Torque and strain can also be measured using other ways. Sensor function, minimum and maximum loads (or torques), number of axes, minimum and maximum working temperature, and sensor size are all essential requirements. From truck scales to bolt tensioning devices, force sensors are employed in various load measurement applications.

Fig 6.1.10 Force Sensors

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https://youtu.be/KlF_70KPxe0

Robotic Sensors
Robotic Sensing

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Intelligent Sensors

Unit 6.2 Machine Vision System

Unit Objectives ⊚

By the end of this unit, participants will be able to:

- Explain the architecture and use of machine vision systems in robotics.

- Explain the visual servo-control.

- Explain various image processing techniques.

- Explain the binary morphological operations.

- Explain different types of cameras used for machine vision.

- Explain the different specialized lighting techniques.

- Describe different methods of segmentation.

6.2.1 Machine Vision System

In machine vision systems (MVS), a computing device inspects, evaluates, and identifies still or moving images.

It is a branch of computer vision similar to security cameras but capable of capturing, analyzing, and processing images automatically.

Digital cameras, back-end hardware, and software for image processing are the standard components of a machine vision system. The front-end camera takes pictures of the surroundings or a targeted item and delivers them to the processing system. The recorded pictures are either saved or processed according to the MVS's design or need.

The machine vision system allows robots to recognize objects using a computer to view them. It is mainly utilised for inspection reasons in industrial robots. Computer vision or artificial vision are other names for this system. It consists of a number of parts, including a camera, a computer, digitising equipment, and interface hardware and software. Three crucial tasks are involved in the machine vision process, namely:

1. Sensing & Digitizing Image Data

2. Image Processing & Analysis

3. Applications

6.2.2 Machine Vision System Architecture

Machine vision systems are different from other systems in that their electrical architecture is more generic. A general high-level architecture used in machine vision systems is depicted in the block diagram below. Some of the blocks listed below may be merged into a more potent processor in these systems, which can have varying degrees of integration and form factors.

Microprocessors operate intelligent sensors by converting the output signal from the sensor to the input signal of the microprocessor. The intelligent sensor mainly focused on microprocessors in the 80s and integrated the sensor signal conditioning circuit, microprocessor memory, and interface circuit into a chip, so it had AI capabilities. Intelligent measurement technology has been further improved in the 90s, such that the sensor can achieve miniaturization, integration, array, digital structure, convenient use, simple operation, and has self-diagnosis, memory and information processing functions, data storage functions, measurements of multiple parameters, networking functions, logical thinking, and judging functions.

Fig. 6.2.1 Machine Vision Architechture

As machine vision is a capacity rather than a product or particular kind of design, there is no defining machine vision system that can be used as a benchmark for other systems. As seen in the block diagram above, machine vision systems share similar traits, although they are implemented using various component sets. To show how image processing methods may be implemented effectively, we need to start at the processor level rather than spouting lists of parts to enable machine vision systems.

6.2.3 Visual Servo Control

The term "visual servo control" describes the use of computer vision data to regulate a robot's movements. The camera may be set in the workspace so that it may view the robot's motion from a stationary position, or it may be installed directly on a robot manipulator or on a mobile robot, in which case movement of the robot causes camera motion. Other arrangements might be taken into account, including many cameras set on pan-tilt heads and watching the robot's movement.

6.2.4 Image Processing Techniques

Image processing is a technique for applying operations on an image to improve or extract information from it. There are many uses for digital image processing, including picture restoration, medical imaging, remote sensing, image segmentation, etc. There are many techniques needed for each step.

The main techniques used in machine vision systems are:

1. Image Restoration
2. Linear Filtering
3. Independent Component Analysis
4. Pixelation
5. Template Matching
6. Image Generation Technique (GAN)

6.2.5 Morphological Image Processing

Morphological image processing is a group of non-linear processes concerned with the form or morphology of features in an image. According to Wikipedia, morphological procedures are particularly well adapted to the processing of binary pictures since they only depend on the relative ordering of pixel values rather than their numerical values. Greyscale pictures can also be subjected to morphological processes such that their light transfer functions are unknown and their absolute pixel values are of no or very little importance.

An picture is probed by morphological approaches using a tiny form or template known as a structuring element. The structuring element is placed in each conceivable spot inside the image and contrasted with the surrounding pixels in that area. Different operations determine if an element "hits" or intersects the neighbourhood, while others determine whether it "fits" inside the neighbourhood.

Fig. 6.2.2 Probing of an image with a structuring element
(white and grey pixels have zero and non-zero values, respectively)

When performing morphological operations on binary images, the resultant binary image only contains pixels with non-zero values when the test at that place in the input picture is successful.

A small binary picture, or a small matrix of pixels, each with a value of zero or one, serves as the structural element:

- The structuring element's size is determined by the matrix's dimensions.
- The structuring element's form is determined by the pattern of ones and zeros.
- Although often the origin might be outside the structuring element, an origin of the structuring element is one of its pixels.

Fig. 6.2.3 Examples of simple structuring elements

It is customary to specify the origin as the centre of the structuring matrix and to have odd dimensions for the matrix. Similar to convolution kernels in linear image filtering, structuring components are used in molecular imaging.

Each pixel of a structuring element that is inserted in a binary picture is connected to the matching pixel of the neighbourhood that is underneath the structuring element. If each of the structuring element's pixels is set to 1, and the matching pixel in the picture is likewise 1, then it is said to fit the image. A structuring element also "hits" or "intersects" a picture if at least one of its pixels is set to 1 and the corresponding pixel in the image is likewise 1.

Fig. 6.2.4 Binary image's fitting and hitting using the structural components s1 and s2.

The structuring element's zero-valued pixels serve as markers for places where the accompanying picture value is unimportant.

6.2.6 Types of Machine Vision Cameras

Basically cameras can be divided into two types:

Analog
Analog cameras transmit a continuously varying electronic signal. This signal's frequency and amplitude are interpreted by the analog output device as video information.

Digital
Digital cameras transmit the data in binary form (in the form of zeroes and ones) as the electronic signal. An output device then converts the binary data into video output. Unlike analog cameras, the transmitted data from digital cameras is invariant and hence, can be interpreted in a unique way.

Four different types of camera formats are available, and they are as follows:

Interlaced
Interlaced cameras are conventional cameras that output an electronic signal compatible to be viewed directly on video monitors. The image is divided into two parts (odd and even) that are exposed sequentially. These parts are integrated to get the full picture. This output sequence was initially adopted to lower transmission bandwidth and reduce jerkiness in the displays.

Progressive
Instead of scanning in two parts like interlaced cameras, progressive cameras scan the lines once, sequentially. The output from progressive cameras, however, are not standardised and few monitors are capable of displaying the image.

Line scan
Line scan cameras use a sensor that is long and narrow. To generate a 2D image with a line scan camera, the object is made to move along the narrow axis of the sensor, scanning one line at a time and reconstructing the image with software. It is essential to coordinate the timing of the line scan sensor with the movement of the object, to obtain stable and useful images. The pixels, in line scan cameras, are arranged in a linear fashion that allows for long arrays.

Area scan
Imaging sensors in area scan cameras have both, length and breadth. Area scan cameras are mostly used when the entire picture is to be collected at once or when synchronizing the movement of the object with the sensors is difficult. In these cameras, the imaging lens focuses the object to be imaged onto the sensor and that image is sampled at pixel level for reconstruction.

6.2.7 Vison Lighting Technique

Vision lighting technique describes the actual physical placement of a light in relation to the target. There are five typical lighting methods for vision: on-axis lighting, low-angle ring lighting, directional lighting (bright-field and dark-field), and ring lighting.

1. Ring Lighting

Fig. 6.2.5 Ring Lighting

In general vision exams, ring lighting is the tried-and-true standard in vision illumination. For simplicity, both components of standard ring lights can be installed as a single unit straight to the camera or vision sensor. Ring lights are particularly helpful for checking small parts since they vividly brighten the space in front of the camera.

2. Backlighting

Fig. 6.2.6 Backlighting

Backlighting involves placing the light source behind the item and shining it straight into the camera. Typically, this is done using a customised backlight that emits even, high-intensity light. The highest contrast lighting technology currently used, backlighting creates a binary image that is simple to comprehend.

Backlighting produces a picture that depicts the component's dark shadow for opaque objects (a silhouette). The correct size and shape of the silhouette may then be checked. For high accuracy applications including precise measuring, gauging small components, detecting the presence or absence of holes, and confirming part placement and orientation, backlit pictures with high contrast are appropriate.

It is a typical approach for transparent items when checking for flaws or determining the degree of translucency. Backlighting is not an effective method for spotting surface defects.

3. Directional Lighting

Fig.6.2.7 Area Lighting

When aimed at an angle away from the lens, directional lighting avoids the glare of shiny surfaces and produces shadows to spotlight certain surface angles and detect changes in depth. There are two types of directional lighting: bright-field and dark-field.

The light source is positioned in bright-field directed lighting such that it shines more or less perpendicular to the target, giving the appearance that the item is bright. Although not clearly contrasted, the characteristics on the object's surface are evident. On extremely reflecting surfaces, bright-field illumination can, however, cause glare and hotspots and may not be able to reveal surface structure.

The light source is positioned at a low angle in dark-field directed lighting so that its light bounces off the subject and away from the camera. Although surface flaws, elevated features, and textures seem brilliant and stand out from the rest of the target under dark-field illumination, the overall image is darker. When analysing bright things, dark-field illumination minimises glare, making it perfect. This method may also be used to assess height changes by casting readily measurable shadows.

Area lights, spotlights, and bar lights are typical light fixtures that emit directed illumination. Independent of the optical axis of the vision sensor, area lights and spotlights may be put within the current inspection to offer even lighting in a focused region. To increase optical contrast, users can adjust the light's distance or direction without adding fixtures or realigning the examined parts.

Bar lights, often referred to as linear array lights, provide higher intensity illumination to illuminate wide areas while piercing through filth, mist, and dust. For dependable precise examinations of larger items at greater distances, bar lights produce the visual contrast required by providing a clean, bright, and even lighting.

4. Low Angle Ring Lighting

Fig. 6.2.8 Low Angle Ring Lighting

A low angle ring light, a type of dark-field illumination, has its LEDs positioned in a ring and pointed in a direction that is practically perpendicular to the camera's field of vision. To measure changes in surface texture and depth, low angle ring lights produce bright spots and shadows. Examining etching, embossed markings, and surface flaws is best done using low-angle ring illumination.

5. On-Axis Lighting

Fig. 6.2.9 On-Axis Lighting

.An on-axis light, a type of bright-field illumination, concentrates light along the optical axis of the camera using a beam splitter, producing direct and diffuse light that makes reflecting objects brilliant without glare. Through the on-axis light, the camera views the target area below from the top.

This method may be applied to get rid of shadows, examine shiny objects, or find variations in surface texture. In terms of which features look dark and brilliant, the pictures produced by the on-axis light and the low angle light are diametrically opposed.

6.2.8 Image Segmentation

Image segmentation is a subset of digital picture processing that focuses on dividing an image into distinct sections based on its characteristics and qualities. Picture segmentation's main objective is to make the image simpler for easy analysis. When segmenting a picture, users break it up into several portions with related characteristics. Image Objects are the segments users split the image into.

For image analysis, it is the initial stage. One would have a very difficult time implementing computer vision without doing picture segmentation.

Using image segmentation techniques, one may separate and group particular pixels from an image, label these groups, and then categorise additional pixels using these labels. One may add borders, draw lines, and isolate some things (critical elements) in a picture from the other objects (unimportant components). The labels users created through picture segmentation may be used in machine learning for both supervised and unsupervised training. One might address a variety of business issues in this way.

Exercise

1. What are robotic sensors and why are they needed?

2. Explain in brief about intelligent sensors.

3. Differentiate between Contact and Non-Contact Sensors.

4. Explain the architecture and use f machine vision systems in robotics.

5. Name different types of cameras used for machine vision.

Notes

7. Soft Skills and Work Ethics

Unit 7.1 – Effective Communication and Coordination at Work

Unit 7.2 – Working Effectively and Maintaining Discipline at Work

Unit 7.3 – Maintaining Social Diversity at Work

Key Learning Outcomes 🔆

By the end of this module, participants will be able to:

- Work effectively at the workplace

- Demonstrate practices related to gender and PwD sensitization

Unit 7.1 – Effective Communication and Coordination at Work

Unit Objectives ⊚

By the end of this unit, participants will be able to:

- State the importance of work ethics and workplace etiquette
- State the importance of effective communication and interpersonal skills
- Explain ways to maintain discipline in the workplace
- Discuss the common reasons for interpersonal conflict and ways of managing them effectively.

7.1.1 Importance of Work Ethics and Workplace Etiquette

Workplace ethics are a set of moral and legal guidelines that organizations follow. These guidelines influence the way customers and employees interact with an organization. Workplace ethics essentially guide how an organization serves its clients and treats its employees.

For example, if a company seeks to fulfil the promises it makes, it may develop processes and set up a robust support system to address this policy and build customer/client loyalty. To achieve this goal, the company may implement specific incentive programs for employees to encourage them to produce high-quality work and ensure the organization fulfils the promises it makes to its clients/ customers.

Many organizations, often the large ones, set detailed ethical codes to guide their operations and control how the organizational processes impact the stakeholders. These ethics usually help organizations maintain certain standards of responsibility, accountability, professionalism and among others, as they navigate through different challenges and day-to-day circumstances. By following these guidelines, organizations often experience several benefits that improve the lives of stakeholders, such as customers, employees, leaders, etc.

Examples of Common Workplace Ethics

Fig 7.1.1 Examples of Common Workplace Ethics

Workplace ethics are essential for a successful organization with a satisfied and loyal team. High ethical standards help in ensuring all stakeholders, such as customers, investors, employees, and other individuals involved in the workplace operations, feel the organization is safeguarding their interests. By creating and implementing ethical guidelines, organizations can keep the best interests of their employees in mind while maintaining a positive influence on those they impact through their processes.

As a result, employees maintain the organization's best interests by being ethical in their daily work duties. For example, fairly-treated employees of an organization who understand the organization's commitments to environmental sustainability are usually less likely to behave in a manner that causes harm to the environment. Thus, they help maintain a positive public image of the organization. It means that workplace ethics help in maintaining reciprocal relationships that benefit organizations at large and the individuals associated with and influenced by the organizational policies.

Benefits of Workplace Ethics
There are various benefits of implementing workplace ethics. When organizations hold themselves to high ethical standards, leaders, stakeholders, and the general public can experience significant improvements. Following are some of the key benefits of employing ethics in the workplace:

Employee statisfaction

Improved workplace culture

Legal compliance

Improved public reputation

Customer engagement and loyalty

Stream lined decision-making processes

Fig 7.1.2 Benefits of Workplace Ethics

7.1.2 Interpersonal Communication

Interpersonal communication is a process that involves sharing ideas and emotions with another person, both - verbally and non-verbally. It is essential to interact effectively with others in both personal and professional lives. In professional life or the workplace, strong interpersonal skills play a crucial role in achieving effective collaboration with colleagues.

Interpersonal Skills
Interpersonal skills, in other terms, are known as people skills, which are used to communicate and interact with others effectively. These are soft skills one uses to communicate with others and understand them. One uses these skills in daily life while interacting with people

Examples of Interpersonal Skills

Active listening
Teamwork
Responsibility
Dependability
Leadership
Motivation
Flexibility
Patience
Empathy
Conflict resolution
Negotiation

Fig 7.1.3 Examples of Interpersonal Skills

Numerous interpersonal skills involve communication. Communication can be verbal, such as persuasion or tone of voice — or non-verbal, such as listening and body language.

Importance of Interpersonal Skills
Interpersonal skills are essential for communicating and collaborating with groups and individuals in both personal and professional life. People with strong interpersonal skills often are able to build good relationships and also tend to work well with others. Most people often enjoy working with co-workers who have good interpersonal skills.

Among other benefits of good interpersonal skills is the ability to solve problems and make the best decisions. One can use the ability to understand others and good interpersonal communication skills to find the best solution or make the best decisions in the interest of everyone involved. Strong interpersonal skills help individuals work well in teams and collaborate effectively. Usually, people who possess good interpersonal skills also tend to be good leaders, owing to their ability to communicate well with others and motivate the people around them.

Interpersonal communication is the key to working in a team environment and working collectively to achieve shared goals. Following are the interpersonal communication skills that vital for success at work:

Verbal Communication
The ability to speak clearly, appropriately and confidently can help one communicate effectively with others. It is vital to select the appropriate vocabulary and tone for the target audience.
For example – one should speak formally and professionally in the work environment, while informal language is acceptable in an intimate environment with close friends and family. Also, one should avoid using complex or technical language while communicating with an audience that may not be familiar with it. Using simple language in a courteous tone helps achieve better communication, irrespective of the audience.

Active Listening
Active listening is defined as the ability to pay complete or undivided attention to someone when they speak and understand what they are saying. It is important for effective communication because without understanding what the speaker is saying, it becomes difficult to carry forward a conversation. One should ensure to use appropriate verbal and non-verbal responses, e.g. eye contact, nodding, or smiling, to show interest in what the speaker says. Active listening is also about paying attention to the speaker's body language and visual cues. Asking and answering questions is one of the best ways to demonstrate an interest in conversing with the other person.

Active listening is critical for communicating effectively without ambiguity. It helps one understand the information or instructions being shared. It may also encourage co-workers to share their ideas, which ultimately helps achieve collaboration.

Body Language
One's expression, posture, and gestures are as important as verbal communication. One should practice open body language to encourage positivity and trust while communicating. Open body language includes - maintaining eye contact, nodding, smiling and being comfortable. On the other hand, one should avoid closed body language, e.g. crossed arms, shifting eyes and restless behaviour.

Empathy
Empathy is the ability to understand the emotions, ideas and needs of others from their point of view. Empathy is also known as emotional intelligence. Empathetic people are good at being aware of others' emotions and compassionate when communicating with them. Being empathetic in the workplace can be good to boost the morale of employees and improve productivity. By showing empathy, one can gain the trust and respect of others.

Conflict Resolution
One can use interpersonal communication skills to help resolve disagreements and conflicts in the workplace. This involves the application of negotiation and persuasion skills to resolve arguments between conflicting parties. It is also important to evaluate and understand both sides of the argument by listening closely to everyone involved and finding an amicable solution acceptable to all.

Good conflict resolution skills can help one contribute to creating a collaborative and positive work environment. With the ability to resolve conflicts, one can earn the trust and respect of co-workers.

Teamwork
Employees who communicate and work well in a team often have better chances of achieving success and common goals. Being a team player can help one avoid conflicts and improve productivity. One can do this by offering to help co-workers when required and asking for their feedback and ideas. When team members give their opinions or advice, one should positively receive and react to the opinions/advice. One should be optimistic and encouraging when working in groups.

Improving Interpersonal Skills
One can develop interpersonal skills by practising good communication and setting goals for improvement. One should consider the following tips to improve their interpersonal skills:

- One should ask for feedback from co-workers, managers, family or friends to figure out what n e e d s improvement concerning their interpersonal skills.

- One can identify the areas of interpersonal communication to strengthen by watching others

- One can learn and improve interpersonal skills by observing co-workers, company leaders and professionals who possess good interpersonal skills. This includes watching and listening to them to note how they communicate and the body language used by them. It is vital to note their speed of speaking, tone of voice, and the way they engage with others. One should practice and apply such traits in their own interactions and relationships.

- One should learn to control their emotions. If stressed or upset, one should wait until being calm to have a conversation. One is more likely to communicate effectively and confidently when not under stress.

- One can reflect on their personal and professional conversations to identify the scope of improvement and learn how to handle conversations better or communicate more clearly. It helps to consider whether one could have reacted differently in a particular situation or used specific words or positive body language more effectively. It is also vital to note the successful and positive interactions to understand why they are successful.

- One should practice interpersonal skills by putting oneself in positions where one can build relationships and use interpersonal skills. For example, one can join groups that have organized meetings or social events. These could be industry-specific groups or groups with members who share an interest or hobby.

- Paying attention to family, friends and co-workers and making efforts to interact with them helps a lot. One should complement their family, friends and co-workers on their good ideas, hard work and achievements. Trying to understand someone's interests and showing interest in knowing them can help one build strong interpersonal skills. Offering to help someone, especially in difficult situations, helps build stronger and positive workplace relationships.

- One should avoid distractions, such as a mobile phone, while interacting with someone. Giving someone full attention while avoiding distractions helps achieve a clear exchange of ideas. By listening with focus, one can understand and respond effectively.

- One can attend appropriate courses on interpersonal skills or sign up for workshops at work to improve interpersonal skills. One can find many resources online also, such as online videos.

- For personal mentoring, one can approach a trusted family member, friend, co-worker, or current/former employer. A person one looks up to with respect and admires is often a good choice to be selected as a mentor. One can even hire a professional career or communication coach.

- Interpersonal communication skills often help one boost their morale, be more productive in the workplace, complete team projects smoothly and build positive and strong relationships with co-workers.

Unit 7.2 – Working Effectively and Maintaining Discipline at Work

Unit Objectives 🎯

By the end of this unit, participants will be able to:

- Discuss the importance of following organizational guidelines for dress code, time schedules, language usage and other behavioural aspects

- Explain the importance of working as per the workflow of the organization to receive instructions and report problems

- Explain the importance of conveying information/instructions as per defined protocols to the authorised persons/team members

- Explain the common workplace guidelines and legal requirements on non-disclosure and confidentiality of business-sensitive information

- Describe the process of reporting grievances and unethical conduct such as data breaches, sexual harassment at the workplace, etc.

- Discuss ways of dealing with heightened emotions of self and others.

7.2.1 Discipline at Work

Discipline is essential for organizational success. It helps improve productivity, reduce conflict and prevent misconduct in the workplace. It is important to have rules concerning workplace discipline and ensure that all employees comply with them. In the absence of discipline, a workplace may experience conflicts, bullying, unethical behaviour and poor employee performance. An efficient workplace disciplinary process helps create transparency in the organization. Benefits of disciplinary standards:

All employee follow the same rules which helps establish uniformity and equality in the workplace

Managers and supervisors have defined guidelines on what action to take while initiating disciplinary action

With well-defined and enforced disciplinary rules, an organization can avoid various safety, security, rupational risks

Fig 7.2.1 Benefits of Disciplinary Standards

Maintaining an organized and cohesive workforce requires maintaining discipline in both personal and professional behaviour. It is important to follow the appropriate measures to keep employees in line without affecting their morale.

Defining Discipline

The first and crucial step in maintaining workplace discipline is to define what is meant by discipline. It helps to evaluate common discipline problems and devise guidelines for handling them effectively.

Among a number of areas, discipline usually covers:

Fig 7.2.2 Examples of Workplace Discipline

According to demography and local issues, it may also include substance use and related issues.

It is vital for a workplace to have an employee handbook or company policy guide, to serve as a rulebook for employees to follow. The employee handbook/ company policy guide should be reviewed and updated periodically according to any issues or areas, or concerns identified concerning workplace discipline. Such manuals should also cover all the laws and regulations governing workplace behaviour.

Defining and documenting workplace rules aids in their implementation, ensuring little or no ambiguity. All employees in a workplace should also have easy access to the workplace guidelines so that they can refer to them to get clarity whenever required. To maintain discipline at work, it is also critical to ensure uniform application of workplace guidelines to all employees without exception.

7.2.2 Employee Code of Conduct

The employee code of conduct manual serves as a guide for employees to inform them regarding the behaviour expected from them at work. It helps create a good work environment with consistent behaviour from employees. The manual should list examples of acceptable and not acceptable behaviours at work. The code of conduct should be discussed with employees so that they have the clarifications required.

For example, an organization may create guidelines concerning the conduct with clients to ensure no contact is made with them except for business purposes, also prescribing the use of appropriate means of communication.

Employees should have a clear understanding concerning their job responsibilities and the behaviour expected from them with all stakeholders, e.g. company personnel, clients and associated third parties. It is critical to have documented guidelines for employees to follow concerning all aspects of work. It should also document the disciplinary action to be followed in case of non-compliance, e.g. verbal and then written warning, temporary suspension or eventual termination of service in case of repeated non-compliance with the employee code of conduct. Employees should know what the company rules are and what will happen if they break the rules. However, disciplinary action should be initiated only when reasonably required to avoid its misuse for employee harassment.

There should also be an effective mechanism for employees to raise their concerns/ grievances and have them addressed while maintaining privacy, as required, e.g. raising concerns regarding the behaviour of a co-worker.

The employee code of conduct manual must be duly reviewed and approved by the concerned stakeholders, such as the Human Resources (HR) department and company executives.

7.2.3 Interpersonal Conflicts

Interpersonal conflict is any type of conflict between two or more people. These are found in both - personal and professional relationships - among friends, family, and co-workers. In the workplace, interpersonal conflict is often observed when a person or group of people interfere with another person's attempts at completing assignments and achieving goals. It is critical to resolve conflicts in the workplace to boost the morale of employees, repair working relationships among them, and improve customer satisfaction.

Reasons for Workplace Conflicts
Workplace conflicts are often observed when two or more people have different points of view. This can happen between managers, co-workers, or clients and customers. In general, interpersonal conflicts are caused by a lack of communication or unclear communication.

Some of the leading reasons for workplace conflicts are:

- Difference in values

- Personality clashes

- Poor communication

Example of poor communication – if a manager reassigns a task to another employee without communicating with the employee to whom it was originally assigned, interpersonal conflict can arise among them. This may potentially make the first employee, i.e. who was originally assigned the task, feel slighted and mistrusted by the manager. It may even cause animosity in the first employee toward the employee who has now been assigned the task.

Types of Interpersonal Conflict

Following are the four types of interpersonal conflicts:

a. **Policy-related interpersonal conflict**
    When a conflict relates to a decision or situation that involves both parties, it can be called a policy-related interpersonal conflict. Example – two people or groups working on the same project, trying to adopt different approaches. To resolve policy-related interpersonal conflicts, the parties involved should try to look for a win-win situation or make a compromise. This is especially critical to resolve trivial issues so that work is not affected and common goals are achieved.

a. **Pseudo-conflicts**

   Pseudo-conflict arises when two people or groups want different things and cannot reach an agreement. Pseudo-conflicts usually involve trivial disagreements that tend to hide the root of the issue.

b. **Ego-related interpersonal conflicts**

   In ego conflicts, losing the argument may hurt or damage a person's pride. Sometimes ego conflicts arise when a number of small conflicts pile up on being left unresolved. To resolve ego-related conflicts, it's best to find the root of the issue and work towards a resolution.

c. **Value-related interpersonal conflicts**

   Sometimes conflicts may occur between people when they have different value systems. Such conflicts can be difficult to identify initially, making the people involved think the other party is being disagreeable or stubborn, wherein they just have different values. Some co-workers may highly value their personal/ family time after office that they may be unreachable to clients during non-office hours, while others may place a high value on client satisfaction and may still be available for clients during non-office hours. Conflict may arise among such people when they may be required to coordinate to help a client during after-office hours. Value-related interpersonal conflicts are often difficult to settle since neither party likes to compromise.

Resolving Interpersonal Conflicts

Conflicts are usually likely in the workplace; they can, however, be prevented. Often resolving interpersonal conflicts through open communication helps build a stronger relationship, paving the way for effective coordination and success. Some ways to resolve interpersonal conflict:

- **Communication** - A great way to resolve interpersonal conflicts is for the opposing parties to listen to one another's opinions and understand their viewpoints. Meeting in person and keeping the conversation goal-oriented is important. One can have effective communication by following some measures, e.g. staying on the topic, listening actively, being mindful of the body language, maintaining eye contact, etc.

- **Active Listening** - One should patiently listen to what the other person is saying without interrupting or talking over them. It helps one display empathy and get to the root of the issue. Asking questions to seek clarification when required helps in clear communication and conveys to the other person that one is listening to them. Practising active listening is a great way to improve one's communication skills.

- **Displaying Empathy** - Listening attentively and identifying the anxieties/ issues of co-workers is a great way to show empathy and concern. It is essential to understand their feelings and actions to encourage honesty and avoid future conflict.

- **Not Holding Grudges** - With different types of people and personalities in a workplace, it is common for co-workers to have conflicts. It is best to accept the difference in opinions and move on. Being forgiving and letting go of grudges allows one to focus on the positive side of things and perform better at work.

Work-related interpersonal conflicts can be complicated because different people have different leadership styles, personality characteristics, job responsibilities and ways in which they interact. One should learn to look above interpersonal conflicts, resolving them to ensure work goals and environment are not affected.

7.2.4 Importance of Following Organizational Guidelines

Policies and procedures or organizational guidelines are essential for any organization. These provide a road map for the operations of the organization. These are also critical in ensuring compliance with the applicable laws and regulations by guiding the decision-making process and business operations.

Organizational guidelines help bring uniformity to the operations of an organization, which helps reduce the risk of unwanted and unexpected events. These determine how employees are supposed to behave at work, which ultimately helps the business achieve its objectives efficiently.

However, organizational guidelines are ineffective and fail to serve their purpose if they are not followed. Many people don't like the idea of following and abiding by specific guidelines. Such people should be made to understand the benefits of following the organizational guidelines. Some of the key benefits are given below:

With well-defined organizational guidelines in place, no individual can act arbitrarily, irrespective of their position in the organization. All individuals will know the pros and cons of taking certain actions and what to expect in case of unacceptable behaviour. Benefits of following organizational guidelines:

- **Consistent processes and structures** - Organization guidelines help maintain consistency in operations, avoiding any disorder. When all employees follow the organizational guidelines, an organization can run smoothly. These ensure that people in different job roles operate as they are supposed to, knowing what they are responsible for, what is expected of them, and what they can expect from their supervisors and co-workers. With clarity in mind, they can do their jobs with confidence and excellence. With every person working the way intended, it's easy to minimise errors.
  With all the staff following organizational guidelines, the organization has a better scope of using time and resources more effectively and efficiently. This allows the organization to grow and achieve its objectives.

- **Better quality service** - By following organizational guidelines, employees perform their duties correctly as per the defined job responsibilities. It helps enhance the quality of the organization's products and services, helping improve the organization's reputation. Working with a reputable organization, employees can take pride in their work and know they are contributing to the reputation.

- **A safer workplace** - When all employees follow organizational guidelines, it becomes easy to minimise workplace incidents and accidents. It reduces the liabilities associated with risks for the organization and limits the interruptions in operations. Employees also feel comfortable and safe in the workplace, knowing their co-workers are ensuring safety at work by following the applicable guidelines.

Different organizations may have different guidelines on dress code, time schedules, language usage, etc. For example – certain organizations in a client-dealing business requiring employees to meet clients personally follow a strict dress code asking their employees to wear formal business attire. Similarly, organizations operating in specific regions may require their employees to use the dominant regional language of the particular region to build rapport with customers and serve them better. Certain organizations, such as banks, often give preference to candidates with knowledge of the regional language during hiring.
Working hours may also differ from one organization to another, with some requiring employees to work extra compared to others. One should follow the organizational guidelines concerning all the aspects of the employment to ensure a cohesive work environment.

7.2.5 Workflow

Workflow is the order of steps from the beginning to the end of a task or work process. In other words, it is the way a particular type of work is organised or the order of stages in a particular work process.

Workflows can help simplify and automate repeatable business tasks, helping improve efficiency and minimise the room for errors. With workflows in place, managers can make quick and smart decisions while employees can collaborate more productively.

Other than the order that workflows create in a business, these have several other benefits, such as:

- **Identifying Redundancies** - Mapping out work processes in a workflow allows one to get a clear, top-level view of a business. It allows one to identify and remove redundant or unproductive processes.

  Workflow gives greater insights into business processes. Utilizing such useful insights, one can improve work processes and the bottom line of the business. In many businesses, there are many unnecessary and redundant tasks that take place daily. Once an organization has insight into its processes while preparing workflow, it can determine which activities are really necessary.

  Identifying and eliminating redundant tasks creates value for a business. With redundant tasks and processes eliminated, an organization can focus on what's important to the business.

- **Increase in Accountability and Reduction in Micromanagement** - Micromanagement often causes problems in a business setting as most employees don't like being micromanaged, and even many managers don't like the practice. Micromanagement is often identified as one of the reasons why people quit their job.

  However, the need for micromanagement can be minimized by clearly mapping out the workflow. This way, every individual in a team knows what tasks need to be completed and by when and who is responsible for completing them. This makes employees more accountable also.

  With clearly defined workflow processes, managers don't have to spend much time micromanaging their employees, who don't have to approach the manager to know what the further steps are. Following a workflow, employees know what is going on and what needs to be done. This, in turn, may help increase the job satisfaction of everyone involved while improving the relationships between management and employees.

- **Improved Communication** - Communication at work is critical because it affects all aspects of an organization. There are instances when the main conflict in an organization originates from miscommunication, e.g. the management and employees disagreeing on an aspect, despite pursuing the same objectives. Poor communication is a common workplace issue that is often not dealt with.

  This highlights why workflow is important. Workplace communication dramatically can increase with the visibility of processes and accountability. It helps make the daily operations smoother overall.

- **Better Customer Service** - Customers or clients are central to a business. Therefore, it is imperative to find and improve ways to improve customer experience. Relying on outdated manual systems may cause customer requests or complaints to be overlooked, with dissatisfied customers taking their business elsewhere. However, following a well-researched and defined workflow can help improve the quality of customer service.

  By automating workflows and processes, an organization can also reduce the likelihood of human error. This also helps improve the quality of products or services over time, resulting in a better customer experience.

7.2.6 Following Instructions and Reporting Problems

All organizations follow a hierarchy, with most employees reporting to a manager or supervisor. For organizational success, it is vital for employees to follow the instructions of their manager or supervisor. They should ensure they perform their duties as per the given instructions to help achieve the common objectives of the organization and deliver quality service or products. This consequently helps maintain the reputation of the organization.

It is also important to be vigilant and identify problems at work or with the organizational work processes. One should deal with the identified within their limits of authority and report out of authority problems to the manager/ supervisor or the concerned person for a prompt resolution to minimise the impact on customers/clients and business.

7.2.7 Information or Data Sharing

Information or data is critical to all organizations. Depending on the nature of its business, an organization may hold different types of data, e.g. personal data of customers or client data concerning their business operations and contacts. It is vital to effective measures for the appropriate handling of different types of data, ensuring its protection from unauthorized access and consequent misuse.

One should access certain data only if authorised to do so. The same is applicable when sharing data which must be shared only with the people authorised to receive it to use it for a specific purpose as per their job role and organizational guidelines. For example – one should be extra cautious while sharing business data with any third parties to ensure they get access only to the limited data they need as per any agreements with them. It is also critical to monitor how the recipient of the data uses it, which should strictly be as per the organizational guidelines. It is a best practice to share appropriate instructions with the recipient of data to ensure they are aware of the purpose with which data is being shared with them and how they are supposed to use and handle it. Any misuse of data must be identified and reported promptly to the appropriate person to minimise any damage arising out of data misuse.

These days most organizations require their employees and business partners or associated third parties to sign and accept the relevant agreement on the non-disclosure of business-sensitive information. In simple terms, business-sensitive information is confidential information. It is proprietary business information collected or created during the course of conducting business, including information about the business, e.g. proposed investments, intellectual property, trade secrets, or plans for a merger and information related to its clients. Business-sensitive information may sometimes also include information regarding a business's competitors in an industry.

The release of business-sensitive information to competitors or the general public poses a risk to a business. For example, information regarding plans for a merger could be harmful to a business if a competitor gets access to it.

7.2.8 Reporting Issues at Work

Most organizations have defined guidelines on appropriate reporting processes to be followed for reporting different types of issues. For example – one can report any grievances or dissatisfaction concerning co-workers to their manager/supervisor, e.g. data breaches or unethical conduct. If the concern is not addressed, then the employee should follow the organizational guidelines and hierarchy for the escalation of such issues that are not addressed appropriately.

For example – any concern related to sexual harassment at the workplace should be escalated to the concerned spokesperson, such as Human Resources (HR) representative, and if not satisfied with the action taken, it should be reported to the senior management for their consideration and prompt action.

7.2.9 Dealing with Heightened Emotions

Humans are emotional beings. There may be occasions when one is overwhelmed by emotions and is unable to suppress them. However, there may be situations when one must manage emotions well, particularly at work.
Stress in one's personal and professional life may often cause emotional outbursts at work. Managing one's emotions well, particularly the negative ones, is often seen as a measure of one's professionalism. Anger, dislike, frustration, worry, and unhappiness are the most common negative emotions experienced at work.

Ways to manage negative emotions at work:

- **Compartmentalisation** – It's about not confining emotions to different aspects of one's life. For example, not letting negative emotions from personal life affect work-life and vice versa. One should try to leave personal matters and issues at home. One should train their mind to let go of personal matters before reaching work. Similarly, one can compartmentalise work-related stresses so that negative emotions from work don't affect one's personal life.

- **Deep breathing and relaxation** – Deep breathing helps with anxiety, worry, frustration and anger. One should take deep breaths, slowly count to ten - inhaling and exhaling until one calms down. One can also take a walk to calm down or listen to relaxing music. Talking to someone and sharing concerns also helps one calm down.

- **The 10-second rule** - This is particularly helpful in controlling anger and frustration. When one feels their temper rising, they should count to 10 to calm down and recompose. If possible, one should move away to allow temper to come down.

- **Clarify** - It is always good to clarify before reacting, as it may be a simple case of misunderstanding or miscommunication.

- **Physical activity** - Instead of losing temper, one should plan to exercise, such as running or going to the gym, to let the anger out. Exercise is also a great way to enhance mood and release any physical tension in the body.

- **Practising restraint** – One should avoid replying or making a decision when angry, not allowing anger or unhappiness to cloud one's judgement. It may be best to pause any communication while one is angry, e.g. not communicating over email when angry or upset.

- **Knowing one's triggers** - It helps when one is able to recognise what upsets or angers them. This way, one can prepare to remain calm and plan their reaction should a situation occur. One may even be able to anticipate the other party's reaction.

- **Be respectful** – One should treat their colleagues the same way one would like to be treated. If the other person is rude, one need not reciprocate. It is possible to stay gracious, firm and assertive without being aggressive. Sometimes, rude people back away when they don't get a reaction from the person they are arguing with.

- **Apologise for any emotional outburst** – Sometimes, one can get overwhelmed by emotions, reacting with an emotional outburst. In such a case, one should accept responsibility and apologise immediately to the affected persons without being defensive.

- **Doing away with negative emotions** - It is recommended to let go of anger, frustration and unhappiness at the end of every workday. Harbouring negative emotions affects one emotionally, affecting their job performance also. Engaging in enjoyable activities after work is a good stress reliever.

Unit 7.3 – Maintaining Social Diversity at Work

Unit Objectives ⊚

By the end of this unit, participants will be able to:

• Explain the concept and importance of gender sensitivity and equality

• Discuss ways to create sensitivity for different genders and Persons with Disabilities (PwD)

7.3.1 Gender Sensitivity

Gender sensitivity is the act of being sensitive towards people and their thoughts regarding gender. It ensures that people know the accurate meaning of gender equality, and one's gender should not be given priority over their capabilities.

Fig 7.3.1 Gender Equality

Women are an important source of labour in many sectors, yet they have limited access to resources and benefits. Women should receive the same benefits and access to resources as men. A business can improve its productivity and quality of work by providing better support and opportunities to women.

Important Terms
• **Gender Sensitivity**-Gender sensitivity is the act of being sensitive to the ways people think about gender.
• **Gender Equality** - It means persons of any gender enjoy equal opportunities, responsibilities, and rights in all areas of life.
• **Gender Discrimination** – It means treating an individual unequally or disadvantageously based on their gender, e.g. paying different wages to men and women for similar or equal job positions.

Strategies for Enhancing Gender Equity

To enhance gender equity, one should:
• Follow gender-neutral practices at all levels at work.
• Participate together in decision-making.
• Help in promoting women's participation in different forums.
• Assist women in getting exposure to relevant skills and practices.

- Assist women in capacity building by mentoring, coaching or motivating them, as appropriate.
- Assist in the formation and operation of women support groups.
- Assist in the implementation of women-centric programmes.
- Combine technical training with reproductive health and nutrition for coffee farming households.
- Assist in making a work environment that is healthy, safe, and free from discrimination.

Bridging Gender Differences

Men and women react and communicate very differently. Thus, there are some work differences as both genders have their style and method of handling a situation.

Although, understanding and maturity vary from person to person, even between these genders, based on their knowledge, education, experience, culture, age, and upbringing, as well as how one's brain functions over a thought or problem.

In order to bridge the gap, one should:

- Not categorize all men and women in one way.
- Be aware of the verbal and non-verbal styles of communication of every gender to avoid any miscommunication and work better.
- Be aware of partial behaviour and avoid it.
- Encourage co-workers of different genders to make room by providing space to others.

Ways to reduce Gender Discrimination

- Effective steps against sexual harassment by the concerned authorities and general public.
- Gender stereotypes are how society expects people to act based on their gender. This can only be reduced by adopting appropriate behaviour and the right attitude.
- Objectification of females must be abolished.

Ways to Promote Gender Sensitivity in the Workplace
- Practices that promote gender diversity should be adopted and promoted.
- All genders should receive equal responsibilities, rights, and privileges.
- All genders should have equal pay for similar or the same job roles/ positions.
- Strict and effective workplace harassment policies should be developed and implemented.
- An open-minded and stress-free work environment should be available to all the employees, irrespective of their gender.
- Women should be encouraged to go ahead in every field of work and assume leadership roles.
- Follow appropriate measures for women's empowerment.
- Men should be taught to be sensitive to women and mindful of their rights.

7.3.2 PwD Sensitivity

Some individuals are born with a disability, while others may become disabled due to an accident, illness or as they get old. People with Disabilities (PwD) may have one or more areas in which their functioning is affected. A disability can affect hearing, sight, communication, breathing, understanding, mobility, balance, and concentration or may include the loss of a limb. A disability may contribute to how a person feels and affect their mental health.

Important Terms

- **Persons with Disabilities (PwD)** – Persons with Disabilities means a person suffering from not less than 40% of any disability as certified by a medical authority.

- **Types of Disability**:
a. Blindness – Visually impaired
b. Low Vision
c. Leprosy Cured
d. Hearing impairment
e. Locomotor disability
f. Mental retardation
g. Mental illness

PwD Sensitivity
PwD sensitivity promotes empathy, etiquette and equal participation of individuals and organizations while working with individuals with a disability, e.g. sensory, physical or intellectual.

Ways to be PwD Sensitive
To be sensitive to PwD, one should:

- Be respectful to all Persons with Disabilities (PwD) and communicate in a way that reflects PwD sensitivity.
- Always be supportive and kind towards a PwD with their daily chores.
- Be ready to assist a PwD to help them avail of any benefit/ livelihood opportunity/ training or any kind that helps them grow.
- Encourage and try to make things easier and accessible to PwD so that they can work without or with minimum help.
- Protest where feasible and report any wrong act/behaviour against any PwD to the appropriate authority.
- Learn and follow the laws, acts, and policies relevant to PwD.

Appropriate Verbal Communication
As part of appropriate verbal communication with all genders and PwD, one should:

- Talk to all genders and PwD respectfully, maintaining a normal tone of voice with appropriate politeness. It is important to ensure one's tone of voice does not have hints of sarcasm, anger, or unwelcome affection.
- Avoid being too self-conscious concerning the words to use while also ensuring not to use words that imply one's superiority over the other.
- Make no difference between a PwD and their caretaker. Treat PwD like adults and talk to them directly.
- Ask a PwD if they need any assistance instead of assuming they need it and offering assistance spontaneously.

Appropriate Non-verbal Communication

Non-verbal communication is essentially the way someone communicates through their body language. These include:

- **Facial expressions** - The human face is quite expressive, capable of conveying many emotions without using words. Facial expressions must usually be maintained neutral and should change according to the situation, e.g. smile as a gesture of greeting.

- **Body posture and movement** - One should be mindful of how to sit, stand, walk, or hold their head. For example - one should sit and walk straight in a composed manner. The way one moves and carries self, communicates a lot to others. This type of non-verbal communication includes one's posture, bearing, stance, and subtle movements.

- **Gestures** - One should be very careful with their gestures, e.g. waving, pointing, beckoning, or using one's hands while speaking. One should use appropriate and positive gestures to maintain respect for the other person while being aware that a gesture may have different meanings in different cultures.

- **Eye contact** - Eye contact is particularly significant in non-verbal communication. The way someone looks at someone else may communicate many things, such as interest, hostility, affection or attraction. Eye contact is vital for maintaining the flow of conversation and for understanding the other person's interest and response. One should maintain appropriate eye contact, ensuring not to stare or look over the shoulders. To maintain respect, one should sit or stand at the other person's eye level to make eye contact.

- **Touch** - Touch is a very sensitive type of non-verbal communication. Examples are - handshakes, hugs, pat on the back or head, gripping the arm, etc. A firm handshake indicates interest, while a weak handshake indicates the opposite. One should be extra cautious not to touch others inappropriately and avoid touching them inadvertently by maintaining a safe distance.

Rights of PwD

PwD have the right to respect and human dignity. Irrespective of the nature and seriousness of their disabilities, PwD have the same fundamental rights as others, such as:

- Disabled persons have the same civil and political rights as other people
- Disabled persons are entitled to the measures designed to enable them to become as self-dependent as possible
- Disabled persons have the right to economic and social security
- Disabled persons have the right to live with their families or foster parents and participate in all social and creative activities.
- Disabled persons are protected against all exploitation and treatment of discriminatory and abusive nature.

Making Workplace PwD Friendly

- One should not make PwD feel uncomfortable by giving too little or too much attention
- One should use a normal tone while communicating with a PwD and treat them as all others keeping in mind their limitations and type of disability
- Any help should be provided only when asked for by a PwD
- One should help in ensuring the health and well-being of PwD.

Expected Employer Behaviour

Some of the common behavioural traits that employees expect from their employers are:

- **Cooperation:** No work is successful without cooperation from the employer's side. Cooperation helps to understand the job role better and complete it within the given timeline.

- **Polite language:** Polite language is always welcomed at work. This is a basic aspect that everybody expects.

- **Positive Attitude:** Employers with a positive attitude can supervise the work of the employees and act as a helping hand to accomplish the given task. A person with a positive attitude looks at the best qualities in others and helps them gain success.

- **Unbiased behaviour:** Employers should always remain fair towards all their employees. One should not adopt practices to favour one employee while neglecting or ignoring the other. This might create animosity among co-workers.

Decent behaviour: The employer should never improperly present oneself before the employee. One should always respect each other's presence and behave accordingly. The employer should not speak or act in a manner that may make the employee feel uneasy, insulted, and insecure.

Exercise

1. List down three examples of workplace ethics.

2. List down three examples of interpersonal skills.

3. Identify two reasons for workplace conflicts.

4. Identify two ways of resolving interpersonal conflicts

5. List down two ways of dealing with heightened emotions at work.

6. List down two types of non-verbal communication.

Notes

8. Basic Health and Safety Practices

Unit 8.1 - Workplace Hazards

Unit 8.2 – Fire Safety

Unit 8.3 – First Aid

Unit 8.4 – Waste Management

Key Learning Outcomes

Key Learning Outcome:

By the end of this module, participants will be able to:

- Apply health and safety practices at the workplace.

Unit 8.1 – Workplace Hazards

Unit Objectives ◎

By the end of this unit, participants will be able to:

- Discuss job-site hazards, risks and accidents
- Explain the organizational safety procedures for maintaining electrical safety, handling tools and hazardous materials
- Describe how to interpret warning signs while accessing sensitive work areas
- Explain the importance of good housekeeping
- Describe the importance of maintaining appropriate postures while lifting heavy objects
- Explain safe handling of tools and Personal Protective Equipment to be used.

8.1.1. Workplace Safety

Workplace safety is important to be established for creating a safe and secure working for the workers. The workplace has to be administered as per the rules of the Occupational Safety and Health Administration (OSHA). It refers to monitoring the working environment and all hazardous factors that impact employees' safety, health, and well-being. It is important to provide a safe working environment to the employees to increase their productivity, wellness, skills, etc.

The benefits of workplace safety are:

- Employee retention increases if they are provided with a safe working environment.
- Failure to follow OSHA's laws and guidelines can result in significant legal and financial consequences.
- A safe environment enables employees to stay invested in their work and increases productivity.
- Employer branding and company reputation can both benefit from a safe working environment.

8.1.2. Workplace Hazards

A workplace is a situation that has the potential to cause harm or injury to the workers and damage the tools or property of the workplace. Hazards exist in every workplace and can come from a variety of sources. Finding and removing them is an important component of making a safe workplace.

Common Workplace Hazards

The common workplace hazards are:
- Biological: The threats caused by biological agents like viruses, bacteria, animals, plants, insects and also humans, are known as biological hazards.

- Chemical: Chemical hazard is the hazard of inhaling various chemicals, liquids and solvents. Skin irritation, respiratory system irritation, blindness, corrosion, and explosions are all possible health and physical consequences of these dangers.

- Mechanical: Mechanical Hazards comprise the injuries that can be caused by the moving parts of machinery, plant or equipment.

- Psychological: Psychological hazards are occupational hazards caused by stress, harassment, and violence.

- Physical: The threats that can cause physical damage to people is called physical hazard. These include unsafe conditions that can cause injury, illness and death.

- Ergonomic: Ergonomic Hazards are the hazards of the workplace caused due to awkward posture, forceful motion, stationary position, direct pressure, vibration, extreme temperature, noise, work stress, etc.

Workplace Hazards Analysis

A workplace hazard analysis is a method of identifying risks before they occur by focusing on occupational tasks. It focuses on the worker's relationship with the task, the tools, and the work environment. After identifying the hazards of the workplace, organisations shall try to eliminate or minimize them to an acceptable level of risk.

Control Measures of Workplace Hazards

Control measures are actions that can be taken to reduce the risk of being exposed to the hazard. Elimination, Substitution, Engineering Controls, Administrative Controls, and Personal Protective Equipment are the five general categories of control measures.

- Elimination: The most successful control technique is to eliminate a specific hazard or hazardous work procedure or prevent it from entering the workplace.

- Substitution: Substitution is the process of replacing something harmful with something less hazardous. While substituting the hazard may not eliminate all of the risks associated with the process or activity, it will reduce the overall harm or health impacts.

- Engineering Controls: Engineered controls protect workers by eliminating hazardous situations or creating a barrier between the worker and the hazard, or removing the hazard from the person.

- Administrative Controls: To reduce exposure to hazards, administrative controls limit the length of time spent working on a hazardous task that might be used in combination with other measures of control.

Personal Protective Equipment: Personal protective equipment protects users from health and safety hazards at work. It includes items like safety helmets, gloves, eye protection, etc.

8.1.3. Risk for a Drone Technician

A drone technician may require to repair the propeller, motor and its mount, battery, mainboards, processor, booms, avionics, camera, sensors, chassis, wiring and landing gear. A technician may face some risks while repairing the drones' equipment.

- The technician is susceptible to being physically harmed by propellers.
- Direct contact with exposed electrical circuits can injure the person.
- If the skin gets in touch with the heat generated from electric arcs, it burns the internal tissues.
- Major electrical injuries can occur due to poorly installed electrical equipment, faulty wiring, overloaded or overheated outlets, use of extension cables, incorrect use of replacement fuses, use of equipment with wet hands, etc.

8.1.4. Workplace Warning Signs

A Hazard sign is defined as 'information or instruction about health and safety at work on a signboard, an illuminated sign or sound signal, a verbal communication or hand signal.'

There are four different types of safety signs:

- Prohibition / Danger Alarm Signs
- Mandatory Signs
- Warning Signs
- And Emergency

1. Prohibition Signs: A "prohibition sign" is a safety sign that prohibits behaviour that is likely to endanger one's health or safety. The colour red is necessary for these health and safety signs. Only what or who is forbidden should be displayed on a restriction sign.

Fig. 8.1.1. Prohibition Warning Signs

2. Mandatory Signs: Mandatory signs give clear directions that must be followed. The icons are white circles that have been reversed out of a blue circle. On a white background, the text is black.

Fig. 8.1.2. Mandatory Signs

3. Warning Signs: Warning signs are the safety information communication signs. They are shown as a 'yellow colour triangle'.

Fig. 8.1.3. Warning Signs

4. Emergency Signs: The location or routes to emergency facilities are indicated by emergency signs. These signs have a green backdrop with a white emblem or writing. These signs convey basic information and frequently refer to housekeeping, company procedures, or logistics.

Fig. 8.1.4. Emergency Signs

8.1.5. Cleanliness in the Workplace

Workplace cleanliness maintenance creates a healthy, efficient and productive environment for the employees. Cleanliness at the workplace is hindered by some elements like cluttered desks, leftover food, waste paper, etc. A tidy workplace is said to improve employee professionalism and enthusiasm while also encouraging a healthy working environment.

Benefits of cleanliness in the workplace:
1. **Productivity:** Cleanliness in the workplace can bring a sense of belonging to the employees, also motivating and boosting the morale of the employees. This results in increasing their productivity.

2. **Employee Well-being:** Employee well-being can be improved by providing a clean work environment. Employees use fewer sick days in a workplace where litter and waste are properly disposed of, and surfaces are cleaned regularly, resulting in increased overall productivity.

3. **Positive Impression:** Cleanliness and orderliness in the workplace provide a positive impression on both employees and visitors.

4. **Cost saving:** By maintaining acceptable levels of cleanliness in the workplace, businesses can save money on cleaning bills and renovations, which may become necessary if the premises are not properly kept.

Reasons for cleaning the workplace
*   Cleaning of dry floors, mostly to prevent workplace slips and falls.
*   Disinfectants stop bacteria in their tracks, preventing the spread of infections and illness.
*   Proper air filtration decreases hazardous substance exposures such as dust and fumes.
*   Light fixture cleaning improves lighting efficiency.
*   Using environmentally friendly cleaning chemicals that are safer for both personnel and the environment.
*   Work environments are kept clean by properly disposing of garbage and recyclable items.

8.1.5. Cleanliness in the Workplace

Musculoskeletal Injuries (MSIs), such as sprains and strains, can occur while lifting, handling, or carrying objects at work. When bending, twisting, uncomfortable postures and lifting heavy objects are involved, the risk of injury increases. Ergonomic controls can help to lower the risk of injury and potentially prevent it.

Types of injuries caused while lifting heavy objects:

- Cuts and abrasions are caused by rough surfaces.

- Crushing of feet or hands.

- Strain to muscles and joints

Fig. 8.1.5. Lifting loads technique

Preparing to lift
A load that appears light enough to bear at first will grow increasingly heavier as one carries it further. The person carrying the weight should be able to see over or around it at all times.

The amount of weight a person can lift, depends on their age, physique, and health.
It also depends on whether or not the person is used to lifting and moving hefty objects.

Common Causes of Back Injuries
The Most Common Causes of Back Injuries are:

1) **Inadequate Training:** The individual raising the load receives no sufficient training or guidance.

2) **Lack of awareness of technique:** The most common cause of back pain is incorrect twisting and posture, which causes back strain.

3) **Load size:** The load size to consider before lifting. If the burden is too much for one's capacity or handling, their back may be strained and damaged.

4) **Physical Strength:** Depending on their muscle power, various persons have varied physical strengths. One must be aware of their limitations.

5) **Teamwork:** The operation of a workplace is all about working together. When opposed to a single person lifting a load, two people can lift it more easily and without difficulty. If one of two people isn't lifting it properly, the other or both of them will suffer back injuries as a result of the extra strain.

Techniques for Lifting Heavy Objects

Technique	Demonstration
1. Ensure one has a wide base of support before lifting the heavy object. Ensure one's feet are shoulder-width apart, and one foot is slightly ahead of the other at all times. This will help one maintain a good balance during the lifting of heavy objects. This is known as the Karate Stance.	
2. Squat down as near to the object as possible when one is ready to lift it, bending at the hips and knees with the buttocks out. If the object is really heavy, one may wish to place one leg on the floor and the other bent at a straight angle in front of them.	
3. Maintain proper posture as one begin to lift upward. To do so, one should keep their back straight, chest out, and shoulders back while gazing straight ahead.	

4. By straightening one's hips and knees, slowly elevate the thing (not the back). As one rises, they should extend their legs and exhale. Lift the heavy object without twisting the body or bending forward.	
5. Do not lift bending forward.	
6. Hold the load close to the body.	
7. Never lift heavy objects above the shoulder	

8.1.8. Personal Protective Equipment

Personal protective equipment, or "PPE," is equipment worn to reduce exposure to risks that might result in significant occupational injuries or illnesses. Chemical, radiological, physical, electrical, mechanical, and other job dangers may cause these injuries and diseases.

PPE used for protection from the following injuries are:

Injury Protection	Protection	PPE
Head Injury Protection	Falling or flying objects, stationary objects, or contact with electrical wires can cause impact, penetration, and electrical injuries. Hard hats can protect one's head from these injuries. A common electrician's hard hat is shown in the figure below. This hard hat is made of nonconductive plastic and comes with a set of safety goggles.	
Foot and Leg Injury Protection	In addition to foot protection and safety shoes, leggings (e.g., leather) can guard against risks such as falling or rolling objects, sharp objects, wet and slippery surfaces, molten metals, hot surfaces, and electrical hazards.	
Eye and Face Injury Protection	Spectacles, goggles, special helmets or shields, and spectacles with side shields and face shields can protect against the hazards of flying fragments, large chips, hot sparks, radiation, and splashes from molten metals. They also offer protection from particles, sand, dirt, mists, dust, and glare.	

8. Use the feet (not the body) to change direction, taking slow, small steps.	
9. Set down the heavy object carefully, squatting with the knees and hips only.	

Table 8.1.1. Techniques for lifting heavy objects
(Source: https://www.braceability.com/blogs/articles/7-proper-heavy-lifting-techniques)

8.1.7. Safe Handling of Tools

Workers should be trained on how to use tools safely. When tools are misplaced or handled incorrectly by workers, they can be dangerous. The following are some suggestions from the National Safety Council for safe tool handling when they are not in use:

- Never carry tools up or down a ladder in a way that makes it difficult to grip them. Instead of being carried by the worker, tools should be lifted up and down using a bucket or strong bag.

- Tools should never be tossed but should be properly passed from one employee to the next. Pointed tools should be passed with the handles facing the receiver or in their carrier.

- When turning and moving around the workplace, workers carrying large tools or equipment on their shoulders should pay particular attention to clearances.

- Pointed tools such as chisels and screwdrivers should never be kept in a worker's pocket. They can be carried in a toolbox, pointing down in a tool belt or pocket tool bag, or in hand with the tip always held away from the body.

- Tools should always be stored while not in use. People below are put in danger when tools are left sitting around on an elevated structure, such as a scaffold. In situations when there is a lot of vibration, this risk increases.

Protection against Hearing Loss	Hearing protection can be obtained by wearing earplugs or earmuffs. High noise levels can result in permanent hearing loss or damage, as well as physical and mental stress. Self-forming earplugs composed of foam, waxed cotton, or fibreglass wool usually fit well. Workers should be fitted for moulded or prefabricated earplugs by a specialist.	
Hand Injury Protection	Hand protection will aid workers who are exposed to dangerous substances by skin absorption, serious wounds, or thermal burns. Gloves are a frequent protective clothing item. When working on electrified circuits, electricians frequently use leather gloves with rubber inserts. When stripping cable with a sharp blade, Kevlar gloves are used to prevent cuts.	
Whole Body Protection	Workers must protect their entire bodies from risks such as heat and radiation. Rubber, leather, synthetics, and plastic are among the materials used in whole-body PPE, in addition to fire-retardant wool and cotton. Maintenance staff who operate with high-power sources such as transformer installations and motor-control centres are frequently obliged to wear fire-resistant clothes.	

Table 8.1.2. Personal protective equipment

Unit 8.2 – Fire Safety

Unit Objectives 🎯

By the end of this unit, participants will be able to:

- List the types of fire and fire extinguishers

8.2.1. Fire Safety

Fire safety is a set of actions aimed at reducing the amount of damage caused by fire. Fire safety procedures include both those that are used to prevent an uncontrolled fire from starting and those that are used to minimise the spread and impact of a fire after it has started. Developing and implementing fire safety measures in the workplace is not only mandated by law but is also essential for the protection of everyone who may be present in the building during a fire emergency.

The basic Fire Safety Responsibilities are:

- To identify risks on the premises, a fire risk assessment must be carried out.
- Ascertain that fire safety measures are properly installed.
- Prepare for unexpected events.
- Fire safety instructions and training should be provided to the employees.

8.2.2. Respond to a Workplace Fire

- Workplace fire drills should be conducted on a regular basis.

- If one has a manual alarm, they should raise it.

- Close the doors and leave the fire-stricken area as soon as possible. Ensure that the evacuation is quick and painless.

- Turn off dangerous machines and don't stop to get personal items.

- Assemble at a central location. Ascertain that the assembly point is easily accessible to the employees.

- If one's clothing catches fire, one shouldn't rush about it. They should stop and descend on the ground and roll to smother the flames if their clothes catch fire.

8.2.3. Fire Extinguisher

Fire extinguishers are portable devices used to put out small flames or minimise their damage until fire-fighters arrive. These are maintained on hand in locations such as fire stations, buildings, workplaces, public transit, and so on. The types and quantity of extinguishers that are legally necessary for a given region are determined by the applicable safety standards.

Types of fire extinguishers are:
There are five main types of fire extinguishers:

1. Water.
2. Powder.
3. Foam.
4. Carbon Dioxide (CO_2).
5. Wet chemical.

1. Water: Water fire extinguishers are one of the most common commercial and residential fire extinguishers on the market. They're meant to be used on class-A flames.

2. Powder: The L2 powder fire extinguisher is the most commonly recommended fire extinguisher in the Class D Specialist Powder category, and is designed to put out burning lithium metal fires.

3. Foam: Foam extinguishers are identified by a cream rectangle with the word "foam" printed on it. They're mostly water-based, but they also contain a foaming component that provides a quick knock-down and blanketing effect on flames. It suffocates the flames and seals the vapours, preventing re-ignition.

4. Carbon Dioxide (CO2): Class B and electrical fires are extinguished with carbon dioxide extinguishers, which suffocate the flames by removing oxygen from the air. They are particularly beneficial for workplaces and workshops where electrical fires may occur since, unlike conventional extinguishers, they do not leave any toxins behind and hence minimise equipment damage.

5. Wet Chemical: Wet chemical extinguishers are designed to put out fires that are classified as class F. They are successful because they can put out extremely high-temperature fires, such as those caused by cooking oils and fats.

Unit 8.3 – First Aid

Unit Objectives 🎯

By the end of this unit, participants will be able to:
- Explain how the administer appropriate first aid to victims in case of bleeding, burns, choking, electric shock, poisoning

- Explain how to administer first aid to victims in case of a heart attack or cardiac arrest due to electric shock.

8.3.1. First Aid

First aid is the treatment or care given to someone who has sustained an injury or disease until more advanced care can be obtained or the person recovers.

The aim of first aid is to:

- Preserve life
- Prevent the worsening of a sickness or injury
- If at all possible, relieve pain
- Encourage recovery
- Keep the unconscious safe.
- First aid can help to lessen the severity of an injury or disease, and in some situations, it can even save a person's life.

8.3.2. Need for First Aid at the Workplace

In the workplace, first aid refers to providing immediate care and life support to persons who have been injured or become unwell at work.

Many times, first aid can help to lessen the severity of an accident or disease.

It can also help an injured or sick person relax. In life-or-death situations, prompt and appropriate first aid can make all the difference.

8.3.3. Treating Minor Cuts and Scrapes

Steps to keep cuts clean and prevent infections and scars:
- **Wash Hands:** Wash hands first with soap and water to avoid introducing bacteria into the cut and causing an infection. One should use the hand sanitiser if one is on the go.

- **Stop the bleeding:** Using a gauze pad or a clean towel, apply pressure to the wound. For a few minutes, keep the pressure on.

- **Clean Wounds:** Once the bleeding has stopped, clean the wound by rinsing it under cool running water or using a saline wound wash. Use soap and a moist washcloth to clean the area around the wound. Soap should not be used on the cut since it may irritate the skin. Also, avoid using hydrogen peroxide or iodine, as these may aggravate the wound.

- **Remove Dirt:** Remove any dirt or debris from the area. Pick out any dirt, gravel, glass, or other material in the cut with a pair of tweezers cleaned with alcohol.

8.3.4. Heart Attack

When the blood flow carrying oxygen to the heart is blocked, a heart attack occurs. The heart muscle runs out of oxygen and starts to die.
Symptoms of a heart attack can vary from person to person. They may be mild or severe. Women, older adults, and people with diabetes are more likely to have subtle or unusual symptoms.

Symptoms in adults may include:

Symptoms in adults may include:
- Changes in mental status, especially in older adults.
- Chest pain that feels like pressure, squeezing, or fullness. The pain is most often in the centre of the chest. It may also be felt in the jaw, shoulder, arms, back, and stomach. It can last for more than a few minutes or come and go.
- Cold sweat.
- Light-headedness.
- Nausea (more common in women).
- Indigestion.
- Vomiting.
- Numbness, aching or tingling in the arm (usually the left arm, but the right arm may be affected alone, or along with the left).
- Shortness of breath.
- Weakness or fatigue, especially in older adults and in women.

First Aid for Heart Attack
- If one thinks someone is experiencing a heart attack, they should:
- Have the person sit down, rest, and try to keep calm.
- Loosen any tight clothing.
- Ask if the person takes any chest pain medicine, such as nitro-glycerine for a known heart condition, and help them take it.
- If the pain does not go away promptly with rest or within 3 minutes of taking nitro-glycerine, call for emergency medical help.
- If the person is unconscious and unresponsive, call 911 or the local emergency number, then begin CPR.
- If an infant or child is unconscious and unresponsive, perform 1 minute of CPR, then call 911 or the local emergency number.

Unit 8.4 – Waste Management

Unit Objectives ⊚

By the end of this unit, participants will be able to:

- Describe the concept of waste management and methods of disposing of hazardous waste.
- List the common sources of pollution and ways to minimize them.
- Elaborate on electronic waste disposal procedures.

8.4.1. Waste Management and Methods of Waste Disposal.

The collection, disposal, monitoring, and processing of waste materials is known as waste management. These wastes affect living beings' health and the environment. For reducing their effects, they have to be managed properly. The waste is usually in solid, liquid or gaseous form.
The importance of waste management is:

Waste management is important because it decreases waste's impact on the environment, health, and other factors. It can also assist in the reuse or recycling of resources like paper, cans, and glass. The disposal of solid, liquid, gaseous, or dangerous substances is the example of waste management.

When it comes to trash management, there are numerous factors to consider, including waste disposal, recycling, waste avoidance and reduction, and garbage transportation. Treatment of solid and liquid wastes is part of the waste management process. It also provides a number of recycling options for goods that aren't classified as garbage during the process.

8.4.2. Methods of Waste Management

Non-biodegradable and toxic wastes, such as radioactive remains, can cause irreversible damage to the environment and human health if they are not properly disposed of. Waste disposal has long been a source of worry, with population increase and industrialisation being the primary causes. Here are a few garbage disposal options.

1. **Landfills:** The most common way of trash disposal today is to throw daily waste/garbage into landfills. This garbage disposal method relies on burying the material in the ground.

2. **Recycling:** Recycling is the process of transforming waste items into new products in order to reduce energy consumption and the use of fresh raw materials. Recycling reduces energy consumption, landfill volume, air and water pollution, greenhouse gas emissions, and the preservation of natural resources for future use.

3. **Composting:** Composting is a simple and natural bio-degradation process that converts organic wastes, such as plant remnants, garden garbage, and kitchen waste, into nutrient-rich food for plants.
4. **Incineration:** Incineration is the process of combusting garbage. The waste material is cooked to extremely high temperatures and turned into materials such as heat, gas, steam, and ash using this technology.

8.4.3. Recyclable, Non-Recyclable and Hazardous Waste

1. **Recyclable Waste:** The waste which can be reused or recycled further is known as recyclable waste.

2. **Non-recyclable Waste:** The waste which cannot be reused or recycled is known as non-recyclable waste. Polythene bags are a great example of non-recyclable waste.

3. **Hazardous Waste:** The waste which can create serious harm to the people and the environment is known as hazardous waste.

8.4.4. Sources of Pollution

Pollution is defined as the harm caused by the presence of a material or substances in places where they would not normally be found or at levels greater than normal. Polluting substances might be in the form of a solid, a liquid, or a gas.

- **Point source of pollution:** Pollution from a point source enters a water body at a precise location and can usually be identified. Effluent discharges from sewage treatment plants and industrial sites, power plants, landfill sites, fish farms, and oil leakage via a pipeline from industrial sites are all potential point sources of contamination.

    Point source pollution is often easy to prevent since it is feasible to identify where it originates, and once identified, individuals responsible for the pollution can take rapid corrective action or invest in longer-term treatment and control facilities.

- **Diffuse source of pollution**: As a result of land-use activities such as urban development, amenity, farming, and forestry, diffuse pollution occurs when pollutants are widely used and diffused over a large region. These activities could have occurred recently or in the past. It might be difficult to pinpoint specific sources of pollution and, as a result, take rapid action to prevent it because prevention often necessitates significant changes in land use and management methods.

Pollution Prevention
Pollution prevention entails acting at the source of pollutants to prevent or minimise their production. It saves natural resources, like water, by using materials and energy more efficiently.

Pollution prevention includes any practice that:

- Reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal;

- Reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants (these practices are known as "source reduction");

- Improved efficiency in the use of raw materials, energy, water, or other resources, or Conservation is a method of safeguarding natural resources.

- Improvements in housekeeping, maintenance, training, or inventory management; equipment or technology adjustments; process or method modifications; product reformulation or redesign; raw material substitution; or improvements in housekeeping, maintenance, training, or inventory control.

8.4.5. Electronic Waste

Lead, cadmium, beryllium, mercury, and brominated flame retardants are found in every piece of electronic waste. When gadgets and devices are disposed of illegally, these hazardous compounds are more likely to contaminate the earth, pollute the air, and leak into water bodies.

When e-waste is dumped in a landfill, it tends to leach trace metals as water runs through it. The contaminated landfill water then reaches natural groundwater with elevated toxic levels, which can be dangerous if it reaches any drinking water bodies. Despite having an environmentally benign approach, recycling generally results in international shipment and dumping of the gadgets in pits.

Some eco-friendly ways of disposing of e-waste are:

- Giving back the e-waste to the electronic companies and off points drop-
- Following guidelines issued by the government
- Selling or donating the outdated technology-based equipment
- Giving e-waste to a certified e-waste recycler

Exercise

1. Name all five types of fire extinguishers.

2. Explain PPE in brief.

3. List the common workplace hazards.

4. Fill in the blacks:

i. A "_____ sign" is a safety sign that prohibits behaviour that is likely to endanger one's health or safety.

ii. _____ entails acting at the source of pollutants to prevent or minimise their production.

iii. _____ is the treatment or care given to someone who has sustained an injury or disease until more advanced care can be obtained or the person recovers.

iv. The threats caused by biological agents like viruses, bacteria, animals, plants, insects and also humans, are known as _____.

v. The workplace has to be administered as per the rules of the _____.

Notes

Notes

Annexure

Chapter Name	Unit Name	Topic Name	URL	Page no.	QR Code	Video Duration
Chapter 1: Introduction to the role of a Robotics Automation Lead	Unit 1.1: Overview of the Electronics Industry	1.1.6 Scope of Electronic Industry	https://www.youtube.com/watch?v=JgLu40JBa-c	6	**Scope of Electronic Industry**	00:06:05
	Unit 1.2: Introduction to a Robotics	1.2.1 What is Robotics?	https://youtu.be/Wab5f3bKR24	10	What is Robotics?	00:03:46
	Unit 1.3: Role and Responsibilities of a Robotics Automation Lead	1.3.2 Job Responsibilities of Robotics Automation Lead	https://youtu.be/gRLGE54CHhI	14	Job Responsibilities of Robotics Automation Lead	00:13:18
Chapter 2: Process of using the appropriate Robotic Process Automation (RPA) software	Unit 2.1 Implementation of Robotic Process Automation (RPA)	2.1.1 Robotic Process Automation (RPA)	https://youtu.be/9URSbTOE4YI	32	Robotic Process Automation (RPA)	00:05:34
	Unit 2.2 Control System and Cybersecurity in Robotic Process Automation (RPA)	2.2.1 Robot Control System	https://youtu.be/xd-nY4GslvQ	44	Robot Control System	00:13:28
		2.2.6 Artificial Intelligence	https://youtu.be/ad79nYk2keg		Artificial Intelligence	00:05:27

Annexure

Chapter 3: Process of Integrating Robot Manipulators with Process Components	Unit 3.1 Setting up Process Components	3.1.1 User Interface (UI) Automation	https://youtu.be/YumuVPxp-cw	63	User Interface (UI) Automation	00:03:13
		3.1.7 Standalone Automation	https://youtu.be/45O4NaduxFk		Standalone Automation	00:10:09
		3.1.8 Robotics Application	https://youtu.be/pIcxOGo7ieU		Robotics Application	00:10:33
	Unit 3.2 Robotics Manipulators	3.2.1 Robotics Manipulators	https://youtu.be/fcaPj7_4oRI	76	Robotics Manipulators	00:06:39
		3.2.5 Geometrical Modeling	https://youtu.be/NBgLTCbUSkY		Geometrical Modeling	00:07:01

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Chapter 4:Process of performing source control integration in the RPA software	Unit 4.1 Carrying out app integration, recording and scraping	4.1.1 App Integration	https://youtu.be/CDRGkE-YyBU	86	App Integration	00:02:00
		4.1.4 Screen Scraping Wizard	https://youtu.be/MdNVjWWkD98		Screen Scraping Wizard	00:13:22
	Unit 4.2 Carrying out data manipulation and PDF automation	4.2.1 Data Manipulation	https://youtu.be/6CzfqZU2k0c	100	Data Manipulation	00:13:30
Chapter 5: Process of using Re-Framework in the RPA software	Unit 5.1 RPA Tools	5.1.1 Robotic Process Automation (RPA) Tools	https://youtu.be/dJ6qJx9DvcQ	119	RPA Tools	00:16:44
		5.1.2. Types of RPA Tools				
		5.1.3 Uses of RPA Tools				
	Unit 5.2 Robotic Enterprise Framework	5.2.1 Robotic Enterprise (Re) Framework	https://youtu.be/F33TIcogzn8	127	Robotic Enterprise Framework	00:35:28
		5.2.2 Use of Re-Framework				
		5.2.3 Use of Re-Framework				
		5.2.4 Re-Framework Implementation Process				
		5.2.5 Re-Framework Workflows				

Annexure

Chapter 6: Process of using the Robot Sensing and Machine Vision Technologies	Unit 6.1 Robotic Sensing System	6.1.1 Robotic Sensors	https://youtu.be/KlF_70KPxe0	139	Robotic Sensing System	00:15:58
		6.1.3 Robotic Sensing				
		6.1.4 Intelligent Sensors	https://youtu.be/OYbey2V2xtE		Intelligent Sensors	00:12:30
	Unit 6.2 Machine Vision System	6.2.1 Machine Vision System	https://youtu.be/x0_6nYKwx0g	50	Machine Vision System	00:19:48
		6.2.2 Machine Vision System Architecture				

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