

6. AUTOMATED & EMERGING TECHNOLOGIES

Automated System

- Combination of software and hardware
 - Designed and programmed to work automatically without need of human intervention.
 - Use sensors, a microprocessor and actuators
- **Sensor:** input devices that take readings from surroundings and convert them into electrical signals which are sent to a microprocessor.
 - **Microprocessor**
 - Type of integrated circuit ...
 - ... that is contained on a single chip
 - It processes input from sensors (compares input values to preset values) & sends instructions to actuator to carry out the output.
 - **Actuator:** Operated by signals from microprocessor to cause physical movement // Controls the movement of a machine

Scenario	Advantages	Disadvantages
Industry	<ul style="list-style-type: none"> - Reduced labour costs - Improved efficiency and accuracy - Increased production rate 	<ul style="list-style-type: none"> - High initial investment - Maintenance costs can be high - Limited flexibility to changes in production processes
Transport	<ul style="list-style-type: none"> - Reduced labour costs - Improved fuel efficiency - Improved safety and reliability 	<ul style="list-style-type: none"> - High initial investment - Maintenance costs can be high - May not be suitable for all types of transportation
Agriculture	<ul style="list-style-type: none"> - Reduced labour costs - Increased efficiency in planting and harvesting crops - Improved crop yield and quality 	<ul style="list-style-type: none"> - High initial investment - Maintenance costs can be high - May not be suitable for all types of crops or terrain
Weather	<ul style="list-style-type: none"> - Improved accuracy in weather prediction - Ability to collect large amounts of data quickly - Ability to issue warnings in a timely manner 	<ul style="list-style-type: none"> - May not be 100% accurate all the time - May require continuous monitoring and calibration - May be affected by external factors like interference or equipment failure

Gaming	<ul style="list-style-type: none"> - Reduced labour costs - Improved speed and efficiency in game development - Ability to create complex and interactive games 	<ul style="list-style-type: none"> - May not be suitable for all types of games or game development - May require significant programming expertise - May be affected by technical glitches or bugs
Lighting	<ul style="list-style-type: none"> - Reduced labour costs - Improved energy efficiency - Ability to program lighting to suit different needs 	<ul style="list-style-type: none"> - High initial investment - Maintenance costs can be high - May not be suitable for all types of lighting needs
Science	<ul style="list-style-type: none"> - Reduced labour costs - Improved speed and accuracy in data collection and analysis - Ability to carry out complex experiment 	<ul style="list-style-type: none"> - High initial investment - May not be suitable for all types of experiments - May require significant technical expertise

Advantage of using automated system in manufacturing (for employee) - explain

- Increases safety
- ...meaning that workers do not need to go into dangerous areas to collect data/make checks/do dangerous tasks
- Can increase jobs/skills
- ...as employees are needed to learn/maintain the equipment
- No need to do repetitive tasks
- ... so, they can use their time on other/more skilled tasks

Disadvantage of using automated system in manufacturing (for company owner)

- High set-up/installation costs
- ... it would mean the company need to find a lot of money up front to pay for the equipment // employees will need training
- Utility/maintenance/repair costs
- ... increase in bills such as electricity // skilled employees will be required to maintain the system // equipment will break/need updating
- Deskilling of the workforce
- ... may mean that workers will no longer have the skills for some of the manufacturing jobs, should the equipment break

Robotics

The branch if computer science that incorporates:

- The design of robots (to perform tasks/operations/functions)
- The construction of robots (to perform tasks/operations/functions)

- The operation of robots (to perform tasks/operations/functions)

Design and Construction:

- Robots designed using combination of mechanical, electrical, and computer engineering
- Robotic design can be customised to meet specific needs

Operation:

- Once robot is built, it is programmed to carry out specific tasks
- Programming involves creating a set of instructions that tell the robot what actions to perform in specific sequence
- Robot's sensors are used to detect and respond to changes in environment
- Robots can also be operated remotely using a controller

Examples

- Factory equipment: Perform tasks like welding, painting, assembling products
- Domestic robots: Designed to perform household chores (vacuuming / lawn mowing)
- Drones: Unmanned aerial vehicles used for aerial photography/ delivery/ surveillance

Characteristics of a robot

- It is programmable
- It has a mechanical structure/framework
- It has electrical components

Advantages of using robots

- Increase productivity: can work continuously without breaks
- More efficient
- More accurate
- Produce consistent results
- Safety: can perform tasks dangerous for humans
- Can lift heavy materials
- Cost-effective: reduces running costs (eg. labour costs) in long run
- Can perform mundane/ repetitive tasks
- Allows employees to utilise their skills in other tasks

Disadvantages of using robots

- High initial investment: Expensive to install/purchase/setup
- High ongoing costs/maintenance costs
- Lack of flexibility: cannot easily adapt to new situations
- Unemployment // May deskill the workforce
- If they malfunction, production may stop

- Vulnerable to cyber attacks

Roles of robots

Field	Reason for use	Examples
Industry	Used in manufacturing & assembly lines to increase productivity and accuracy	heavy lifting, spray-painting car bodies, manufacturing microchips
Transport	used in warehouses and logistics to move and transport goods	Self-parking / self-driving cars, Adaptive cruise control, Aeroplane autopilot, Autonomous trains
Agriculture	used for tasks such as planting, harvesting, and spraying crops	Planting, Irrigation systems, Fertiliser distribution, Harvesting, Weed control Phenotyping (to identify diseases)
Medicine	used in surgical procedures to increase precision and reduce risk of errors	Surgical assistance, Monitor patients, Take blood samples, Prosthetic limbs, For disinfecting
Domestic	used for tasks such as vacuuming, lawn mowing, and cleaning	Autonomous vacuum cleaners, Autonomous lawn mowers, Personal assistants
Entertainment	used as toys or in amusement parks to provide entertainment	Theme parks to interact with visitors , Makes amusement rides more immersive and exciting , Robotic cameras used to film complex film shots, Make dangerous, heavy-action film sequences more realistic, Enhance live events, concerts, etc.

Artificial Intelligence

Branch of computer science dealing with simulation of intelligent behaviours by computers. These intelligent behaviours include problem-solving, decision-making, natural language processing.

Characteristics of AI

- Collects data
- Stores rules for using the data
- The ability to reason
- The ability to learn & adapt // uses machine learning
- ...by changing its own rules
- ...by changing its own data
- ...by being trained
- ...for example, adapts from its mistakes to not make them again
- Makes one or more predictions (to make a decision)
- Find/analyse patterns

Main characteristics

- The ability to learn/adapt // machine learning abilities
- – The collection of data and the rules for using that data
- – The ability to reason // has problem solving abilities // makes predictions
- – Simulates intelligent/human behaviour
- – Analyses patterns

Robot needs to find its way through different puzzles. Each puzzle has a series of paths that the robot needs to follow to find its way to the end. The puzzle contains dead ends and obstacles, so the robot needs to decide which way to go. The robot's program will use artificial intelligence (AI). Explain how the program uses AI.

- Use machine learning algorithms
- Collects data about where it has been
- Collect data about obstacles/problems
- Store successful actions
- Stores unsuccessful actions
- Identify/store patterns
- ... to make sure it does not repeat the same incorrect route
- ... so, it knows how to react to obstacles next time
- ...so, it knows what is most likely to work next time

Areas in which AI is used

- Robotics
- Natural language processing
- Expert systems
- Machine learning

AI Systems

1. Expert Systems
2. Machine learning

Expert systems

Mimic human knowledge/ experiences.

Components of an expert system

- Knowledge base
- Rule base
- Inference engine
- Interface

Knowledge base

- A database of facts
- That is used to generate rules
- That are used to solve problems & to make decisions

Rule base

- Stores a set of rules or logic for the system
- For the inference engine to use
- Used to link the facts in the knowledge base // Used to apply the knowledge in the knowledge base

Inference engine

- It makes decisions
- By applying the rules in the rules base to the facts in the knowledge base
- To provide a result/diagnosis // to solve problems

Interface

A way for users to interact with the system and provide input.

Explain how expert system operates

- It has an interface ...
- ... used to input data/view output
- It has a knowledge base
- It has a rule base
- It has an inference engine
- Applies the rule base to/and the knowledge base to provide output/diagnosis/result/solution/decision

- Decides what to ask next based on the data input

Machine learning

When a program has the ability to automatically adapt its own processes and/or data.

- Uses algorithms to analyse data and identify patterns or relationships
- The system can learn from the data and improve its performance over time
- Can be supervised or unsupervised:
 - Supervised machine learning uses labelled data to train the system
 - Unsupervised machine learning uses unlabelled data

Describe what is meant by machine learning capabilities

- – It is a form of artificial intelligence
- – Means it can adapt/change (its own processes) // It can edit its own algorithms
- – It can edit its own data
- – It can be trained
- – ... this can be supervised/unsupervised
- – ... meaning it can learn with/without human interaction
- – Analyses patterns and stores successful/unsuccessful results ...
- – ... to influence future decisions
- – (Supervised) means a user tells the system the input and output
- – (Unsupervised) means the system is given the input and needs to work out the output

Artificial intelligence	Machine learning
Simulating intelligence in machines.	Designing machines to make decisions without being programmed to do so.
Aims to create machines capable of thinking like humans.	Aims to create machines that can learn through acquisition of data and experience, so they can solve new problems.