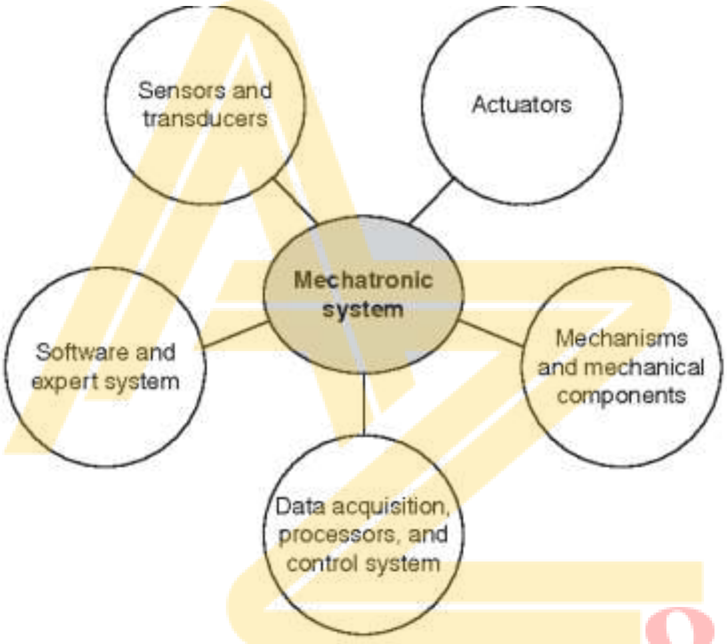
MODULE 5

Introduction to Mechatronics and Robotics: open-loop and closed-loop mechatronic systems. Classification based on robotics configuration: polar cylindrical, Cartesian coordinate and spherical. Application, Advantages and disadvantages.
Automation in industry: Definition, types – Fixed, programmable and flexible automation, basic elements with block diagrams, advantages.
Introduction to IOT: Definition and Characteristics, Physical design, protocols, Logical design of IoT, Functional blocks, and communication models.

MECHATRONICS

Mechatronics is a multidisciplinary field that combines mechanical engineering, electrical engineering, and computer science to design and control advanced systems. Mechatronic systems can be classified into two categories based on their feedback mechanism: open-loop and closed-loop systems.



Mechatronics systems are found in a wide range of applications, such as robotics, automotive systems, aerospace systems, manufacturing processes, and medical devices. They typically include sensors to measure physical parameters, actuators to control physical processes, and microcontrollers or programmable logic controllers (PLCs) to control the system.

Mechatronics systems are designed to operate in a closed-loop control system where the output of the system is monitored and compared to a desired setpoint. If there is a difference between the output and the setpoint, the control system takes action to adjust the input to the system to bring the output closer to the setpoint.

Overall, mechatronics systems provide advanced functionality and precision control, which is essential in many modern technologies.

Mechatronics in daily life

Mechatronics is becoming increasingly common in our daily lives, as it is used in many consumer products and systems that we interact with every day. Here are a few examples:

- Smartphones: Our smartphones are complex mechatronics systems that combine sensors, processors, and actuators to provide us with a range of functions, such as touchscreens, cameras, GPS, and wireless connectivity.

- Home appliances: Many home appliances, such as washing machines, refrigerators, and air conditioners, are mechatronics systems that incorporate sensors, microcontrollers, and actuators to provide advanced functionality and control.

- Automobiles: Modern automobiles are advanced mechatronics systems that incorporate sensors, control systems, and actuators to provide features such as advanced safety systems, engine control, and entertainment systems.

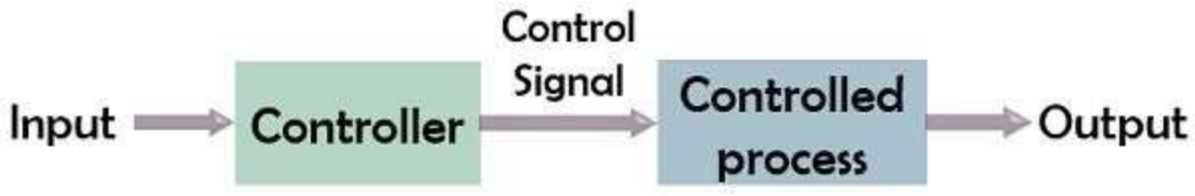
- Robotics: Robotics is a field that relies heavily on mechatronics systems to control the movements and actions of robots used in a wide range of applications, such as manufacturing, medical devices, and space exploration.

- Industrial automation: Industrial automation systems, such as manufacturing lines and packaging systems, are complex mechatronics systems that use sensors, controllers, and actuators to optimize production efficiency and product quality.

Overall, mechatronics has become an integral part of many modern systems and technologies, making our daily lives more convenient, efficient, and safe.

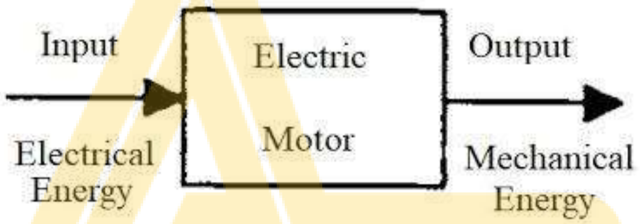
Open-Loop Mechatronic System

An open-loop mechatronic system is a system that operates without feedback control. In an open-loop system, the control input is determined based on the system's initial conditions and is not adjusted based on the system's output or performance. The control action is predetermined and does not change in response to changes in the system's environment or behavior.



Open Loop Control System

Example:



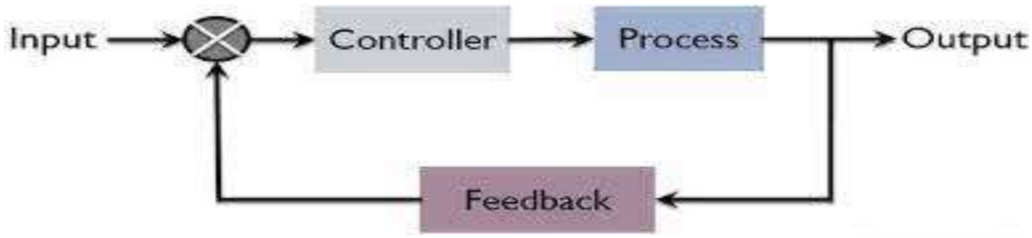
open-loop control system, the motor is operated without any feedback control. The input to the motor is directly controlled by the user, and the output of the motor is not measured or monitored. For example, in a simple electric toy car, the motor is driven by a switch or a button, and the speed of the car is not controlled based on any feedback from the environment or the user. In this case, the motor is operating as an open-loop system.

An on-off bulb can be considered as an example of an open-loop control system. When the user switches on the bulb, it operates at a fixed level of brightness, irrespective of any changes in the ambient lighting conditions or any feedback from the user. The user has no control over the brightness level of the bulb, and it does not respond to any feedback from the environment or the user.

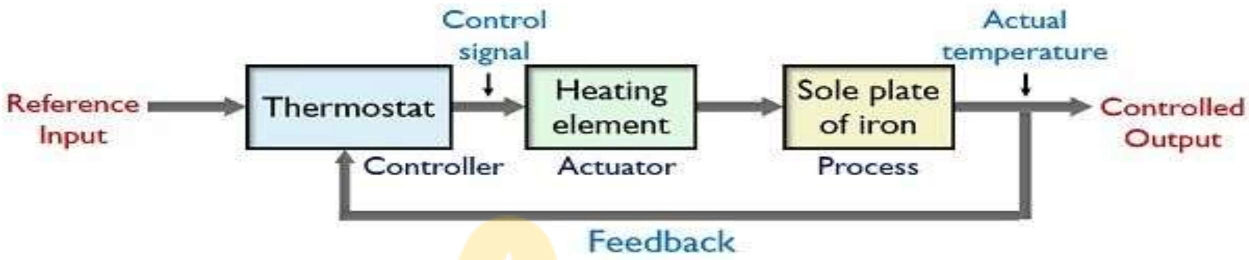
Closed-Loop Mechatronic System

On the other hand, a closed-loop mechatronic system is a system that uses feedback to adjust its control action based on the system's output or performance. In a closed-loop system, a sensor is used to measure the system's output or performance, and the feedback signal is used to adjust the control action to improve the system's performance. Closed-loop systems are also known as feedback control systems.

Examples of closed-loop systems include thermostats, cruise control in cars, and aircraft autopilot systems.



Example:



Automatic Electric Iron

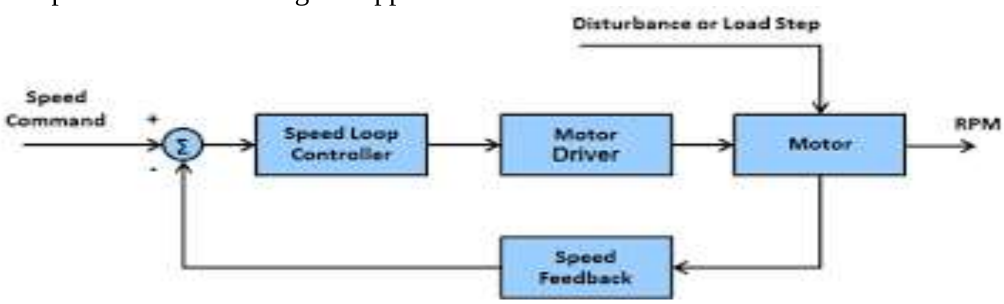
The closed-loop control system ensures that the iron box operates at the correct temperature, improving its efficiency and safety. It also reduces the risk of overheating, which can damage clothes or cause a fire.

In the case of an automatic iron box, the temperature sensor measures the temperature of the heating element and sends this information to the microcontroller. The microcontroller compares the measured temperature with the desired temperature set by the user and adjusts the heating element's power input accordingly. This feedback loop continues until the desired temperature is achieved and maintained throughout the ironing process.

This closed-loop control system ensures that the iron box operates at the correct temperature, improving its efficiency and safety. It also reduces the risk of overheating, which can damage clothes or cause a fire. Overall, closed-loop control systems are widely used in many applications, such as robotics, manufacturing, and process control, to ensure accurate and reliable operation.
In summary, open-loop systems operate without feedback control, while closed-loop systems use feedback to adjust their control action based on the system's output or performance.

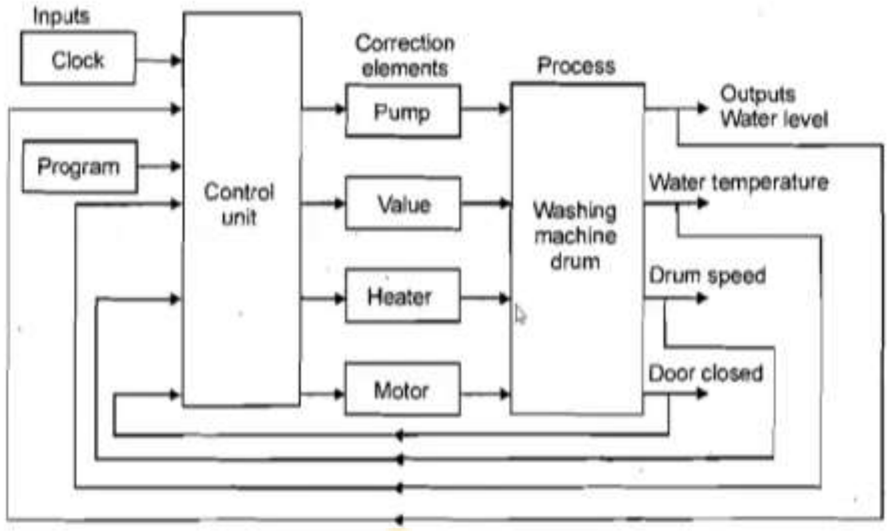
Automatic Speed Control Of Motors

Automatic speed control of motors using a closed loop control system involves measuring the actual speed of the motor and comparing it to the desired speed. The difference between the two is used to adjust the input to the motor controller, which in turn adjusts the speed of the motor. This process continues until the actual speed of the motor matches the desired speed. Closed loop control systems provide a robust and accurate way to control the speed of motors, which is important in a wide range of applications.



Automatic Speed Control Of Motors

Domestic Washing machine as a Closed loop control system



A domestic washing machine can be considered as a closed-loop control system because it takes input (dirty clothes, detergent, water), processes it through the washing cycle, and produces an output (clean clothes). The machine uses sensors to measure the water level, temperature, and other variables to ensure that the washing cycle runs smoothly and produces the desired output.
In a washing machine, the closed-loop control system uses sensors and feedback to ensure that the washing cycle runs smoothly and produces the desired output. Here is a more detailed explanation of how the closed-loop control system works in a washing machine:

- Sensors: The washing machine has various sensors that measure different parameters such as water level, temperature, and load balance. These sensors provide feedback to the control unit about the washing cycle's progress and performance.

- Control Unit: The control unit receives feedback from the sensors and uses that information to adjust the washing cycle. For example, if the water level is too high, the control unit will signal the water valve to stop filling the machine with water.

- Actuators: The control unit also uses actuators to make adjustments to the washing cycle. For instance, if the water temperature is too low, the control unit will increase the heating element's power to raise the temperature.

- Closed-Loop Feedback: As the washing cycle progresses, the closed-loop control system continuously receives feedback from the sensors and adjusts the washing cycle's parameters accordingly. This closed-loop feedback system ensures that the washing cycle runs efficiently and produces clean clothes as output.

For example, if the washing machine is overloaded with clothes, the load balance sensor will detect the imbalance and signal the control unit to adjust the washing cycle. The control unit will then adjust the motor's speed to balance the load and prevent the machine from vibrating excessively.

In conclusion, the closed-loop control system in a washing machine uses sensors, control units, and actuators to monitor and adjust the washing cycle's parameters. The closed-loop feedback system ensures that the washing cycle runs efficiently and produces the desired output. The closed-loop control system enables washing machines to operate reliably and produce clean clothes while minimizing water and energy consumption.

ROBOTICS AND AUTOMATION

ROBOTICS can be defined as"A field of technology that deals with the conception, design, construction, operation and application of robots"

Robot

A Robot is a reprogrammable, multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions of performance of a variety of tasks.

Industrial Robot

An industrial robot can perform wide range of industrial tasks like **loading**, **unloading**, **welding**, **painting**, **inspection**, **assembly**, **material transfer**, etc.

A robot is a machine that is designed to perform tasks that are typically done by humans, either autonomously or under the control of a human operator. Robots can be programmed to perform a wide range of tasks, from simple actions such as picking up an object to complex tasks such as assembling a car. Robots typically consist of mechanical components, such as arms, grippers, and wheels, as well as electronic components such as sensors, actuators, and control systems. These components work together to enable the robot to interact with its environment and perform its designated tasks.

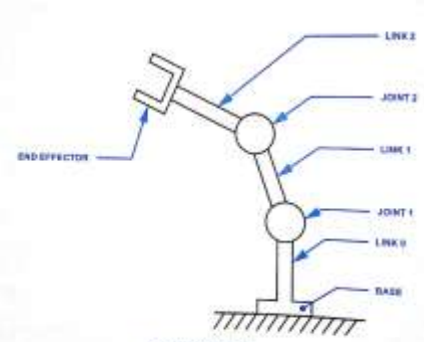
There are many types of robots, each designed for specific applications. Some examples include:

- Industrial robots: These are used in manufacturing and production lines to perform tasks such as welding, painting, and assembly.
- Service robots: These are used in a variety of applications, such as in healthcare, hospitality, and transportation. Examples include cleaning robots, delivery robots, and surgical robots.
- Military robots: These are used for tasks such as reconnaissance, surveillance, and bomb disposal.
- Exploration robots: These are used in space and underwater exploration to gather data and perform tasks that would be difficult or dangerous for humans.

Robots are becoming increasingly sophisticated and are being developed to perform a wider range of tasks. They have the potential to increase productivity, improve safety, and reduce costs in many industries.

<u>Basic term related to Industrial Robot</u>

- Manipulator: A manipulator is a robotic arm that consists of a series of joints and links that allow it to move and position objects.
- Joint: A joint is a connection between two or more links that allows motion in one or more degrees of freedom. Examples include rotational joints, linear joints, and orthogonal joints.
- Link: A link is a rigid component of a manipulator that connects two joints. Links can have different shapes and sizes depending on the requirements of the application.
- Degrees of freedom (D.O.F): The degrees of freedom of a robotic manipulator refers to the number of independent motions that it can perform. Each joint in a manipulator typically provides one degree of freedom. The total number of degrees of freedom in a manipulator determines its range of motion and flexibility.



- End effector: The end effector is the tool or device that is attached to the end of the robotic arm and is used to interact with objects. Examples include grippers, welding torches, and sensors.

- Base: The base of a robotic manipulator is the fixed point from which the arm operates. It provides a stable foundation for the arm and often includes motors and sensors that control its motion.

Together, these components make up a robotic manipulator that can be programmed to perform a wide range of tasks in manufacturing, assembly, and other applications.

<u>**Elements of a Robotic System**</u>

- **The Robot - manipulator, end effector, actuators, transmission elements**
- **Control system – mechanical controls, hydraulic control, electrical controls, sensors**
- **Computer system – use to program the robots to perform required tasks**
- **Power source – to supply electrical energy**

1. Robot Manipulator: This refers to the robotic arm that carries out various tasks. It consists of multiple joints connected by links, and each joint can move in a specific direction to provide a range of motion.

2. End Effector: This refers to the tool or device attached to the end of the robot manipulator that is used to perform specific tasks, such as a gripper, welding torch, or cutting tool.

3. Actuators: These are the components that generate motion in the robot. They can be electric, hydraulic, or pneumatic, and they convert energy into motion to move the robot's joints and end effector.

4. Transmission Elements: These are the mechanical components that transmit motion from the actuators to the robot's joints and end effector. Examples include gears, belts, and pulleys.

5. Control System: This refers to the system that controls the robot's motion and behavior. It can be mechanical, hydraulic, or electrical, and it includes sensors, controllers, and feedback mechanisms to ensure the robot moves accurately and safely.

6. Sensors: These are the components that detect and measure physical quantities such as position, velocity, and force. They provide feedback to the control system to ensure the robot moves accurately and safely.

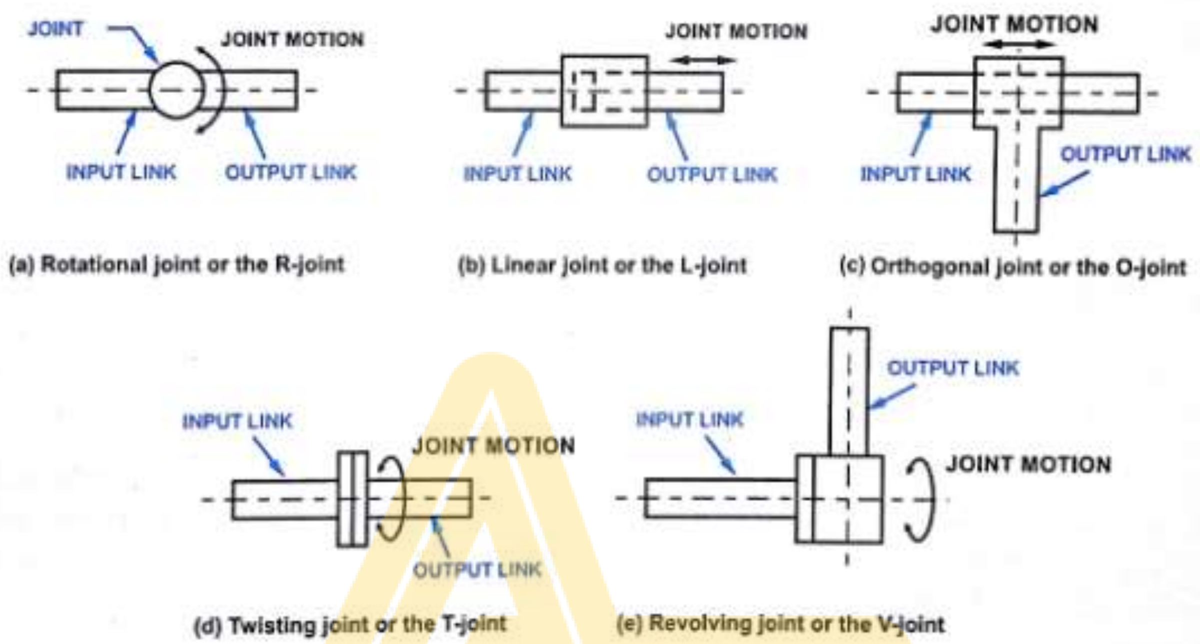
7. Computer System: This is used to program the robot to perform specific tasks. It includes software and hardware components, and it enables the robot to be programmed for different applications.

8. Power Source: This is the energy source that powers the robot's motion and control systems. It can be electrical, hydraulic, or pneumatic, depending on the robot's design and application.

Overall, these components work together to create a functioning robotic system that can perform a wide range of tasks in various industries

TYPES OF ROBOT JOINTS

- Rotational joint or the R-joint
- Linear joint or the L-joint
- Orthogonal joint or the O-joint
- Twisting joint or the T-joint
- Revolving joint or the V-joint



Types of Robot Joints

The five joints mentioned are types of robot joints that are commonly used in robotic systems. Here is a brief description of each joint:

- Rotational joint (R-joint): This joint allows rotation around an axis, such as a shoulder joint in a human arm.

- Linear joint (L-joint): This joint allows linear motion along a straight line, such as a piston moving in a cylinder.

- Orthogonal joint (O-joint): This joint allows rotation around two orthogonal axes, such as a wrist joint in a human arm.

- Twisting joint (T-joint): This joint allows twisting motion around an axis, such as a screwdriver.

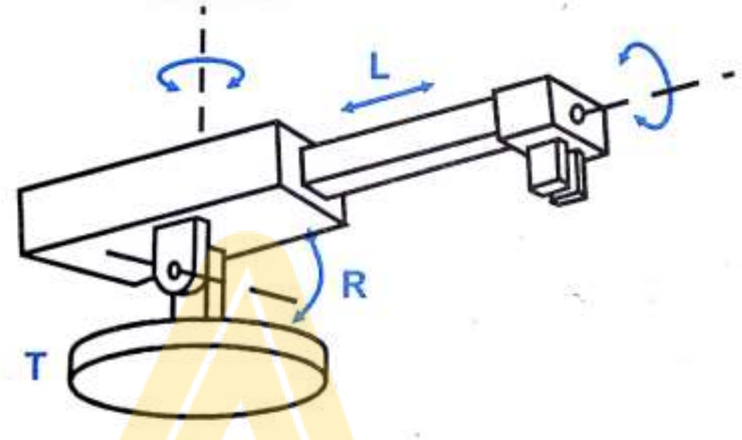
- Revolving joint (V-joint): This joint allows rotation around a central axis, such as a wheel rotating around its axle.

These joints are combined to create robotic arms and end effectors that can perform a wide range of tasks. For example, a robotic arm might have several rotational joints and one linear joint to enable it to reach and manipulate objects in three-dimensional space. The specific type and number of joints used depend on the specific application and the required range of motion and precision.

Classification Based On Robotics Configuration

- **Polar Configuration (Spherical Configuration)**
- **Cylindrical Configuration**
- **Cartesian Co-ordinate Robot**
- **Jointed – arm Configuration**

Polar Configuration (Spherical Configuration): A polar or spherical configuration has three rotary joints that allow the end effector to move in a spherical coordinate system. This configuration is useful for **applications that require a high degree of accuracy and precision, such as assembling electronic components.**



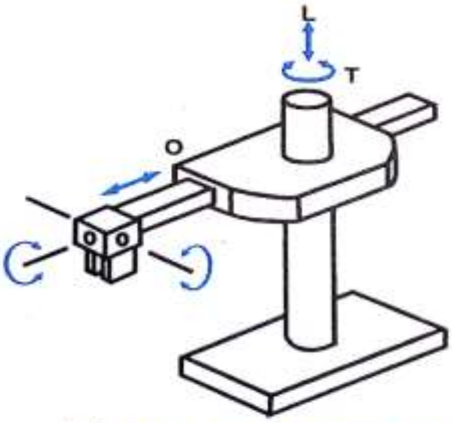
Polar Configuration Robot

A polar or spherical configuration is a type of robotic manipulator that has three rotary joints that allow the end effector to move in a spherical coordinate system. This configuration is also referred to as a spherical configuration. The three rotary joints are arranged in a radial pattern around the base of the manipulator, with one joint providing rotation around the vertical axis, another joint providing rotation around the horizontal axis, and a third joint providing rotation around the end effector axis.

The end effector can move in any direction within a sphere defined by the length of the manipulator arms. This configuration is ideal for applications that require a high degree of accuracy and precision, such as assembling small electronic components or conducting delicate surgical procedures. Spherical coordinate systems are commonly used in robotics and are also useful in computer graphics, virtual reality, and other applications that require spatial orientation.

One drawback of a polar or spherical configuration is that it has limited reach in the vertical direction, which can be a disadvantage in some applications. Another potential drawback is that the complex kinematics and control systems required for this configuration can be challenging to design and implement. However, with proper engineering and programming, a polar or spherical configuration can provide high accuracy, precision, and flexibility in a wide range of applications.

Cylindrical Configuration: A cylindrical configuration has one rotary joint and one linear joint that allow the end effector to move in a cylindrical coordinate system. **This configuration is often used for applications such as arc welding or drilling.**



Cylindrical Configuration Robot

A cylindrical configuration is a type of robotic manipulator that has one rotary joint and one linear joint that allow the end effector to move in a cylindrical coordinate system. The rotary joint provides rotation around the vertical axis, while the linear joint moves the end effector along a straight line parallel to the vertical axis.

- This configuration is well-suited for applications such as drilling or welding where the end effector needs to move along a straight line while maintaining a constant distance from the workpiece. The cylindrical configuration is also useful in applications where a large work envelope is needed, but the end effector only needs to move in one direction.

- One potential disadvantage of a cylindrical configuration is that it is limited to a cylindrical workspace and cannot move the end effector outside of that cylinder. Additionally, the configuration is not as flexible as some other configurations, such as the jointed-arm configuration, which can move the end effector in multiple directions.

Despite these limitations, the cylindrical configuration is a popular choice for applications where a straight-line motion is required, and the workspace is well-defined. With proper design and control, a cylindrical manipulator can provide accurate and efficient performance in a wide range of industrial applications.

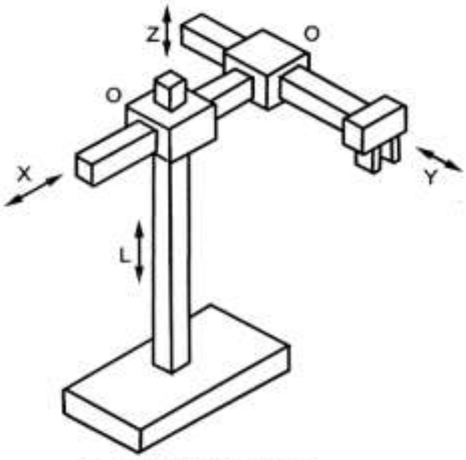
Cartesian Co-ordinate Robot: A Cartesian coordinate robot has three linear joints that move the end effector along the X, Y, and Z axes. **This configuration is useful for applications such as pick-and-place operations in manufacturing**.

A Cartesian coordinate robot, also known as a rectilinear or gantry robot, is a type of robotic manipulator that has three linear joints that move the end effector along the X, Y, and Z axes of a Cartesian coordinate system. The base of the manipulator typically has a fixed frame that supports the linear joints and the end effector.

This configuration is well-suited for applications such as pick-and-place operations, assembly, and material handling, where precise movements along straight lines are required. Cartesian robots are also commonly used in CNC (computer numerical control) machines, where they can be programmed to move tools along precise paths in a three-dimensional workspace.

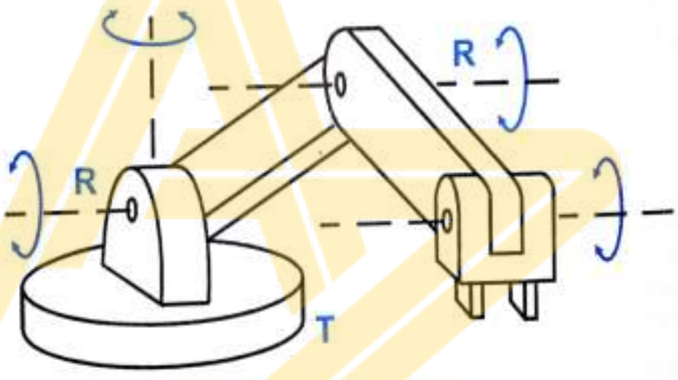
- One advantage of a Cartesian coordinate robot is its high accuracy and repeatability, which makes it ideal for applications that require precise positioning and movement. Additionally, this configuration is relatively simple to program and control, compared to some other configurations, such as the jointed-arm configuration.

- One potential disadvantage of a Cartesian coordinate robot is its limited range of motion compared to other configurations. Additionally, this configuration can be less flexible than other configurations, which can limit its usefulness in certain applications.Overall, a Cartesian coordinate robot is a versatile and reliable choice for a wide range of applications that require precise, straight-line movements in a defined workspace.



Cartesian Co-ordinate Robot

Jointed-arm Configuration: A jointed-arm configuration has several rotary joints that allow the end effector to move in a wide range of directions. **This configuration is often used for applications such as welding or painting**,pick and place robot.



Jointed arm Configuration Robot

A jointed-arm configuration, also known as an articulated robot, is a type of robotic manipulator that consists of several rigid links connected by rotary or linear joints. This configuration allows the robot to move its end effector in a wide range of motions and orientations, making it well-suited for a variety of applications such as welding, painting, and material handling.

The number of degrees of freedom of a jointed-arm robot can vary, depending on the number of joints and links. Most jointed-arm robots have six degrees of freedom, which allow the end effector to move in any direction and orientation within a six-dimensional space. Some jointed-arm robots have fewer or more degrees of freedom, depending on the specific application requirements.

- One advantage of a jointed-arm configuration is its flexibility and range of motion, which allows the robot to perform complex tasks in a wide range of workspaces. Additionally, jointed-arm robots can be programmed to perform a variety of tasks, making them well-suited for applications that require high adaptability and versatility.

- One potential disadvantage of a jointed-arm configuration is its complexity and cost. The multiple joints and links require complex kinematics and control systems, which can make the robot more challenging to design and program. Additionally, jointed-arm robots tend to be more expensive than other configurations, making them less accessible to some industries and applications.

Despite these challenges, jointed-arm robots are a popular choice for applications that require high precision, versatility, and adaptability in complex workspaces. With proper design and programming, jointed-arm robots can provide reliable and efficient performance in a wide range of industrial and commercial applications.

Each configuration has its advantages and disadvantages, and the choice of configuration depends on the specific application requirements such as workspace, accuracy, and payload capacity.

ADVANTAGES OF ROBOTS

- Can work in hazardous work environment
- Can produce greater quantity in short span of time
- Provides consistency and repeatability with accuracy
- Can work at constant speeds without any break
- Can work in tight spaces
- Produces lesser or no defective parts and hence saves times of rework and money to the organisation.
- Can perform risky jobs and avoids accidents at workplace.

DISADVANTAGES OF ROBOTS

- Organisations have to make huge investments
- Since parts of a robots are made very precisely, their replacements is very difficult and to maintain, it costs huge amount of money
- it requires highly skilled technical engineers and programmers which again is a significant cost for the organizations
- Need good program capability and computers for performing a given task
  Cannot recharge themselves, and hence need energy/ command from outide

Industrial robots have a wide range of applications

1. Manufacturing: Industrial robots are widely used in manufacturing processes, including welding, painting, material handling, and assembly. They can perform repetitive and dangerous tasks with high accuracy and efficiency, leading to increased productivity and reduced labor costs.

2. Packaging and Palletizing: Industrial robots can be used for packaging and palletizing products in factories and warehouses. They can handle different types of products and packaging materials, and can work at high speeds and with precision, leading to increased throughput and efficiency.

3. Inspection and Testing: Industrial robots can be used for inspecting and testing products, components, and materials during the manufacturing process. They can use sensors and cameras to detect defects, measure dimensions, and perform quality checks, leading to improved product quality and reduced waste.

4. Material Removal: Industrial robots can be used for cutting, grinding, and polishing materials such as metals, plastics, and composites. They can work with high precision and speed, leading to improved accuracy and reduced processing time.

5. Cleaning and Maintenance: Industrial robots can be used for cleaning and maintaining equipment, machinery, and facilities in factories and warehouses. They can work in hazardous or hard-to-reach areas, leading to improved safety and reduced downtime.

6. Food and Beverage Industry: Industrial robots are increasingly being used in the food and beverage industry, for tasks such as sorting, packaging, and quality control. They can work in sterile environments and handle delicate or perishable products, leading to improved hygiene and reduced waste.

Overall, industrial robots have a significant impact on the efficiency, quality, and safety of various manufacturing and production processes across different industries, and their use is expected to continue to grow in the coming years.

AUTOMATION

'**Automation**' – greek words
"**Auto**" means **self**
"**Matos**" means **moving**

Automation can be defined as

"**the set of technologies of carrying out a process or procedure without human assistance and achieves performance superior to manual operation**"

TYPES OF AUTOMATION

1. Fixed Automation or Hard Automation
2. Programmable Automation or Soft Automation
3. Flexible Automation

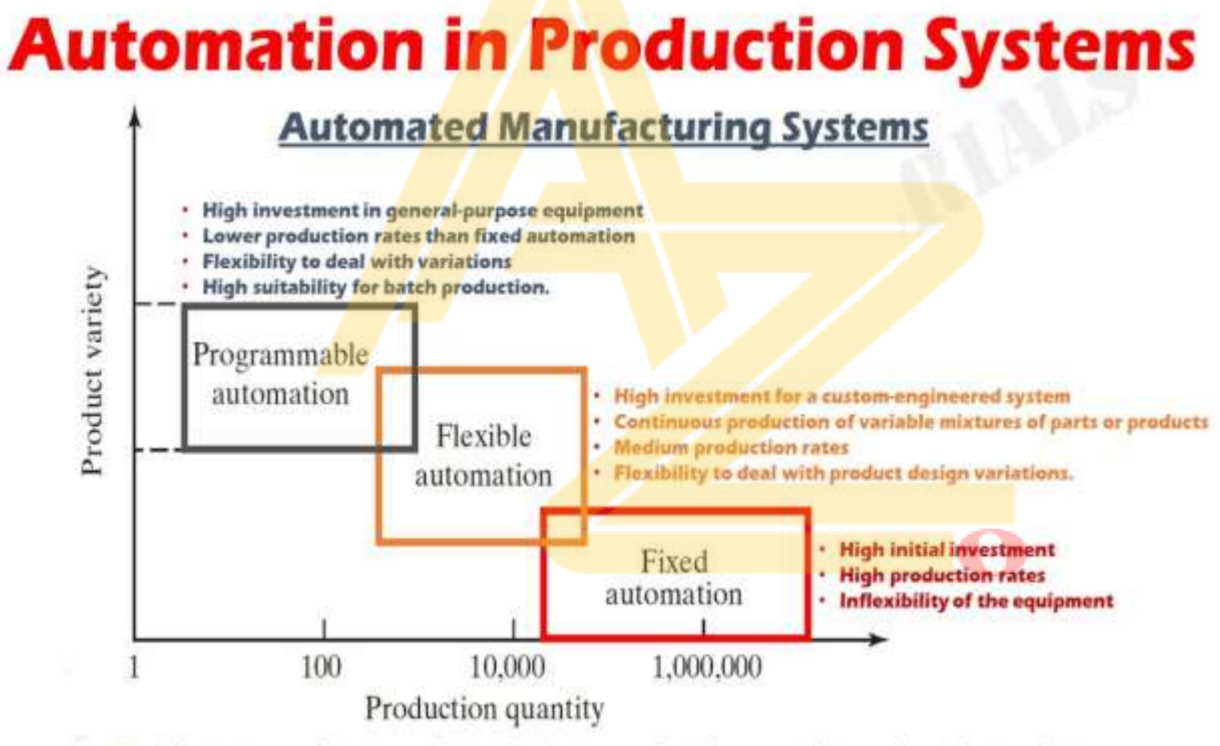


Fig: Three types of automation relative to production quantity and product variety.

The three main types of automation are fixed automation, programmable automation, and flexible automation.

1. Fixed Automation or Hard Automation: Fixed automation, also known as hard automation, is a type of automation that is designed to perform a specific task repeatedly. The equipment used in fixed automation is usually specialized and dedicated to a particular function. It is not easily adaptable to changes in product design or production volume. Examples of fixed automation include assembly lines, conveyor belts, and specialized machinery used in manufacturing processes.

2. Programmable Automation or Soft Automation: Programmable automation, also known as soft automation, is a type of automation that uses computer-controlled equipment to perform a variety of tasks. This type of

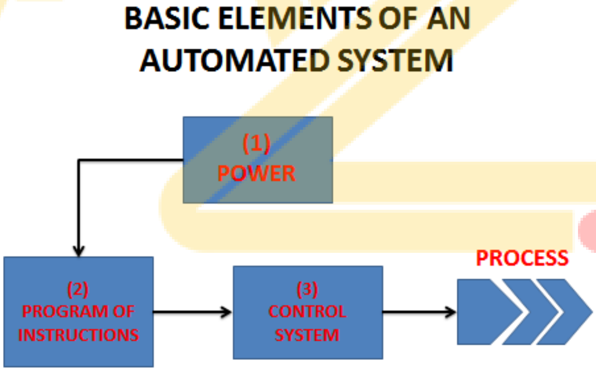
automation is more flexible than fixed automation, as the equipment can be reprogrammed to perform different tasks. Examples of programmable automation include computer numerical control (CNC) machines, robots, and automated guided vehicles (AGVs).

3. Flexible Automation: Flexible automation is a type of automation that combines the best features of fixed and programmable automation. It is designed to be highly adaptable to changes in product design and production volume, while still maintaining a high level of efficiency. Flexible automation systems typically use computer-controlled equipment that can be reconfigured quickly and easily. Examples of flexible automation include automated manufacturing cells and flexible manufacturing systems (FMS).

Example

Fixed Automation or Hard Automation: • Automated car washes • Bottling lines in beverage industry • Assembly lines in manufacturing • Industrial robots that perform repetitive tasks • Flexible Automation: • Automated manufacturing cells that can be reconfigured for different products	Programmable Automation or Soft Automation: • CNC machines used in metalworking, woodworking, and other industries • Automated guided vehicles (AGVs) used in material handling and logistics • Robotics used in medical procedures such as surgery • 3D printing machines that can be programmed to produce various designs	• Flexible manufacturing systems (FMS) that can produce a variety of products on demand • CNC machines that can switch between different machining operations automatically • Robotics systems that can perform multiple tasks in a production line

Basic Elements Of Automated system



The basic elements of an automated system typically include:

1. Sensors: Sensors are devices that detect physical or environmental changes, such as temperature, pressure, motion, or light. They provide input data to the control system, which uses this information to make decisions.

2. Actuators: Actuators are devices that convert the output signals from the control system into physical actions, such as movement, heat, light, or sound. They are used to control the physical processes in the system.

3. Control system: The control system is the "brain" of the automated system, which receives input data from sensors, processes it, and sends output signals to actuators. The control system can be programmed to perform

specific tasks, based on the input data and predefined logic.

4. Human-Machine Interface (HMI): The HMI is the user interface of the automated system, which allows humans to interact with the control system. It can be a simple display or a more complex system that includes touchscreens, buttons, and other input/output devices.

5. Communication network: The communication network is used to connect the different elements of the automated system, such as sensors, actuators, and the control system. It can be a wired or wireless network, depending on the requirements of the system.

6. Power supply: The power supply is responsible for providing the necessary electrical power to the sensors, actuators, and control system. It can be a local or remote power source, depending on the location of the automated system.

ADVANTAGES OF AUTOMATION	DISADVANTAGES OF AUTOMATION
• Increase in productivity • Improvement in Product Quality • Increase in accuracy and repeatability • Improved safety at workplace • Reduction in manufacturing lead time • Reduced direct human labour cost and expenses • Mitigation of Potential Labour Shortages	• High initial cost • Additional cost • Security threats • Human dependency on machines • Results in increased Unemployment

INTRODUCTION TO IOT

The Internet of Things (IoT) refers to the network of physical devices, vehicles, home appliances, and other items that are embedded with sensors, software, and connectivity to exchange data and perform automated actions. The IoT allows these devices to communicate and interact with each other, as well as with humans, over the internet.

The basic idea of the IoT is to create a world where everything is interconnected and can be controlled and monitored remotely. This includes everything from smart homes and wearable devices to industrial machinery and city infrastructure. By collecting and analyzing data from these devices, the IoT can enable better decision-making, improve efficiency, and create new opportunities for innovation.

Some examples of IoT devices and applications include:

- Smart thermostats that can learn your preferences and adjust the temperature accordingly
- Wearable fitness trackers that can monitor your physical activity and heart rate
- Smart home security systems that can send alerts and activate cameras when motion is detected
- Industrial sensors that can monitor machine performance and predict maintenance needs
- Connected cars that can provide real-time traffic updates and safety alerts

As the IoT continues to evolve, it is expected to have a major impact on many aspects of daily life, from healthcare and transportation to manufacturing and agriculture. However, there are also concerns about privacy and security, as well as the potential for unintended consequences as more devices become connected to the internet.

Characteristics of IOT

1. Interconnectivity: IoT devices are designed to be interconnected with each other and with other systems through the internet or other networks. This allows for seamless data exchange and communication between devices.

2. Sensor-based: IoT devices typically incorporate sensors that gather data about their environment or the object they are monitoring. This data can be used for a variety of purposes, such as tracking performance, monitoring conditions, or detecting anomalies.

3. Data-driven: The IoT is built around the collection, analysis, and utilization of large amounts of data. This data can be used to improve decision-making, optimize performance, or enable new applications and services.

4. Automation: IoT devices are often designed to automate tasks or processes, such as turning lights on and off, adjusting thermostats, or monitoring inventory levels. This can help reduce manual labor and improve efficiency.

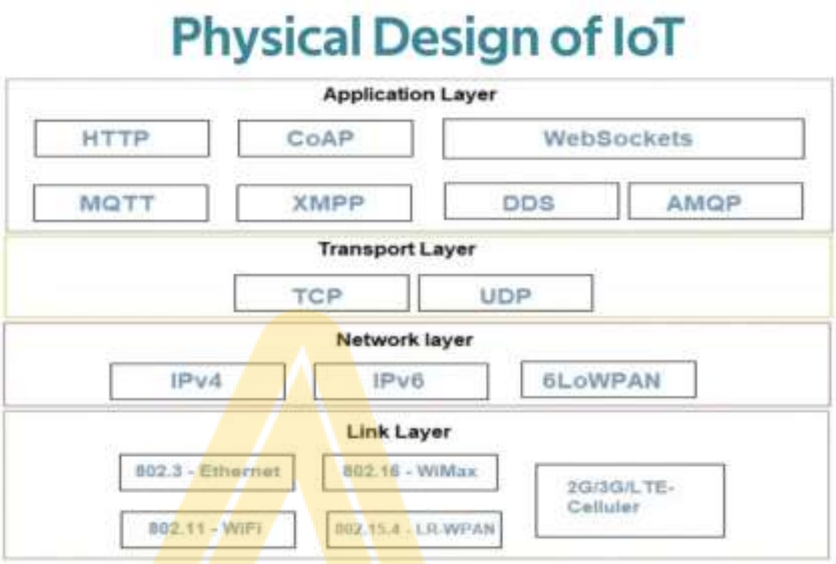
5. Remote control: IoT devices can be controlled remotely, which means that users can access and interact with their devices from anywhere in the world. This allows for greater flexibility and convenience.

6. Real-time communication: IoT devices often communicate in real-time, which means that data can be exchanged and processed quickly. This can be especially important in applications such as healthcare, where real-time monitoring and response can be critical.

7. Security: IoT devices can pose unique security challenges, as they are often connected to the internet and can be vulnerable to cyber attacks. Security is therefore a key consideration in the design and deployment of IoT systems.

The physical design of an IoT

The physical design of an IoT system depends on the specific application and the devices involved, but generally involves the following elements:



Sensors: IoT devices typically include sensors that collect data about the environment or object they are monitoring. These sensors can include temperature, pressure, motion, light, humidity, and other types of sensors, depending on the application.

Connectivity: IoT devices must be connected to a network in order to transmit data and receive commands. This can be done using a variety of technologies, such as Wi-Fi, Bluetooth, Zigbee, or cellular networks.

Data processing: IoT devices often include a microprocessor or other processing unit that can analyze the data collected by the sensors and make decisions based on that data. This processing can take place locally on the device or in the cloud, depending on the application.

Power source: IoT devices require a power source to operate, which can be a battery, AC power, or another source of energy, depending on the device and the application.

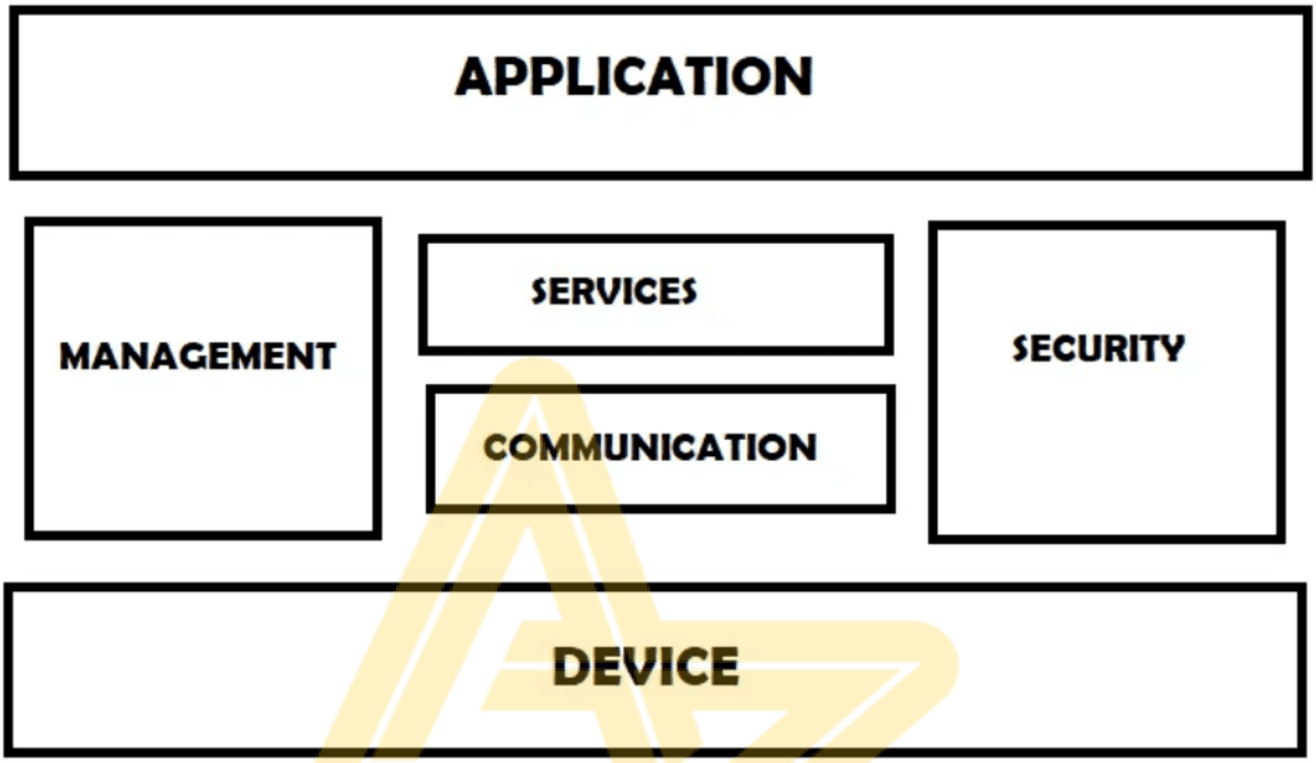
Enclosure: IoT devices are often enclosed in a protective casing or enclosure to protect them from the environment and to provide a means for mounting or attaching the device.

User interface: IoT devices may include a user interface that allows users to interact with the device, such as a touchscreen display or a mobile app.

Security: IoT devices must be designed with security in mind, including measures such as encryption, authentication, and access control, to protect against cyber threats and unauthorized access.

Overall, the physical design of an IoT system is critical to its performance, reliability, and security. It must be carefully planned and executed to ensure that the system meets the needs of its intended application and is capable of performing as expected in a variety of conditions.

Logical design of IoT Functional blocks



Logical design of IoT Functional blocks

The logical design of an IoT system involves defining the software and data architecture that enables the system to function as desired. Here are some key elements of the logical design of IoT:

- Data collection and processing: IoT systems typically collect data from sensors and other sources, process that data, and transmit it to other systems or users. The logical design of an IoT system should define how data is collected, processed, and transmitted, including the protocols and data formats used.

- Cloud infrastructure: Many IoT systems rely on cloud infrastructure to store and process data. The logical design of an IoT system should define how data is stored, accessed, and processed in the cloud, including the use of databases, analytics tools, and other cloud services.

- Analytics and insights: IoT systems generate large amounts of data, and the logical design should include tools and techniques for analyzing that data and generating insights. This may include machine learning algorithms, predictive analytics, and other techniques.

- Integration with other systems: IoT systems often need to integrate with other systems, such as enterprise resource planning (ERP) systems, customer relationship management (CRM) systems, or other business applications. The logical design of an IoT system should define how data is exchanged between these systems, and how the IoT system can be integrated into existing IT infrastructure.

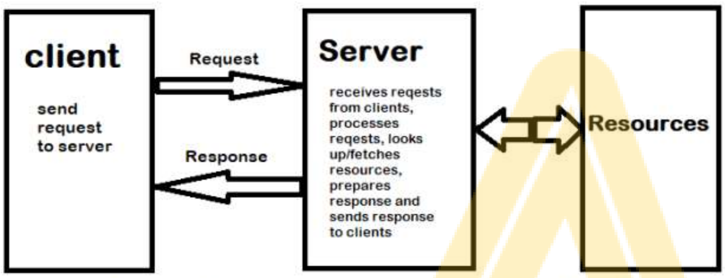
- User interfaces: IoT systems may include user interfaces for configuring, monitoring, and controlling devices.

The logical design should define how these user interfaces are designed and implemented, including the use of mobile apps, web interfaces, or other technologies.

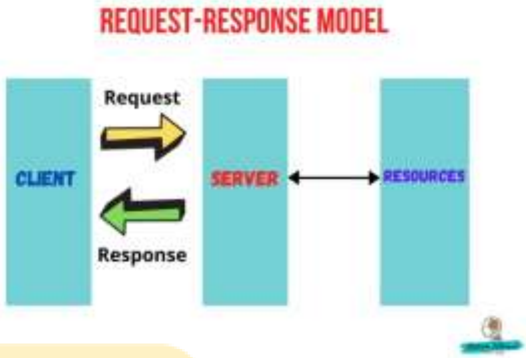
- Security: IoT systems must be designed with security in mind, including measures such as encryption, authentication, and access control, to protect against cyber threats and unauthorized access. The logical design of an IoT system should define how security is implemented across the system, including the use of firewalls, intrusion detection systems, and other security technologies.

Overall, the logical design of an IoT system is critical to its functionality and performance. It must be carefully planned and executed to ensure that the system meets the needs of its intended application and is capable of performing as expected in a variety of conditions.

Communication Models Used In IoT Systems



Request-Response Communication Model



There are several communication models used in IoT systems to enable communication between devices, sensors, and the cloud. Here are some of the most common communication models in IoT:

Device-to-device (D2D) communication: In this model, devices communicate directly with each other without the need for an intermediary. This model is used in scenarios where devices need to communicate in real-time, such as in industrial automation or smart homes.

Device-to-cloud (D2C) communication: In this model, devices communicate with a cloud server or platform that collects and processes data from multiple devices. The cloud platform can then analyze the data and send commands back to the devices as needed. This model is commonly used in applications such as smart cities or remote monitoring of equipment.

Cloud-to-device (C2D) communication: In this model, the cloud platform sends commands or updates to devices, which then take action based on those commands. This model is commonly used in scenarios such as firmware updates or remote control of devices.

Cloud-to-cloud (C2C) communication: In this model, multiple cloud platforms communicate with each other to exchange data and services. This model is used in applications such as cross-platform integration or data exchange between different cloud services.

Peer-to-peer (P2P) communication: In this model, devices communicate directly with each other in a decentralized network without the need for a central server or cloud platform. This model is used in scenarios such as decentralized applications or blockchain-based systems.

Overall, the choice of communication model depends on the specific requirements of the IoT application, including factors such as latency, bandwidth, security, and scalability. IoT systems may use a combination of these communication models to achieve the desired functionality and performance.

Question Bank

1. **With Suitable Example explain the concept of open and Closed loop System**
2. **What are robots? Explain Cartesian coordinates used for robots**
3. **Explain Fixed, programmable and flexible automation**
4. **Illustrate the working of an automated washing machine to demonstrate the mechatronic system**
5. **What is open and Closed loop mechatronic systems System? Explain with example**
6. **Write a note on Characteristics, Physical design of IOT, List its application area**
7. **What are robots? Explain the application of robot in assembly and inspections**
8. **What is IOT? Explain how IOT improve Automation in industries?**
9. **Write a note on Characteristics, Physical design of IOT, List its application area**
10. **What are robots? Explain polar & cylindrical coordinates used for robots**
11. **Explain Future of Smart manufacturing**
12. **Explain Fixed, programmable and flexible automation**
13. **Explain scope and Future of IOT**
14. **What is IoT? Explain The physical design of an IoT**
15. **Explain Logical design of IoT with block diagram**
16. **What is IOT? Communication Models Used In Iot Systems**
17. **With Suitable Example explain the concept of Open and Closed loop System**
18. **Write a note on Fixed, programmable and flexible automation**
19. **What is Smart Manufacturing? Discuss the role of IoT in smart manufacturing**