CANARA ENGINEERING COLLEGE,

Benjanapadavu, Bantwal

Department of Basic Science and Humanities

Introduction to Mechanical Engineering

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Module No.: 5

Module Title: Advances in Mechanical Engineering

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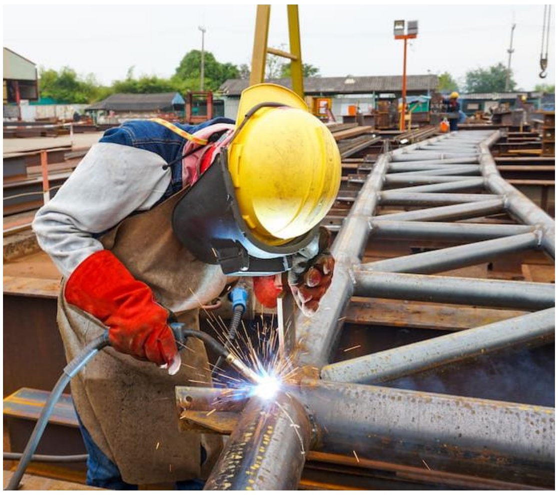


MODULE 5

Introduction to Mechatronics and Robotics

Advances in Mechanical Engineering: Automation technology: Definition of automation, types of automation, basic elements of automation. Mechatronic systems: Definition of mechatronics, elements of mechatronics systems, examples. Elementary sensors: Working principle and applications of Potentiometer, capacitive sensor and optical encoders. Integrated system: Need for integration of technologies, ADAS (Advanced Driver Assistance system.)

Automation Technology

Automation is the technology by which a process or procedure is accomplished without human assistance. It is implemented using a program of instructions combined with a control system that executes the instructions, To automate a process. power is required, both to drive the process itself and to operate the program and control system.

Definition of automation

Automation is the use of technology to perform tasks with minimal human intervention. It involves using machinery, computer systems, and software to operate processes automatically, aiming to improve efficiency, reduce costs, and enhance safety

Although automation can be applied in a wide variety of areas, it is most closely associated with the manufacturing industries. It was in the context of manufacturing that the term was originally coined by an engineering manager at Ford Motor Company in 1946 to describe the variety of automatic transfer devices and feed mechanisms that had been installed in Ford's production plants.

Examples of automated manufacturing systems include

- automated machine tools that process parts
- transfer lines that perform a series of machining operations
- automated assembly systems
- manufacturing systems that use industrial robots to perform processing or assembly operations
- automatic material handling and storage systems to integrate manufacturing operations
- automatic inspection systems for quality control

Types of automated manufacturing system

(1) fixed automation.
(2) programmable automation, and
(3) flexible automation.

Fixed Automation

Fixed automation is a system in which the sequence of processing (or assembly) operations is fixed by the equipment configuration. Each of the operations in the sequence is usually simple, involving perhaps a plain linear or rotational motion or an uncomplicated combination of the two;

Typical features of fixed automation are:
- high initial investment for custom-engineered equipment
- high production rates
- relatively inflexible in accommodating product variety

Examples of fixed automation include machining transfer lines and automated assembly machines.

Programmable Automation

In programmable automation. the production equipment is designed with the capability to change the sequence of operations to accommodate different product configuration. The operation sequence is controlled by a program, which is a set of instructions coded so that they can be read and interpreted by the system. New programs can be prepared and entered into the equipment to produce new products.

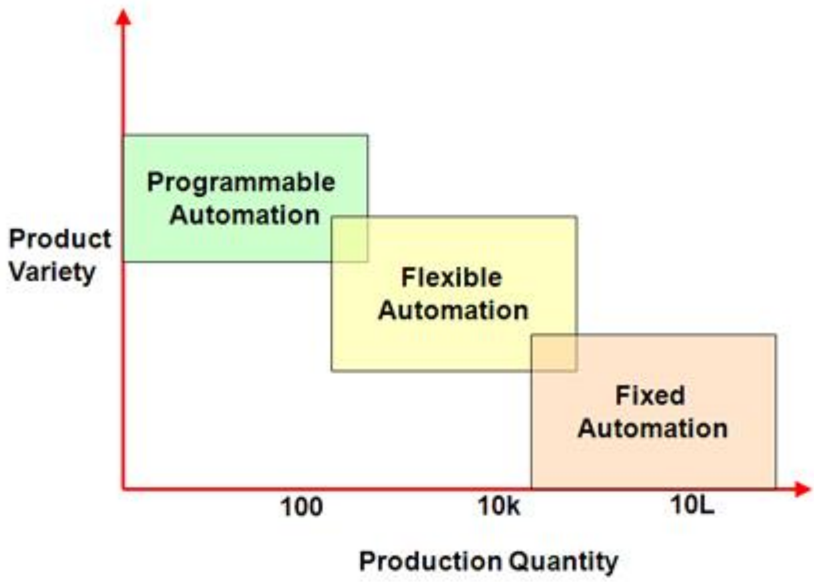
Typical features of programmable automation:
- high investment in general purpose equipment
- lower production rates than fixed automation
- flexibility to deal with variations and changes in product configuration
- most suitable for batch production

Examples of programmable automation include numerically controlled (NC) machine tools, industrial robots, and programmable logic controllers.

Flexible Automation

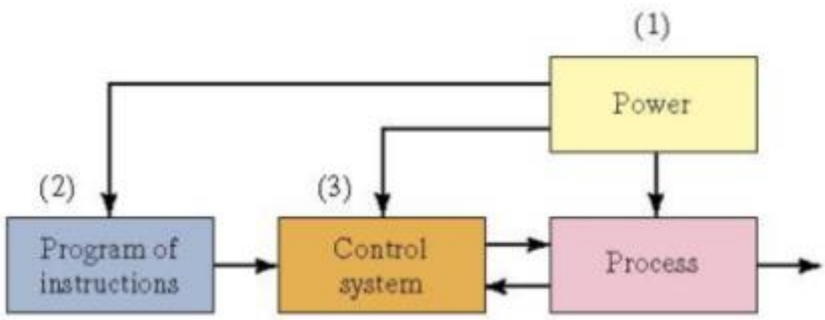
Flexible automation is an extension of programmable automation. A flexible automated system is capable of producing a variety of parts (or products) with virtually no time lost for changeovers from one part style to the next. There is no lost production time while reprogramming the system and altering the physical setup (tooting, fixtures, machine settings).

The features of flexible automation
- high investment for a custom-engineered system
- continuous production of variable mixtures of products
- medium production rate,
- flexibility to deal with product design variations



Basic Elements of An Automated System

An automated system consists of three basic elements:
(1) *Power* to accomplish the process and operate the system.
(2) a *program of instructions* to direct the process, and
(3) a *control system* to actuate the instructions.



Power to Accomplish the Automated Process

An automated system is used to operate some process, and power is required to drive the process as well as the controls. The principal source of power in automated systems is electricity. Electric power has many advantages in automated as well as nonautomated processes

Program of Instructions

The actions performed by an automated process are defined by a program of instructions Whether the manufacturing operation involves low, medium, or high production, each part or product style made in the operation requires one or more processing steps that are unique to that style, these processing steps are performed during a work cycle. A new part is completed during each work cycle in some manufacturing operations, more than one part is produced during the work cycle. The particular processing steps for the work cycle are specified in a work cycle program. Work cycle programs are called part programs in numerical control. Other process control applications use different names for this type of program.

Control System

The control element of the automated system executes the program of instructions. The control system causes the process to accomplish its defined function. which for our purpose is to carry out some manufacturing operation. The controls in an automated system can be either closed loop or open loop. A closed loop control system, also known as a feedback control system. is one in which the output variable is compared with an input parameter, and any difference between the two is used to drive the output into agreement with the input.

Advantages of Automation in Industries.

1. **Lower operating costs**

Robots can perform the work of three to five people, depending on the task. In addition to savings on the cost of labor, energy savings can also be significant due to lower heating requirements in automated operations. Robots streamline processes and increase part accuracy, which means minimal material waste for your operation.

2. **Improved worker safety**

Automated cells remove workers from dangerous tasks. Your employees will thank you for safeguarding them against the hazards of a factory environment.

3. **Reduced factory lead times**

Automation can keep your process in-house, improve process control and significantly reduce lead times compared to outsourcing or going overseas.

4. **Faster Return on Investment(ROI)**

Automation solutions are based on your unique needs and goals and pay for themselves quickly due to lower operating costs, reduced lead times, increased output and more.

5. **Ability to be more competitive**

Automated cells allow you to decrease cycle times and cost-per-piece while improving quality. This allows you to better compete on a global scale. Additionally, the flexibility of robots enables you to retool a cell to exceed the capabilities of your competition.

6. Increased production output

A robot has the ability to work at a constant speed, unattended, 24/7. That means you've got the potential to produce more. New products can be more quickly introduced into the production process and new product programming can be done offline with no disruption to existing processes.

7. Consistent and improved part production and quality

Automated cells typically perform the manufacturing process with less variability than human workers. This results in greater control and consistency of product quality.

8. Smaller environmental footprint

By streamlining equipment and processes, reducing scrap and using less space, automation uses less energy. Reducing your environmental footprint can save real money.

9. Better planning

Consistent production by robots allows a shop to reliably predict timing and costs. That predictability permits a tighter margin on most any project.

10. Reduce need for outsourcing

Automated cells have large amounts of potential capacity concentrated in one compact system. This allows shops to produce parts in-house that have previously been outsourced.

11. Optimal utilization of floor space

Robots are designed on compact bases to fit in confined spaces. In addition to being mounted on the floor, robots can be mounted on walls, ceilings, rail tracks and shelves. They can perform tasks in confined spaces, saving you valuable floor space.

12. Easy integration

Productivity will work with you to provide a complete system – hardware, software and controls included. Your cell will be proven out at Productivity and shipped production-ready – allowing you to start making parts as soon as it's installed in your shop.

13. Increase productivity and efficiency

- 24/7 production, JIT manufacturing-friendly
- More uptime with historic efficiency figures above 90 percent
- Secondary operations capability — gauging, washing, deburring, etc.
- Real-time factory communications with automated cell and machines
- Quick changeover for multiple parts, tooling and programs

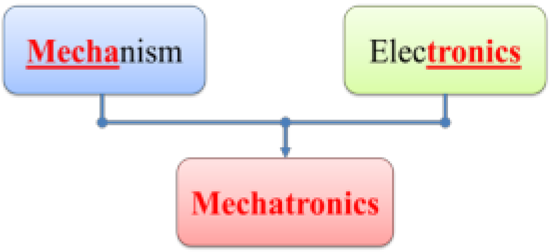
14. Increase system versatility

- System flexibility, easily retooled and repositioned for new production programs.
- Robots are flexible and can easily be redeployed in new applications.
- Robots have the ability to easily switch between a wide range of products without having to completely rebuild production lines.

- Quick changeover with auto grippers and vision allows for different part sizes and shapes to be part of the same run.
- Mixed-flow production approach allows for flexibility in adjusting to demand fluctuations.
- Robots are able to instantaneously "learn" new processes.
- Reduced changeover time.

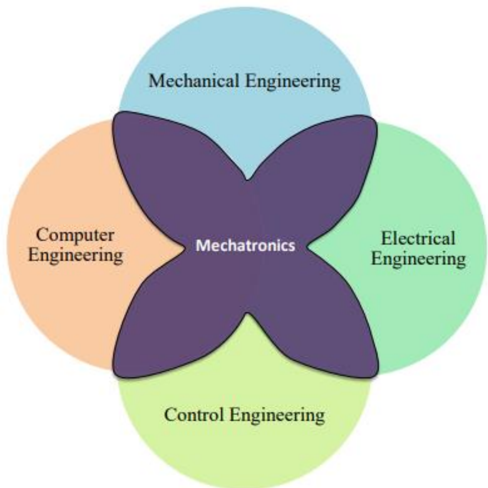
Introduction to Mechatronics

Mechatronics is a concept of Japanese origin (1970's) and can be defined as the application of electronics and computer technology to control the motions of mechanical systems.



Definition of Mechatronics: It is a multidisciplinary approach to product and manufacturing system design. It involves application of electrical, mechanical, control and computer engineering to develop products, processes and systems with greater flexibility, ease in redesign and ability of reprogramming. It concurrently includes all these disciplines.

Mechatronics can also be termed as replacement of mechanics with electronics or enhance mechanics with electronics. For example, in modern automobiles, mechanical fuel injection systems are now replaced with electronic fuel injection systems. This replacement made the automobiles more efficient and less pollutant.



With the help of microelectronics and sensor technology, mechatronics systems are providing high levels of precision and reliability. It is now possible to move (in x – y plane) the worktable of a modern production machine tool in a step of 0.0001 mm.

By employment of reprogrammable microcontrollers/microcomputers, it is now easy to add new functions and capabilities to a product or a system. Today's domestic washing machines are "intelligent" and four-wheel passenger automobiles are equipped with safety installations such as air-bags, parking (proximity) sensors, antitheft electronic keys etc.

System

System when a number of elements or components are connected in a sequence to perform a specific function, the group thus formed is called a system.

Example: a lamp (made up of glass, filaments)

Control System

In a system when the output quantity is controlled by varying the input quantity the system is called control system

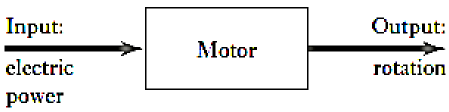
Example: a lamp controlled by a switch

The output quantity is called controlled variable or response The input quantity is called command signal or excitation.

a) Spring

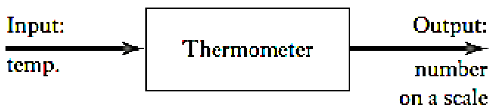
(a)

b) Motor



(b)

c) Thermometer



(c)

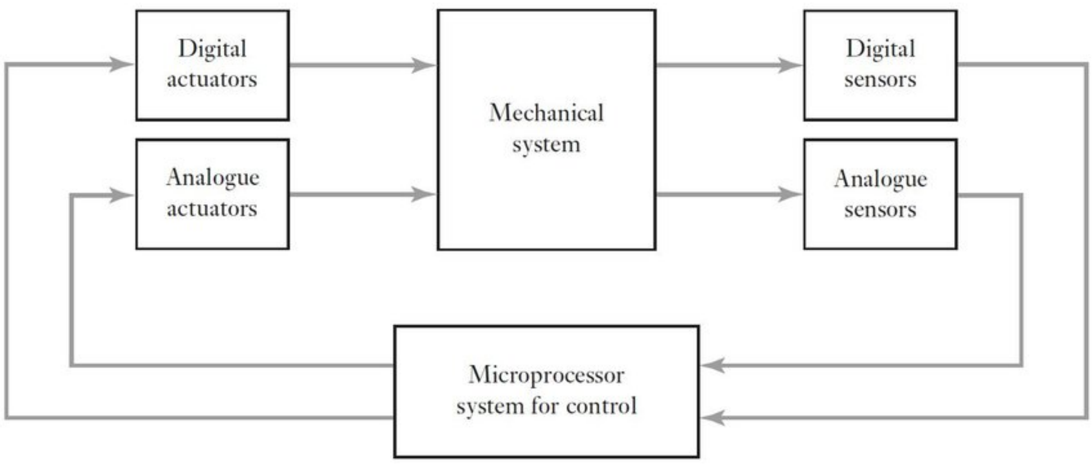
Key Elements of Mechatronics Systems

A typical mechatronics system involves the following components working in synergy:

- Mechanical Components: This forms the physical structure of the system and performs the actual physical movement or action. Examples include gears, bearings, chassis, and other structural elements that enable mechanical operations.
- Sensors and Transducers: Sensors act as the "eyes and ears" of the system, detecting physical parameters (e.g., temperature, position, force, light) in the environment or system state and converting them into measurable electrical signals. Common examples include thermocouples, potentiometers, and accelerometers.

- Signal Conditioning and Interfacing: The raw signals from sensors often need processing before a controller can use them. This stage involves amplification, filtering unwanted noise, and converting analog signals to digital form (using analog-to-digital converters, or ADCs).
- Control System/Controller: This is the "brain" of the system, which processes the input signals, makes decisions based on programmed logic or algorithms, and generates command signals for the output. This often involves a computer, microprocessor, microcontroller (MCU), or Programmable Logic Controller (PLC).
- Actuators: Actuators convert the electrical command signals from the controller back into physical action or mechanical motion. Examples include DC motors, stepper motors, servo motors, solenoids, and pneumatic or hydraulic systems.
- Output Signal Conditioning: Similar to input conditioning, this stage transforms the small command signals from the controller into a form that can drive the actuators, often involving amplifiers and digital-to-analog converters (DACs).
- Software and Information Systems: Software provides the intelligence and control logic for the entire system, enabling complex tasks, automation, and decision-making. This includes control algorithms, communication protocols, and user interfaces.
- Data Presentation/Display Systems: For monitoring or user interaction, the system's state or output can be displayed using devices like LEDs, LCDs, or graphical user interfaces.

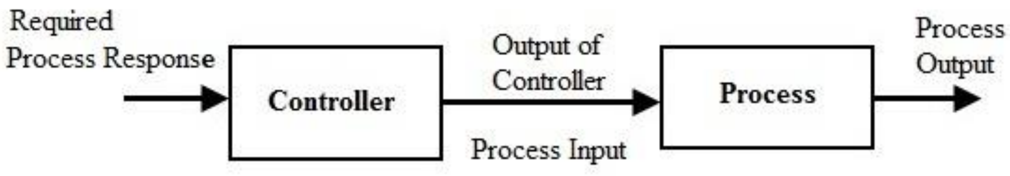
These elements are integrated through a combination of mechanical, electrical, and control engineering principles, often employing a feedback loop where sensor data continuously informs the controller's actions.



Open Loop Control System

The open loop control systems output is dependent on the input but the input or controlling action is independent of the output or change in the output.

An open-loop system has no self-regulation or control action over the output value. Each input setting determines a fixed operating position for the controller. Changes or disturbances in external conditions does not result in a direct output change (unless the controller setting is altered manually).



A reference input signal is applied to the controller, whose output access actuating the signal. The actuating signal then controls the control process so that the control variable will perform according to some prescribed standards.

Consider an electric room heater operated by a switch. If a person turns on the switch, the room will heat up and reach the temperature which is only determined by the wattage rating electric heater. The heat output cannot be adjusted and constant if there are changed in weather condition because no information is fed back to the heating element.

The conventional electric washing machine is an example of an open-loop control system because the wash time is set by the estimation of the human operator, but not on the basis of whether the clothes are clean properly. No information is fed back cleanliness off the clothes.

Advantages:

1. Simple design and easy to construct.
2. Economical.
3. Easy for maintenance
4. Highly stable operation

Dis-advantages:

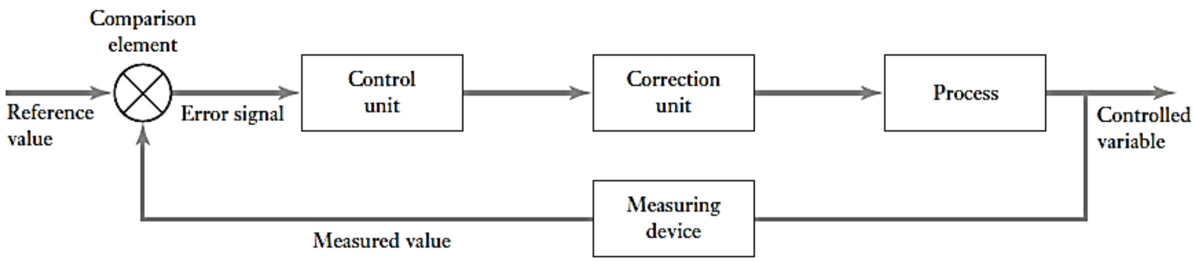
1. Not accurate and reliable when input or system parameters are variable in nature.
2. Recalibration of the parameters are required time to time.

Closed Loop Control System

The closed loop control systems output is dependent on the input and also the output decides the further input. It is characterized by a feedback system, which permits the output to be compared against the input and make necessary changes

A closed loop control system is a mechanical or electronic device that automatically regulates a system to maintain a desired state or set point without human interaction.

It uses a feedback system or sensor. The error signal generated by the error detector is sent to controller. Controller sends actuating signal based on the error signal to plant to control the process.



It consists of the following five elements.

1. Comparison Element:

This compares the required or reference value of the variable condition being controlled with the measured value of what is being achieved and produces an error signal. Comparison element gives the difference between the reference Input and feedback signal.

Error signal= (Reference value signal-Measured value signal)

The feedback is said to be negative feedback when the signal which is fed back subtracts from the input value. The feedback will be positive when the signal fed back adds to the input signal.

2. Control unit:

This decides what action to take when it receives an error signal may be to operate a switch or to open a valve. A control unit can be mechanical system which is fixed or a programmable system which can be altered by reprogramming.

3. Correction unit:

The correction unit produces a change in the process to correct or change the controlled condition. Thus, it might be a switch which switches on a heater and so increase the temperature of the process or a valve which opens and allow more liquid to enter the process. The term actuator is for the element of a correction unit that provides the power to carry out the control action.

4. Process unit:

The process is what is being controlled. It could be the temperature of the room or the speed of the fan, etc.

5. Measuring unit:

This produces a signal related to the variable condition of the process that is being controlled. In other words, this actually measures the output value.

Advantages:

1. More accurate operation than that of open-loop control system.
2. Can operate efficiently when input or system parameters are variable in nature.
3. Less nonlinearity effect of these systems on output response.
4. High bandwidth of operation.
5. There is facility of automation.
6. Time to time recalibration of the parameters is not required.

Dis-advantages:

1. Complex design and difficult to construct.
2. Expensive than that of open-loop control system.
3. Complicate for maintenance.
4. Less stable operation than that of open-loop control system

Comparison between open loop and closed loop system

Sl. No.	Open-loop control systems	Closed-loop control systems
1	No feedback is given to the control system	A feedback is given to the control system
2	Cannot be intelligent	Intelligent controlling action
3	There is no possibility of undesirable system oscillation(hunting)	Closed loop control introduces the possibility of undesirable system oscillation(hunting)
4	The output will not very for a constant input, provided the system parameters remain unaltered	In the system the output may vary for a constant input, depending upon the feedback
5	System output variation due to variation in parameters of the system is greater and the output very in an uncontrolled way	System output variation due to variation in parameters of the system is less.
6	Error detection is not present	Error detection is present
7	Small bandwidth	Large bandwidth
8	More stable	Less stable or prone to instability
9	Affected by non-linearities	Not affected by non-linearities
10	Very sensitive in nature	Less sensitive to disturbances
11	Simple design	Complex design
12	Cheap	Costly

Elementary sensors:

Elementary sensors are the interface between the physical world and the control system of a mechatronic device. They measure physical quantities (like position, distance, or motion) and convert them into electrical signals for processing.

Potentiometer

A potentiometer is a variable resistor that acts as a simple, cost-effective position or displacement sensor. It can be used for both linear and rotational measurements.

Working Principle

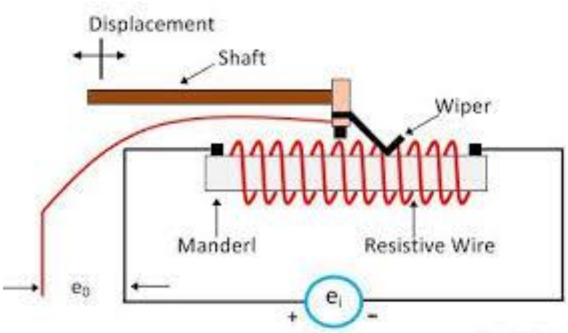
A potentiometer is an analog position sensor that works on the principle of variable resistance. It converts mechanical displacement (linear or angular) into a corresponding change in electrical resistance ($R \propto L$), which produces a proportional output voltage.

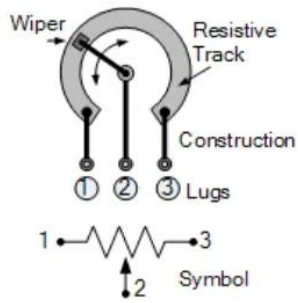
Construction: A potentiometer consists of a uniform resistive element, and a movable contact called a wiper. A fixed voltage is applied across the entire length of the resistive element.

A standard potentiometer consists of:

1. **Resistive element**
   Made of carbon film, cermet, or wire-wound material.
   Length of the element determines maximum resistance (e.g., 10 kΩ).
2. **Sliding contact (Wiper)**
   Moves along the resistive path.
   Divides the resistor into two variable parts.
3. **Two fixed terminals**
   Connected across the resistive element.
4. **One variable terminal (wiper terminal)**
   Outputs a voltage proportional to position.
5. **Mechanical arrangement**
   Rotary knob or linear slider.

Operation: As an external force or motion moves the wiper along the resistive track, the point at which the output voltage is "tapped" changes. The output voltage, measured between one end and the wiper, is directly proportional to the wiper's position along the track.





Applications

- **Position Feedback:** Used as position sensors in robotics and industrial machinery to provide feedback on the location of moving parts.
- **Volume/Signal Control:** Commonly used in audio equipment for volume control, where they adjust the level of audio output.
- **Motor Speed Control:** Employed in some motor control systems to adjust speed and direction.
- **User Interface Devices:** Used in joysticks, sliders, and knobs in consumer electronics and control panels.

Types of Potentiometers

1. **Rotary Potentiometer**
   - Circular resistive track
   - Used in volume controls, tuning circuits
2. **Linear Potentiometer (Slider Pot)**
   - Straight resistive track
   - Used in industrial displacement measurement
3. **Digital Potentiometer**
   - Electronic control, no mechanical movement

Applications

- Position sensing
- Volume control in audio devices
- Calibration and tuning
- Motion control feedback
- Servo mechanisms
- Automotive throttle position sensors (TPS)

Capacitive Sensor

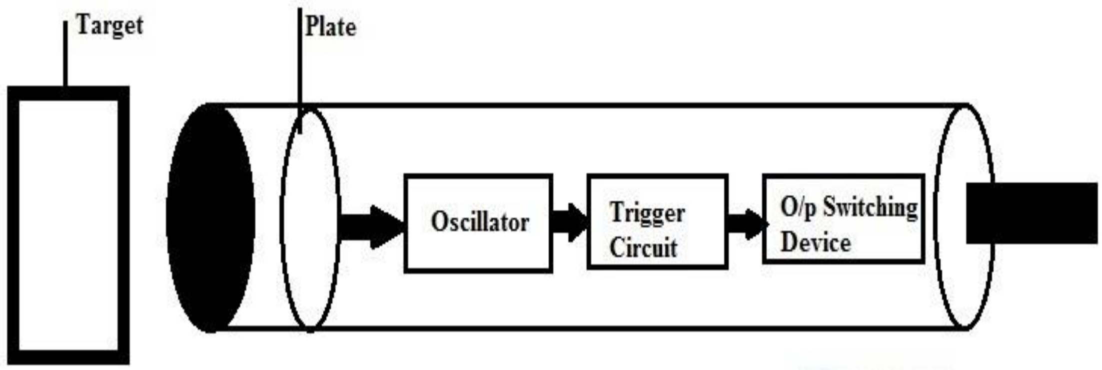
A capacitive sensor is a non-contact sensing device that detects objects by measuring changes in an electric field.

Working Principle

Capacitive sensor's function based on the principle of **capacitive coupling**, similar to an ideal plate capacitor.

- **Construction:** The sensor has a sensing surface formed by two metal electrodes, creating an electrostatic field in front of the sensor face.

- **Operation:** When an object approaches this electrostatic field, it enters the field and changes the dielectric constant of the area or acts as a second capacitor plate. This change in capacitance is detected by an internal oscillator circuit. The circuit detects the change and varies its output state (e.g., switches an output on or off) when the capacitance reaches a certain threshold. These sensors can detect both conductive and non-conductive materials like plastic, glass, or liquids, as long as their dielectric constant is different from air.



Applications

- **Touch Screens:** Widely used in modern smartphones and tablets for touch input, replacing mechanical buttons.

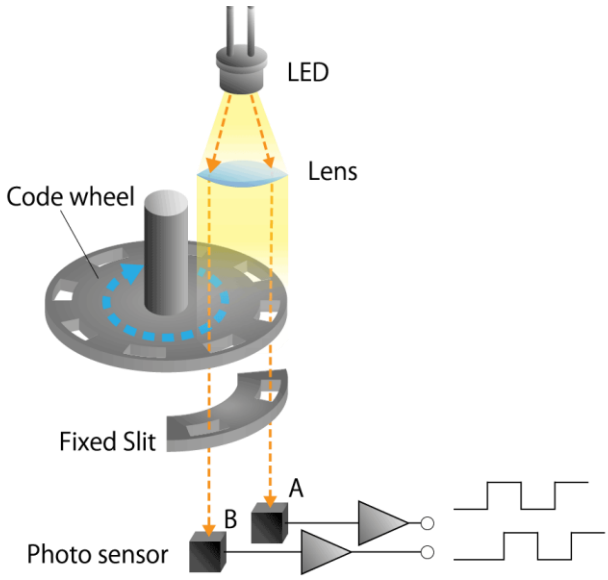
- **Fluid Level Detection:** Can detect liquid levels inside non-metallic tanks or pipes by "seeing through" the container wall, as liquids have a higher dielectric constant than air.

- **Proximity Sensing:** Used in industrial automation for non-contact object detection, counting, and presence checks.

- **Displacement/Position Measurement:** Capable of highly accurate distance and position measurements in very small areas

Optical Encoder

An optical encoder is a sensor that converts mechanical motion (usually rotation) into a digital signal (a series of pulses) using a light beam. Optical encoder is a transducer commonly used to measure rotational speed. It consists of a shaft connected to a circular disc, with one or more tracks of alternating transparent and opaque spheres. A light source and an optical sensor are mounted on opposite sides of track. When the shaft rotates, the light sensor emits a series of pulses as the light source is interrupted by patterns on the disc. This output signal can be directly proportional with digital circuitry. The number of output pulses per rotation of the disc is a known number, so the number of output pulses per second can be directly converted into the shaft's rotational speed (or rotations per second) and commonly used in motor speed control applications.



Working Principle

The working principle of an optical encoder revolves around light detection and interruption.

Construction: The optical encoder is composed of a light-emitting device (LED), photo sensors, and a disc called a code wheel with holes in the radial direction and detects rotational position information as an optical pulse signal. When a code wheel attached to a rotating shaft such as a motor rotates, an optical pulse is generated based on whether light emitted from a fixed light-emitting element passes through a hole of the code wheel or not. The photo sensor detects the optical pulse, converts it into an electrical signal, and outputs it Light-emitting devices used in optical encoders are generally inexpensive infrared LEDs, but colour LEDs with shorter wavelengths are sometimes used to suppress light diffusion and laser diodes are used in applications that require high performance. The code wheel is a disc with holes for passing/blocking the light emitted from the LED. The material of the code wheel is metal, glass and resin. Metal is strong robustness against temperature and vibration, humidity and is used in the industrial field. Resin is cheap and suitable for mass production and also used for consumer applications. The material of code wheel Glass is used in applications where high resolution and precision are required. In addition, a fixed hole can be placed at the position facing the code wheel in order to clarify the passing / blocking of the light that passes through the code wheel and enters the light receiving element.

Operation: The LED shines a beam of light at the code wheel. As the wheel rotates, the light is either passed through (transmissive type) or blocked/reflected (reflective type). The photodetector captures these rapid variations in light intensity and converts them into a series of electrical pulses (a square wave signal). A counter or controller interprets these pulses to determine motion parameters. The number and frequency of the pulses indicate the distance or speed, while the phase difference between signals from two detectors can indicate direction.

Integrated system:

The development of modern complex systems, particularly in interdisciplinary fields like mechatronics and automotive engineering, necessitates the integration of various technologies. No single technology can meet the complex demands of contemporary engineering challenges. The core idea is to combine diverse components (hardware, software, communication protocols, etc.) into a cohesive and functional whole, ensuring they work together seamlessly to achieve overarching objectives.

Need for Integration of Technologies

1. Enhanced Functionality and Performance: Integrating different technologies allows for functions that individual components could not achieve alone. The synergy between components results in a system with higher performance and greater value.

2. Improved Efficiency and Productivity: Integrated systems streamline workflows and automate processes, reducing manual effort, minimizing redundancy, and increasing overall efficiency.

3. Better Data Management and Decision-Making: Integration creates a centralized repository for data, ensuring consistency and accuracy across the system. Access to real-time, reliable data allows for more informed and faster decision-making.

4. Increased Safety and Reliability: In safety-critical systems, such as in the automotive or healthcare industries, integration allows for redundancy and comprehensive monitoring, enhancing safety and the ability to detect and respond to potential hazards effectively.

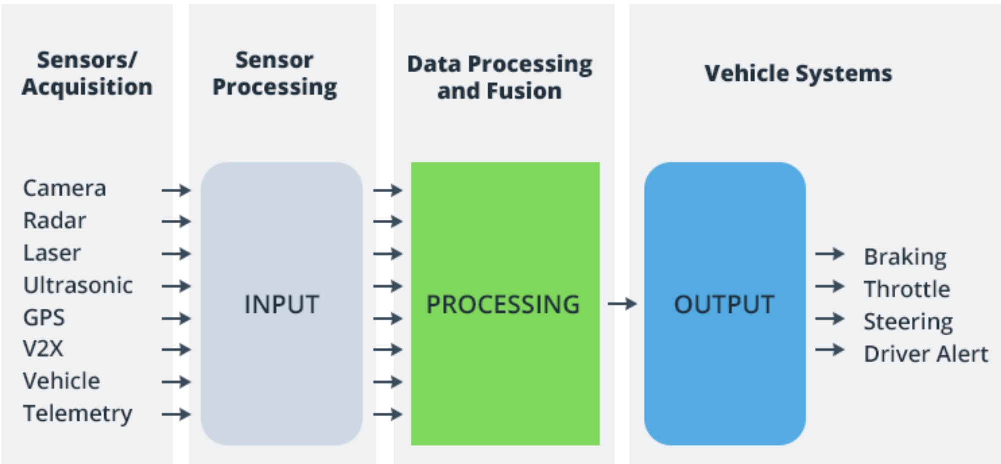
5. Scalability and Flexibility: A modular, integrated design makes it easier to adapt systems to changing requirements, scale operations, and accommodate future growth or modifications.

6. User Experience: Seamless integration creates an intuitive and consistent user experience, reducing complexity and increasing user trust and satisfaction.

7. Enabling Advanced Technologies: Modern advancements like Artificial Intelligence (AI), Machine Learning (ML), and the Internet of Things (IoT) rely heavily on the ability to integrate diverse data sources and communication platforms.

Advanced Driver Assistance Systems (ADAS)

Advanced Driver Assistance Systems (ADAS) are a prime example of a sophisticated integrated system in the automotive industry. They are a collection of electronic technologies designed to enhance driver safety, improve vehicle performance, and provide convenience by reducing human error, which is the cause of over 90% of accidents. ADAS acts as the bridge between basic safety features and fully autonomous driving.



- **Architecture and Components of ADAS**
  The architecture of an ADAS system involves a complex interplay of several integrated components:
- **Sensors:** These are the "eyes and ears" of the system, gathering real-time data about the vehicle's surroundings. Common sensor types include:
  - **Cameras:** Provide visual data for lane detection, traffic sign recognition, object classification (pedestrians, other vehicles), and 360-degree views.

  - **Radar:** Uses radio waves to measure the distance, speed, and direction of objects, effective even in poor weather conditions.
  - **LiDAR (Light Detection and Ranging):** Uses pulsed laser light to create detailed 3D maps of the environment, crucial for precise obstacle detection and navigation.
  - **Ultrasonic Sensors:** Used for short-range detection, primarily in parking assistance systems.
  - **GPS and Mapping Systems:** Provide precise location and route information, which can be integrated with sensor data to enhance situational awareness.
- **Processors (ECUs - Electronic Control Units):** These are the "brains" of the system. Powerful processors and microcontrollers run complex algorithms (often involving AI and machine learning) to interpret the vast amounts of data from the sensors in real time, assess potential hazards, and make decisions.
- **Software and Algorithms:** The intelligence of the system lies in its software, which processes the sensor data, performs sensor fusion (combining data from multiple sensors for a more robust understanding of the environment), and implements the control logic for various features.
- **Actuators:** These components execute the physical actions commanded by the control unit. Examples include:
  - **Braking Actuators:** Automatically apply the brakes during emergency braking systems.
  - **Steering Actuators:** Control the steering wheel for lane-keeping assist and automatic parking.
  - **Acceleration Actuators:** Regulate the throttle to maintain safe distances in adaptive cruise control.
- **Human-Machine Interface (HMI):** This system provides alerts and feedback to the driver through visual displays, auditory warnings, or haptic feedback (e.g., steering wheel vibration), ensuring the driver remains engaged and informed.

Key ADAS Features (Applications)

Through the integration of these technologies, ADAS enables various features:

- **Adaptive Cruise Control (ACC):** Automatically adjusts vehicle speed to maintain a safe distance from the car ahead.
- **Automatic Emergency Braking (AEB):** Automatically applies brakes to avoid or mitigate collisions if the driver doesn't react in time.
- **Lane Departure Warning (LDW) & Lane Keeping Assist (LKA):** Alert the driver when the vehicle drifts from its lane and can actively steer it back into the lane.

- **Blind Spot Detection (BSD):** Warns the driver of vehicles in their blind spots during lane changes.
- **Traffic Sign Recognition (TSR):** Uses cameras to identify and display traffic signs (e.g., speed limits) on the dashboard.
- **Driver Monitoring Systems (DMS):** Monitor the driver's alertness and attention to detect fatigue or distraction.

The seamless integration of all these systems allows ADAS-equipped vehicles to perceive their environment, process information rapidly, and take timely actions to enhance safety and comfort, paving the way for the future of fully autonomous driving

QUESTION BANK

1. Define Automation. List and explain the types of Automation with examples. List its merits and demerits.
2. Define Automation. explain the components of Automation with a block diagram
3. Define Mechatronics. Explain open loop and closed loop mechatronic system with example.
4. Define mechatronics systems and explain the key elements of mechatronics systems, with examples.
5. Explain with a short note on the Elementary sensors, capacitive sensors and optical encoders
6. List the comparison between closed loop and open loop mechatronic systems
7. Outline the Working principle and applications of the Potentiometer Explain the different types of automation
8. Why is the integration of technologies needed? Explain the Advanced Driver Assistance System.

WEB RESOCRES

1. https://www.startertutorials.com/blog/introduction-to-iot.html
2. https://www.startertutorials.com/blog/logical-design-of-iot.html