

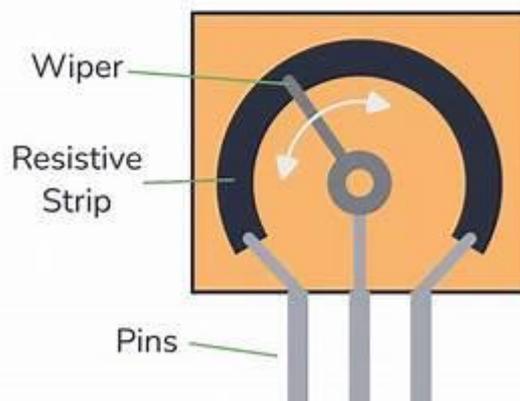
POSITION SENSORS:

Position sensors are devices used to measure how far something moves. They can measure straight movement (linear) or circular movement (angular). In robots, these sensors help to know the exact position of parts like arms or wheels. Some sensors, like encoders, can also use the position data to find how fast something is moving (velocity). These sensors are very important in robotics to control movement accurately.

Types of position sensor:

- **POTENTIOMETER:**

A **potentiometer** is a simple device used to measure position. It works by changing electrical resistance when a knob is turned or a slider is moved. Inside, it has a resistive track and a small moving part called a wiper. When the position changes, the wiper moves along the track, which changes the output voltage. By measuring this voltage, we can know how much something has moved. Potentiometers are commonly used in robotics and electronic devices because they are simple, low-cost, and easy to use.

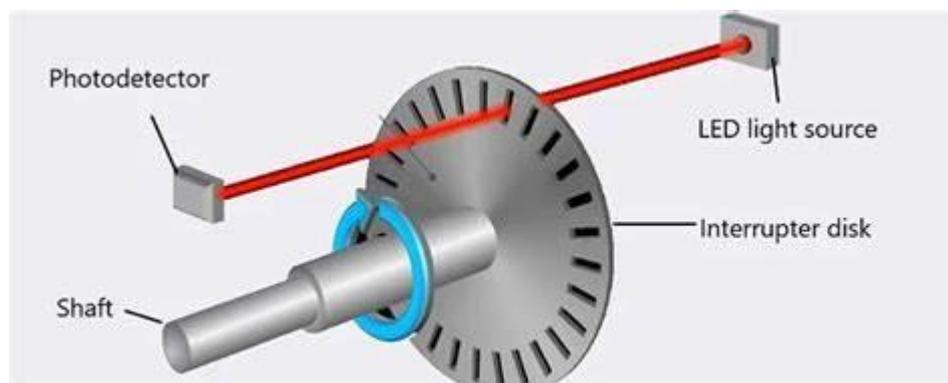


ENCODERS:

An encoder is a sensor that converts mechanical motion (rotation or linear movement) into electrical signals so that a control system can know the position, speed, and direction of a moving object. It is commonly used in motors, robots, CNC machines, and medical devices. In a rotary optical encoder, a circular disc with many small transparent and opaque slots is fixed to the rotating shaft. On one side of the disc there is a light source (LED), and on the other side there is a

photo sensor. When the shaft rotates, the disc also rotates, and the light passes through the transparent slots and is blocked by the opaque parts. This produces a series of electrical pulses. The number of pulses counted gives the position, and the number of pulses per second gives the speed.

If two signals (Channel A and B) are used with a small phase difference, the system can also detect the direction of rotation. This type is called an incremental encoder, and it needs continuous pulse counting, so position is lost if power fails. In an absolute encoder, the disc has multiple coded tracks that give a unique digital output for every position, so the exact position is known even after power loss. Encoders may work using optical, magnetic, or capacitive sensing methods, but their main purpose is to provide accurate feedback in control systems.



LVDT (LINEAR VARIABLE DIFFERENTIAL TRANSFORMER) :

An **LVDT (Linear Variable Differential Transformer)** is a sensor used to measure **straight-line movement**. It tells us how much an object has moved from its original position. Inside the LVDT, there are three coils (one primary coil in the center and two secondary coils on the sides) and a soft iron rod called a core that can move back and forth. When AC current is given to the primary coil, it creates a magnetic field. This magnetic field produces voltage in the two secondary coils. If the core is exactly in the center, both secondary coils produce equal voltage, so the output is zero. When the core moves to one side, one coil produces more voltage and the other produces less. The difference between these

two voltages is the output. The bigger the movement, the bigger the output voltage. The direction of movement can also be identified.

LVDT is very accurate, has no friction (because the core does not touch the coils), and is widely used in machines, robotics, and industrial systems to measure linear displacement.

HALL EFFECT SENSOR:

A **Hall Effect Sensor** is a device used to detect a magnetic field and measure its strength, position, or movement. It works based on the **Hall Effect principle**, which states that when electric current flows through a thin semiconductor material and a magnetic field is applied perpendicular (at right angle) to the current, a small voltage is produced across the material in the sideways direction. This voltage is called **Hall voltage**. Inside the sensor, there is a small semiconductor plate through which current continuously flows. When no magnet is present, the charges (electrons) move straight and no voltage difference is produced across the sides. When a magnet comes near, the magnetic field pushes the moving electrons to one side, creating an imbalance of charges. This imbalance produces a measurable voltage output. The strength of the output voltage depends on the strength of the magnetic field, and its polarity indicates the direction of the magnetic field.

Hall effect sensors can give either analog output (continuous voltage change) or digital output (ON/OFF signal). Since they work without physical contact, they are reliable, have long life, and are widely used in speed sensing, position sensing, current measurement, automotive systems, robotics, and industrial automation.