OCCUPANCY

AND MOTION DETECTORS

Position, Displacement, and Level

Inductive and Magnetic Sensors

Magnetostrictive Detector

Grating Sensors

Linear Optical Sensors

LVDT and RVDT

Transverse Inductive Sensor

Optical Sensors

Ultrasonic Sensors

Radar Sensors

Eddy Current Sensors

Hall Effect Sensors

Magnetoresistive Sensors

Optical Bridge

Fiber-Optic Sensors

Pointing Devices

https://www.youtube.com/watch?v=2ii_2tTN35I

1-Inductive and Magnetic Sensors

The advantages of using magnetic field for sensing position and distance:

1-Any nonmagnetic material can be penetrated by the filed with no loss of position accuracy.

2-The magnetic sensors can work in severe environments and corrosive situations

2-Eddy Current Sensors

Eddy current appears in two cases:
1-: when a conductor is exposed to a changing magnetic field due to relative motion of the field source and conductor

2-:due to changing intensity of the magnetic field

The depth of the object where eddy currents are produced:

$$\delta = \frac{1}{\sqrt{\pi f \mu \sigma}},$$

f is the frequency

σ is the target conductivity.

The operating frequency range of the eddy current sensors ranges from 50 kHz to 10 MHz

Advantage of the eddy current sensors

1-They do not need magnetic material for the operation, thus they can be quite effective at high temperatures

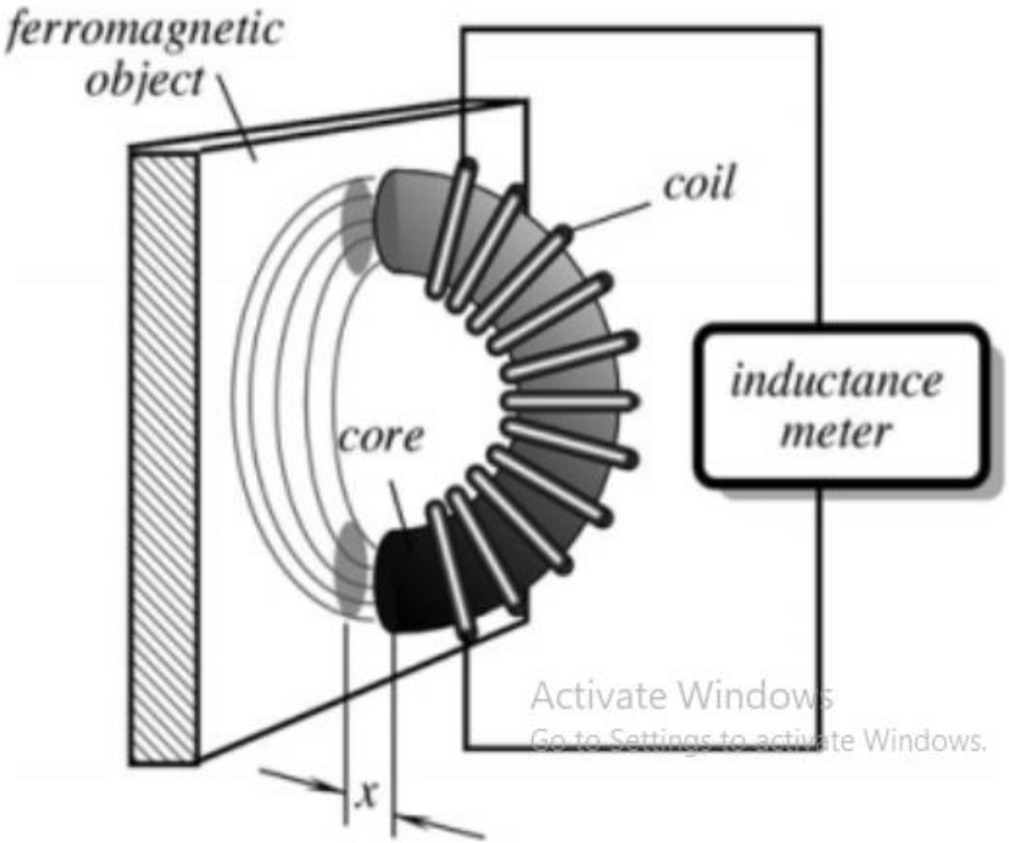
2-They are not mechanically coupled to the object and thus the loading effect is very low

Transverse Inductive Sensor

It is useful for sensing relatively small displacements of ferromagnetic materials, the sensor measures the distance to an object, which alters the magnetic field in the coil.

The advantage of the sensor

It is a noncontact device whose interaction with the object is only through the magnetic field



The limitation

It is useful only for the ferromagnetic objects at relatively short distances

To overcome the limitation for measuring only ferrous materials, a ferromagnetic disk is attached to a displacing object while the coil has a stationary position. Alternatively, the coil may be attached to the object and the core is stationary.

Hall Effect Sensors

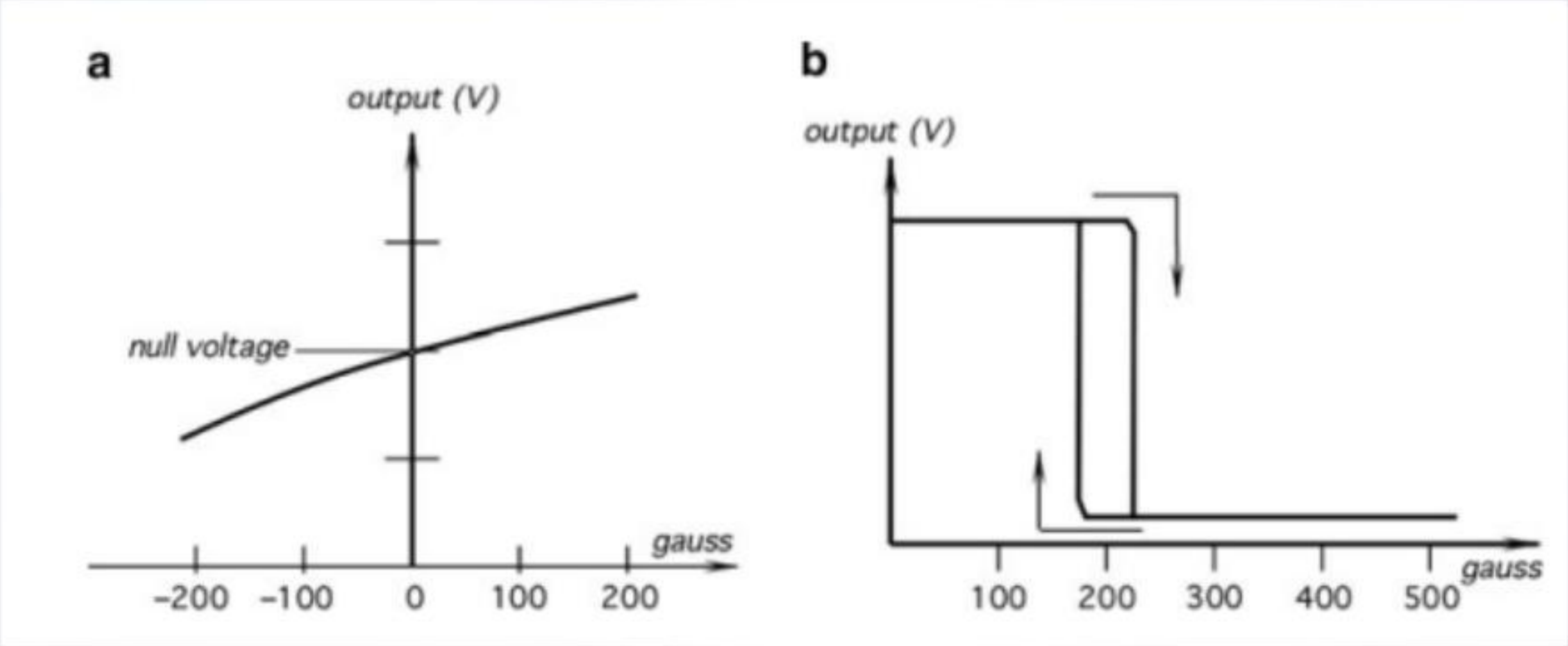
There are two types of the Hall sensors:

1-analog

Analog sensors usually incorporate amplifiers for easier interface with the peripheral circuits. In comparison with a basic sensor the analog sensor operates over a broader voltage range and more stable in a noisy environment. These sensors are not quite linear.

2-bi-level sensor

The hysteresis eliminates spurious oscillations by introducing a dead band zone in which the action is disabled after the threshold value has passed



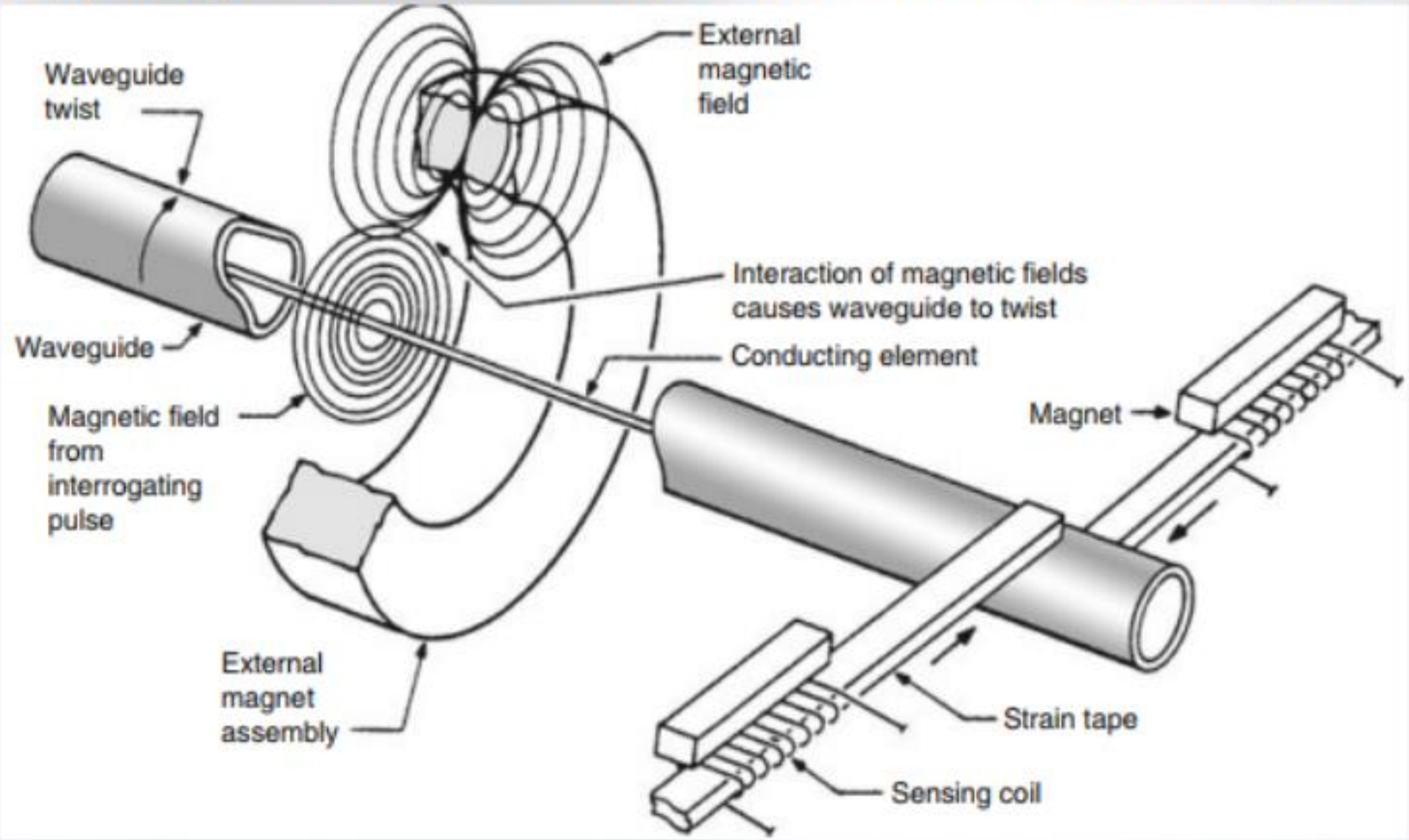
Transfer functions of a linear (**a**) and a threshold (**b**) Hall effect sensors

Magnetoresistive Sensors

These sensors are similar in application to the Hall effect sensors. For functioning, they require an external magnetic field. Hence, whenever the magnetoresistive sensor
is used as a proximity, position, or rotation detector, it must be combined with a source

Magnetostrictive Detector

A transducer, which can measure displacement with high resolution across long, can be built by using magnetostrictive and ultrasonic technologies



A magnetostrictive detector uses ultrasonic waves

Optical Sensors

optical sensors are probably the most popular for measuring position and displacement.

The advantages

simplicity, the absence of a loading effect, and relatively long operating distances. They are insensitive to stray magnetic fields and electrostatic interferences, which makes them quite suitable for many sensitive applications

Fabry-Perot Sensors

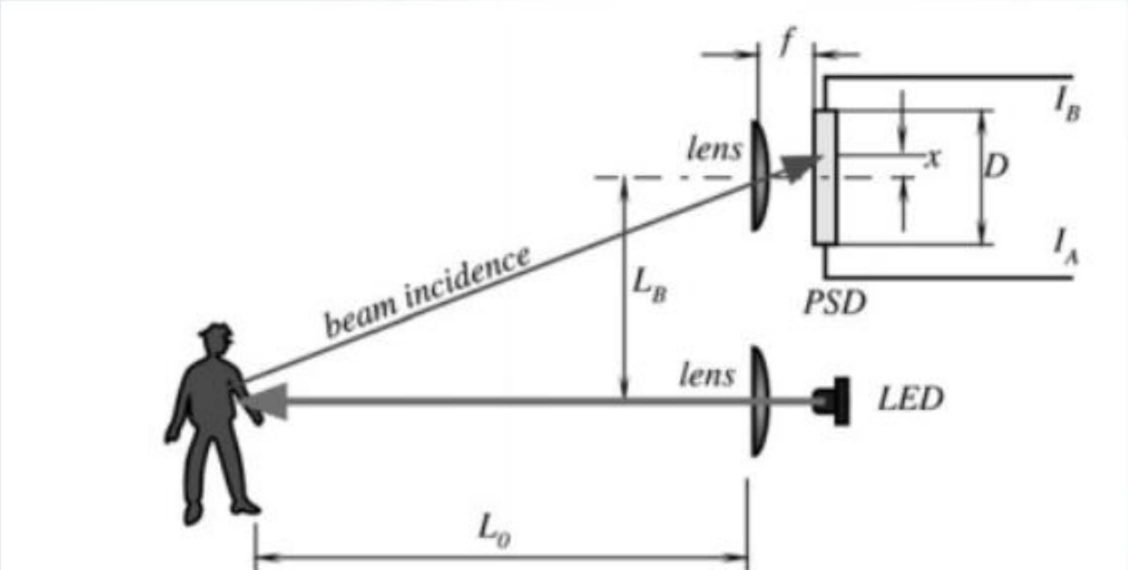
For measuring small displacements with high precision in harsh environment, the so-called Fabry-Perot optical cavity can be employed

Linear Optical Sensors

For precision position measurements over short and long ranges, optical system operating in the near infrared can be quite effective

Example

PSD produced for precision position sensing and autofocusing in photographic and video cameras



Ultrasonic Sensors

For noncontact distance measurements, an active sensor that transmits some kind of a pilot signal and receives a signal reflected from the object can be designed. The transmitted energy may be in form of any radiation

A distance L0 to the object:

$$L_0 = \frac{vt\cos\Theta}{2},$$

v the speed

t is the time for the ultrasonic waves to travel to the object and back to the receiver

Radar Sensors

Micropower Impulse Radar(MIR)

Applications for the MIR

range meters, intrusion alarms, level detectors,vehicle ranging devices, automation systems, robotics, medical instruments, weapons,novelty products, and even toys where relatively short range of detection is required

Ground Penetrating Radars(GPR)

Applications for the **GPR**

Civil engineering, archeology, forensic science are just few examples of many applications of the high-frequency ground-penetrating radar

Ground-penetrating radar transmits radio waves and receives the reflected signal

A practical GPR operates at frequencies from 500 MHz to 1.5 GHz

Thickness and Level Sensors

In many industrial applications, measurement of thickness of a material is essential for manufacturing, process and quality control, safety, airspace, etc. The methods of thickness gauging are ranging from optical to ultrasonic to X-ray. Here we briefly review some less known methods

Ablation Sensors

Thin Film Sensors

LiquidLevelSensors

Pointing Devices

Optical Pointing Devices

Example:

a computer “mouse”

was invented. The purpose of the mouse (or a tracking ball) is to move the pointer to a desired x–y coordinate on a computer monitor. A sensor on the pointing device should detect a displacement in a particular direction

Magnetic Pickup

A Hall sensor can be used as a pickup of a magnetic irregularities build into a ball

Example

Is a mouse with a ball having the inner magnetic core that contains evenly spaced bumps or depressions

The magnetic bumps or depressions form irregularities in the magnetic field that are picked up by two x–y Hall sensors and translated into the mouse displacement

Inertial and Gyroscopic Mice

Example: air mouse

does not require a surface to operate.

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