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Post Mid

Week – 5

Sensor: Sensors can be of two type, sensing by material & by engineering.

Sensor can be:

→ Active sensor	→ Passive sensor
→ requires emitter, needs to emitt something to gather data, detector, needs external power source.	→ sensing environment directly no need for emitters.

→ It is a device which measures a physical quality & converts them into an easily readable format.

→ not all transducer are sensors but most sensors are transducers.

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Transducer: converts energy from one form to another,

→ Pressure (AC), Ultra-sound (Sonar), temperature (boilers).

→ sensors are a part of transducers.

→ There are 6 different types of measurements,

→ i) mechanical, ii) magnetic, iii) thermal, iv) electric, v) chemical & vi) radiation.

→ input transducer

→ takes measurements of a physical energy & converts it into different signal.

↓ digital

→ output transducer

→ also known as actuator, they take electrical signals and convert them into different form.

→ sensor —(detected quantity)→ signal conditioning unit → data representation

transducer

electrical quantity

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light based sensor:

→ Camera → reflected light goes onto CCD & it creates raw analog image

→ the sensing part is composed of CCD (charged coupled device).

→ the lens is focused on the CCD & it produces electric signal based on the light / RGB.

→ This raw analog data is then converted into digital signal & then sent to DSP (digital signal procesor) to generate the digital image.

IR sensor: → door sensor

→ composed of pyro electric materials

→ pyro electricity can be described as the ability of certain materials to generate a temporary voltage when they are heated or cooled / vibration.

eg: quartz.

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→ electronic device that emits to sense the environment around it,

→ all objects radiate some sort of thermal radiation, an they get detected by IR sensors.

→ The emitter is simply an IR LED & the detector is an IR photodiode which is sensitive to IR light of the same wavelength as the emitter.

→ Gives output as 1/0 based on the input amount and a threshold set by potentiometer.

eg: Flame detection, line (black & white) detection.

PIR

Passive infrared sensor ⇒

→ Use fresnel lenses used to focus the heat onto the material.

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→ the dome shaped lens is used to gather the environmental IR and focus it all on the infrared sensor.

→ PIR needs stabilizing period to adjust the room temperature.

→ When any animal pass the heat increases & stabilized again.

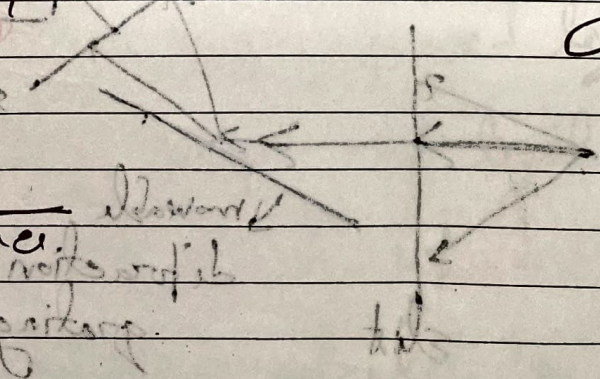
→ used as a motion sensor by using two PIR sensors (object moves to right from left or vice versa)

**

LDR :- uses photo sensitive semi-conductor material,

→ if there is light, it increases the conductivity & output voltage.

→ light $\propto \frac{1}{\text{resistance}}$



Infrared temperature sensor:-

→ contactless temperature measurements.

→ it has a lens infront ∫ it produces a ~~IR~~ IR ∫

when the ray touches our skin, then if we have high temperature than the molecules of that skin vibrates on high rate / motion higher. ∫ based on that the IR that gets reflected will have different wavelength / frequency. This frequency difference helps to generate a voltage that determine the body temperature.

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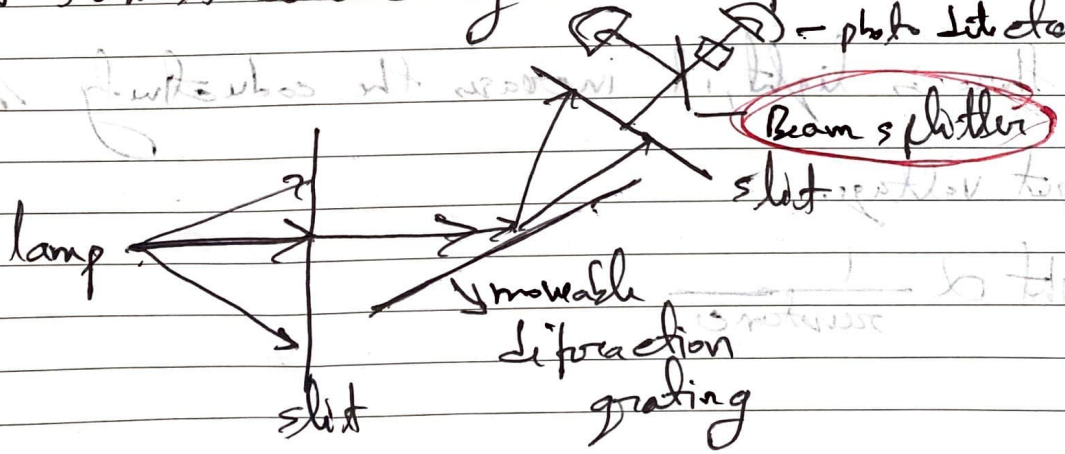
UV sensor Module ★★★

→ it only allows to pass the UV light / or light of a specific wavelength.

→ It uses beam splitter to split the light into two parts by following the basics of critical angle, the beam splitter is angled in such a way that the UV ray comes to the beam on an angle more than its critical angle it reflected into a photo detector, thus it receives only UV light.

→ rest is detected by another photo detector



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Pulse Oximeter:-

→ Depends on the amount of red blood cells present, it can measure the oxygen level in our body.

→ it emitters an IR signal/red light through the finger and receives it on the other end.

→ if we receive many on the receiving side that means that low concentration of red blood cells & vice-versa.

★ Hemoglobin contains oxygen, hemoglobin is fully saturated & de-saturated, fully saturated hemoglobin (SpO_2) will absorbs more infrared light & de-saturated hemoglobin absorbs red light.

By passing this info, how much infrared & red light is absorbed, the machine calculates the amount of fully saturated hemoglobin in one blood.

→ can also measure heart bit rate.

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Magnetic & electro magnetic sensor:-

→ Reed switch → if a magnet comes near this reed switch the material gets shorted & the switch turns on.

→ Near magnet sensing material.

Liquid level sensor using reed switch:-

→ When the water level rises, the floating part of the sensor goes up & inside this part, there is a magnet. When the magnet comes near to the reed switch, the reed switch gets shorted.

Sound based sensor:- Microphone, Ultra-sonic, Pressure.

by using transducers or using pyro piezoelectric

Water level sensor :-

Capacitive level measurement → based on change in capacitance,

→ two plate, one plate acts as an insulated electrode &

the other as tank wall. The capacitance depends on the liquid level. An empty tank has lower capacitance than a filled tank.

→ the value of capacitance depends on dielectric constant and, area of the plate & distance.

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Perio electric material:→

Natural & Man made.

↳ cane sugar ↳ Barium titanate

↳ Quartz (SiO_2)

↳ Topaz

Ultrasonic sensor: Emitter & receiver, frequency 40KHz

wave

↳ spud of ultrasonic wave is: 340 meter/s.

Sound Sensor:

↳ Diaphragm: vibrate differently for high & low frequencies, mini coil vibrates with the up & down along with the diaphragm.

↳ Magnet interacts with the coil to produce electrical signals.

↳ use amplifiers

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Temperature Sensing

RTD: Resistance temperature detector, Platinum, copper, Nickel.

→ temperature is measured by measuring the resistance of a wire / electrical wire.

→ RTD is the best solution if we want to measure temperature with high accuracy.

Thermocouple: Junction of two material. (Contd Alimd)

→ this junction, functions based on the phenomenon of the thermoelectric effect; the temperature difference is directly converted into an electric voltage.

→ its simple, so built & cost effective.

→ The temperature difference between two different metals will induce a potential difference between two points of the thermocouple plates. a small amount of current will flow through the circuit & voltage will be measured & it will be a function of temp. different between two junctions. Thus we can calculate the temp of hot junction.

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Thermistor:- is defined as a type of resistor whose electrical resistance varies with changes in temperature.

→ acts as a passive component & very sensitive to temperature.

→ ohmmeter is used to measure the resistance changes to calculate the temperature & its changes

→ Made of polymer & ceramic materials

NTC	PTC
The temperature $\propto \frac{1}{R}$	temperature $\propto R$
→ are non-linear & most commonly	→ frequently used as a form of circuit protection.
	→ it can work as a current limiting device.

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Proximity Sensor: (contactless sensor)

↳ measure the distance of two things.

↳ Inductive:- ↳ measure metal magnetic field from induction coil.

(detect metal)

Capacitive:- measure the metallic & non metallic objects. Detect any type of material.

LiDAR:- light intensity is measured to measure the distance.

↳ light / laser pulse, turn rapid pulse of laser light.

* Microwave proximity sensor:- (for moving objects)

↳ using doppler effect, if it's moving along the wave, then the wavelength seems to get shorter (∿∿ → ∿∿) and vice versa (∿∿ → ∿∿)

↳ if moves opposite to the wave.

Inductive: sensor has a magnet & there is a induction coil inside of it.

→ when a metal gets close to the magnet / sensors, it generates a magnetic field & thus the coil generates electricity & based on the electricity generated, the sensor gives the output.

Capacitive proximity sensor:-

→ it has an oscillator circuit, and it works on the basis of change of capacitance in the circuit.

→ the more we close to the sensor, the capacitance will change & the oscillation will increase & output is generated.

distance.

→ light / laser pulse, times rapid pulse of laser light.

✱ Microwave proximity sensor:- (for moving objects)

→ using doppler effect, if its moving along the wave, then

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Smoke Detector:-

→ Radio Active material is used, americium-241

→ very cheap & widely used.

→ Ionization smoke alarm, responsive to flaming fires,

→ a small amount of radioactive material between two electrically charged plate, which ionizes the air & cause the current to flow between two plates. When smoke enter this air pocket, it disrupts the flow of ions, reduces the flow of current & activates the alarm.

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Smoke & Gas Sensors:-

Materials: Metal conductors / oxide, semiconductors, carbon-based materials & conducting polymers.

Ex: carbon nanotube / gas resistance

→ **Photoelectric smoke alarm:-**

→ responsive to fires that begin with a long period of smoldering.

→ It aims a light source into a sensing chamber at a angle away from the sensor, so when smoke enters the chamber, the light reflects onto the sensor & trigger alarm.

Gas sensor:- to detect gases depends on the (gas resistor) to conduct current. The most commonly used is tin oxide (SnO_2), it has four electrons (n-type semiconductor).

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→ The oxygen particles attract the free electrons present in the SnO_2 and pushes them to the surface of SnO_2.

→ Thus, as there are no free electron available the output current will be 0.

→ If toxic gases enters the chamber, it reacts with the oxygen & breaks the bond between the oxygen particles & free electrons. As this releases the free electrons. The current starts to conduct again & output current will be >0.

Touch Sensor

Capacitive touch sensor:-

→ contains two parallel conductors with an insulator between them. This plate works / acts as a capacitor with a capacitance value.

Ionization smoke sensors:-

→ more responsive to fire, (blaming fire). → this type of smoke alarm has a small amount of radioactive material in between two electrically charged plates, which ionizes the air & causes current to flow between the plates. when smoke enter between these two plates, it disrupts the flow of current in between the plates and activates the alarm.

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when we touch, our finger works as a conductive object & capacitance increases.

& the change in capacitance detects the & a signal is then sent.

Resistive touch sensors :- calculate the pressure applied to the surface of the touch sensors. When pressure is applied the the top coated conductive film touches the bottom one & a voltage drop is generated which generates a signal detecting the touch.

Break beam sensor :- There is a continuous beam is going from one part to another, if there is an object in between the beams, blocking it forms reaching the other side. This is sensed by the other side and the door opens.

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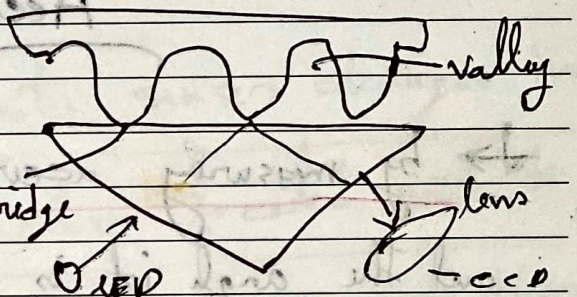
Finger print Sensor :-

☆ Finger-print optical scanner :→ there is a led light where we set the finger on & that LED light helps to create a digital image of that finger & keeps it.

→ ridges 1 & valley as 0 stored.

→ this ridges & valley creates a digital data & stores it. Next time while we digit it will check the new data with the stored one & unlock if matched.



→ a digital photo can be replicated & used imprint on clear tape to unlock. Thus less secure.

☆ Capacitive finger print sensor :- → uses capacitance to collect the fingerprint data.

→ the finger placed on a capacitor based circuit. the ridge part will connect & will change the capacitors charge capacitance but valley will not.

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↳ more secure is this data stored using the analog to digital converter by using the change in capacitance as input data.

Accelerometer

↳ by measuring acceration due to gravity, it can figure out the angle it is tilted at with respect to the earth.

↳ By sensing the amount of dynamic acceleration, it can find out how fast is in what direction the device is moving.

↳ It works in mainly two way, 1) piezoelectric effect 2) capacitance sensor

1) most common uses microscopic crystal structure that become stressed due to accelerative forces, the crystals voltage from the stress & accelerometer interprets the V to determine the velocity & direction.

↳ there is a spring mad of piezoelectric material inside it.

the force caused by vibration or change in motion, causes mass to squeeze the piezoelectric material which produces an electrical charge that is proportional to the force and acceleration.

→ The capacitance accelerometer sensor changes in capacitance between micro structures located next to the device. If an acceleration force moves one of these structures, it will change the capacitance value & accelerometer will translate the ~~it~~ to voltage for interpretation.

↳ also has a spring, and spring expands & compressed which changes the ~~cap~~ capacitance.

Gyro sensor

→ vibration gyro sensor senses angular velocity from the coriolis force applied to a vibrating object.

ex: Epson's double T- structure crystal element

→ normally, a drive arm vibrates in a certain direction but when the motion changes (direction of rotation), gyro is rotated, the coriolis force acts on the drive arms, producing vertical vibration.

→ the stationary part bends due to vertical drive arm vibration, producing a sensing motion in the sensing arms

→ The motion of a pair of sensing arms produces a potential difference from which angular velocity is sensed. Angular velocity is then converted to electrical signal as output.

Hall effect

→ a current passing material is connected to a power supply, it gets electricity pass through it.

→ then if we bring a magnet close to it, it will create a magnetic field thus it will make electrons go on one side & electrons on the other.

→ we can get a voltage difference due to the magnetic field, we use this to work with hall effect sensor.

→ Wheel speed sensor → RPM, a wheel made of conductible material, & hall effect sensor & a magnet.

→ when the ridges of the wheel gets close to the magnet it creates a magnetic field thus ~~a~~ hall effect sensor senses ~~it~~ ~~the~~ the voltage created due to the magnetic field.

→ ~~the~~ variation of voltage will help us determine