T.Y.B.Sc. Electronic Science 2021(CBCS Pattern)

Practical No.:7

GROUP C: Sensors and Systems

STUDY OF SMART SENSORS

1)IR sensor:

Theory:

Infrared waves are not visible to the human eye. In the electromagnetic spectrum, infrared

radiation can be found between the visible and microwave regions. The infrared waves typically have wavelengths between 0.75 and 1000μm. The wavelength region which ranges from 0.75 to 3μm is known as the near infrared regions. The region between 3 and 6μm is known as the midinfrared and infrared radiation which has a wavelength greater higher than 6μm is known as far infrared.

Infrared technology finds applications in many everyday products.

Televisions use an infrared detector to interpret the signals sent from a remote control. The key benefits of infrared sensors include their low power requirements, their simple circuitry and their portable features.

The Types of Infrared Sensors

Infrared sensors are broadly classified into two main types:

• Thermal infrared sensors – use infrared energy as heat. Their photo sensitivity is independent of the wavelength being detected. Thermal detectors do not require cooling but do have slow response times and low detection capabilities.

• Quantum infrared sensors – provide higher detection performance and faster response speed. Their photo sensitivity is dependent on wavelength. Quantum detectors have to be cooled in order to obtain accurate measurements.

The Working Principle of Infrared Sensors

All objects which have a temperature greater than absolute zero (0 Kelvin) possess thermal energy and are sources of infrared radiation as a result. Sources of infrared radiation include blackbody radiators, tungsten lamps and silicon carbide. Infrared sensors typically use infrared lasers and LEDs with specific infrared wavelengths as

sources. A transmission medium is required for infrared transmission, which can be comprised of either a vacuum, the atmosphere or an optical fiber.
Optical components, such as optical lenses made from quartz, CaF2, Ge and Si,polyethylene Fresnel lenses and Al or Au mirrors, are used to converge or focus the infrared radiation. In order to limit spectral response, band-pass filters can be used. Next, infrared detectors are used in order to detect the radiation which has been focused.

The output from the detector is usually very small and hence pre-amplifiers coupled with circuitry are required to further process the received signals.

The Key Applications of Infrared Technology

1. Night Vision Devices: Infrared technology is implemented in night vision equipment if there is not enough visible light available to see unaided. Night vision devices convert ambient photons of light into electrons and then amplify them using a chemical and electrical process,before finally converting them back into visible light.

2. Infrared Astronomy: Infrared astronomy is a field of astronomy which studies astronomical

objects which are visible in infrared radiation. Using telescopes and solidstate detectors,

astronomers are able to observe objects in the universe which are impossible to detect using

light in the visible range of the electromagnetic spectrum.

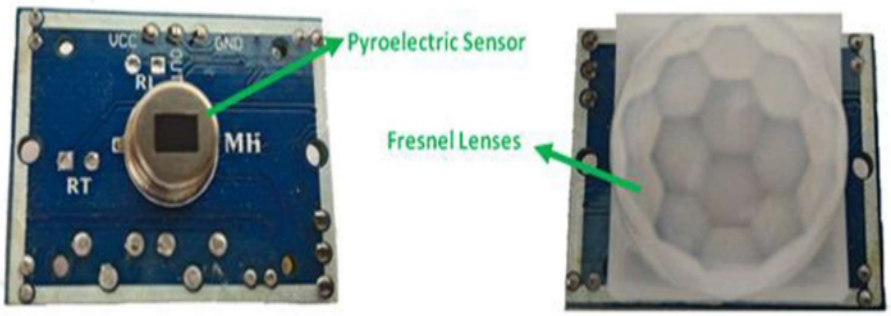
3. Inferred motion sensors: They are used to detect the motion of any living being and can be

applied in security applications

2)PIR SENSOR BASED MOTION DETECTION

PIR is Passive Infrared Sensor. Basically, it is a smart sensor used to detect the motion. It receives infrared signal and not emit, hence called as passive sensor.

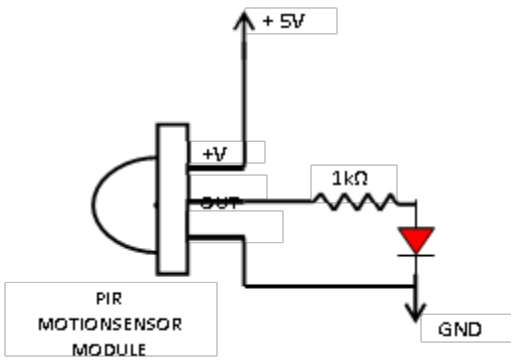
Every object emits infrared when heated. Human also emits infrared because of body heat. PIR sensors can detect small amount of change in infrared. Whenever an object passes through sensor range, it produces infrared, because of friction between air and object, and detected by PIR sensor. Below figure shows the top view of the PIR module (with and without dome).



Motion sensors are electronic devices, used to detect movement inside and surroundings of your home and give an alert. For instance, this sensor can activate the lights once it detects you while entering into a room otherwise, they can give an alert once an intruder is trying to enter your home. These types of sensors are mainly used in homes, security systems, paper towel dispensers, phones, virtual reality systems & game consoles.

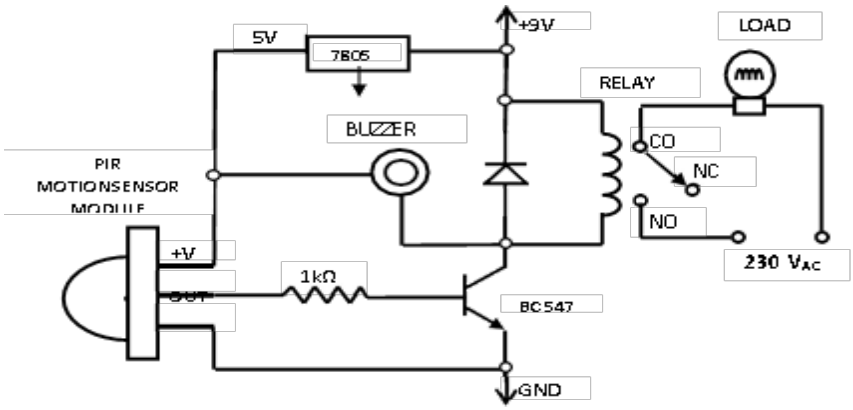
Two pots are available in the module. The distance adjustment and delay adjustment. The clockwise rotation of the distance adjustment pot, increases sensing distance about 7 meters. The clockwise rotation of delay adjustment pot increases the delay up to 10 minutes, on the opposite side, decreases the delay up to 0.3 sec.

The simple circuit for Motion detector using PIR smart sensor is given as below:



Application:

The below circuit can be used in the office/mall to turn on Lights automatically, when someone enter in the office.

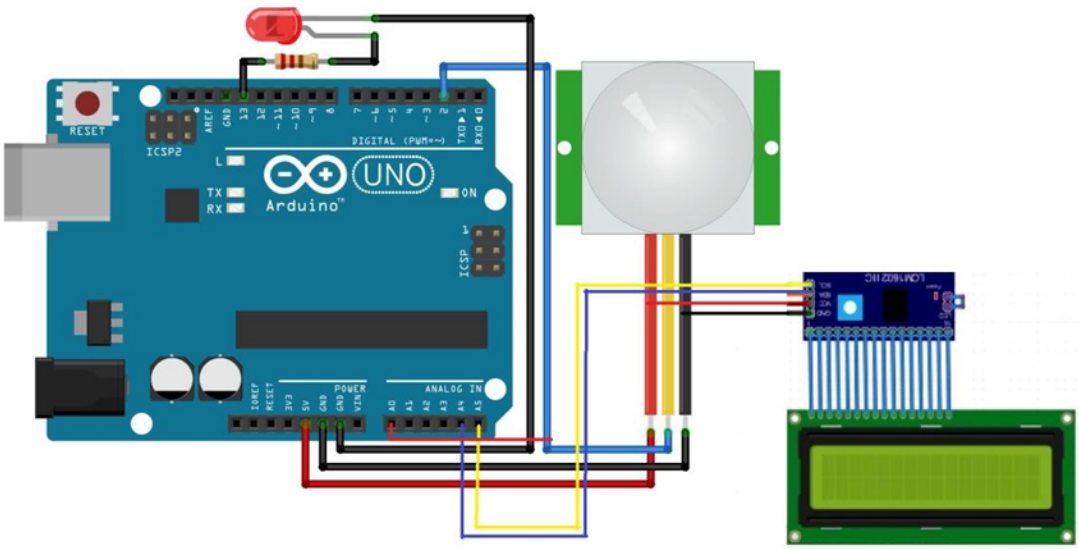


Observations:

1) PIR motion sensor

List of Components/apparatus: Arduino UNO, PIR motion sensor, LCD display(16x2), Led,

Circuit diagram:



Procedure:

Step 1: connect the dc power supply to the controller (Arduino UNO)
Step 2: connect the PIR motion sensor as shown in the circuit diagram
Step 3: Connect LED in pin 13 of the controller.
Step 4: connect LCD (SCL to A5, SDA to A4)
Step 5: upload the sketch
Step 6: Place the target and increase the distance by One feet for every observation
Step 7: Observe the feed back from LCD at different distance and note it down
Step8 : measure the output voltage at every observation from the LCD

Observation table:

Sr. No	Distance from the sensor (feet)	Output Voltage(v0)	Feedback LED (ON/OFF)	Feedback from LCD (Detected/Not detected

Result and discussion:

3) Ultrasonic proximity sensor:

Theory:

Sonar: Sonar (originally an acronym for Sound Navigation And Ranging) is a technique that uses sound propagation (usually underwater, as in submarine navigation) to navigate, communicate with or detect objects on or under the surface of the water, such as other vessels. Two types of technology share the name "sonar": passive sonar is essentially listening for the sound made by vessels; active sonar is emitting pulses of sounds and listening for echoes. Sonar may be used as a means of acoustic location and of measurement of the echo characteristics of "targets" in the water. Acoustic location in air was used before the introduction of radar. Sonar may also be used in air for robot navigation, and SODAR (an upward looking in-air sonar) is used for atmospheric investigations. The term sonar is also used for the equipment used to generate and receive the sound. The acoustic frequencies used in sonar systems vary from very low (infrasonic) to extremely high (ultrasonic).

The study of underwater sound is known as underwater acoustics or hydro acoustics.

Ultrasonic sensor:

The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats do. It offers excellent non-contact range detection with high accuracy and stable readings in an easy- to-use package. From 2cm to 400 cm or 1” to 13 feet. Its operation is not affected by sunlight or black material like sharp rangefinders are (although acoustically soft materials like cloth can be difficult to detect). It comes complete with ultrasonic transmitter and receiver module.

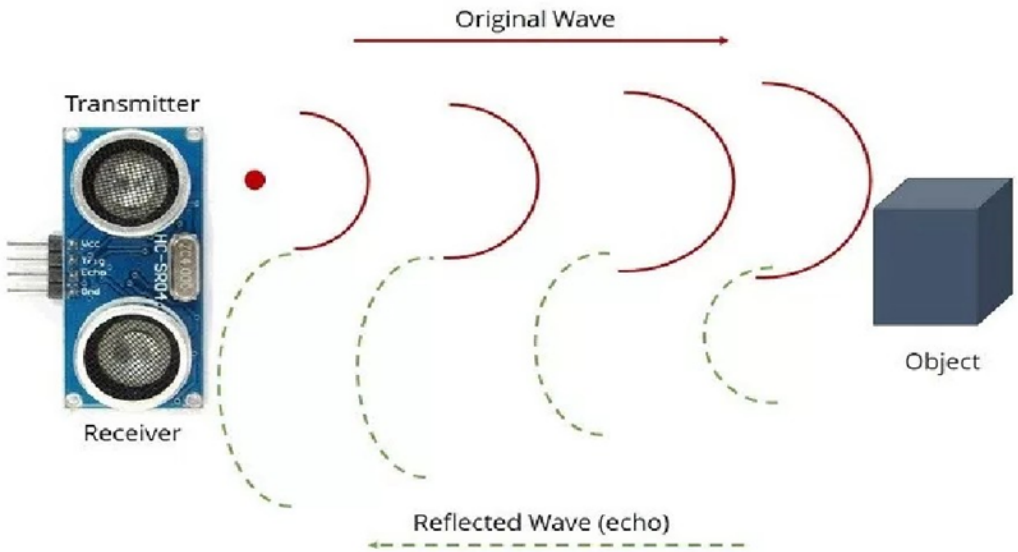
Features

- Power Supply: +5V Dc
- Quiescent Current :<2mA
- Working Current: 15mA
- Effectual Angle: <15°
- Ranging Distance: 2cm – 400 cm/1" – 13ft
- Resolution: 0.3 cm
- Measuring Angle: 30 degree
- Trigger Input Pulse width: 10uS
- Dimension: 45mm x 20mm x 15mm

How Does it Work?

The ultrasonic sensor uses sonar to determine the distance to an object. Here’s what happens:

1. the transmitter (trig pin) sends a signal: a high-frequency sound
2. when the signal finds an object, it is reflected and
3. the transmitter (echo pin) receives it.

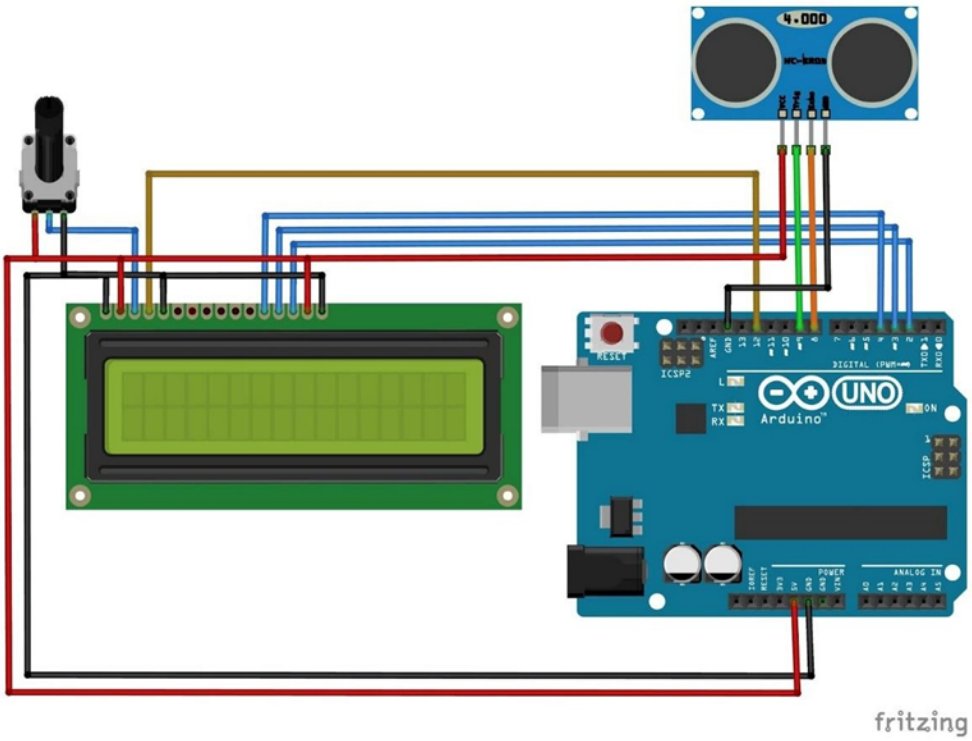


Observations:

Ultrasonic sensor:

List of apparatus: Arduino UNO,Ultrasonic sensor,Lcd display,Power supply,Scale

Circuit diagram:



Procedure:

Step 1: connect the dc power supply to the controller (Arduino UNO)

Step 2: connect the Ultrasonic sensor as shown in the circuit diagram.

Step 3: place the scale beside the sensor in such a way that the zero reading of scale touch the tip of the sensor.

Step 4: upload the sketch

Step 6: Place the target and increase the distance by One cm for every observation over a scale

Step 7: Observe the reading from LCD at different distance and note it down

Observation table:

No of obs.	Reading from scale (Cm)	LCD reading(Cm)	Difference in reading	Error in reading, E
1				
2				
3				

Result and Conclusion:

4: DHT-11 humidity sensor

Theory:

Humidity: term is invisible to the human eye. Humidity indicates the likelihood of precipitation; Humidity is the amount of water vapor present in the air. Water vapor is the gaseous state of, or fog. Higher humidity reduces the effectiveness of sweating in cooling the body by reducing the rate of evaporation of moisture from the skin. There are three main measurements of humidity: absolute, relative and specific. Absolute humidity is the water content of air expressed in gram per cubic meter or grams per kilogram. Relative humidity, expressed as a percent, measures the current absolute humidity relative to the maximum (highest point) for that temperature. Specific humidity is the ratio of the mass of water vapor to the total mass of the moist air parcel.

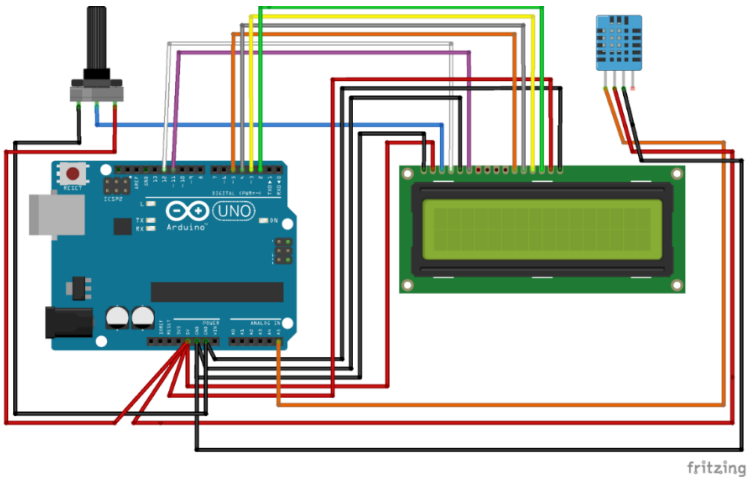
Controlling or monitoring humidity is of paramount importance in many industrial & domestic applications. In semiconductor industry, humidity or moisture levels needs to be properly controlled & monitored during wafer processing. In medical applications, humidity control is required for respiratory equipment, sterilizers, incubators, pharmaceutical processing, and biological products. Humidity control is also necessary in chemical gas purification, dryers, ovens, film desiccation, paper and textile production, and food processing. In agriculture, measurement of humidity is important for plantation protection (dew prevention), soil moisture monitoring, etc. For domestic applications, humidity control is required for living environment in buildings, cooking control for

microwave ovens, etc.
In all such applications and many others, humidity sensors are employed to provide an indication of the moisture levels in the environment.

The DHT-11 is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use, but requires careful timing to grab data. Simply connect the first pin on the left to 3 -5V power, the second pin is data input pin and the rightmost pin to ground. Compared to the DHT11, this sensor is more precise, more accurate and works in a bigger range of temperature/humidity, but its larger and more expensive.

List of apparatus: Arduino UNO, DHT-11, Lcd display, Standard Humidity Meter, Humidifier

Circuit diagram:



Procedure:
Step 1: connect the dc power supply to the controller (Arduino UNO)

Step 2: connect the DHT 11 humidity sensor as
shown in the circuit diagram Step 3: connect LCD as
show in the circuit diagram
Step 5: upload the sketch
Step 6: Start the humidifier and place the sensor and the standard humidity meter to absorb humidity

Step 7: Observe the feed back from both sensor and the standard instrument

Observation table:

No of observation	Reading from sensor (LCD reading)	Reading from standard instrument	Difference in reading (error, E_n)
1			
2			
3.			

Result and discussion:

Average error: E=
$(E_1+E_2+...+En)/n) \times 100\%$
Accuracy (100-E) %

Note: You can add information about any type of smart sensor & note the observations of any type of smart sensors that you used in your project (Sem I/Sem II)