Experiment No.: 05

Experiment Name: Study and Observation of Arduino Uno Based PIR Sensor

Objective:

Theory:

Required Hardwares with Quantity:

Required Software:

Working Procedure:

Hardware Arrangement Diagram:

Sketch:

Result and Output:

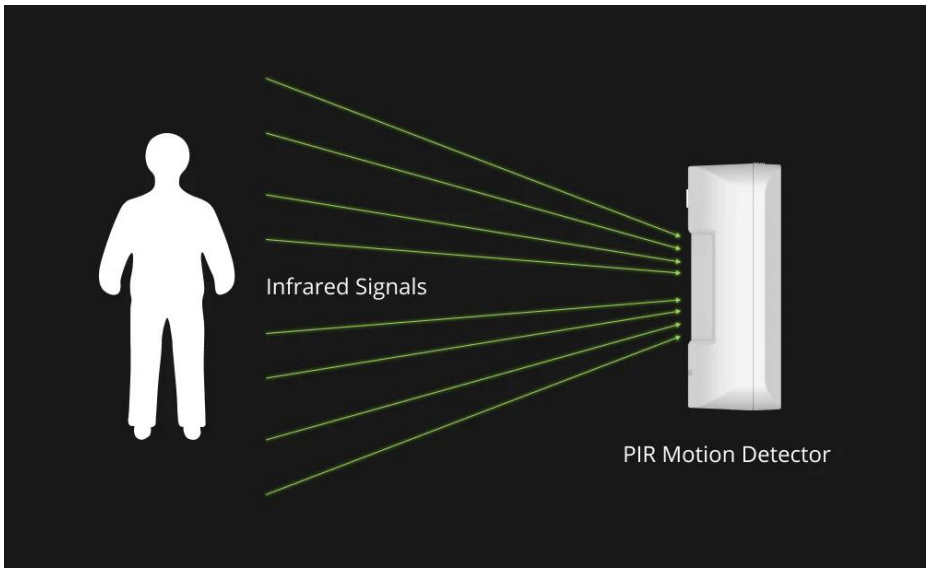
Conclusion:

Basic Knowledge:

Motion detection has become a pivotal component in various fields such as IoT lighting control, home automation, office automation, apartment security, and more IoT applications, because of the global wave of intelligence and and growing emphasis on sustainable practices.

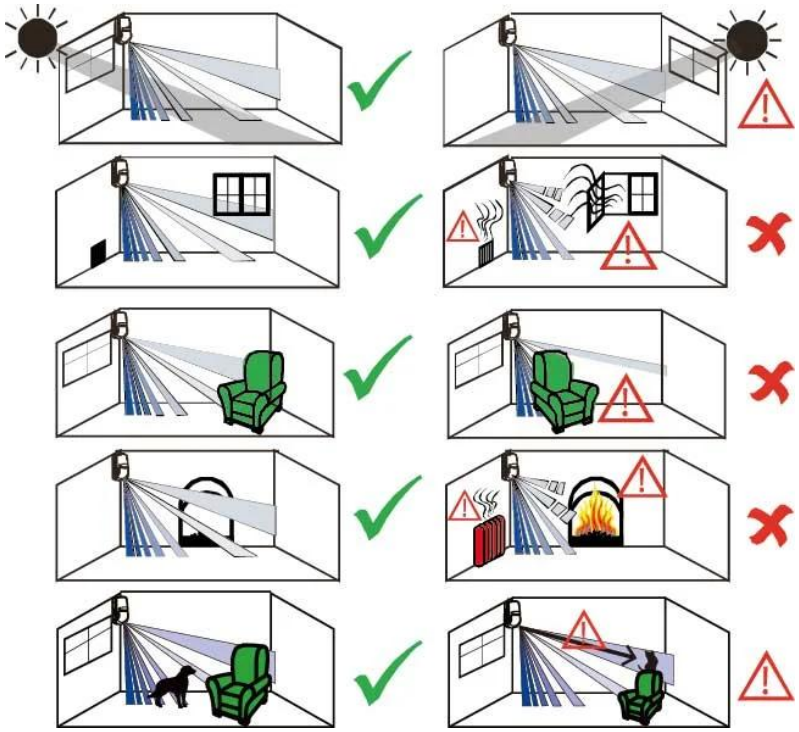
Therefore, the Passive Infrared (PIR) motion sensor has become one of the most widely used sensors for its ability to detect human motion in all walks of life. Whether it's the automatic lighting in hallways or the intrusion alarm in houses and villas, the PIR sensor has become a ubiquitous presence. Countless individuals have experienced its functionality firsthand.

The term "PIR sensor" stands for Passive Infrared Sensor, which is a type of sensor that functions by detecting infrared radiation. As the name suggests, PIR sensors are passive in nature, meaning they do not emit any form of energy themselves. Instead, they are designed to detect the infrared radiation emitted by moving things within their field of view, including objects, animals, and humans. Some also use Pyroelectric InfraRed Sensor to illustrate the abbreviation.



When an object enters the sensing range of the PIR sensor, it senses changes in the infrared radiation emitted by the object, and identifies whether there is an entry of a human body or animal.

It should be noted that a PIR sensor does not directly detect the shape, size or color of an object. Rather, it bases all of its calculations only on variations in infrared radiation. Therefore, proper placement and adjustment of the PIR sensor are required to avoid false alarms and missed detections.



What is the Working Principle of PIR Sensor?

The pyroelectric effect plays a fundamental role in the operation of PIR sensors. It allows PIR sensors to detect infrared radiation emitted by people and and convert them into electrical signals. The **pyroelectric effect** is a property of certain materials to generate an electric charge in response to a change in temperature.

Objects with different temperatures emit infrared rays at different wavelengths, so infrared wavelengths are related to the temperature. The human body typically radiates infrared rays of approximately 10μm at a temperature of 37°C.

PIR sensors typically employ pyroelectric elements as their infrared sensing source. When a person enters the detection area of a PIR sensor, the temperature difference between the human body and the ambient environment causes the pyroelectric element to experience a change in infrared radiation temperature. This upsets the charge balance within the element, resulting in the release of charges. These charges are then detected and processed by the subsequent circuit, generating a signal output.

The detection wavelength range of PIR is generally in the range of 5-14um, that is, it can convert infrared signal changes of 5~12um wavelength into electrical signals.

It is important to note that PIR sensors detect changes in temperature, rather than fixed-wavelength infrared radiation. If an object with a fixed wavelength stays motionless within the detection range or moves too quickly, the PIR sensor can not detect it. Consequently, if a human body enters the detection area but remains stationary, without any temperature change, the sensor will not produce an output. Therefore, PIR sensors are specifically made to recognize variations in infrared radiation brought on by movement, which allows them to identify human or animal activity.

A Fresnel lens is a specialized type of lens that differs from traditional lenses in its design. It is composed of a series of concentric annular convex mirrors, with their centers all located at the same point. The radius of curvature of these mirrors gradually decreases, creating a lens-like structure.

When it comes to PIR sensors, the infrared rays emitted by the human body are enhanced by the Fresnel lens and then concentrated on the pyroelectric element of the infrared sensing source.

A typical PIR sensor has **three pins**:

1. **VCC (Power)**: Supplies power to the sensor. This is typically connected to a +5V (or +3.3V, depending on the sensor) power supply.
2. **GND (Ground)**: Connects to the ground of the power supply.
3. **OUT (Output)**: This is the signal output pin, which goes HIGH when motion is detected and LOW when no motion is detected.

CODE:

```
// Define pin numbers
int pirPin = 2;     // Pin connected to the PIR sensor's output
int ledPin = 13;    // Pin connected to the LED (built-in LED on most Arduino boards)
int buzzerPin = 8;  // Pin connected to the buzzer

void setup() {
```

```
  // Initialize the PIR sensor input pin
  pinMode(pirPin, INPUT);

  // Initialize the LED and buzzer output pins
  pinMode(ledPin, OUTPUT);
  pinMode(buzzerPin, OUTPUT);

  // Start serial communication for debugging (optional)
  Serial.begin(9600);
}

void loop() {
  // Read the PIR sensor's output
  int pirState = digitalRead(pirPin);

  // Check if motion is detected
  if (pirState == HIGH) {
    // Motion detected, turn on the LED and buzzer
    digitalWrite(ledPin, HIGH);
    digitalWrite(buzzerPin, HIGH);
    Serial.println("Motion detected!");
  } else {
    // No motion, turn off the LED and buzzer
    digitalWrite(ledPin, LOW);
    digitalWrite(buzzerPin, LOW);
    Serial.println("No motion.");
  }

  // Small delay for stability
  delay(100);
}
```