Written Report for Project Lab at United States International University-Africa

(Motion Detector)

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Abstract

The purpose of this project was to build a motion detector. The main components used were the Arduino microcontroller and the PIR sensor. The project also used an LED and a Piezo buzzer to indicate when motion was detected. The group sought to demonstrate the workings of each component as well as how they work together to carry out the task. The group also drew up a circuit from which the components were connected.

The main objective for the project was to practice the skills learnt over the Spring 2016 semester and to creatively show how analog signals can be converted to digital signals. The group started their work by researching briefly o what other people had been able to do on the same issue. They later agreed upon the actual project, the components required and the modulus operandi.

From the results, it was demonstrated that motion, which is a physical property, can be used to effect changes in a digital device and using the LED and Piezo buzzer, the motion can be announced thereby allowing it to be used as an intruder alarm.

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Introduction

Samuel Bango was the first person to invent a motion detector whereby he came up with a burglar alarm in the early 1950s. He used principles of a radar to ultrasonic waves in which he could detect fire or thieves that people were unable to hear. Doppler Effect is the main principle upon which Samuel's motion detector is based on. Majority of motion detectors today still employ the same principle. A good example is the IR sensor and microwave sensor which by the changes in the frequencies they emit they are able to sense motion.

Security systems have picked up the motion detectors and they are being used in offices and shopping malls as well as in homes as intruder alarms. The motion detectors are also being used to stop serious accidents by detecting anyone who is too close to it. Automatic doors in office buildings and shopping malls employ the motion detectors. In the motion detector, the dual infrared reflective sensor is the major element. Some detectors use different kind of sensors (Agarwal, 2013).

There are different types of motion detectors. The main ones are; the Passive Infrared Sensor, Ultrasonic sensor and IR sensor. The Passive Infrared Sensor (PIR) detects somebody's body heat as they get closer to the device. They are small and require very minimal amount of power. They are also cheap. For these reasons, PIR are very common in gardgets and home appliences. When the PIR senses motion, it gives out a digital output. The Ultrasonic sensors on the other hand are used to measure a moving object's reflection. Ther also go by the name of transducers. In principle, the transducer vibrates with a specific range of frequencies and emits sound waves when some voltage is fed into it in the form of a. electric pulse. As an obstacle comes within sensor's range, then there is a reflection of the sound waves, a process which gives out an electric pulse.

The echo patterns detect the motion. The IR Sensor detects the aspects of its surroundings by emitting or sensing IR radiation. It is an electronic device that is made up an IR LED source emitting the light which has the actual IR wavelengths. The emitted frequency of the IR beam is received by the detector circuit which has at the same time an optical component that focuses the infrared radiation and limits the spectral response.

In this project, the group used a PIR Sensor. There are three things that are very crucial in this sensor. A Fresnel lens, an infrared detector and supporting detection circuitry. Any infrared around is focused by the lens towards the infrared detector. Human bodies give out infrared heat and this is detected by the sensor. With the detection of a person, the sensor gives out a 5V signal for a sixty seconds period. The span of detection offered by this sensor is approximately 6m and it is highly sensitive (DIY Hacking, 2016).
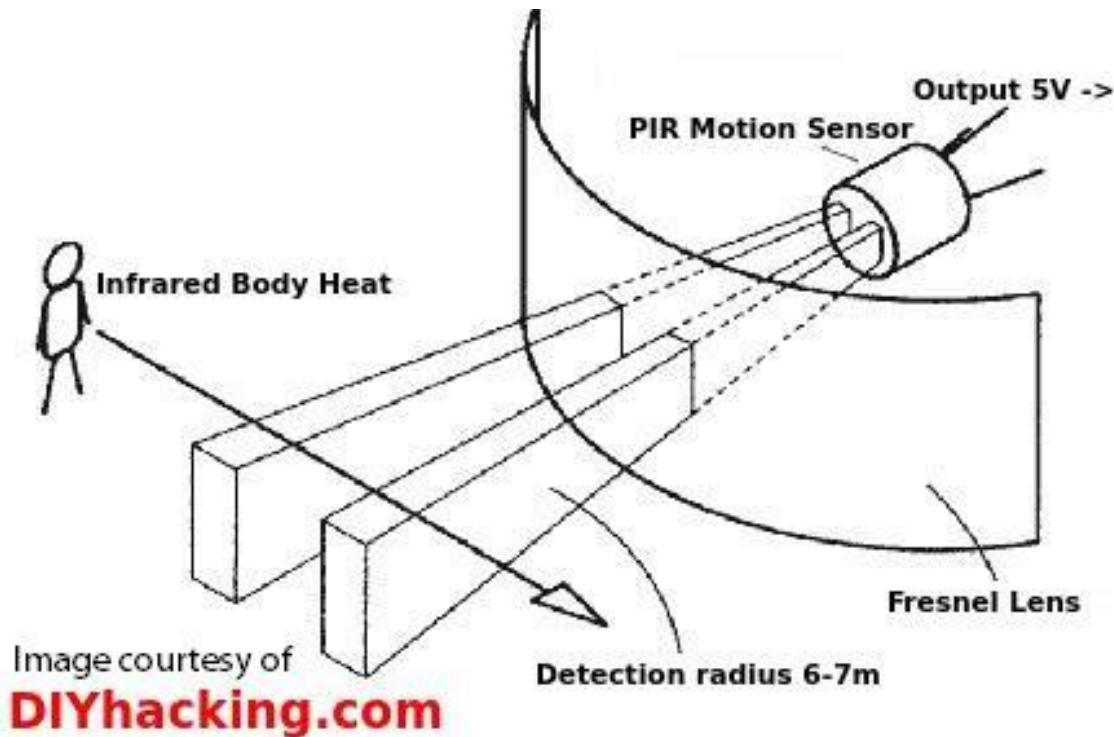

Fig 1 – Workings of a PIR Motion Sensor

The other main component that was used by the group is the Arduino. This is technically an open-source prototyping platform which relies on easy-to-use hardware and software. Arduino have the ability to read inputs for example, someone's finger on a button or a message on Twitter and eventually turn the input into output such as turning on an LED or publishing something online. By sending instructions to the microcontroller, a user can command the board to carry out some functions. This is done by the use of Arduino programming language which is based on the wiring done on the board and the Arduino Software or Integrated Development Environment, which is based on Processing.

The Arduino was invented at the Ivrea Interaction Design Institute. The main use for the device was as an easy tool for fast prototyping, and it was targeting those students who lacked knowledge on fundamentals of electronics and programming. As its market grew, the board began to evolve adapting new needs and challenges.

There are a few factors that make give Arduinos an edge over other systems:

- They are inexpensive

- They are cross-platform; they run windows, Macintosh OSX and Linux operating systems.

- They have a simple, clear programming environment.

- They are open source and extensible hardware (Arduino Newsletter, 2016).

The group also used a Piezoelectric buzzer. This is technically an electronic device whose main job is to produce sound. The fact that they are not heavy, they are easy to construct and inexpensive has made them popular in such instalments as car/truck reversing indicator, computers and also car bells.

Piezo buzzer work on the inverse principle of piezo electricity that was discovered in the year 1880 by Jacques and Pierre Curie. Simply put, when mechanical pressure is applied to some materials, electricity is produced and the inverse is true. Those kind of materials are called piezo electric materials. These materials can either be artificially made or be naturally available. An example of a manmade material is piezo ceramic which has piezo electric effect and is used in many instances to disc which forms the backbone of the piezo buzzer. These materials stretch of compress as they are put through an alternating current and they do so in accordance with the signal's frequency eventually generating sound (Jain, 2012).
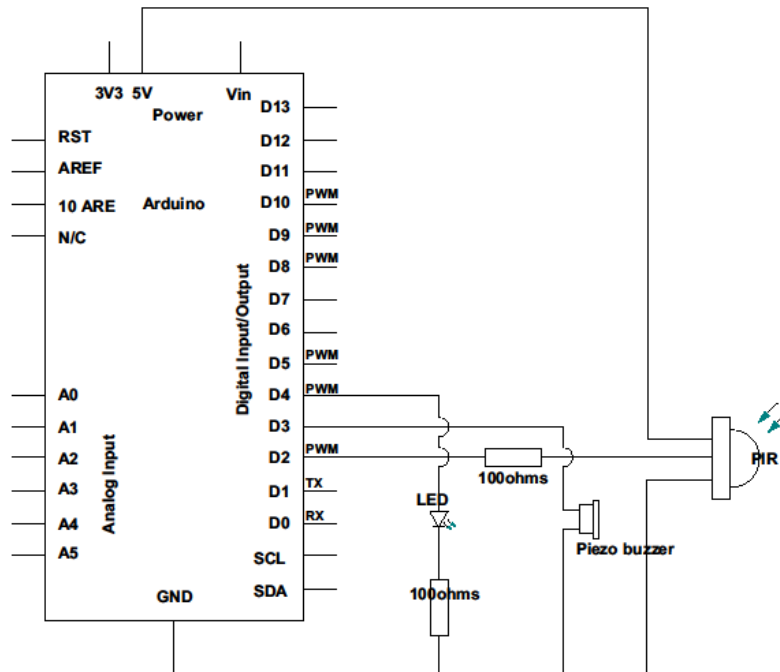
Requirements

Below is the full list of the components that the group used to work on their project.

- Arduino Uno

- 1x LED's

- 2x 100 Ohm Resistors (Brown Black Brown)

- 1 x Piezo Buzzer

- 1 x PIR Sensor

- Breadboard

- Breadboard wire

Circuit layout

Fig 2 – Motion sensor circuit schematic drawing

Procedure

1. First run a wire from the 5V pin to the positive rail on the breadboard.

2. Now run a wire from the ground pin to the ground/negative rail on the breadboard.

3. For the PIR sensor do the following steps:

- Run the black wire to the ground rail.

- Run the red wire to the positive/5v rail.

- Place a 100-ohm resistor onto the breadboard.

- Run the yellow wire to one end of the resistor and then another wire from the other end of the resistor to pin 2.

4. Now for the Piezo buzzer do the following:

- Run the red wire to pin 3 on the Arduino.

- Now the black wire to the ground rail on the breadboard.

5. Now for the red LED do the following:

- Run a 100-ohm resistor from the ground rail to a spot on the breadboard.

- Connect the negative end of the LED to the resistor and the other positive end to another spot on the breadboard.

- Run a wire from pin 4 to the positive pin on the red LED.

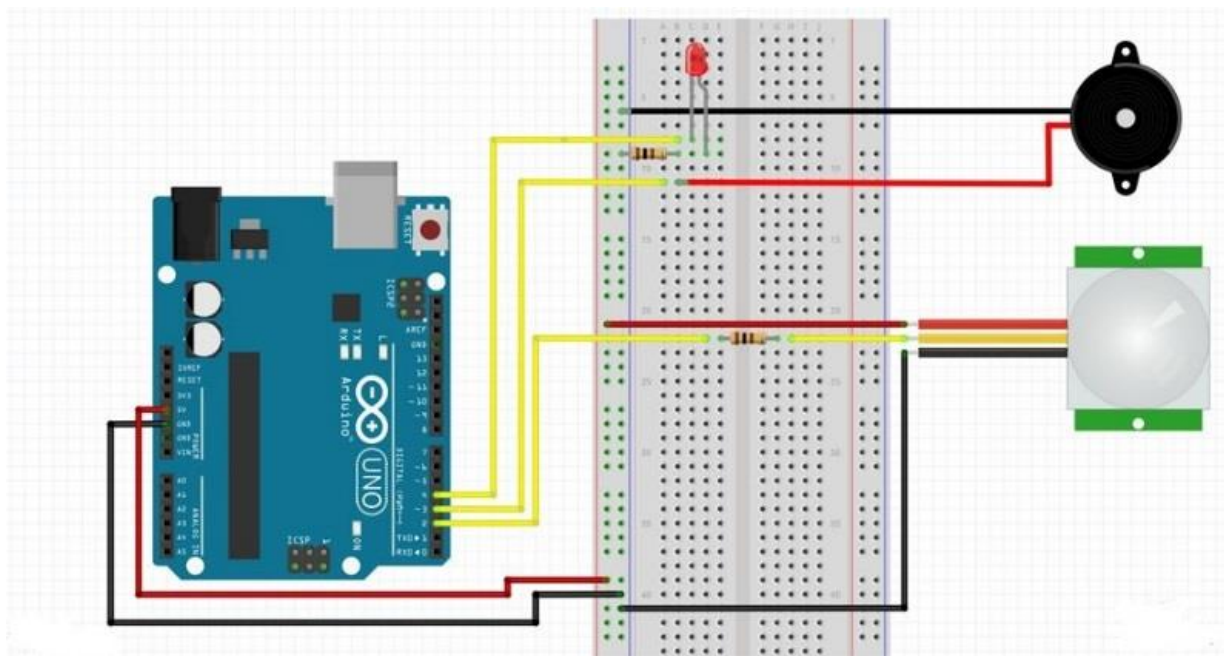The circuit was connected as shown below on a breadboard.

Fig 3 – Motion sensor circuit layout on the breadboard.

Programming

After that, the following is coded into the Arduino Software. The code instructs the PIR how to react when it detects motion. It also sets how loud the Piezo Buzzer sounds and the number times the LED lights in a certain period of time.

```
int ledPin = 4;
int piezoBuzzerPin = 3;
int pirSensorPin = 2;
int motionDetected = LOW;
void setup()
{
pinMode(ledPin, OUTPUT);
pinMode(pirSensorPin, INPUT);
pinMode(piezoBuzzerPin, OUTPUT);
Serial.begin(9600);
delay(5000);
}
void loop()
{
motionDetected = digitalRead(pirSensorPin);
if(motionDetected == HIGH) //If motion detected
    {
            digitalWrite(ledPin, HIGH);
            analogWrite(piezoBuzzerPin, 200);
            delay(100);
            analogWrite(ledPin, LOW);
            analogWrite(piezoBuzzerPin, 25);
            delay(100);
    }
digitalWrite(ledPin, LOW);
```

```
                    digitalWrite(piezoBuzzerPin,LOW);
            }
```

Once the code was within the Arduino program it was uploaded to the Arduino and the circuit came to life.

Observations and results

Once the circuit came to life, the LED was flashing continuously and the buzzer sounded all through. The group adjusted the sensitivity of PIR but that did not have a major effect. The group realized that the PIR was too sensitive. The group opened the Serial Monitor on the Arduino program and they were to confirm that the circuit was correctly detecting motion.

Discussions

Save for the fact that the PIR was too sensitive, the project was a success as it demonstrated how motion can be picked up and converted to digital signals which were later used to light the LED and make the Piezo buzzer sound. The group managed to follow through the design from the circuit to implementation.

Conclusion

Physical properties of analog signals can be converted to digital signals. A motion detector can be easily built using components that are readily available. Working in groups helps because the members are able to share their ideas and assist each other especially because everyone is talented differently.

Recommendations

The high sensitivity of the PIR can be curbed in a number of ways such by covering it with either a cardboard putting it inside a pill bottle wrapped in tissue paper. This would help in reducing instances of the sensor picking up on every movement and focusing itself on specific or directional sensing.

This simple circuit can be extended to do some pretty cool stuff for example activate lights, a speaker and much more.

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