

PASSIVE INFRARED MOTION DETECTION WITH BLUETOOTH INTERFACE

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ABSTRACT

Nowadays, people are getting more concerned to protect their residence from unauthorized people and as such, setting up an effective and reliable presence detection for residential and office usage has been a necessity. With technology advancement, movement can be sensed and a message sent quietly on a smart mobile phone to make the home occupant be aware of the motion for prompt action. This paper discusses the use of passive infrared (PIR) sensor and Bluetooth device to notify a house occupant of a guest coming into the house. This system employs a PIR sensor, a microcontroller, a Bluetooth module and Bluetooth controller application for Android smart phones. The sensor, when powered, senses any movement of human being within its field of view, measure the infrared light radiating from that body in terms of heat variation and sends it as a signal to the microcontroller. The microcontroller takes this signal, processes it and sends the information to the Bluetooth module which in turn transfers this information unto the smart mobile phone Bluetooth application to notify the house resident that a movement is detected. Tests conducted showed that the system worked effectively, more compact and affordable.

Keywords: PIR, Microcontroller, Bluetooth, Android mobile phone.

1. INTRODUCTION

One of the major trend in modern technology is the use of Bluetooth application in smart mobile phone, a technological advancement which makes smart living possible in the present era of human life. The necessity of being conscious of any unapproved movement around home and offices has made both homeowners and office occupants to lookout for an efficient system such as a movement detector that is cost-friendly. Motion sensing system is achieved by setting an external sensor up to spot movement around the door entrance or the gate and then get an advanced notice of the guests coming into the house/compound or offices. The system can watch over a house with the aid of sensor incorporated with microcontroller and Bluetooth device to get users aware via Android mobile phone when a conceivable invasion occur. The motion sensor, aside being used as intruder alarm is also employed in many applications like home automation system, energy efficiency system, etc. There are various categories of sensors used in movement detector's spectrum, these includes continuous wave radar detectors, active ultrasonic sensors, vibration sensors, active infrared and passive infrared detectors. In this system, a PIR detector was used for the movement detection.

A PIR sensor is an inexpensive sensor that can sense the presence of creatures be it human or animals. This sensor has three output pins namely; the Vcc, the Output and the Ground pins and can be used with any interfaces like Arduino, Raspberry, PIC, ARM, 8051 etc. It is essentially made of a pyroelectric sensor which can detect levels of infrared emission and is consequently referred to as *Pyroelectric sensor*. Any living and non-living objects whose temperature is somewhat above absolute zero emits infrared radiation and the warmer the object is, the more the radiation emitted. This radiated energy, though invisible to the human eye, is then detected by a PIR sensor by capturing the infrared rays released by objects. PIR sensor is easily affected by the variation of heat sources and sunlight, and is therefore more suitable for indoor movement detection (RobotsCraft technology, 2016). Positioning the sensor meticulously increases its operations, for instance, placing the sensor such that an intruder walks across its field of sight improves its performance in movement detection when compared to its placement when an intruder walks straight towards it.

Bluetooth has contributed greatly to the innovative advancement in technology. Bluetooth technology exchanges data wirelessly within a short distance range by enabling a required

platform for convenience and adequate control (Krishna et al., 2015). Among different wireless technologies, Bluetooth technology stands atop because it enables communication between devices and users in a simple and efficient manner. There are many kinds of Bluetooth devices being used in our daily life. In these varieties, there are numerous Bluetooth modules designed to control various appliances (Yan and Shi, n.d.). These modules perform related operations based on their specifications. Among these specifications are that they work within the range of 45metres and at an operating frequency of 2.4GHz.

Several researchers have worked on the deployment of PIR sensor for several application like security, home automation etc. Nepal et.al., (2013) worked on Passive Infrared based security device that employed a sensor to detect the alteration in infrared emission of warm-blooded moving objects in its detection range. The variation in the infrared emission alters the voltage generated, amplifies it in order to activate the relay that controls the device. In the evaluation of a low-cost security system using small Pyro electric Infrared sensor assembled around a microcontroller, Chowdhury et.al (2014) employed this low-powered PIR detectors to detect the presence of a human bodies that are not at thermal equilibrium with the neighboring environs. The system triggers an alarm when the presence of an unauthorized person in any specific time interval is noticed, and also sets up a call to a predefined number through a GSM modem. This system being a highly sensitive method, has low computational obligations thus its application is only suited in surveillance, industries and smart environments. Manal and Saeed (2016) implemented a design that employed four pyroelectric infrared sensor. The designed system has a stepper motor which controlled the AVR microcontroller-based Arduino board that makes the camera trail the objective movement. The direction of rotation is always indicated anytime any of the sensor is interrupted by the object.

The “Global System for Mobile Communication (GSM) Based Home Security System with Short Message Service (SMS) Alert Using Human Body Motion Detective and GSM Module”, developed by Iyapo et al., (2017), consist of an infrared motion detector and magnetic sensor which acts as a transducer for sensing intruder’s motion or break-in through a door. An embedded microcontroller unit processes the signals from the sensor, trigger an alarm and also the GSM module which in turn sends SMS message to the house owner’s mobile phone. Nosiri

et al., (2018) developed a motion detector security system for indoor geo-location by utilizing PIR sensor and Raspberry Pi such that when movement is detected, the Raspberry Pi permits the buzzer to alert the personnel on a potential intrusion. The recorded video is then sent to a specified online web server, the homeowner can then login to watch the recorded videos. The web server is as well tasked with sending SMS to the owner's mobile phone. When the PIR sensor perceives motion, raspberry pi allows the Pi camera to capture and store the image.

This paper presents the deployment of PIR sensor incorporated with Bluetooth module to send message to an Android mobile phone notifying a resident whenever movement is detected around the house/office.

2. METHODOLOGY

Figure 1 shows the block diagram of the motion detection. The block diagram consists majorly of the power supply units, voltage regulator, microcontroller, PIR sensor, Bluetooth module and the Android based mobile phone

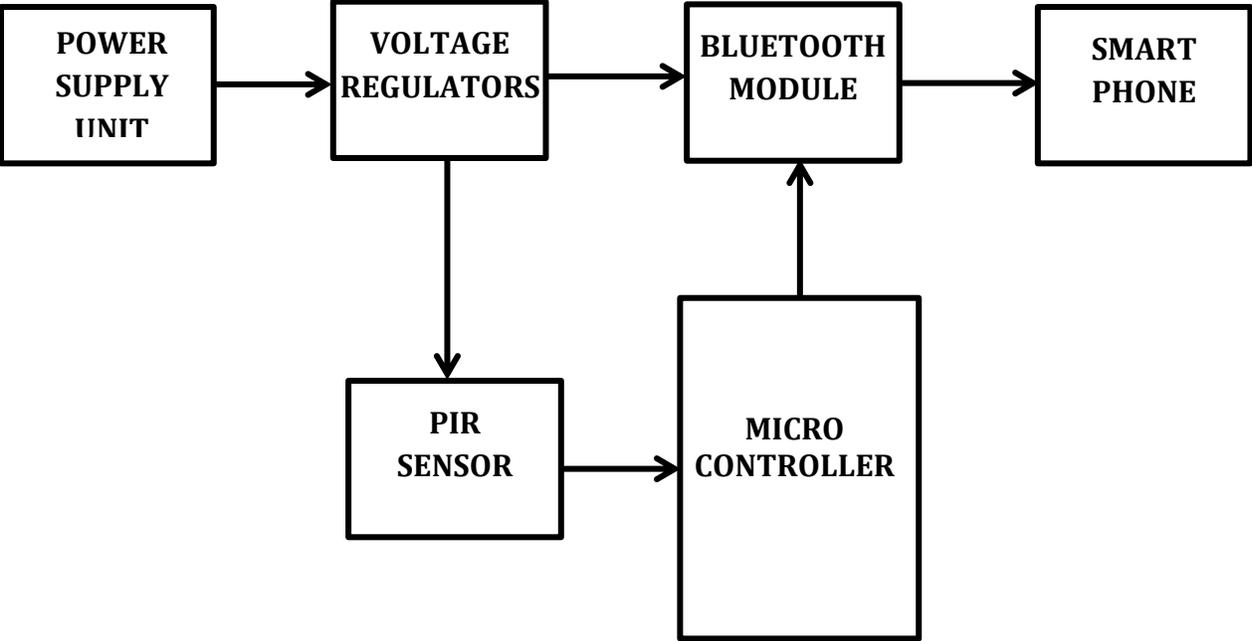


Figure 1: Block diagram representation of the motion detector with Bluetooth interface

2.1 Power supply unit

This comprises of an AC – DC converter and a 6V rechargeable lithium ion battery. The converter (adapter) serves to convert the 230V alternating current (a.c) supply from the mains into 12V direct current (d.c) source. The battery is provided as an alternative source of supply in case of power outage and can last for about six (6) hours. While the main supply is ON, the converter also charges the battery.

2.2 Voltage Regulators

Two voltage regulators, LM7805 and LM 371 were employed in this design. The LM7805 voltage regulator is a three terminal linear voltage regulator which supplies +5V to power the microcontroller. It takes its input from the 230VAC to 12V DC adapter and regulate it to +5V which is required for the microcontroller. The LM317 voltage regulator is an adjustable voltage regulator and it is used in this design to charge the battery. LM 317 has configurable output voltage governed by equation (1).

$$V_{out} = 1.25 \left(1 + \left(\frac{R_2}{R_1} \right) \right) \quad (1)$$

This configurable V_{out} is the voltage required to charge the battery and is calculated using equation (1). For this design, R_1 is 220Ω and R_2 is $1.2K \Omega$

Thus

$$\begin{aligned} V_{out} &= 1.25 \left(1 + \left(\frac{1200}{220} \right) \right) \\ &= 1.25(1 + 5.45) \end{aligned} \quad (2)$$

$$V_{out} = 8.1V$$

Therefore, the 6V battery will be fully charged with the 8V output from the LM 317.

2.3 Passive Infrared (PIR) Sensor (HC – SR501)

A PIR sensor is a sensor that measures infrared (IR) light radiating from objects in its field of sight. PIR enables movement recognition in that it detects if a human moved in or out of its range. This HC – SR501 sensor is commonly employed in home and office appliances and gadgets due to its small size, inexpensive, low-power consumption of 65mA, easy to use and

non-aging ability. Moreover, it can distinguish between object movement and human movement and was, for this implementation, operated on non-repeatable mode. Input voltage is +5V, though can be operated with the range of 4.5 to 12V. It has High/Low Output (Dout) of 3.3V TTL when triggered (motion detected) and 0V when idle (no motion detected). Figure 2 depicts the PIR and its pin configuration while figure 3 shows its mode of operation.

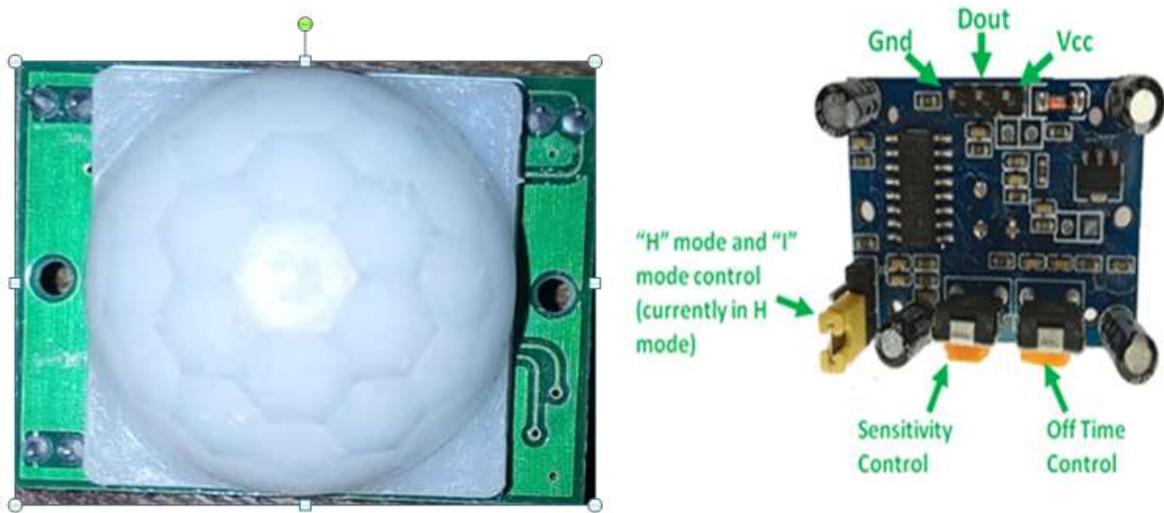


Figure 2. PIR and its pin configuration

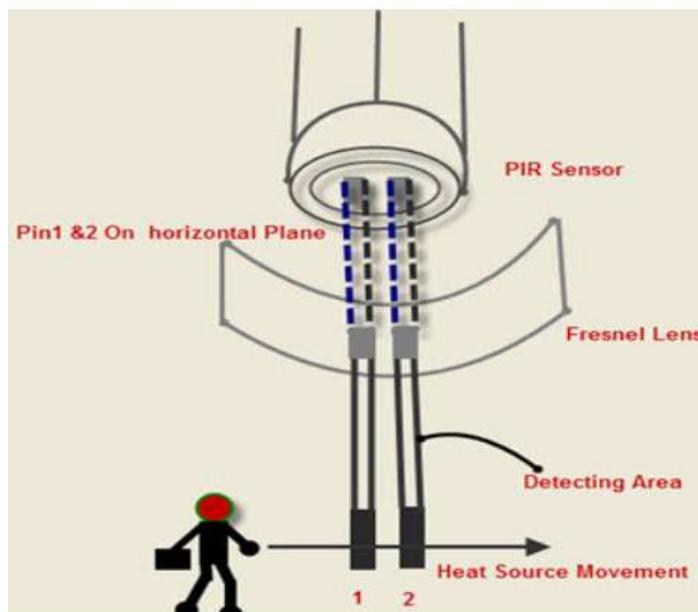


Figure 3: Operation of PIR sensor.

2.4 Microcontroller ATMEGA 328P

In this design, ATMEGA328P microcontroller was used. The ATMEGA328P is an 8-bit, high performance, low power microcontroller chip having 28 pins as shown in figure 4. The microcontroller was powered with 5V DC supply and for its effective operation, pin 1 was pulled up to 5V using the 1kΩ resistor.

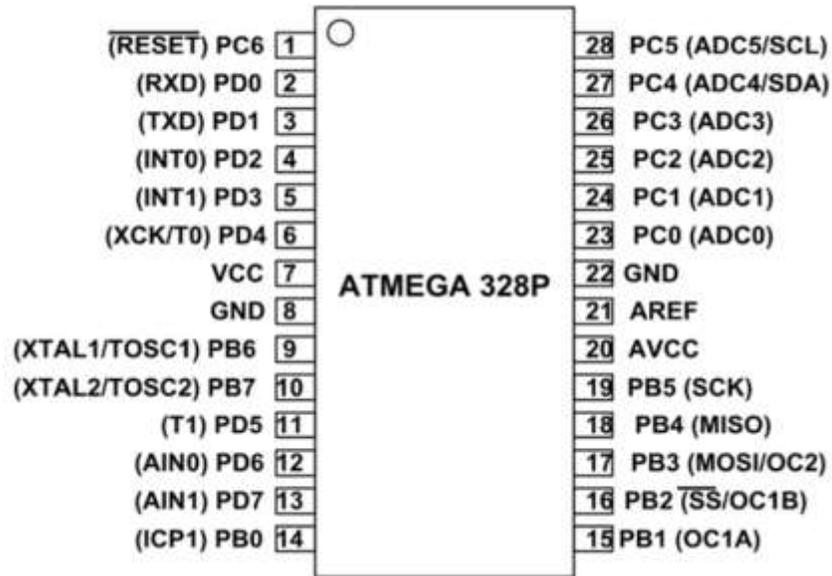


Figure 4: Pin configuration of ATMEGA 328P microcontroller

Here, as depicted in figure 4, pin 1 was pulled up through 1kΩ resistor to 5V supply, pin 7 and 20 served as the Vcc, pin 8 and 22 was used for ground. However, Pin 23 was used for transmitting which served as the output pin connected to the Bluetooth module while pin 25 was used for receiving signal from the PIR sensor and as such was connected to the output of the PIR sensor. The operating frequency of this ATMEGA 328P is set internally to 16MHz.

2.5 Bluetooth module (HC – 05)

Bluetooth is a standardised feature or specification that is accessible in all Smartphone running on android or IOS, laptops and computers. HC-05 is an easy to use Bluetooth Serial Port Protocol (SPP) module designed for translucent wireless serial connection setup which is employed at civil level and not at the industrial level. This module is used for converting serial port to Bluetooth. HC-05 has two operating modes namely; master and slave device, a work mode (master or slave) that can be set by users using AT commands. The core task of

Bluetooth serial module is to replace the serial port line. Once the device is paired, connection can be established. The connection is comparable to that of serial port line which includes receiving and transmitting signals. Bluetooth is the only suitable communications protocol with no fear of frequency interferences because it uses the MAC Address of the device i.e. Bluetooth permits connectivity between two devices using their MAC Address (Aritra *et al.*, 2015). Figure 5 shows the HC – 05 Bluetooth module.

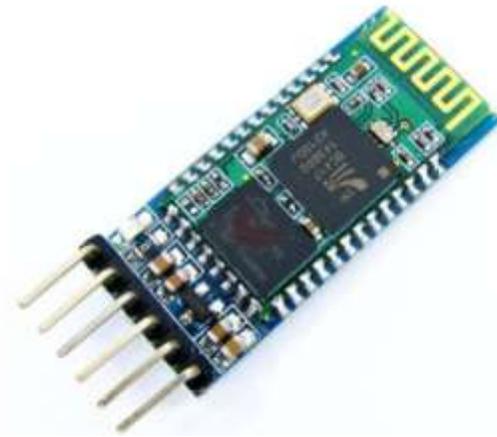


Figure 5: HC – 05 Bluetooth module.

2.6 Android Application

The android application used here is the Arduino Bluetooth controller App. It is downloaded unto a smart phone through the Google play store. Once installed, connect your android smart phone with the Bluetooth module using the following procedure:

1. Turn on the motion detector
2. Turn on your phone's Bluetooth.
3. Open the app and pair with the Bluetooth module.
4. Connect to HC-05 (if it asks for the connection password then type 1234 or 0000).
5. Open the terminal in the app.

Figure 6 shows the screenshot of the outlook of the ArduinoRC Bluetooth interface on the Android smart phone.

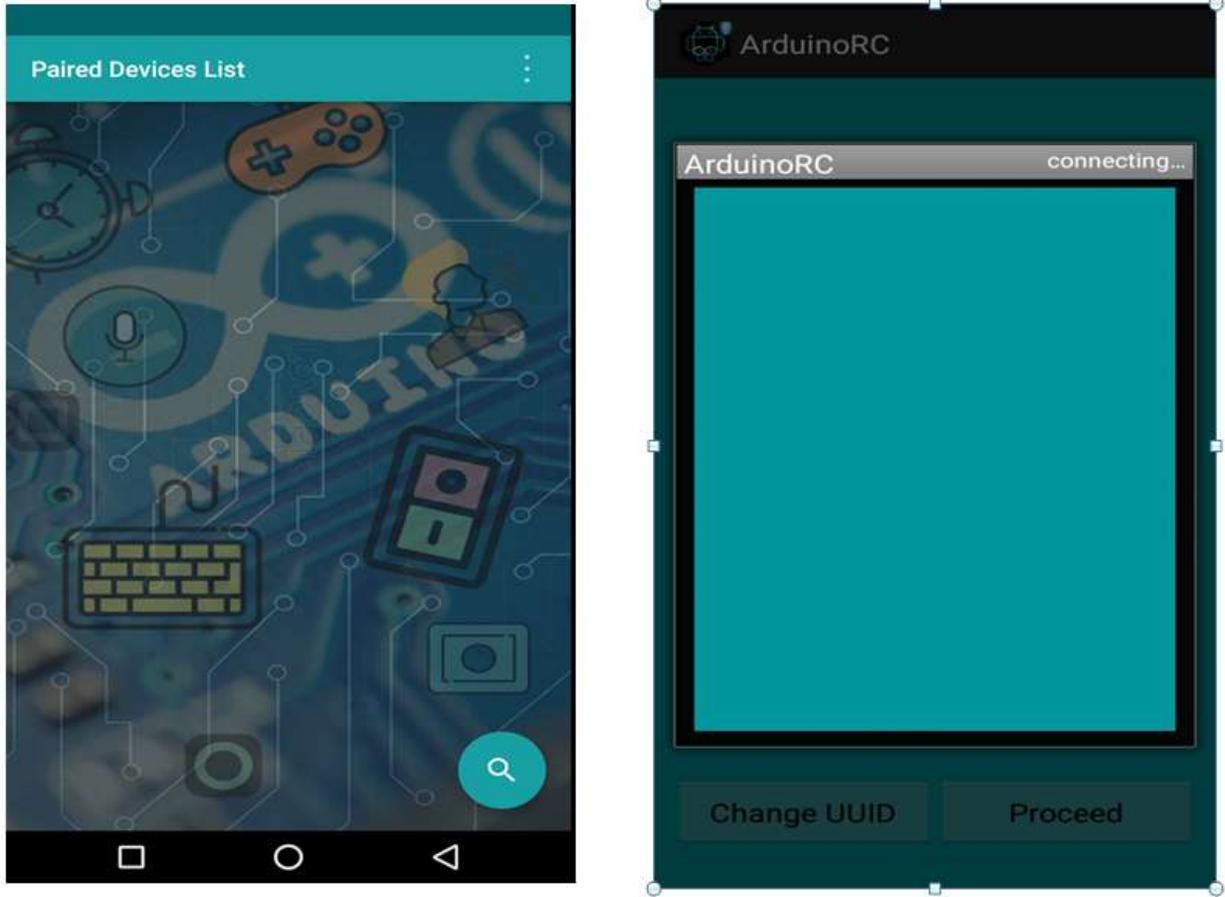


Figure 6: The outlook of the ArduinoRC Bluetooth interface on the Android smart phone.

Figure 7 shows the flow chart representation of the implementation of the algorithm used in the programming of the microcontroller while figure 8 depicts the circuit diagram implementation of the motion detection.

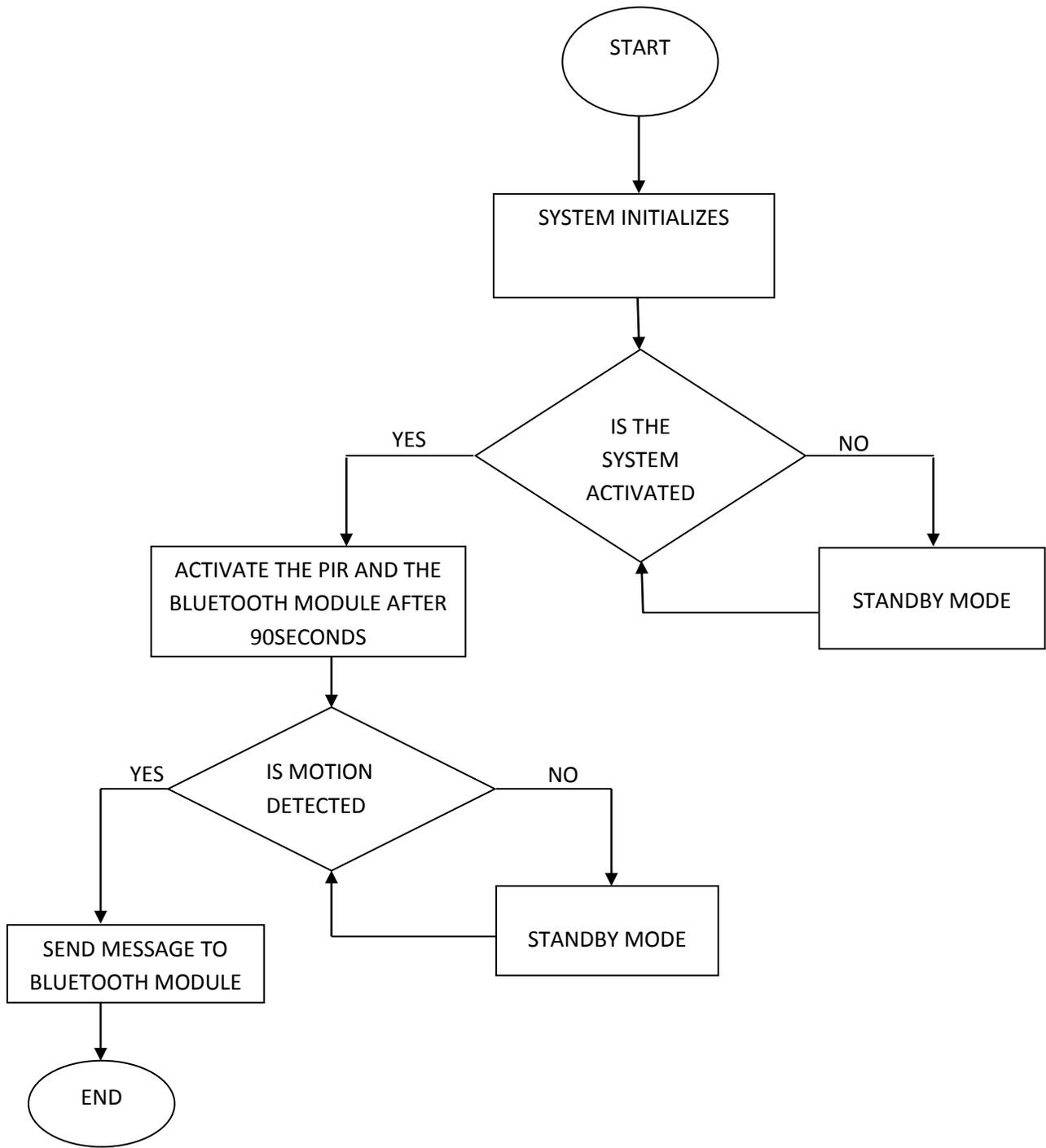


Figure 7: Flow chart representation of the circuit implementation.

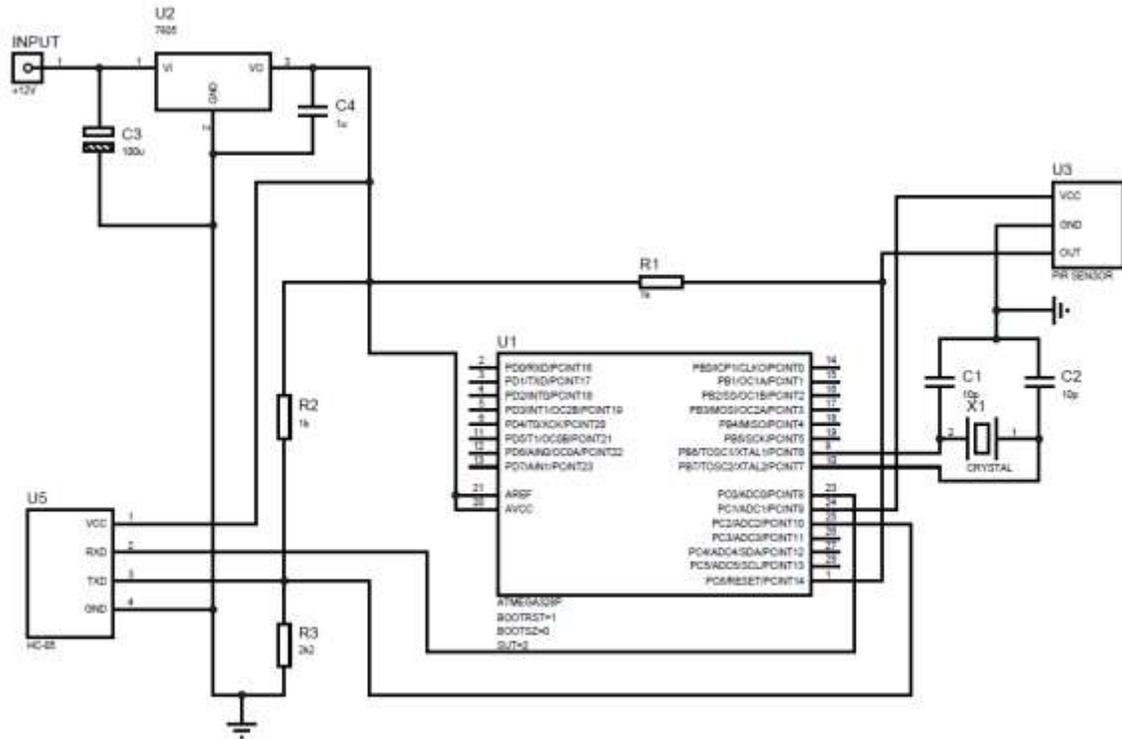


Figure 8: Circuit diagram of the motion detector

An AC to DC converter was used to convert the 220V a.c mains to 12V d.c which serves as the input to the circuit. The LM 7805 regulated the 12V d.c to 5V d.c to power the ATMEGA328P microcontroller which plays an important role having configured to work with a crystal oscillator. A Passive Infrared Sensor (PIR sensor) is used to detect the human presence and is connected to pin 25 (the receiving pin) of the microcontroller. When it detects the human presence at its field of view, it sends signal to the microcontroller which processes the signal. The output of the microcontroller is connected through pin 23 (the transmitting pin) to Bluetooth HC – 05 module which receives the message and send it to the Bluetooth App on the smartphone.

3. RESULT AND DISCUSSION

As the detector was powered, the PIR was allowed to calibrate itself for 90 seconds as the program initialises, and the Bluetooth on the smart phone was put in ON mode to allow visibility. When there was no movement of object, no message was received on the phone.

During the system implementation, several tests were carried out to ascertain the functionality of the developed motion detector. The test results are as depicted in Tables 1 to 3.

Table 1. Results of voltage test carried out the pins of ATMEGA328P

| Condition/State | Pin 1 | Pin 7 & 20 (Vcc) | Pin 23 | Pin 25 |
|---------------------|-------|------------------|--------|--------|
| When not powered | 0.0V | 0.0V | 0.0V | 0.0V |
| When powered | 5.0V | 5.0V | 0.0V | 0.0V |
| During operation | 5.0V | 5.0V | 0.0V | 0.0V |
| Motion detected | 5.0V | 5.0V | 5.0V | 5.0V |
| Motion not detected | 5.0V | 5.0V | 0.0V | 0.0V |

Table 2. Operational test on Pin 23 and Pin 25

| Condition/State | Pin 23 | Pin 25 |
|-----------------------------|--------|--------|
| When motion is detected | High | High |
| When motion is not detected | Low | Low |

Table 3. Results of the tests carried out at different distances from the PIR sensor

| Distance (m) | Response | Remark |
|--------------|---------------------|--------------|
| 1.00 | Motion detected | Satisfactory |
| 5.00 | Motion detected | Satisfactory |
| 7.50 | Motion detected | Satisfactory |
| 10.00 | Motion detected | Satisfactory |
| 12.50 | Motion detected | Satisfactory |
| 15.00 | Motion not detected | Satisfactory |
| 20.00 | Motion not detected | Satisfactory |

When motion was detected, pin 23 goes HIGH because signal has been sent to the Bluetooth which in turn send the message to the smart phone App. So also, pin 25 goes HIGH because the signal to be processed by the microcontroller has been received by the PIR sensor which is connected to the pin. However, the pins go LOW when no movement was detected. So also, when the person has left the coverage area of the PIR sensor, the pins go LOW and message sent

that the motion has ended. This is because the PIR was operated at non-repeatable mode. Figure 9 illustrates the messages received on the android App.

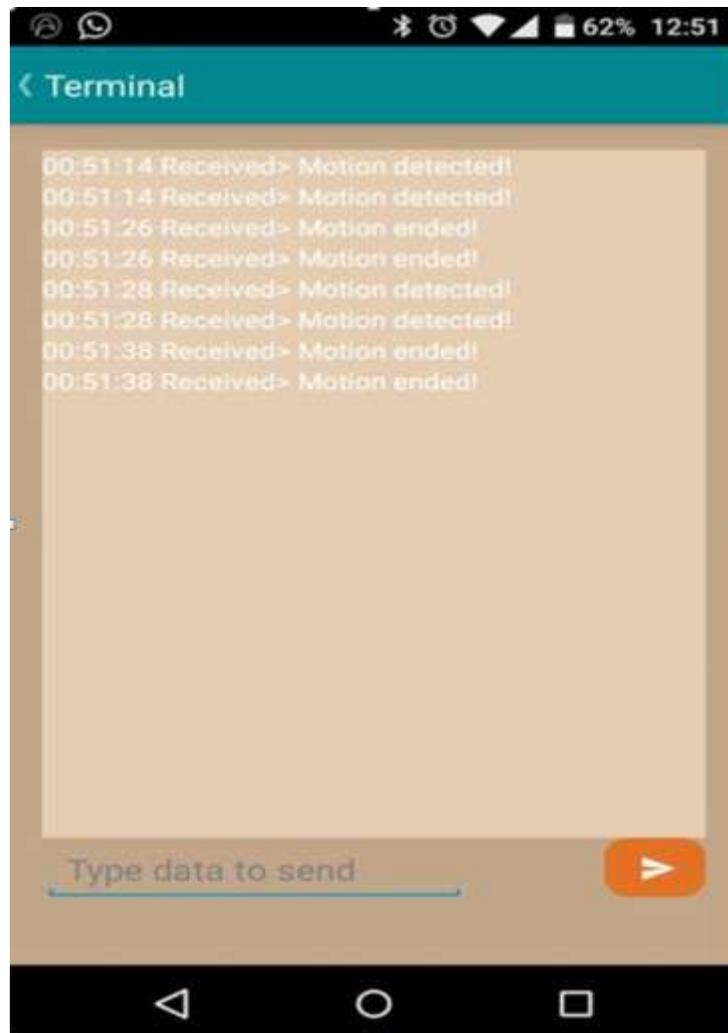


Figure 9: Messages received on the Android App.

4. CONCLUSION AND RECOMMENDATION

In this paper, a passive infrared motion detection with Bluetooth interface has been developed and implemented. The PIR sensor uses the infrared radiations which alter as a result of human motion across its area of coverage. When a motion is being detected, the data (motion detections) can be viewed on a smartphone via the Bluetooth, thus, notifying the house or office occupants of any incoming movement. This system is cost effective, reliable and independent of availability of

utility supply as it employs battery as power backup, thus making suitable for use at homes and offices.

It is recommended that this work can be improved on by incorporating a d.c motor controlled door such that command can be sent through the android App on the mobile phone to ALLOW or NOT the entrance of the person whose motion is been detected.

References

1. Aritra, D., Akash, P., Sayantan, N., and Lusika, R. (2015). Three Way Controlled Android Smartphone based Robotic Vehicle via Bluetooth. *International Journal of Applied Science Engineering and Management (IJASEM)* vol 1(1),
2. Chowdhury Z., Imtiaz, M., Azam, M. M., Sumi, M.R.A. and Nur, N.S. (2014). Design and implementation of Pyroelectric Infrared sensor based security system using microcontroller. 10.1109/TECHSYM. 2014.
3. Iyapo K.O., Odo E.A, Fasunla O.M, Egbuwalo S.A and Raimi O.A, (2017) "Design and Construction of an Automatic Home Security System based on GSM Technology and Embedded Microcontroller Unit", *American Journal of Electrical and Computer Engineering*. Vol 1(1), pp. 25-32
4. Krishna, B. M., Nayak, V. N., Reddy, K. R., Rakesh, B., Kumar, P. M and Sandhya, N. (2015) Bluetooth Based Wireless Home Automation System Using FPGA. *Journal of Theoretical and Applied Information Technology* Vol. 77 (3), pp. 411- 420
5. Manal H., and Saeed . (2016). Implementation of Tracking System for Human Detection based on Pyroelectric Infrared (PIR) Sensor. *International Journal of Computer Applications*. 138. pp 15-20. 10.5120/ IJCA.
6. Master P2. (2016) Bluetooth Controlled Motion Sensor Alarm. URL: <http://www.instructables.com/id/Introduction-to-PIR-Sensor-and-Integrating-It-With/2016.>, accessed 10th November 2019.
7. Yan, M. and Shi, H. (n.d.) “Smart Living Using Bluetoothbased Android Smartphone”, *International Journal of Wireless & Mobile Networks (IJWMN)* Vol. 5, No. 1.
8. Nepal, Gopal, Biswa, Rajen, Adhikari, D., Chodon P, Gyeltshen, Sangay and Chencho., (2013). Passive Infrared (PIR) Sensor Based Security System. *International Journal of Electrical, Electronics and Computer Systems*. 14. pp. 772-778.
9. Nosiri, O. C., Akwiwu-Uzoma, C. C., Nmaju, U. A., and Elumeziem, C. H. (2018) Motion Detector Security System for Indoor Geolocation. *International Journal of Engineering and Applied Sciences (IJEAS)* Vol. 5(11) pp 24 – 30
10. RobotsCraft Technology. (2016). "Introduction to PIR Sensor and Integrating It With Arduino, URL: <http://www.instructables.com/id/Introduction-to-PIR-Sensor-and-Integrating-It-With/2016>. accessed 10th November 2019.

Appendix
The developed PIR motion detector

