

# PC Controlled Wireless Robot for Detecting Human Presence

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**Abstract** - The emergence of new high-speed technology has been proven both a boon and bane for humankind. However, technology itself, if used efficiently, can be used to counteract the bane. Robotics is one such field which has undergone numerous developments to make human life easier. Natural calamity is one of the commonly known negative impacts of technology. High performance robots can be used to negate the adverse effects of disasters on human lives. In this paper, we propose to use a PC controller wireless robot for detecting human presence. The robot is embedded with PIR and ultrasonic sensors to detect the human presence and its exact location. Since, it is a wireless robot, it is mobile and can go through the devastated areas, which can be risky for humans to enter. This robotic vehicle can be also be used to detect intruders/terrorists.

**Key Words:** Robotics, Microcontroller, PIR sensor, XBee, Arduino

## 1. INTRODUCTION

With the dramatic changes in the environment, almost entire planet is prone to natural calamities. These are unpredictable and unstoppable; devastating human lives to such an extent that it takes sometimes a lifetime to overcome from its tribulations. It is very common in these calamities that humans get captured under the wreckage and nobody is aware of their presence. Till the time, the rescue team gets notified of missing victims, they are either dead or in a very critical state. A timely rescue is the most crucial part of rescue operation and if delayed, can cost many human lives. We propose to use a PC controlled robotic vehicle that moves in these affected areas and helps in identifying the alive people and thereby, contributing in the rescue operations. The robot consists of Arduino board which works as the central control unit of all the operations. PIR sensor, ultrasonic sensor and temperature sensor are encapsulated in the Arduino. The PIR (Passive Infra-Red) Sensor is a pyroelectric device that detects motion by measuring changes in the infrared (heat) levels emitted by surrounding objects. When motion is detected, the PIR sensor outputs a high signal on its output pin, which is read by a microcontroller present in the Arduino. Ultrasonic sensor is used to measure the distance of the human body from the robotic vehicle and temperature sensor prevents the robot from entering in the areas of high temperature. Having detected the sign of alive human, the sensors trigger the microcontroller to switch on the buzzer or led. The ZigBee has been used to give direction to the robot so that it can move wirelessly. The distance and temperature measurements and PIR sensor output signals are sent via XBee router, which is interfaced with Arduino, to the XBee coordinator which is connected to the PC. Hence, the proposed robot helps in precise detection of humans. It also enables wireless monitor and governance of robot.

Apart from this, the proposed robotic vehicle can be used to detect the intruders. This has become very important in today's criminal environment which surrounds us at almost every place. Hence, designing such a detector can prevent various terrorist attacks and also can contribute in the home security system. It can also help in saving electricity which is a very costly resource nowadays.

## 2. ARCHITECTURE

The robotic vehicle consists of two modules, coalesced together to form an efficient wireless detection of humans. The two verticals are as follows:

1. **Robot module:** Arduino, ZigBee, sensors and motors are used to create a robot module. The interaction between these elements is illustrated in Fig-1.
  - a. **Arduino Uno board**, based on the ATmega32-8, is used as a robot platform. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller.

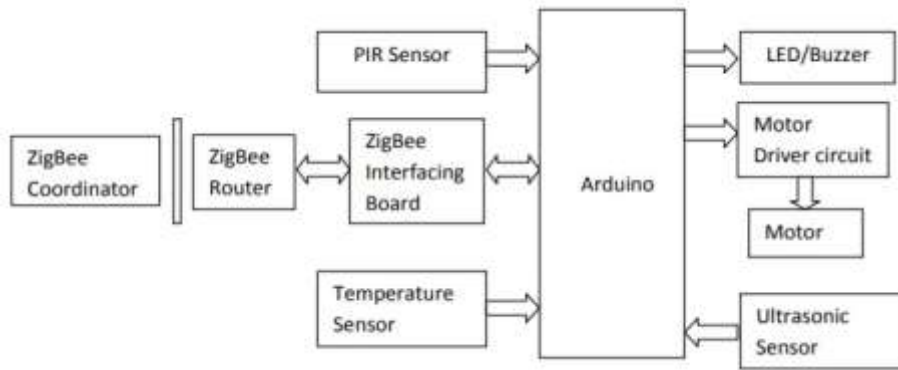


Fig-1: Robot module

- b. A **passive infrared sensor** (PIR sensor) is used to sense movement of people, animals, or other objects. It measures infrared (IR) light radiating from objects in its field of view. All objects with a temperature above absolute zero emit heat energy in the form of radiation. Usually this radiation is invisible to the human eye because it radiates at infrared wavelengths, but it can be detected by electronic devices designed for such a purpose. PIR sensors don't detect or measure "heat"; instead they detect the infrared radiation emitted or reflected from an object. When an object, such as a human, passes in front of the background, such as a wall, the temperature at that point in the sensor's field of view will rise from room temperature to body temperature, and then back again. The sensor converts the resulting change in the incoming infrared radiation into a change in the output voltage.
- c. An **analog temperature sensor** is a chip that tells what the ambient temperature is. This precludes the robot from entering into high temperature areas. These sensors use a solid-state technique to determine the temperature. They use the fact as temperature increases, the voltage across a diode increases at a known rate.
- d. **Ultrasonic transducers** are used to measure the distance of humans from the robot, hence determining the exact position of human. These devices work on a principle similar to that of transducers used in radar and sonar systems, which evaluate attributes of a target by interpreting the echoes from radio or sound waves, respectively. Active ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor, measuring the time interval between sending the signal and receiving the echo to determine the distance to an object.
- e. **DC Motor** is used to enable the movement of robotic vehicle. It is an electrical machine that converts direct current electrical power into mechanical power. The circuitry used for interfacing Arduino with DC motor is as shown in Fig-2.

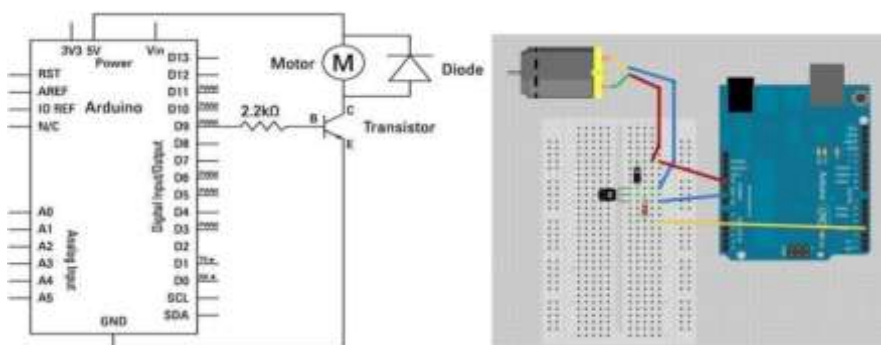


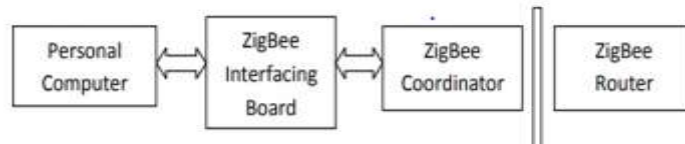
Fig-2: Interface between Arduino and DC Motor

2. **Control room module:** This is used for wireless signal transmission from computer to robot.

- a. ZigBee, low-cost and low-power wireless mesh network standard targeted at wide development of long battery life devices in wireless control and monitoring applications. Though its low power consumption limits transmission distances to 10–100 meters line-of-sight, ZigBee devices can transmit data over long

distances by passing data through a mesh network of intermediate devices to reach more distant ones. ZigBee is typically used in low data rate applications that require long battery life and secure networking. ZigBee has a defined rate of 250kbit/s, best suited for intermittent data transmissions from a sensor or input device. A combination of ZigBee Coordinator (ZC), ZigBee Router (ZR) and ZigBee End Device (ZED) can be used to complete the communication circuit, as illustrated in Fig-3.

- b. To ease the process, XBee Series 2 (ZigBee Mesh) is used as an alternative to ZigBee. Series 2 modules allow one to create complex mesh networks based on the XBee ZB ZigBee mesh firmware. These modules allow a very reliable and simple communication between microcontrollers, computers, systems, etc. with a serial port. Point to point and multi-point networks are supported.

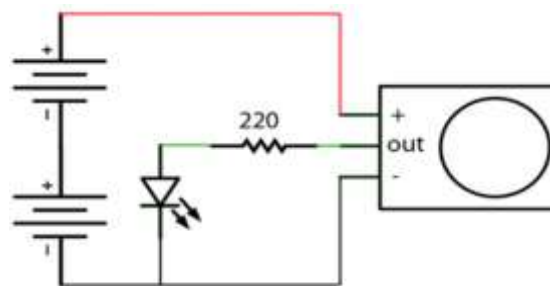


**Fig-3:** Control room module

### 3. METHODOLOGY USED FOR CONSTRUCTION

The robot implementation was divided into below 4 phases:

1. **Mechanical construction of robot:** A high quality metal chassis, DC gear motors and wheels are used to form the robot skeleton.
2. **XBee configuration:** Two XBee ZB24-B modules are configured by using X-CTU software. The module is firstly interfaced with XBee USB adaptor board and then it is connected to the personal computer via USB cable. Start X-CTU software and then configure XBee router and coordinator.
3. **PIR sensor testing:** Temperature sensor and PIR sensor are tested for their appropriate performance. Their testing circuits (as illustrated in Fig-4) are implemented on the breadboard and readings are noted. Following circuit is implemented on the breadboard. 5V power supply, one led, one 220ohms resistance is used in this circuit. Proper connections are done and following readings are obtained. In this circuit, LED glows whenever any movement of any human being is detected by the PIR sensor. Readings are taken corresponding to human standing at different distances. Output voltage and on time of LED are noted.



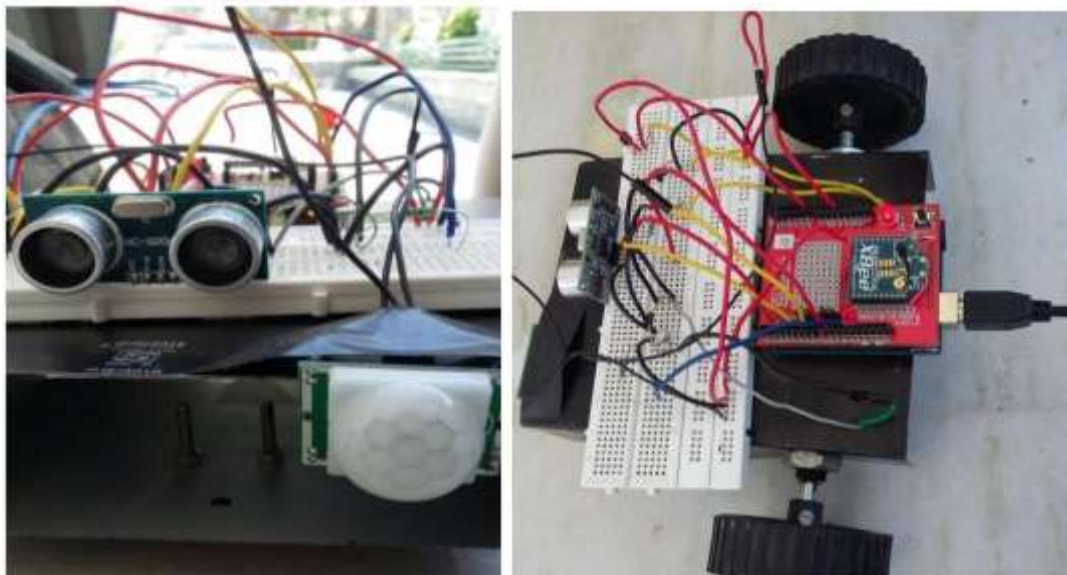
**Fig-4:** PIR sensor testing circuit

**Table -1:** Readings obtained while testing PIR Sensor

Distance	Output Voltage (V)	LED ON Time (sec)
8.5	3.13	2.0
15	3.12	2.0
30	3.13	2.0
45	3.12	2.0

1. **PC controlled wireless robot:** Robot is made wireless pc controlled by using XBee. The XBee coordinator is connected to pc via XBee USB adaptor and XBee router is connected to Arduino via XBee shield. Motor driver circuit is implemented on the breadboard and motors are connected to the Arduino by using this motor driver circuit. The left motor is connected to pwm pin12 and right motor is connected to pwm pin9 of the Arduino board. The code for wirelessly controlling the robotic vehicle with the help of 'w', 'a', 's' and 'd' keys of keyboard is written and compiled. Then it is uploaded on Arduino via USB cable. 'w' is used to move the robot in the forward direction, 'a' for moving it in left, 'd' for right and 's' for backward motion. Different serial commands for serial communication with XBee and digital input/output commands for motor interfacing are used in the Arduino code.
2. **Assembling of all the sensors on robot:** All the sensors are interfaced with Arduino board by writing the corresponding code. The distance measurements, temperature measurements and PIR sensor output signals are sent to Xbee router connected to the Arduino which are then sent wirelessly to XBee coordinator connected to the PC. Hence, all the readings are obtained on PC wirelessly. The sensors are interfaced as follows:
  - a. **Ultrasonic Sensor** Trigger pin of sensor is connected to pin 2 and echo pin is connected to pin 4 of the Arduino board. Firstly, a low pulse of 2 microseconds is sent to the trigger pin and then trigger pin is made high for 10 microseconds. Then, the time duration until echo pin is high is recorded and converted to distance by using mathematical calculations. This calculated distance is then sent to serial port for wireless transmission to pc.
  - b. **Temperature Sensor** The output pin of the temperature sensor is connected to pin 0 of Arduino board. The data on this pin is read and converted to temperature which is then sent to the serial port for transmission to pc.
  - c. **PIR Sensor** The output pin of PIR sensor is connected to pin 6 of Arduino board. Firstly PIR sensor is calibrated by using a 'for loop' and a delay function. Then PIR output pin is monitored for motion detection.

The final robot model (as shown in Fig-5) turned out to be compact, user friendly and efficient in detecting human presence.



**Fig-5:** Front and top view of robot

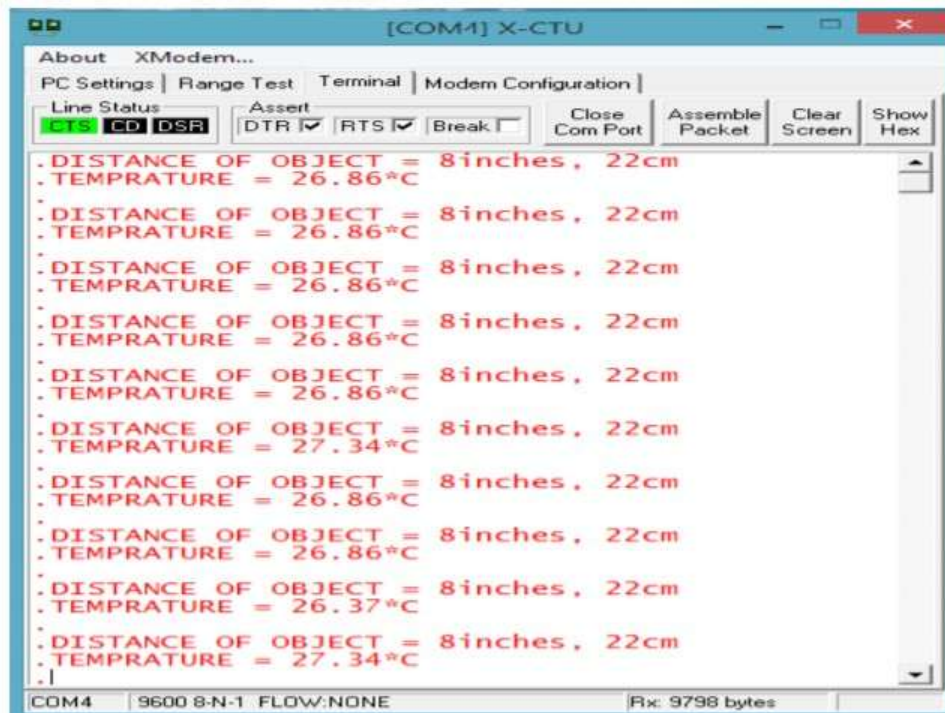


Fig-6: Terminal at personal computer

#### 4. CONCLUSION

On implementing the robotic vehicle for detecting human presence, we can assert with confidence that such systems can be used in variety of different applications. This wireless pc controlled robot can be efficiently used in disaster prone areas. Hence, many lives can be saved in a short duration which becomes time consuming and unaffected if done manually. In addition to this application, there can be many other aspects in which the robot can turn out to be efficient and useful. Nowadays, human has become too busy and is unable to find time even to switch off the lights wherever not necessary. This system also provides us with amazing features of distance measurement and temperature measurement. Because of being pc controlled and wireless system, the robot is very 59 portable and efficient. There is always a need to modify and add features according to the growing technology to compete the market. Even though, there are certain limitations to this system, but they can be overcome by making certain changes and enhancements to this robotic vehicle.

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