AUTONOMOUS HUMAN DETECTION ROVER

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

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INTERNAL EXAMINER   **EXTERNAL EXAMINER**

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ABSTRACT

During earthquakes, landslides and building collapses many people would be trapped inside the debris. Clearing the rubble, and then sending the rescue team consumes more time. According to the statistics of Urban Search and Rescue (USAR), the probability of saving a victim is high within the first 48 hours of the rescue operation, after that, the probability becomes very less. In order to overcome the difficulties faced by the rescue team small rovers are designed which could navigate itself into small spaces where humans could not enter easily. The human detection is made possible by using passive infrared sensors which detects the alive humans through the heat radiated by them. Human beings when alive usually emit radiation at wavelength of 9-10 micro meters which is in the infrared spectrum of electromagnetic radiation. These rovers would then detect the people who are trapped inside the rubble using this heat radiation. These rovers can navigate automatically over the terrain using values from ultrasonic sensors interfaced with them. In addition, the exact location of alive humans are obtained using a Global Positioning System module. The coordinates that are obtained is sent to the rescuers by the rover. Using these coordinates the rescue team can effectively save the people trapped in the debris. It is advantageous in the sense that it uses automatic navigation and human detection without the need for anyone operating it. By this way the chances of saving the people who are trapped inside the rubble is increased to a great extant.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER-1

INTRODUCTION

1.1 NEED FOR THE PROJECT

Disasters can disrupt economic and social balance of the society. Natural disasters occur frequently nowadays. Many human beings are victims of such occurrences. Because of high rise buildings and other manmade structures urban and industrial areas can be consider to be more susceptible to disasters. These disasters can be categorized into natural and human induced disasters.Natural disasters include floods, storms, cyclones, land slides and earthquakes.Man made disasters includes bombing of buildings and industrial fire. During such calamities in order to prevent loss of life and property various essential services (like fire brigades, medical and paramedical personnel, police) are deployed. Some lose their lives because of not being treated at time.

According to the statistics of Urban Search and Rescue (USAR), the probability of saving a victim is high within the first 48 hours of the rescue operation, after that, the probability becomes very less. Generally, Rescue People cannot enter into some parts / places of the earth quake affected areas. Some of these tasks are performed mostly by human and trained dogs, often in very dangerous and risky situations. In some cases the rescuer may become a victim who needs to be rescued. To avoid such losses, a robotic system can perform well for providing alert (detection) of human being.

1.2 OVERVIEW OF THE PROJECT:

The system consists of two sections the rover and the base station.The overall block diagram of the project is:
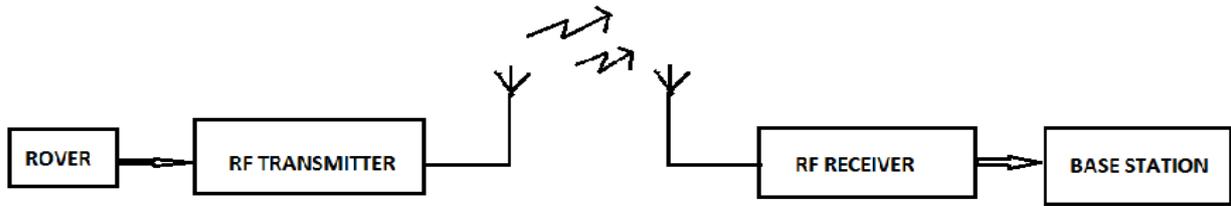
Fig. 1.1 Overall Block Diagram

1.2.1 ROVER SECTION:

The following figure gives the block diagram of the rover section:
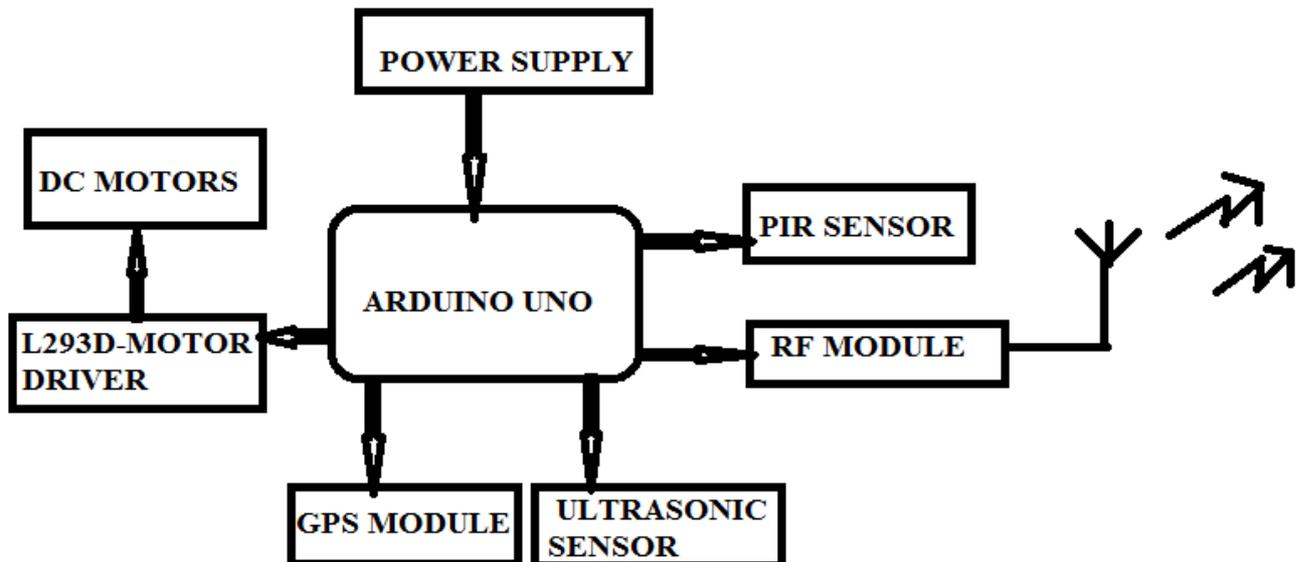

Fig 1.2 Rover Block Diagram

- The rover consists of the navigational block, the human detection block, the microcontroller block, the GPS block, the propulsion block, the communication block and the power supply.

- The navigational block consists of the ultrasonic sensor which is used to detect the presence of obstacles in front of the rover. The ultrasonic sensor sends sound waves

that gets reflected and is received by it. Based on the time duration between the sending and revieving of the sound waves the distance is calculated and the values are sent to the microcontroller. When the distance of the obstacle is too close the microcontroller sends a signal to the rover to take a left turn.

- The human detection block consists of the Passive Infrared sensor interfaced with the microcontroller. Human beings generally emit heat radiation which is in the infrared part of the spectrum. When a human is nearby, the PIR sensor can detect this heat radiation and send a signal to the microcontroller.

- The microcontroller block consists of the Atmega 328P microcontroller. It receives the output signals sents from the sensors and is programmed to instruct the rover accordingly. It is the heart of the rover.

- The GPS block provides the location of the rover in case if a human is detected. The coordinates in lattitudes and longitudes are sent to the base ststion.

- The communication block consists of the RF transmitter. It receives the data which is to be sent from the microcontroller and sends it serially to the base station using RF transmission at a frequency of 433 MHz. The scheme used is Amplitude Shift Keying.

- The motors are attached with the caterpillar tracks and the microcontroller. Based on the signals from the microcontroller the motors rotate and enables the rover to move. The caterpillar tacks provides good traction on all surfaces so that it can navigate though them with ease.

- The power supply module is used to supply a steady DC supply for thr operation of the rover.

1.2.2 BASE STATION:

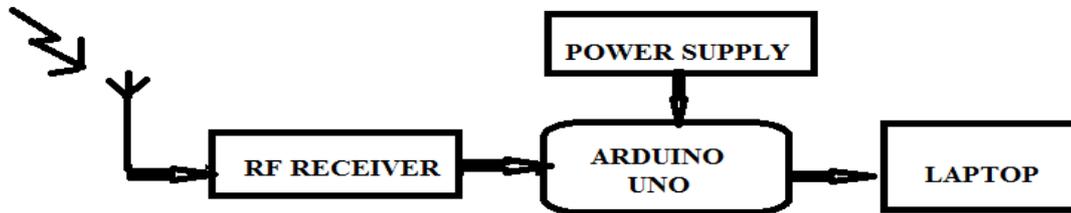The following figure gives the block diagram of the base station:

Fig 1.3 Base Station Block Diagram

- The base station consists of two blocks namely the microntroller block and the communication block. The communication block consisting of the RF receiver receives the signals from its transmitter at the same frequency and sends the data to the microcontroller. The microcontroller Atmega 328P at the rover interprets the data, sends a message and the GPS location which gets displayed using a laptop.

- Based and the location obtained at the base station the resue people are directed to the area so that the victims trapped inside the debris can be rescued in time.

The main purpose of the rover is to detect alive human beings after the occurrence of natural calamities with the help of Passive Infrared Sensor.The rover uses Ultrasonic Sensors for obstacle detection and is able to navigate through the rubble on its own without any human support. While detecting human being, there may be some obstacle on the way of robot. In order to identify the obstacle and to have an alternate path to perform its defined task an ultrasonic detection is used which effectively fulfills this operation.The rover based system will sense the heat radiation of the trapped human being and send the GPS data to the base station .Using this information the rescue team can go to the location of the trapped person in time to save him/her. For this project, we will focus on robots which will work in a disaster environment of both manmade and natural causes. The rover has the capability to

determine its current location in real-time, to wirelessly communicate with the rescue team, and to locally store the status and location information about the trapped victims in case the wireless communications link is temporarily disconnected.

The hardware description is discussed in chapter 2. It explains about the microcontroller, sensors used, RF module and GPS module. Chapter 3 gives the software description which includes the Algorithms, Arduino IDE and embedded C.

CHAPTER-2

HARDWARE DESCRIPTION

INTRODUCTION

This chapter deals with the hardware components that are used in the project along with a circuit diagram explaining how these componenets are connected with each other. In addition to this the working principle, the specifications and the construction of these compenents are also discussed.

2.1 CIRCUIT DIAGRAM

This section deals with the circuit design of both the Rover and the Base station.

2.1.1.Rover

The rover section has two arduino uno boards with ATmega 328P ICs (U1 and U2 of figure 2.1). The sensors, GPS and the RF module are connected to the microcontroller as shown in the following figure:
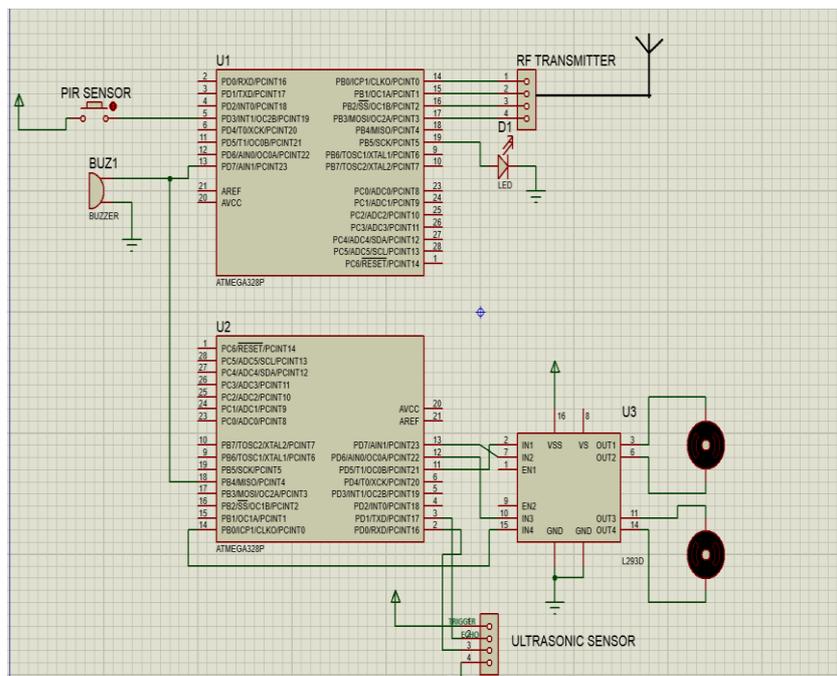

Figure 2.1 Rover circuit diagram

2.1.2. Description

- The ultrasonic sensor is connected to atmega 328P U2. The trigger pin of ultrasonic sensor is connected to pin 3 of the atmega 328P U2. The echo pin of ultrasonic sensor is connected to pin 2 of atmega 328P U2.

- The L293D Motor Driver is connected to atmega 328P U2. The motor 1 input pins IN1 and IN2 are connected to pins 5 and 6 of atmega 328P U2 respectively. The motor 2 input pins IN3 and IN4 are connected to pins 7 and 8 of atmega 328P U2 respectively. A 5 v supply is given to enable pins EN1 and EN2 of L293D to enable it.

- Motor 1 is connected to OUT1 and OUT2 pins of L293D IC. Motor 2 is conntected to OUT3 and OUT4 pins of L293D IC.

- The PIR sensor is connected to atmega 328P U1. The PIR sensor output is connected to digital pin 3 of atmega 328P U1.

- A buzzer is connected to digital pin 13 of atmega 328P U1. The digital pin 13 of atmega 328P U1 is connected to digital pin 4 of atmega 328P U2 which enables it.

- The digital pins 4,5,6,7 of atmega 328P U1 is connected to the data pins of RF transmitter for serial transmission.

- An LED is connected to pin 8 of atmega 328P U1.

- The Arduino is provided with a power supply of 5 V for its operation.

2.1.3 Base Station

The base station has a single arduino board with Atmega 328P IC(U1). It is connected with a RF receiver and a laptop as in the following figure:
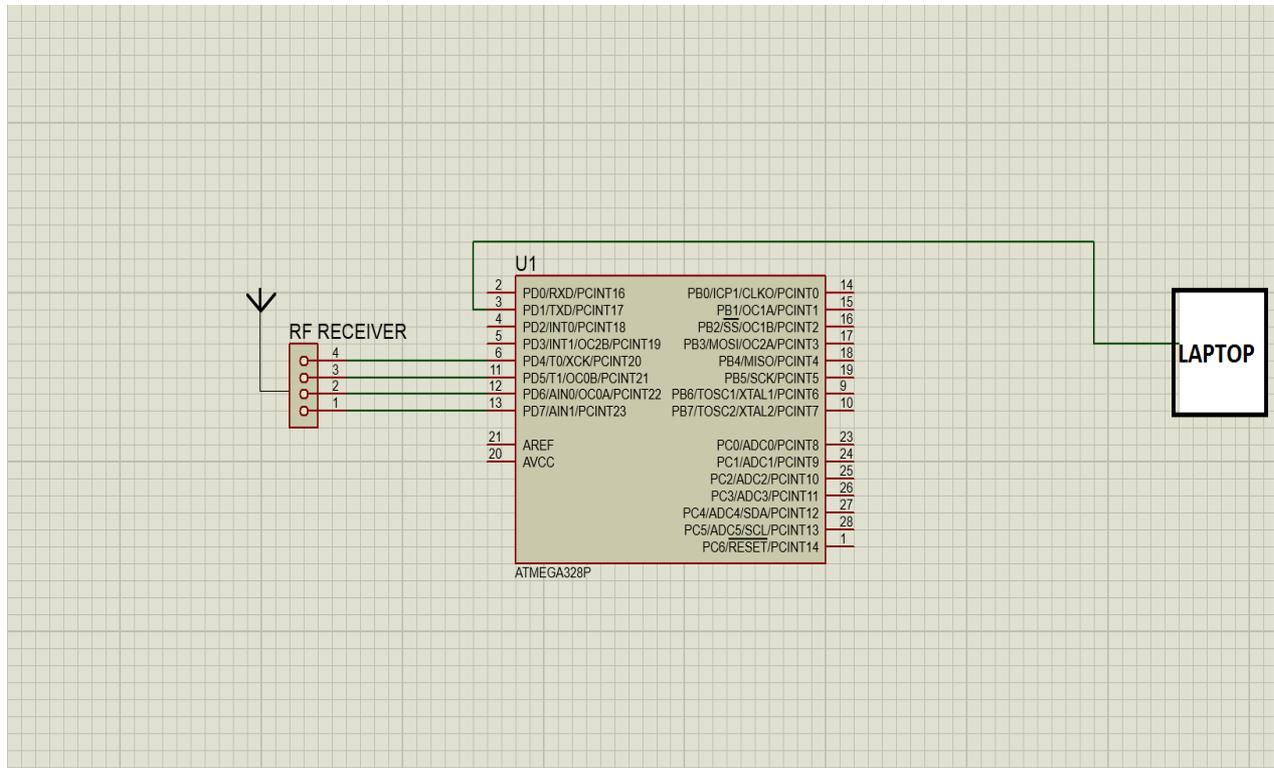
Figure 2.2 Base station circuit diagram

2.1.4.1 Description

- The RF Reciever is connected to atmega 328P U1 of base station. The data pins of RF receiver are connected to digital pins 4,5,6,7 of atmega 328P U1.

- The base station atmega 328P U1 is conntectd to a laptop through the pin 2(tx). This is used for diaplaying the messages.

- The Arduino is provided with a power supply of 5 V for its operation.

Thus the circuit diagram and its description is discussed.

2.2 PIR SENSOR

The PIR sensor is used for human detection purpose. This section deals in detail regarding the working and construction of this sensor.

2.2.1 OVERVIEW:

2.2.1.1 Operating principle:

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.

The term *passive* in this instance refers to the fact that PIR devices do not generate or radiate any energy for detection purposes. They work entirely by detecting the energy given off by other objects. PIR sensors don't detect or measure "heat"; instead they detect the infrared radiation emitted or reflected from an object.

2.2.1.2 Construction:

Infrared radiation enters through the front of the sensor, known as the 'sensor face'. At the core of a PIR sensor is a solid state sensor or set of sensors, made from pyroelectric materials—materials which generate energy when exposed to heat. Typically, the sensors are approximately 1/4 inch square ($40 \, mm^2$), and take the form of a thin film. Materials commonly used in PIR sensors include gallium nitride (GaN), caesium nitrate ($CsNO_3$), polyvinyl fluorides, derivatives of phenyl pyridine, and cobalt phthalocyanine. The sensor is often manufactured as part of an integrated circuit.

The IR sensor itself is housed in a hermetically sealed metal can to improve noise/temperature/humidity immunity. There is a window made of IR-transmissive material (typically coated silicon since that is very easy to come by) that protects the sensing element. Behind the window are the two balanced sensors. The element window and the sensing material dimensions are show in the figure below.
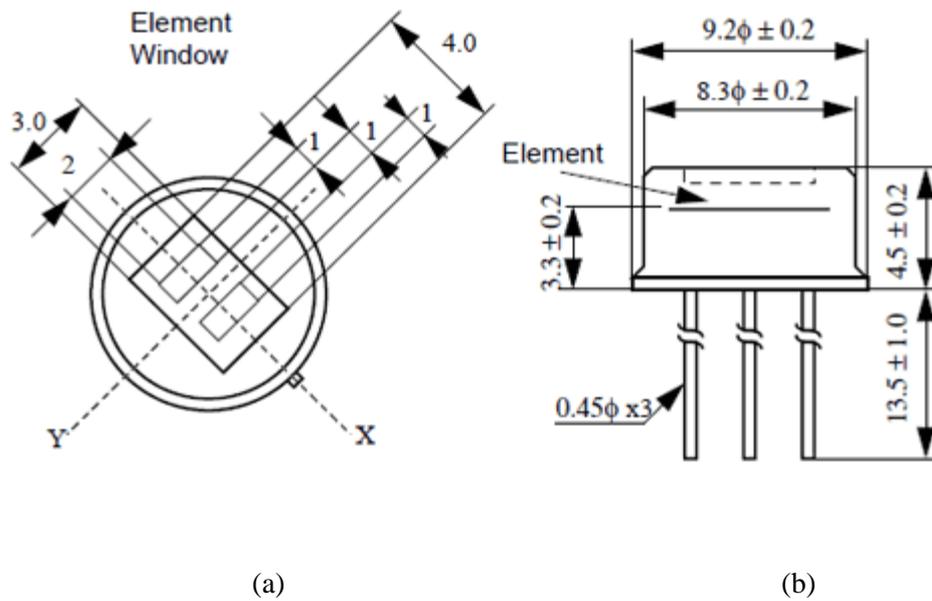
Figure 2.3-(a) Element Window, (b) Sensing Material.

2.2.1.3 Sensor design:

The PIR sensor is typically mounted on a printed circuit board containing the necessary electronics required to interpret the signals from the sensor itself. The complete assembly is usually contained within a housing, mounted in a location where the sensor can cover area to be monitored.

The housing will usually have a plastic "window" through which the infrared energy can enter. Despite often being only translucent to visible light, infrared energy is able to reach the sensor through the window because the plastic used is transparent to infrared radiation. The plastic window reduces the chance of foreign objects (dust, insects, etc.) from obscuring the sensor's field of view, damaging the mechanism, and/or causing false alarms. The window may be used as a filter, to limit the wavelengths to 8-14 micrometres, which is closest to the infrared radiation emitted by humans. It may also serve as a focusing mechanism which is shown in figure 2.9.

Figure 2.4 The Multiple Facet Section(plastic window)

2.2.1.4 Focusing:

Different mechanisms can be used to focus the distant infrared energy onto the sensor surface.The plastic window covering may have multiple facets molded into it, to focus the infrared energy onto the sensor. Each individual facet is a Fresnel lens.

2.2.1.5 Lenses:

In the diagram 2.4, the lens is just a piece of plastic, but that means that the detection area is just two rectangles. Usually, detection area is much larger. To do that, a simple lens such as those found in a camera is used: they condenses a large area (such as a landscape) into a small one (on film or a CCD sensor). For this reason, the PIR lenses which are small and thin made from moldable cheap plastic is used, even though it may add distortion. Hence the sensors are actually Fresnel lenses as shown below:
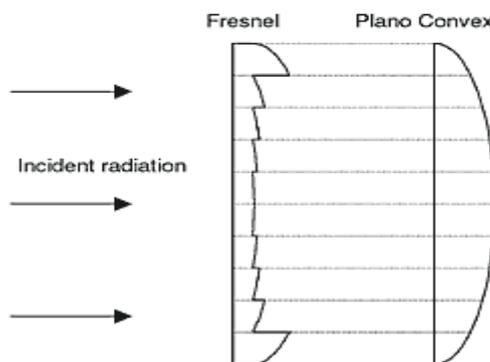

Figure 2.5 Fresnel Lens

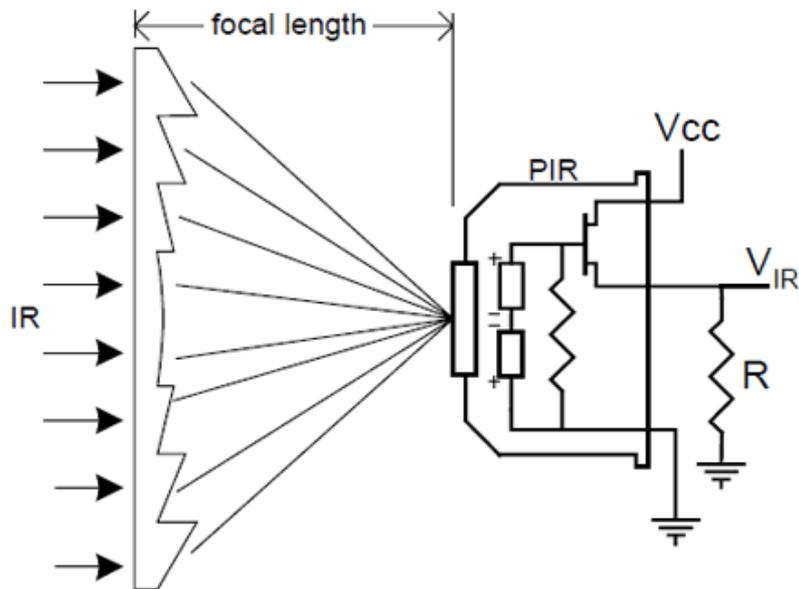The Fresnel lens condenses light, providing a larger range of IR to the sensor.

Figure 2.6 Fresnel Lens light condensing

2.2.2 PIR Motion Based Detector:

A PIR-based motion detector is used to sense movement of people, animals, or other objects. They are commonly used in burglar alarms and automatically-activated lighting systems. They are commonly called simply "PIR", or sometimes "PID", for "passive infrared detector".

2.2.3 Operation

An individual PIR sensor detects changes in the amount of infrared radiation impinging upon it, which varies depending on the temperature and surface characteristics of the objects in front of the sensor.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, and this triggers the detection. Moving objects of similar temperature to the background but

different surface characteristics may also have a different infrared emission pattern, and thus sometimes trigger the detector.

PIRs come in many configurations for a wide variety of applications. The most common models have numerous Fresnel lenses or mirror segments, an effective range of about ten metres (thirty feet), and a field of view less than 180 degrees. Models with wider fields of view, including 360 degrees, are available—typically designed to mount on a ceiling. Some larger PIRs are made with single segment mirrors and can sense changes in infrared energy over one hundred feet away from the PIR. There are also PIRs designed with reversible orientation mirrors which allow either broad coverage (110° wide) or very narrow "curtain" coverage, or with individually selectable segments to "shape" the coverage.

2.2.3.1 Differential detection:

Pairs of sensor elements may be wired as opposite inputs to a differential amplifier. In such a configuration, the PIR measurements cancel each other so that the average temperature of the field of view is removed from the electrical signal; an increase of IR energy across the entire sensor is self-cancelling and will not trigger the device. This allows the device to resist false indications of change in the event of being exposed to brief flashes of light or field-wide illumination. (Continuous high energy exposure may still be able to saturate the sensor materials and render the sensor unable to register further information.) At the same time, this differential arrangement minimizes common-mode interference, allowing the device to resist triggering due to nearby electric fields. However, a differential pair of sensors cannot measure temperature in this configuration, and therefore is only useful for motion detection.

2.2.3.2 PIR Working:

The PIR sensor itself has two slots in it, each slot is made of a special material that is sensitive to IR. When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. When a warm body like a human or animal passes by, it first intercepts one half of the PIR sensor, which causes

a *positive differential* change between the two halves. When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change. These change pulses are the one that is detected.

The working schematic of the PIR human detection is given by the following figure:
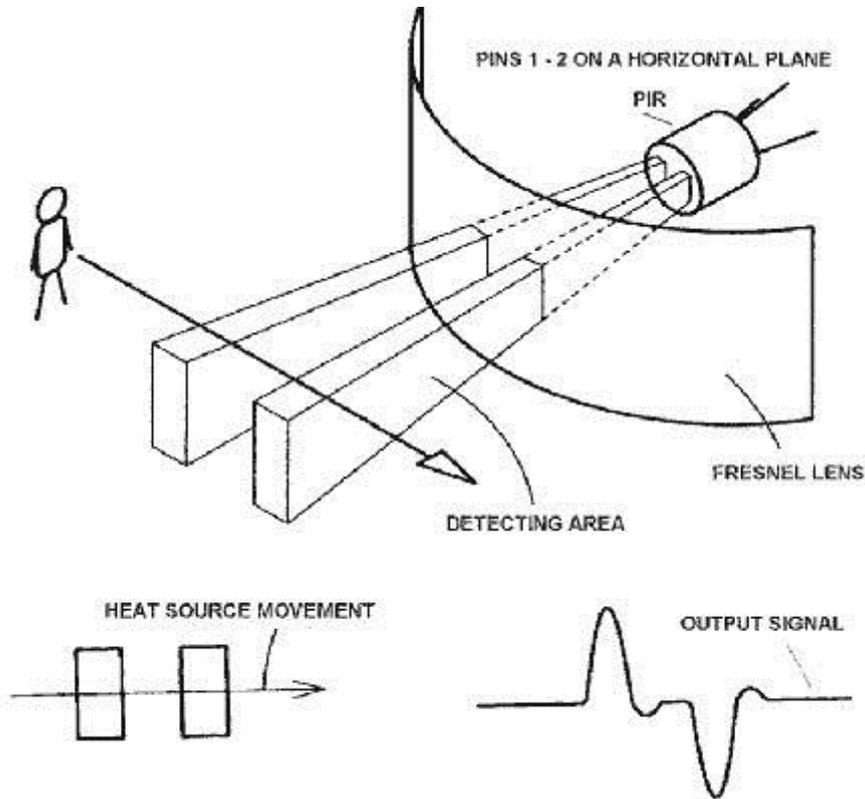
Figure 2.8 Human Detection using PIR sensor

2.2.4 Field Of View:

The sensitivity of the PIR sensor from the side view relative to the distance of the movement from the sensor is shown below.

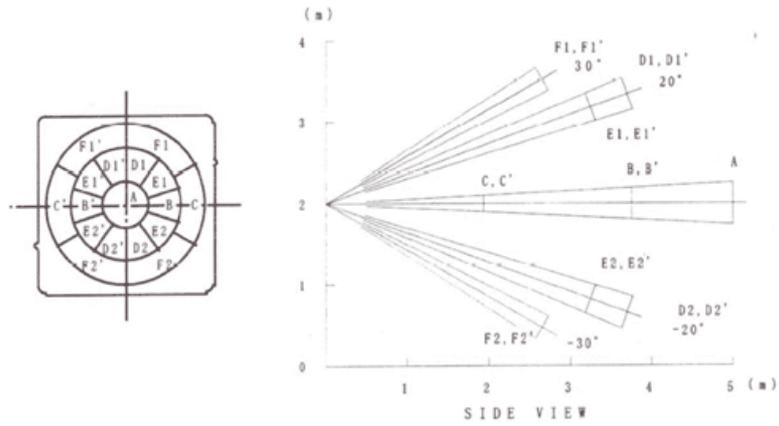**Figure 2.8 PIR sensor Field of view.**

2.3.5 Applications

- Motion Detection

- Burgular alarms

- Industrial automation

- Automative Doors

Thus working of PIR sensor and its construction aspects is discussed in detail in this section.

2.3 ULTRASONIC SENSOR

The ultrasonic sensor is used for obstacle detection assisting for the automatic navigation of the rover. The working principle, electrical parameters and construction are dealt in this section.

2.3.1 Ultrasonic Principle:

Ultrasonic sensors emit short, high-frequency sound pulses at regular intervals. These propagate in the air at the velocity of sound. If they strike an object, then they are reflected back as echo signals to the sensor, which itself computes the distance to the target based on the time-span between emitting the signal and receiving the echo. The principle of working is shown in the figure below.
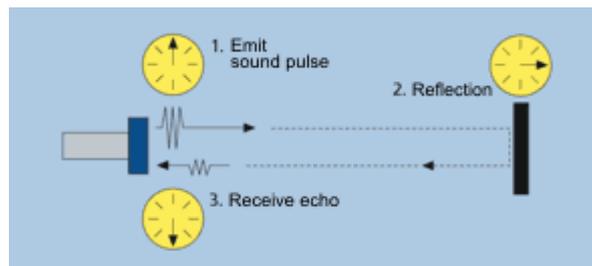
Figure 2.9 Ultrasonic principle

As the distance to an object is determined by measuring the time of flight and not by the intensity of the sound, ultrasonic sensors are excellent at suppressing background interference.Virtually all materials which reflect sound can be detected, regardless of their colour. Even transparent materials or thin foils represent no problem for an ultrasonic sensor. Ultrasonic sensors are suitable for target distances from 20 mm to 10 m and as they measure the time of flight they can ascertain a measurement with pinpoint accuracy. Some of the sensors can even resolve the signal to an accuracy of 0.025 mm. Ultrasonic sensors can see through dust-laden air and ink mists. Even thin deposits on the sensor membrane do not impair its function. Sensors with a blind zone of only 20 mm and an extremely thin

beam spread are making entirely new applications possible today: Fill level measurement in wells of microtiter plates and test tubes, as well as the detection of small bottles in the packaging industry, can be implemented with ease. Even thin wires are reliably detected.

2.3.2 Ultrasonic Ranging Module HC - SR04

HC-SR04 is the ultrasonic sensor module used for the automatic rover navigation.

2.3.2.1 Product features:

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle for the sensor to work is given below:

(1) Using IO trigger for at least 10us high level signal,
(2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.
(3) IF the signal is back, through high level, time of high output duration is the time from sending ultrasonic to returning.

2.3.2.2 Electric Parameter

The various electrical parameters of the ultrasonic sensor is given below:

Table 2.1 Ultrasonic Sensor Parameters

Working Voltage	5V-DC
Working Current	15Ma
Working Frequency	40Hz
Maximum Range	400cm
Minimun Range	2cm

Measuring Angle	15 degrees
Trigger Input	10uS TTL pulse
Echo Output	Input TTL level signal and the range in proportion

2.3.2.3 Timing diagram of Trigger and Echo pulse

The Timing diagram is shown below. A short 10uS pulse is given as trigger input to start the ranging, and then the module will send out an 8 cycle burst of ultrasound at 40 kHz and raise its echo. The Echo is a distance object that is pulse width and the range in proportion. The distance can be calculated through the time interval between sending trigger signal and receiving echo signal using the formulae given below:

Formula: Distance = high level time * velocity of sound(340M/S) / 2.

The timing diagram of the trigger and echo pulse is given in the figure below:
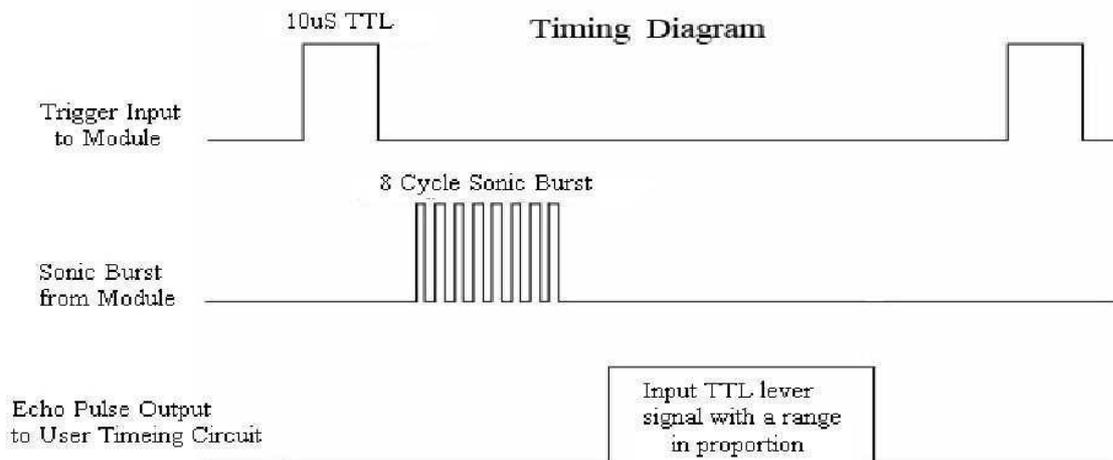

Figure 2.10 Timing Diagram of Ultrasonic Sensor

2.3.4 Applications

1. Distance calculation

2. Robot navigation

3. Automation in industries

4. Used in automotive electronics

Thus the working of Ultrasonic sensor is discussed in detailed in the above section.

2.4 MICROCONTROLLER- ATMEGA 328P

2.4.1 Introduction:

The ATmega48A/PA/88A/PA/168A/PA/328/P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega48A/PA/88A/PA/168A/PA/328/P achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

2.4.2 Pin Diagram:
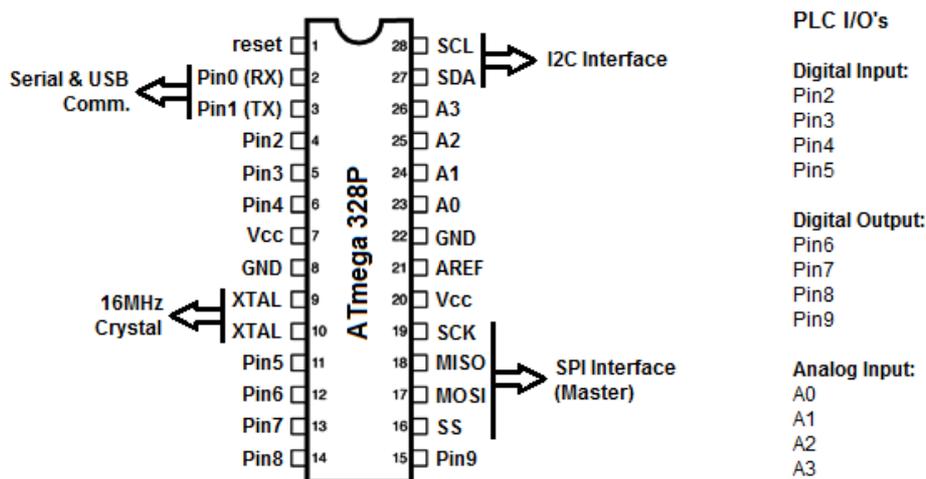
The pin diagram of Atmega 328P IC is shown below.

Figure 2.11 ATMEGA 328P PIN OUT

3.3.2.1 Pin Descriptions

1. V$_{CC}$

Digital supply voltage.

2. GND

Ground.

3. Port B (PB7:0) XTAL1/XTAL2/TOSC1/TOSC2

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tristated when a reset condition becomes active, even if the clock is not running. Depending on the clock selection fuse settings, PB6 can be used as input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

Depending on the clock selection fuse settings, PB7 can be used as output from the inverting Oscillator amplifier. If the Internal Calibrated RC Oscillator is used as chip clock source, PB7...6 is used as TOSC2...1 input for the synchronous Timer/Counter2 if the AS2 bit in ASSR is set.

4. Port C (PC5:0)

Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC5...0 output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tristated when a reset condition becomes active, even if the clock is not running.

5. PC6/RESET

If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C. If the RSTDISBL Fuse is unprogrammed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running.

6. Port D (PD7:0)

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tristated when a reset condition becomes active, even if the clock is not running.

7. AV_{CC}

AV_{CC} is the supply voltage pin for the A/D Converter, PC3:0, and ADC7:6. It should be externally connected to V_{CC}, even if the ADC is not used. If the ADC is used, it should be connected to V_{CC} through a low-pass filter.
Note that PC6...4 use digital supply voltage, V_{CC}.

8. AREF

AREF is the analog reference pin for the A/D Converter.

2.4.3 Architecture Of ATMEGA- 328P:

The various blocks of Atmega 328P IC and their bus interconnections are shown below
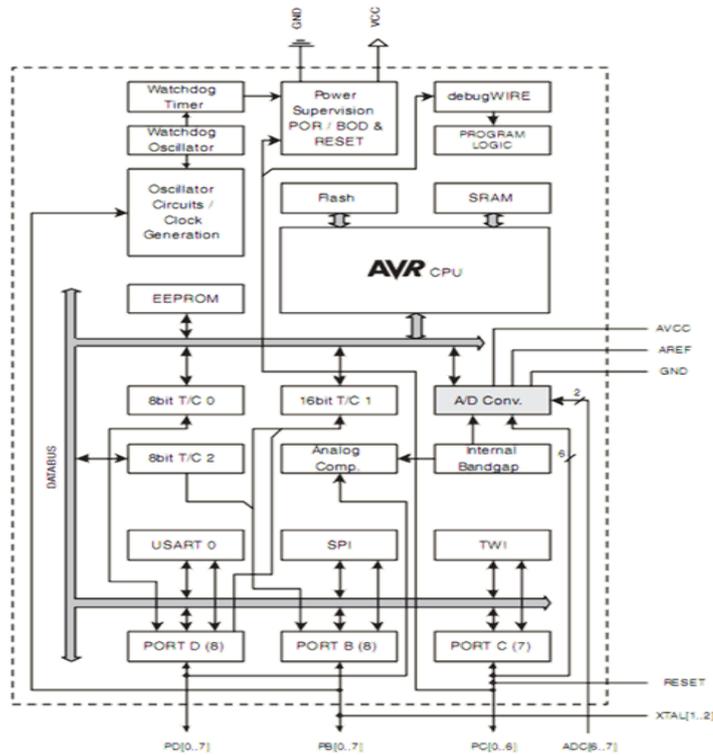
Figure 2.14 Architecture of ATMEGA 328P

The ATmega48A/PA/88A/PA/168A/PA/328/P provides the following features: 4K/8Kbytes of In-System Programmable Flash with Read-While-Write capabilities, 256/512/512/1Kbytes EEPROM, 512/1K/1K/2Kbytes SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, a byte-oriented 2-wire Serial Interface, an SPI serial port, a 6-channel 10-bit ADC (8 channels in TQFP and QFN/MLF packages), a programmable Watchdog Timer with internal Oscillator, and five software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, USART, 2-wire Serial Interface, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes

the Oscillator, disabling all other chip functions until the next interrupt or hardware reset. In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low power consumption.

The On-chip ISP Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, by a conventional non-volatile memory programmer, or by an On-chip Boot program running on the AVR core. The Boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true Read-While-Write operation. By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel ATmega48A/PA/88A/PA/168A/PA/328/P is a powerful microcontroller that provides a highly flexible and cost effective solution to many embedded control applications.

The ATmega48A/PA/88A/PA/168A/PA/328/P AVR is supported with a full suite of program and system development tools including: C Compilers, Macro Assemblers, Program Debugger/Simulators, In-Circuit Emulators, and Evaluation kits.

Thus the architecture, internal schematic and pin description is discussed in this section

2.5 ARDUINO UNO

2.5.1 Overview:

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). 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; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform.

2.5.2 Features:

The various features of the Arduino Uno along with Atmega 328P is given in the table below.

Table 2.2 Freatures of Arduino Uno

Micro Controller	ATmega 328
Operating Voltage	5V
Input voltage(Recommended)	7-12 V

Input voltage (limits)	6-20V
Digital I/O pins	14(of which 6 provide PWM output)
Analog Input Pins	6
DC current per I/O pin	40mA
DC current for 3.3V pin	50mA
Flash Memory	32KB (ATmega 328) of which 0.5KB used by bootloader
SRAM	2KB(ATmega 328)
EEPROM	1KB(ATmega 328)
Clock speed	16MHz
Length	68.6mm
Width	53.4mm
Weight	25g

Note: The Arduino reference design can use an ATmega8, 168, or 328, Current models use an ATmega328. The pin configuration is identical on all three processors.

2.5.2.1 Power:

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be

unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

- VIN. The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

- 5V. This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it.

- 3V3. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.

- GND. Ground pins.

- IOREF. This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs for working with the 5V or 3.3V.

2.5.2.2 Memory

The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode(), digitalWrite(), anddigitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up

resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.

- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.

- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.

- LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function. Additionally, some pins have specialized functionality:

- TWI: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library.

There are a couple of other pins on the board:

- AREF. Reference voltage for the analog inputs. Used with analogReference().

- Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and

appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).A SoftwareSerial library allows for serial communication on any of the Uno's digital pins.The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus. Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of theATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.

The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-

EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see this forum thread for details.

USB Overcurrent Protection

The Arduino Uno has a resettable polyfuse that protects a computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

2.5.2.3 Physical Characteristics:

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.

2.5.3 Arduino To Atmega 328 Mapping:

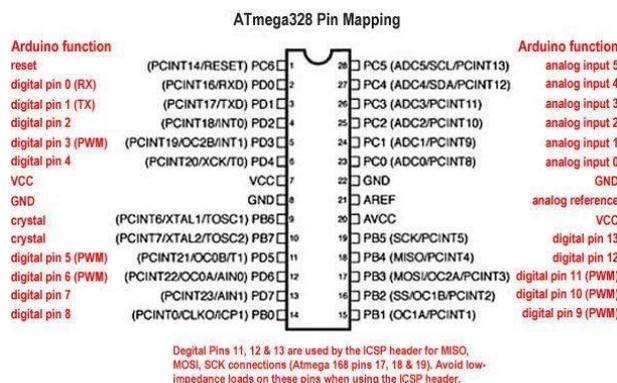The connection between Arduino Uno and Atmega 328P is shown in the following figure.

Figure 2.13 Arduino to ATMEGA 328 Pin mapping

Thus the Arduino Uno Pin description and mapping is given in the above section.

2.6 GPS

2.6.1 Introduction:

The SkyNav SKM58 Series with embedded GPS antenna enables high performance navigation in the most stringent applications and solid fix even in harsh GPS visibility environments. It is based on the high performance features of the MediaTek 3329 single-chip architecture, Its −165dBm tracking sensitivity extends positioning coverage into place like urban canyons and dense foliage environment where the GPS was not possible before. The 6-pin UART connector design is the easiest and convenient solution to be embedded in a portable device and receiver like PND, GPS mouse, car holder, personal locator, speed camera detector and vehicle locator. The Global Positioning System, also called NavStar, that we use was built by the US military and has been fully operational since 1995. Many modern GPS receivers use a combination of both GPS and the Russian GLONASS satellites for improved coverage and accuracy. The GPS system currently has 31 active satellites in orbits inclined 55 degrees to the equator. The satellites orbit about 20,000km from the earth's surface and make two orbits per day. The orbits are designed so that there are always 6 satellites in view, from most places on the earth.The GPS receiver gets a signal from each GPS satellite. The satellites transmit the exact time the signals are sent. By subtracting the time the signal was transmitted from the time it was received, the GPS can tell how far it is from each satellite. The GPS receiver also knows the exact position in the sky of the satellites, at the moment they sent their signals. So given the travel time of the GPS signals from three satellites and their exact position in the sky, the GPS receiver can determine your position in three dimensions - east, north and altitude.There is a complication. To calculate the time the GPS signals took to arrive, the GPS receiver needs to know the time very accurately. The GPS satellites have atomic clocks that keep very precise time, but it's not feasible to equip a GPS receiver with an atomic clock. However, if the GPS receiver uses the signal from a fourth satellite it can

solve an equation that lets it determine the exact time, without needing an atomic clock.If the GPS receiver is only able to get signals from 3 satellites, you can still get your position, but it will be less accurate. As we noted above, the GPS receiver needs 4 satellites to work out your position in 3-dimensions. If only 3 satellites are available, the GPS receiver can get an approximate position by making the assumption that you are at mean sea level. If you really are at mean sea level, the position will be reasonably accurate. However if you are in the mountains, the 2-D fix could be hundreds of metres off.A modern GPS receiver will typically track all of the available satellites simultaneously, but only a selection of them will be used to calculate your position.

2.6.2 Features

1. Ultra high sensitivity: -165dBm „
2. 22 tracking/66 acquisition-channel receiver „
3. WAAS/EGNOS/MSAS/GAGAN support „
4. AGPS support „
5. NMEA protocols (default speed: 9600bps) „
6. One serial port „
7. Embedded patch antenna 12*12*4 mm „
8. Operating temperature range: -40 to 85℃ „
9. RoHS compliant (Lead-free) „
10. Tiny form factor : 20.5mm x12.8mm x 7.8mm

2.6.3 Pin Assignment
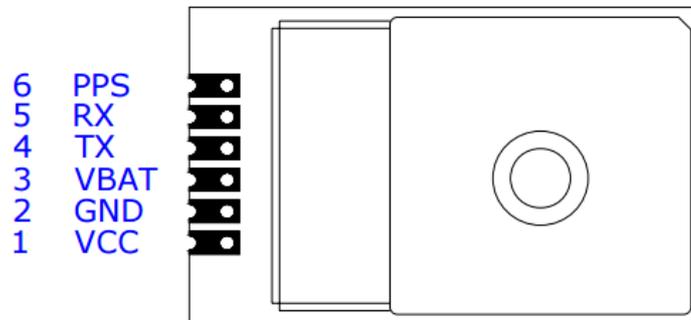
The pin diagram of the GPS module is shown below.

Figure 2.14 GPS Pin out

2.6.3.1 Pin Description

The details of the pin out of the GPS module is given in the following table.

Table 2.3 Pin Description of GPS

Pin no.	Pin name	I/O	Description	Remarks
UART Port				
1	Vcc	P	Module power supply	Vcc:3.0-4.0V
2	GND	G	Module power ground	Reference ground
3	VBAT	O	RTC and backup SRAM power(2.0 -4.2V)	May be connect to battery
4	TXD	O	TTL:3.1V>=VOH>=2.4V-0.3V<=VOL<=0.4V	Strap pin,default MUST pullup
5	RXD	I	TTL:3.6V>=VIH>=2.0V -0.3V<=VIL<=0.8V	Leave open if not used
6	PPS	O	Time pulse signal(default 100ms pps)	Leave open if not used

2.6.4 Specifications

The specifications of the GPS module is given in detail in the following table

Table 2.3 GPS specifications

PARAMETER	SPECIFICATION	
GPS Receiver		
Receiver type	L1 frequency band, C/A code,22 tracking /66 acquisition-channel	
Sensitivity	Tracking	-165dBm
	Acquisition	-148dBm
Accuracy	Position	3.0m CEP50 without SA(Typical open sky)
	Velocity	0.1 m/s without SA
	Timing(PPS)	60 ns RMS
Acquisition time	Cold start	36s
	Warm start	33s
	Hot start	1s
	Re-Acquisition	<1s
Power consumption	Tracking	40mA @3.3V Typical
	Acquisition	45mA @3.3V
	Sleep/Stand by	TBD

2.6.9 Applications

- LBS (Location Based Service) ,,
- Vehicle navigation system ,,
- PND (Portable Navigation Device) ,,
- GPS mouse and Bluetooth GPS receiver ,,

Thus the working and construction of GPS is given in detail in this section.

2.7 DC MOTORS

2.7.1 Overview

A DC motor in simple words is a device that converts direct current(electrical energy) into mechanical energy. It's of vital importance for the industry today, and is equally important for engineers to look into the **working principle of DC motor.**

Working principle.

The   DC   or   **direct** current **motor** works   on   the   principal,   when a current carrying conductor is placed in a magnetic field, it experiences a torque and has a tendency to move. This is known as motoring action. If the direction of current in the wire is reversed, the direction of rotation also reverses. When magnetic field and electric field interact they produce a mechanical force, and based on that the working principle of **dc motor** established. The direction of rotation of a this motor is given by Fleming's left hand rule, which states that if the index finger, middle finger and thumb of your left hand are extended mutually perpendicular to each other and if the index finger represents the direction of magnetic field, middle finger indicates the direction of current, then the thumb represents the direction in which force is experienced by the shaft of the **dc motor**.

DC motors are widely used in robotics because of their small size and high energy output. They are excellent for powering the drive wheels of a mobile robot as well as powering other mechanical assemblies.

2.7.1 Ratings and Specifications

Several characteristics are important in selecting a DC motor. The first two are its input ratings that specify the electrical characteristics of the motor.

2.7.2 Operating Voltage

If batteries are the source of power for the motor, low operating voltages are desirable because fewer cells are needed to obtain the specified voltage. However, the electronics to drive motors are typically more efficient at higher voltages. Typical DC motors may operate on as few as 1.5 Volts or up to 100 Volts or more. Roboticists often use motors that operate on 6, 12, or 24 volts because most robots are battery powered, and batteries are typically available with these values.

2.7.3 Operating Current

The ideal motor would produce a great deal of power while requiring a minimum of current. However, the current rating (in conjunction with the voltage rating) is usually a good indication of the power output capacity of a motor. The power input (current times voltage) is a good indicator of the mechanical power output. Also, a given motor draws more current as it delivers more output torque. Thus current ratings are often given when the motor is stalled. At this point it is drawing the maximum amount of current and applying maximum torque. A low voltage (e.g., 12 Volt or less) DC motor may draw from 100 mA to several amperes at stall, depending on its design.

The next three ratings describe the motor's output characteristics:

2.7.4 Speed

Usually this is specified as the speed in rotations per minute (RPM) of the motor when it is unloaded, or running freely, at its specified operating voltage. Typical DC motors run at speeds from one to twenty thousand RPM. Motor speed can be measured easily by mounting a disk or LEGO pulley wheel with one hole on the motor, and using a slotted optical switch and oscilloscope to measure the time between the switch openings.

2.7.5 Torque

The torque of a motor is the rotary force produced on its output shaft. When a motor is stalled it is producing the maximum amount of torque that it can produce. Hence the torque rating is usually taken when the motor has stalled and is called the stall torque. The motor torque is measured in ounce-inches (in the English system) or Newton-meters (metric). The torque of small electric motors is often given in milli-Newton-meters (mN-m) or 1/1000 of a N-m. A rating of one ounce-inch means that the motor is exerting a tangential force of one ounce at a radius of one inch from the center of its shaft. Torque ratings may vary from less than one ounce-inch to several dozen ounce-inches for large motors.

2.7.6 Power

The power of a motor is the product of its speed and torque. The power output is greatest at about half way between the unloaded speed (maximum speed, no torque) and the stalled state (maximum torque, no speed). The output power in watts is about (torque) x (rpm).

2.7.7 Types of dc motors

There are several types of motors commonly used in robotic and related applications.

2.7.7.1 Brushed DC motor

Brushed DC motor, or simply a "DC motor" is a classical example of electrical motor. As discussed before, a motor has a rotor and a stator with one of them being a permanent magnet. In a brushed DC motor, the rotor has permanent magnet and the stator has electromagnets. Since the motor needs a way to detect the rotor's orientation, it uses brushes as a commutator which is a piece of rotor touching the shaft. When the rotor rotates (in turn the brush rotates), it detects the

change in orientation and flips the current. DC motors are available in different sizes and at different speeds. Although DC motors run at enough speeds, they are generally useless in robots as they produce the slightest torque. DC motors have only two wires running into them; one for ground and the other for power.

2.7.7.2 Stepper motors

A stepper motor (or step motor) is a brushless DC electric motor that divides a full rotation into a number of equal steps. Themotor's position can then be commanded to move and hold at one of these steps without any feedback sensor (an open-loop controller), as long as the motor is carefully sized to the application. Also called actuators, do not rotate continuously, but turn in fixed increments, and resist a change in their fixed positions.

They require special driving circuits to apply the correct sequence of currents to their multiple coils. They are commonly used in robotics, particular in mechanisms that perform linear positioning, such as floppy and hard disk drive head motors and X-Y tables.

2.7.7.3 Servo motors

A servomotor is a rotary actuator that allows for precise control of angular position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Are used for angular positioning, such as in radio control airplanes to control the position of wing flaps, or in RC cars to turn the wheels. The output shaft of a servo does not rotate freely as do the shafts of DC motors, but rather is made to seek a particular angular position under electronic control. In effect, a servo motor is a combination of a DC motor, a shaft position sensor, and a feedback circuit. A servo motor also

usually includes a built-in gear-train and is capable of delivering high torques directly. No servo motors are included in the 1999 ELEC 201 kit.

2.7.7.4 Linear DC motor

Not likely to be used in standard mobile robots, a linear DC motor is a normal DC motor with its stator spread out. To be more specific, a brushed DC motor has a rotor spinning inside a stator; in a classical linear DC motor, the stator is unwrapped and laid out in the form of a track made of flat coils. The rotor rolls over the stator in a straight line.

2.7.8 Applications

1. Industrial automation

2. Toy cars

3. Robots

4. Vaccum Cleaners

5. Drills

Thus the construction, working and principle of DC motors is given in detail.

2.8 RF TRANSMITTER AND RECIEVER

2.8.1.Overview

A wireless radio frequency (RF) transmitter and receiver can be easily made using HT12D Decoder, HT12E Encoder and ASK RF Module. Wireless transmission can be done by using 433Mhz or 315MHz ASK RF Transmitter and Receiver modules. In these modules digital data is represented by different amplitudes of the carrier wave, hence this modulation is known as Amplitude Shift Keying (ASK). Radio Frequency (RF) transmission is more strong and reliable than Infrared (IR) transmission due to following reasons :

- Radio Frequency signals can travel longer distances than Infrared.
- Only line of sight communication is possible through Infrared while radio frequency signals can be transmitted even when there is obstacles.
- Infrared signals will get interfered by other IR sources but signals on one frequency band in RF will not interfered by other frequency RF signals.

2.8.2.Working

HT12E Encoder IC will convert the 4 bit parallel data given to pins D0 – D3 to serial data and will be available at DOUT. This output serial data is given to ASK RF Transmitter. Address inputs A0 – A7 can be used to provide data security and can be connected to GND (Logic ZERO) or left open (Logic ONE). Status of these Address pins should match with status of address pins in the receiver for the transmission of the data. Data will be transmitted only when the Transmit Enable pin (TE) is LOW. 1.1MΩ resistor will provide the necessary external resistance for the operation of the internal oscillator of HT12E.

ASK RF Receiver receives the data transmitted using ASK RF Transmitter. HT12D decoder will convert the received serial data to 4 bit parallel data D0 – D3. The status of these address pins A0-A7 should match with status of address pin in

the HT12E at the transmitter for the transmission of data. The LED connected to the above circuit glows when valid data transmission occurs from transmitter to receiver. 51KΩ resistor will provide the necessary resistance required for the internal oscillator of the HT12D.

2.8.3. Transmiter Circuit Diagram

The circuit diagram of the transmitter along with the antenna is shown below
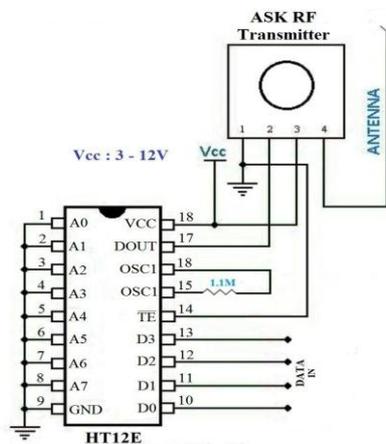

Figure 2.15 RF Transmitter Circuit

2.8.4. Reciever Circuit Diagram

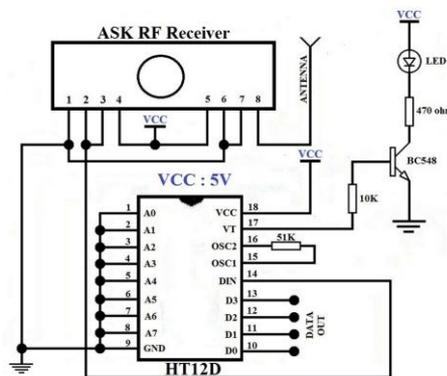The circuit diagram of the reciever along with the antenna is shown below

Figure 2.16 RF Reciever Circuit

2.8.5.Pin Description

The PIN diagram description of Transmitter and Receiver pair is given in the following table.

Table 2.4 RF Transmitter

Pin No	Function	Name
1	Ground (0V)	Ground
2	Serial data input pin	Data
3	Supply voltage; 5V	Vcc
4	Antenna output pin	ANT

Table 2.5 RF Receiver

Pin No	Function	Name
1	Ground (0V)	Ground
2	Serial data output pin	Data
3	Linear output pin; not connected	NC
4	Supply voltage; 5V	Vcc
5	Supply voltage; 5V	Vcc
6	Ground (0V)	Ground
7	Ground (0V)	Ground
8	Antenna input pin	ANT

2.8.6.Main Factors Affecting Rf Module's Performance:

As compared to the other radio-frequency devices, the performance of an RF module will depend on several factors like by increasing the transmitter's power a large communication distance will be gathered. However, which will result in high electrical power drain on the transmitter device, which causes shorter operating life of the battery powered devices. Also by using this devices at higher transmitted power will create interference with other RF devices.

2.8.7.Features Of RF Module:

1. Receiver frequency 433MHz
2. Receiver typical frequency 105Dbm
3. Receiver supply current 3.5mA
4. Low power consumption
5. Receiver operating voltage 5v
6. Transmitter frequency range 433.92MHz
7. Transmitter supply voltage 3v~6v
8. Transmitter output power 4v~12v

2.8.9.7.Applications

1. Burglar alarm system
2. Smoke and fire alarm system
3. Garage door controllers
4. Car door controllers
5. Car alarm system
6. Security system
7. Cordless telephones
8. Other remote control systems

Thus the RF transmitter and receiver working and its schematic is given in this section in detail.

CHAPTER-3

SOFTWARE DESCRIPTION

Introduction

In this chapter the development of the Arduino software starting with the algorithm , flow chart and Arduino IDE software that is used in the microcontroller is discussed in detail.

3.1 Algorithm

1. START

2. The rover is deployed in the affected field.

3. The rover moves in a straight line initially using the caterpillar tracks and motor.

4. The ultrasonic sensor is used to detect the obstacles. In case if the obstacle is detected in front of the rover the ultrasonic sensor sends a signal to the rover microcontroller .

5. The PIR sensor then detects whether the obstacle in front is human or not.

6. If a human is detected the a signal is sent to the base station using the RF transmitter .

7. The GPS data(location) is then sent to the base station.

8. The rescue people are then directed to the area and the human is rescued.

9. If the obstacle detected is not a human being then the microcontroller instructs the rover takes a left turn or a right turn alternatively.

10. Go to step 3.

11.Stop.

3.1.1.Algorithm For Human Detection.

1. The human detection unit comprises of the PIR sensor and an onboard GPS.

2. The PIR sensor is used to detect the presence of humans through the heat radiated from them.

3. In order to detect only humans a frensel lens is provide along with the PIR module. This enables the PIR sensor to detect only the heat radiated from a human body (in the range of 12 micron wavelength)

4. The sensor requires a steady dc voltage of 5 volts which is taken from the microcontroller board.

5. The default output of the sensor is low (without the presence of humans in front).

6. When a human is detected by the sensor a high signal is sent as output by the sensor to the microcontroller.

7. This inturn is used to trigger the GPS from which the location of the people is found.

8. The GPS data is sent to the base station.

9. Thus the human is detected and rescued.

3.1.2 Functional Flowchart:

The flowchart explaining the rover movement is given below:
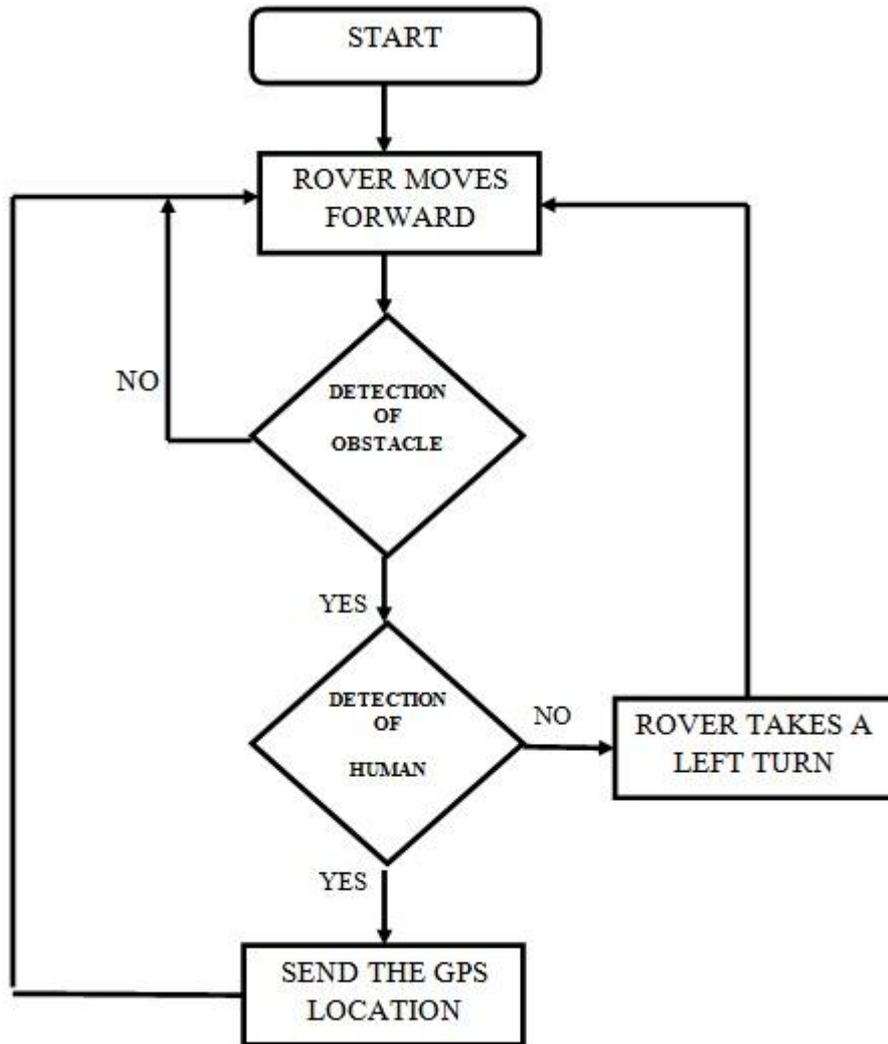
- The rover is deployed in the field.

- It moves forward until an obstacle or a human is detected.

- If the detected obstacle is a human then a human detected signal and the GPS location is sent to the base station.

- The robot takes a left turn and the process continues from the beginning.

3.2 EMBEDDED C

The C for microcontrollers and the standard C syntax and semantics are slightly different. The former is aimed at the general purpose programming paradigm whereas the latter is for a specific target microcontroller such as 8051 or PIC. The underlying fact is that everything will be ultimately mapped into the microcontroller machine code. If a certain feature such as indirect access to I/O registers is inhibited in the target microcontroller, the compiler will also restrict the same at higher level. Similarly some C operators which are meant for general purpose computing are also not available with the C for microcontrollers. Even theoperators and constructs which may lead to memory inefficiency are not available in C programming meant for microcontrollers

Be aware that the target code should fit in the limited on-chip memory of the processor. Even the I/O functions available in standard C such as printf() or scanf() are either not made available in C compilers for microcontrollers or advised not to use them. These functions eat up lot of memory space and are not time-efficient owing to the dragging of supporting functions like floating point routines and lot of delimiters. Another striking difference in case of embedded systems programs is that they do nothave the umbrella or support of the operating system. The programmer has to be accustomed with the absence of system calls which makes life easy in traditional C.

3.2.1 Features of Arduino Uno Embedded C

1. Platform independent

2. Opensource Software

3. Easy to learn

4. Works on 32 bit as well as 64 bit systems

5. Linux Based

6. Easy Installation

7. Detailed libraries.

3.3 Arduino IDE:

The open-source Arduino environment makes it easy to write code and upload it to the I/O board. It runs on Windows, Mac OS X and Linux. The environment is written in Java and based on Processing, avr-gcc, and other open source software.

The Arduino development environment contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions, and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them. The steps involved in programming are

New

Creates a new sketch.

Open

Presents a menu of all the sketches in your sketchbook. Clicking one will open it within the current window.

Save

Saves your sketch.

Verify

Checks your code for errors.

Upload

Compiles your code and upload it to the Arduino I/O board

In this chapter the software description and its intergration is discussed.
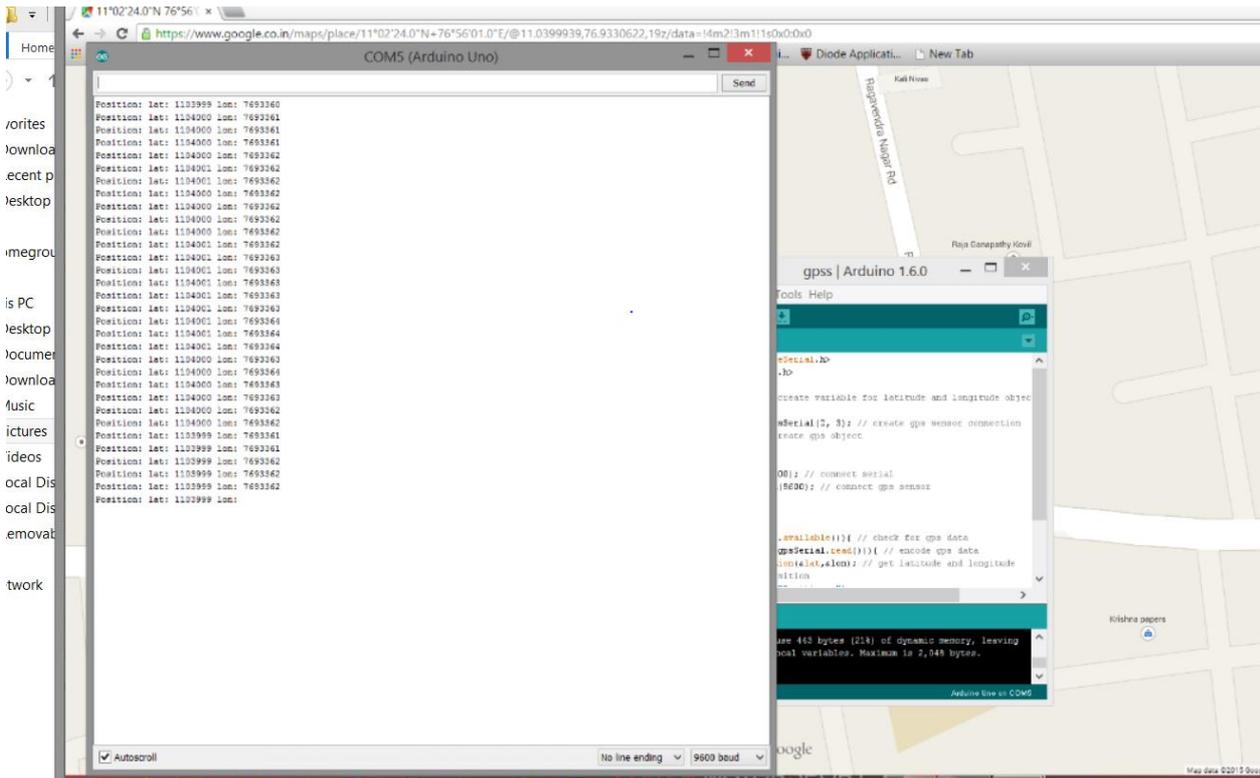
CHAPTER-4

RESULT

The result of the project is obtained in the Serial Monitor that is available with the Adruino IDE software. The Ultrasonic output, the PIR output and the GPS output are shown in the figures below.
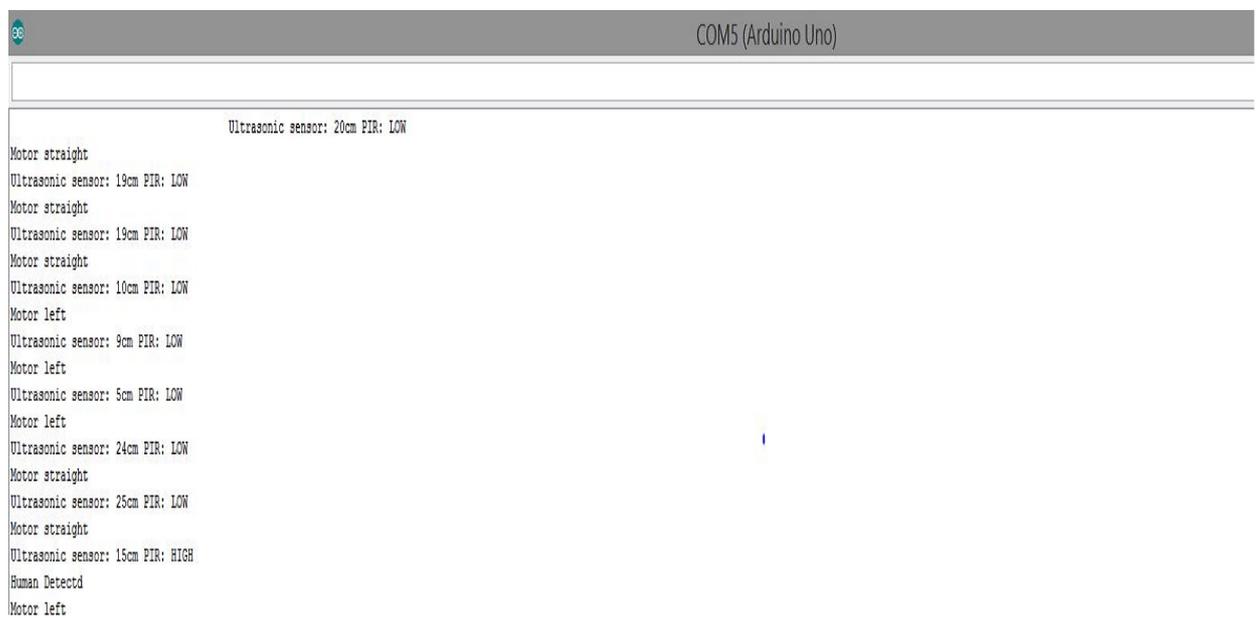
The rover initially moves straight and when it detects an obstacle within 10cm ,which is non human it takes a left turn and when it detects a human a message is displayed and the process starts from first. The GPS data that has to be displayed is also shown.

In the next chapter the conclusions , advantages, disadvantages and future scope is discussed.

CHAPTER-5

CONCLUSION

The rover navigates through the debris by itself avoiding any obstacles in front of it. When a human is detected a message is sent to the Base station. Since no human interaction is required for operating the rover it helps to save valuble human resources. The rover can move through small places that cannot be reached by the recue team. Also by deploying multiple rovers at various points the chances of finding the victims trapped in the debris is increased greatly. The system is cost effective and is reliable.

The rover can only detect the victims trapped and cannot save them. It can only give a location of the trapped victims. Hence it relies on the rescue team to actually save the people. It is still operated by a battery and is needed to be charged periodically. In case if the rover has to move through a steep solpe it may get toppled. It does not provide any medical assistance.

Future Scope

In order to overcome the terrain problem rover with enhanced design like a snake could be made. Aslo rovers that can provide certain basic medical suppliments such as oxygen or sedations can be designed. This application can also be extended for military purposes to detect humans crossing the borders. The size of the rover can also be reduced so that it can navigate even through small spaces that the current design cannot do. In addition to this microphones can be added which can listen to the distress signals of the trapped victims. The rovers can also communicate with each other based on swarm intelligence to search through the affected area effectively. With reduction in sensor size and microcontroller size small rovers with improved reliability is possible.

CHAPTER-6

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CHAPTER-7

APPENDIX