DESIGN AND IMPLEMENTATION OF ARDUINO BASED BATTLEFIELD ASSISTIVE ROBOT

by

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CERTIFICATE OF APPROVAL

The thesis/project entitled as "**Design and Implementation of Arduino Based Battlefield Assistive Robot**" submitted by **Md. Baijid Hasan**, bearing Matric ID. **ET-133001** and **Shekh Nuruzzaman**, bearing Matric ID. **ET-133001** of session **Autumn13-Spring-17**, to the Department of Electrical and Electronic Engineering, International Islamic University Chittagong, has been accepted as satisfactory in partial fulfilment of the requirements for the degree of Bachelor of Science in Engineering and approved for the examination held on 18 **August, 2017**.

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DECLARATION

It is hereby declared that this work has been done by us and no portion of the work contained in this thesis/project has been submitted elsewhere for the award of any degree or diploma.

_____
Md. Baijid Hasan Shorif

_____
Shekh Nuruzzaman

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Moreover, we would finally like to thank our parents, whom kept praying for us to prosper in life and moving forward.

Authors

ABSTRACT

With the sophisticated technological advancement nowadays robotics has become a hot field for research. Robots are now used by military forces for reducing risk of their causalities and to defeat their enemies. The major focus of this project is on the use of robot in war, peace and as well as their impact on society. Here Radio Frequency modules signals are used in wireless remote control system for transmitting and receiving wireless logic signals to control the motors and actuators of robot control system. Night vision monitoring system has been added which will capture and transmit the information surrounding the robot to the operator. With this feature the robot can not only transmit real time videos with night vision capabilities but cannot also be identified by the enemies in war zone. A metal detector and GSM module has also been added which will inform us about any bomb underneath the robot vehicle. Another assistive feature here added that is a robotic arm has been installed to pick or drop some particle if needed.
In this paper, Remote operated Warfield assistive robot is a small robot designed for assistance, sort range surveillance and inspection purpose.

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CHAPTER 1

INTRODUCTION

1.1 Background

Science has brought out wondering technologies to ease human life. Robotics is one of the branches of it which has made human life easier and lessened the workload. It has also enabled us to reduce the participation of human in risky works. Nowadays robots are being used for various purpose in industries, labs, Space and also in battlefield. People are sending robots to places where man can hardly go like in space, underwater, bomb surrounded areas. Wireless communication system has become one of the essential features for commercial products and a popular research topic within the last ten years. There are now more mobile phone subscriptions than wired-line subscriptions. Lately, one area of commercial interest has been low-cost, low- power, and short distance wireless communication used for personal wireless networks. Technology advancements are providing smaller and more cost effective devices for integrating computational processing, wireless communication, and a host of other functionalities.

This project's main functionality is to deal with tough situations where human beings cannot handle situations like darkness, entering narrow and small places and detecting hidden bombs etc. This system works using an RF signal through which the whole controlling of the system response is done. Using night vision camera attached to robot situations around the system is observed according which the robot is instructed to move or do other functionalities. Besides with the robotic arm anything can be picked and carried within its limit and with the help of metal detector and GPS system and a cell phone a signal will be obtained if there is ant short of bomb or metallic weapons around the robot.

1.2 Motivation

With the vision to upgrade the relationship between men and robots this project is built. As the name suggests this Assistive Robot can be used for the purpose of assistance of soldiers on battlefield.

From some recent incidences like Holey Artisan Restaurant attack [1] in our country we have been inspired to come up with the idea of this assistive robot which can be used in such attacks. In that attack two of our policemen were shot and 20 hostages were killed just because we took so long time to find out the location of the terrorists where with the help of this type of spy robots we could easily find out the location of the terrorists and perhaps we could save the civilian lives and the lives of the policemen too.

Another heart touching incidence happened when a small child named Zihad felled into a 600 feet deep pipe of Railway authority. Those accidents show us the lack of surveillance system of our country and limitation of human being in such kind of rescue operations. From those accidents we got our motivation to serve the nation by developing a manually controlled wireless night vision camera mounted robot which will also detect metal or any bomb hidden into the ground. Many conceptual implementation related to our project has also been used in US army and NASA in different operations.

1.3 Objectives

The project has been designed for developing a wireless surveillance robot for helping the soldiers during their operation, war or other situations where human life is at risk. The robot along with camera can wirelessly transmit real time video with camera controlling capabilities and also using a robotic arm anything can be picked or dropped within its limit. This kind of robot can be very useful for helping purpose in war fields. The project is also designed to search invisible metal stuffs from where people are not capable

to reach and it is so designed to work in hostile environment where visible light will not be available. Basic objectives that our robot will be able to perform can be noted as follow:

- It will assist our soldiers in their operations by taking photos from enemy territory without alarming them.
- The robot will detect hidden any metal right underneath the robot and transmit the signal to the operator's mobile via SMS.
- This robot will carry and drop Tear shell or small objects if needed in its grip.
- This will capture live videos of surrounding of the robot and will transmit to operator's monitor.

1.4 Outline of the report

- Chapter 1 "Introduction" shows the background, motivation and objectives of the project.
- Chapter 2 "Literature review" discusses about the history and literature importance of this project. The history of the development of the robotic research is discussed briefly. Wireless communication and its important in application for security and cost efficient implementations are cited from many dissertations.
- Chapter 3 "Design Methodology" shows the implementation process of the device.
- Chapter 4 "Hardware Description" describes the hardware used in the projects.
- Chapter 5 "Design Implementation and Analysis" shows the on field implementation of the system that has been designed before.
- Chapter 6 "Result and Discussion" Shows the performance analysis of the device with proper output.
- Chapter 7 "conclusion" Shows the limitation and future works in this field.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Nowadays there has been a lot of researches and inventions over unmanned robots. Human life is the most precious thing so nowadays for risky places many countries are using robots instead of human soldiers. Military robots are autonomous robots or remote-controlled mobile robots designed for military applications, from transport to search & rescue and attack. The use of robots in warfare, although traditionally a topic for science fiction, is being researched as a possible future means of fighting wars. Already several military robots have been developed by various armies. For the development of the research on this field many competition has been hosted.

2.1.1 Definition of Battlefield assistive robot

Literally the word robot comes from the Slavic word ROBOTA which means labor. Basically a robot is generally an electromechanical machine that is able to perform tasks weather automatically or manually or in both mood. It is also defined as the industrial machine that replaces the human being to work in such condition which is hazardous and unsafe. Battle field assistive Robot can be defined as a machine that removes the mines in war all on its behalf and can be used spying on the enemies.

2.2 Present technology

Nowadays with the improvement of technology robots are used in military operations which are not completely automatic. They are actually controlled remotely. The robots or unmanned machines as they are termed, can be any moving object or a flying aero plane

fitted with all necessary equipment like sensors, LIDARS (Laser based Communication RADARS), cameras etc. [2]. Their operations can be from disposing bombs, to surveying enemy territories.

Generally there are 3 kinds of unmanned machines used in the military operations:

- Unmanned Ground Vehicle (UGV): They are used for ground purposes. They can carry heavy load, move on uneven terrains and have various sensors and cameras fitted on them.
- Unmanned Aerial Vehicle (UAV): They are used to carry aerial weapons and are basically flying machines.
- Unmanned Underwater Vehicle (UUV): They are basically submarines or machines which can survey under water [3].

2.3 Previous Works

Day by day use of unmanned robots in military is increasing. Many developed and developing countries are replacing soldiers with unmanned vehicle in dangerous places.

1. North American Military, ‘’TISON, heavy EOD robot’’ This unmanned multi mission robot is capable of Heavy-lift 9 degree-of-freedom manipulator [4].

   Advantages:

   - It is able to carry heavy loads.
   - It has better gripper mechanism.
   - It has better wheel system which enables it to adjust in rough surfaces.

   Limitations:

   - This robot cannot operate properly at night.

Fig. 2.1 TISON, heavy EOD robot [4].

2. Naskar S. in his present paper tried to explore how a radio frequency controlled robot can be used in defense and in real war field. The robot is radio operated, self-powered, and has back tracking facility, in case of loss of connection from the base station. Wireless cameras will send back real time video and audio inputs which can be seen on a remote monitor in the base station from where the robot is being controlled and action can be taken accordingly. The robot can be controlled from a base station by means of radio frequency [5].

   Advantage:

   - His robot can be operated from long distance.

   Limitations:

   - This robot cannot operate properly at night mode.

3. S. Y. Harmon in his paper introduces the intelligent security robot developed by National Chung Cheng University (NCCU). The robot is named "Security Warrior" and consists of six systems including vision, motion, robot arms, power estimation, remote supervise and sensory system [6].

   Advantages:

   - It contains special features like robotic arm, sensory system.
   - It has power estimation system.

   Limitations:

   - This robot is unable to detect bomb and cannot operate at night mode.

4. Lei Yang, Xin Song, Yancong Li, Huiyong Shan, Junwang Guo in their 'Household assistive robot' they implemented a free moving arm for better working angle [7].

   Advantage:

   - It has arm with improved working angle.

   Limitations:

   - Their robot isn't made in purpose of battlefield. So no metal detector was attached.

5. Wai Mo Mo Khaing designed and implemented a similar robot where a camera is mounted [8].

   Advantages:

   - It has got better wheel system.
   - A camera is installed which facilitates it to better view.

   Limitations:

   - The robot isn't mounted with any kind of arm.
   - No metal detector is installed.

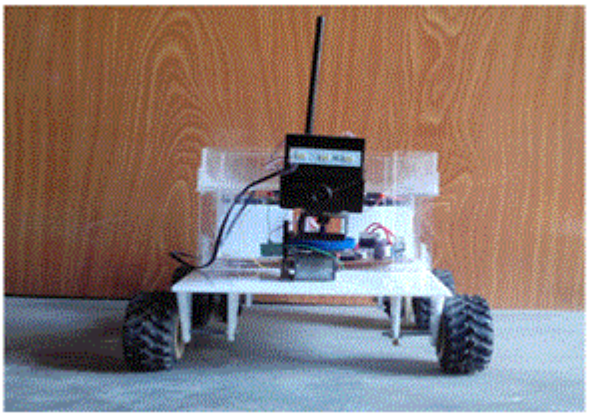


Fig. 2.2 Spy robot made by Wai Mo Mo Khaing and Kyaw Thiha[8].

6. Aaruni Jha made a project of spy robot in which night vision camera is attached so that it can operate even in night mode. [9]

   Advantages:

- Capable of operating at night mood.

Limitations:

- There are no robotic arm or metal detector in this robot.

7. Er Vansh Raheja in his project, developed a war field helping robot where a firefighting circuit is also implemented. [10]

   Advantages:

   - Firefighting circuit implemented.

   Limitations:

   - There are no robotic arm or metal detector in this robot.

8. The Special Weapons Observation Reconnaissance Detection System, or SWORDS [11]

   Advantages:

   - It is capable of climbing stairs.
   - Has robotic arm with gripper.

Fig.2.3 SWORDS [11]

   - Camera mounted.
   - Rocket launcher is also mounted.
   - Gun installed.

- Fire detecting circuit is implemented.

Limitations:

- The robot is not autonomous.

9. **Dragon Runner**: The Dragon Runner small tactical robot was originally developed for the U.S. Marines by Automatika, which became a Foster-Miller subsidiary in 2007 [11].

Fig. 2.4 The Dragon Runner [11]

Advantages:

- This produces huge torque to carry and move heavy objects.

Limitations:

- This is not autonomous.
- Its size is bulky and can easily be spotted at battlefield.

10. **TAGS-CX Unmanned Vehicle**: In September 2005, the U.S. Army's Tank-Automotive Research, Development, and Engineering Center (TARDEC) instituted a robotics system called TAGS-CX (Tactical Amphibious Ground Support System) [11]

Fig. 2.5 TAGs-CX [11].

Advantages:

- It has better wheel system so can climb stairs and can walk easily on rough surface.

Limitations:

- It does not have better gripper arm.

11. **Mobile Operated Spy Robot:** Dhiraj Singh Patel developed a combat Robot which is capable of multi-tasking and can be controlled by mobile phone [12].

Advantages:

- This can be controlled by mobile phone.

Limitations:

- No metal detector is used in this robot.

12. Multi-tasking Robot vehicle: Amritanshu Srivastava developed a multitasking robot [13].

Advantages:

- This can be protected with password.

Limitations:

- It does not have robotic arm.

CHAPTER 3

DESIGN METHODOLOGY

3.1 Introduction

The project entitled “Arduino Based Battlefield Helping Spy Robot” is designed and implemented for the betterment of the service of our soldiers in defense. In this project we used a RF remote module to control the whole robot movement and the arm system. We’ve also added a night vision camera which will send the real time video from the location. The robot is also capable of detecting landmine or any metal weapon around the robot within its range as we’ve connected a metal detector in it. We can also pick any particle with the robotic arm in it which is activated by actuators.

3.2 Stages

In the process of completing this project we’ve followed four steps.
Which are,

- Planning
- Analyzing
- Designing
- Final implementation

3.2.1 Stage 1 - Planning

At first stage of starting the project we discussed about our project with our supervisor. After the idea being selected he said us to put a considerable name of the project so we came up with the name “Design and Implementation of Arduino Based Battlefield Helping Spy Robot” considering our objectives. After naming the project we budgeted our

approximate cost on the project. Then we studied on the background work on this field and shockingly we found out that there are not many researches done in this field where in other countries (like America, japan, china) are using this kind of technology in their defense work. Unfortunately our police and military are still compromising with the old technology that we had many years ago that is why we are still losing lives in war fields. It's high time we updated our strategy of fighting. Robots can be replaced with soldiers where life is endangered.

Based on our research we found out that present technology that exist today has limitations too. So we pointed them out and planned to fulfil as much as the lacking we can.

3.2.2 Stage 2 - Analyzing

After planning about the project we started analyzing about some of the spy robots that has been made before. We downloaded some papers from IEEE page which helped us during analyzing. We also saw many videos on YOU TUBE on this kind of spy robots and robots that US army uses in their operations. We did our literature review section according to this analysis.

Then we analyzed the hardware's operation and their specifications that we are using. Study on suitable programming language and different platforms are important to ensure that the programming language is sufficient to build the proposed system and how to integrate different modules with different platforms into a meaningful system to provide useful information to the user. We also analyzed the previous works in our university on this field. There was a work similar to us but they had many limitations which we tried to solve in our project.

We also analyzed about some incidences that happened in recent times where application of this robot could be proven beneficial. Like in the incidence of Holey Artisan Restaurant where this type of robot could be proven handy.

3.2.3 Stage 3 - Design

The main project constructing process starts from this stage. Here the entire system will be theoretically designed which will be implemented in the implementation chapter.

3.2.3.1 Block Diagram

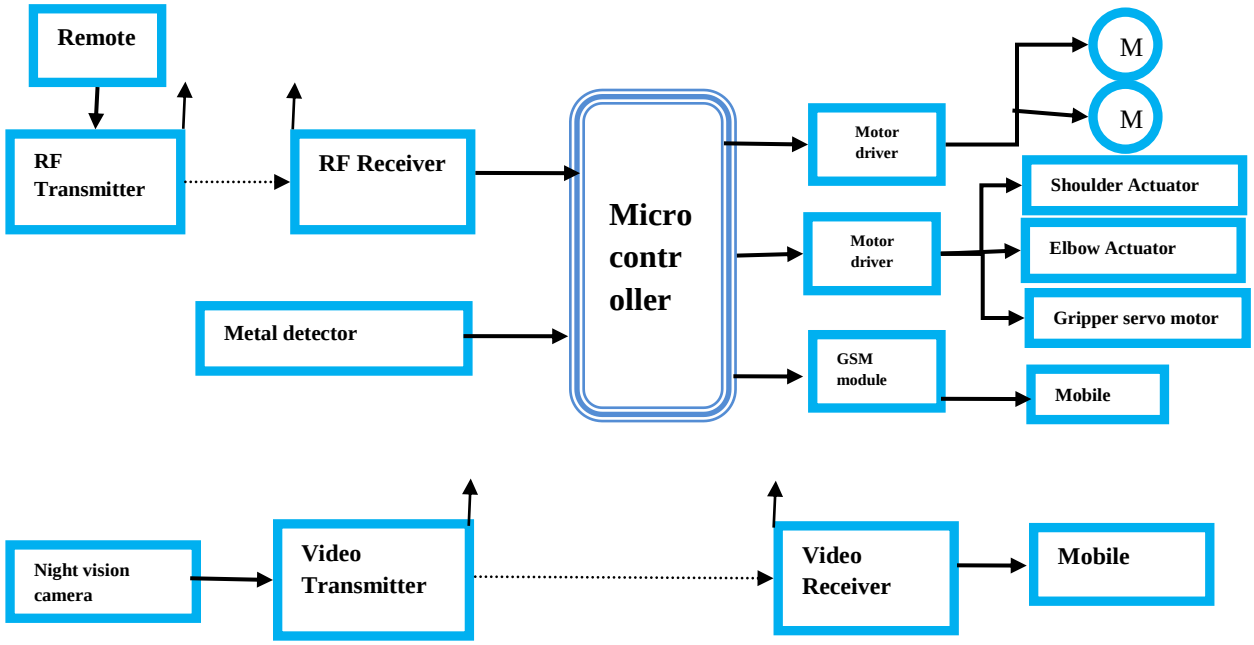


Fig.3.1 Block diagram of the entire system and subsystem.

Here the block diagram representation of the entire robot system is depicted from where its operating procedure can be described. The remote block represents the operator controlling section from where instructions are encoded and transmitted in form of RF logic signal which is received by the receiver antenna and it is then decoded and delivered to the brain block of the robot which is the microcontroller module. This microcontroller is then programmed according to the instructor's demand. The microcontroller block is connected to motor drivers block which means the motors and actuators are controlled by the microcontroller commands through motor drivers.

Another subsystem block is the metal detector block which is connected to GSM module block via microcontroller which means when the metal detector gets a signal then it sends it to microcontroller and then to GSM from where a text message is sent to the operator's mobile phone.

And the last subsystem in the diagram is the wireless video transmitter module which will capture images around the robot and its internal transmitter will transmit them to the receiving monitor section. At the receiving monitor section the movement of the camera head is also controlled.

Base structure

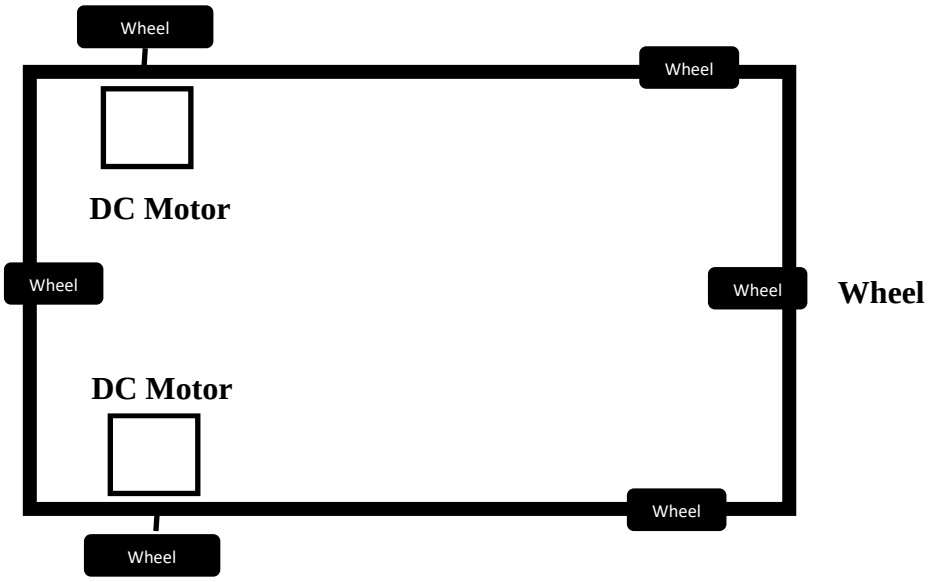


Fig. 3.2 Base structure

Arm structure

Design of arm structure is shown in the **fig3.3** below,

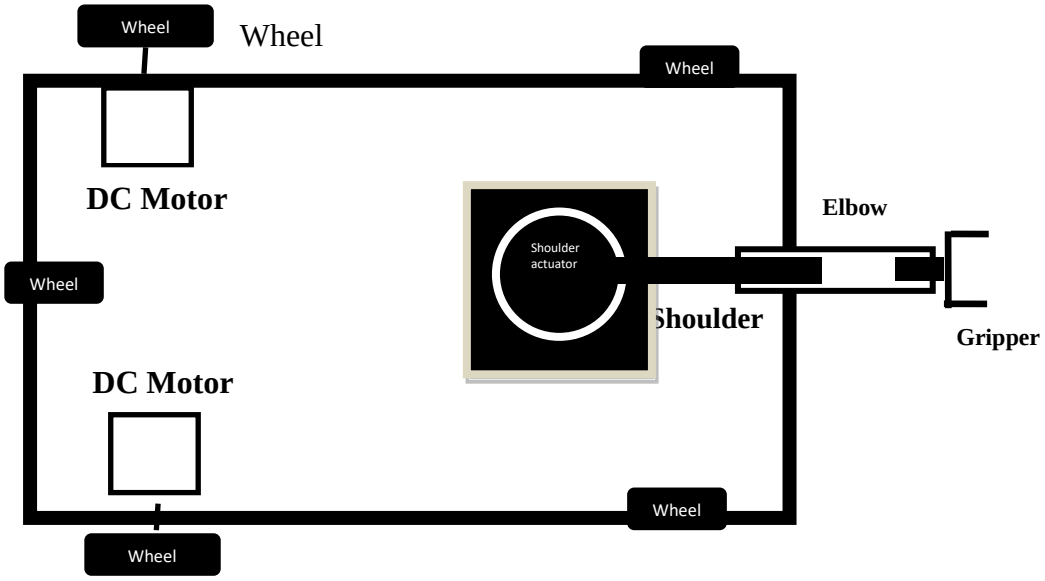


Fig. 3.3 Arm structure

System Context Diagram

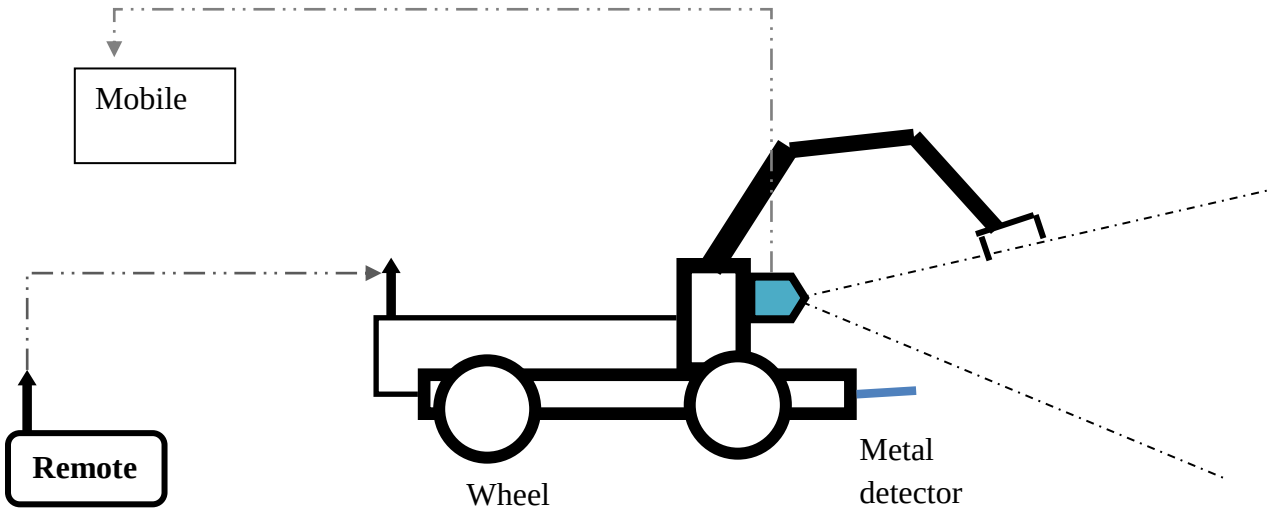


Fig. 3.4 System context Diagram

3.2.4 Stage 4 - Design implementation

After the completion of all the designs and measurements being we started implementing the theoretical designs where all hardware are implemented and functionality is checked. First of all, the base of the robot is built and the wheels are attached where fiber glass is used in the middle and at the edge two aluminum bar is attached to make the base strong enough to hold the entire system and subsystems.

Secondly, dc motors are connected to the wheels and motor driver is connected to Arduino and motor. Then other subsystems are connected and simulated one by one which will be discussed in the later Hardware implementation section.

Finally, after all the hardware works been done final testing has been performed and results are noted.

CHAPTER 4

HARDWARE DESCRIPTION

The development of this project is based on several types of device. These devices are:

- Arduino UNO-R3 Microcontroller (AT mega 32)
- RF Transmitter and Receiver (433MHz)
- DC Motor(12 v)
- Motor Driver(L298D)
- Buck Converter
- Actuator
- Metal Detector
- GSM(SIM 900A)
- Night Vision Camera
- Power Source

4.1 Arduino UNO R3 Microcontroller

In the project we have used Arduino UNO microcontroller. It can be termed as the brain of our project. The reason for selecting this device is its reliability and availability. In addition to all the features of the previous board, the Uno now uses an ATmega16U2 instead of the 8U2 found on the Uno (or the FTDI found on previous generations). This allows for faster transfer rates and more memory. No drivers needed for Linux or Mac (info file for Windows is needed and included in the Arduino IDE), and the ability to have the Uno show up as a keyboard, mouse, joystick, etc.

4.1.1 Specifications:

- ATmega328 microcontroller
- Input voltage - 7-12V
- 14 Digital I/O Pins(6 PWM Outputs)
- 6 Analog Inputs
- 32K Flash Memory
- 16Mhz Clock Speed

4.1.2 Pin description:

The Arduino Uno [15] is based on the ATmega328 (datasheet) having 14 digital input/output pins (6 of them can be used as PWM out), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. The pins which we used are described below,

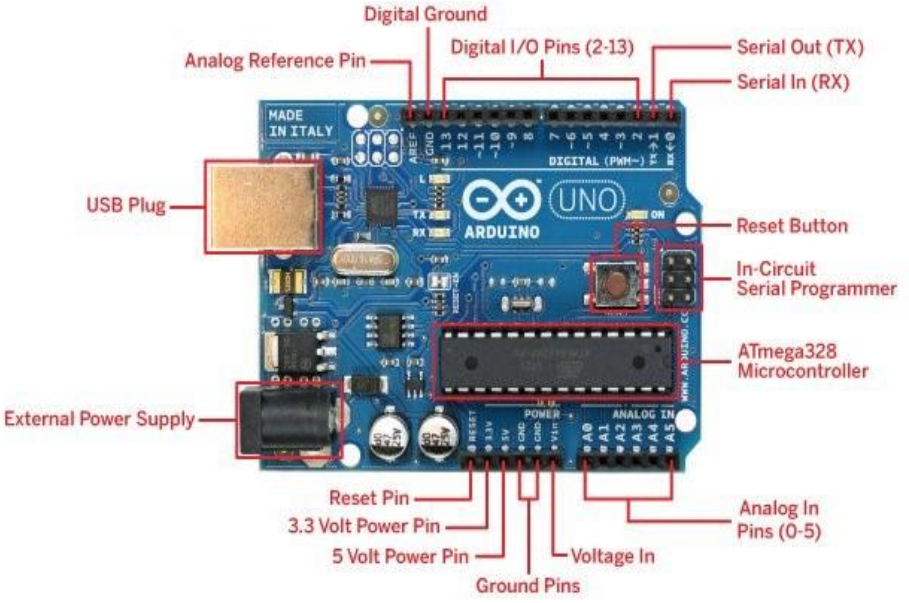


Fig. 4.1 Arduino UNO R3 [15]

- Digital Pin 6, 7, 8, 9 are connected to the motor driver of the base controlling motor for controlling the motion of the robot vehicle.

- Digital Pin 4, 5, 10, 12 are connected to the motor driver of the arm controlling actuator to move the actuator.
- Digital Pin 11 is connected to gripper servo motor to control the gripper movement.
- Metal detector is connected to Analog pin A0.
- Pin 0 is connected to the TXD pin of the GSM module.
- Pin 1 is connected to the RXD pin of the GSM module.
- Pin 2 is connected to the Receiver module.
- Pin 13 is connected to a Buzzer.

4.2 RF Module (FS1000A)

For controlling purpose here we used a wireless RF module which is 433MHz RF transmitter with receiver for Arduino ARM MCU wireless. [16] This pair is also used for many other purpose like remote control switching, receiver module, remote control socket, remote control door opener, car door controller, security system etc. This kind of RF modules are internally paired with series of encoders.

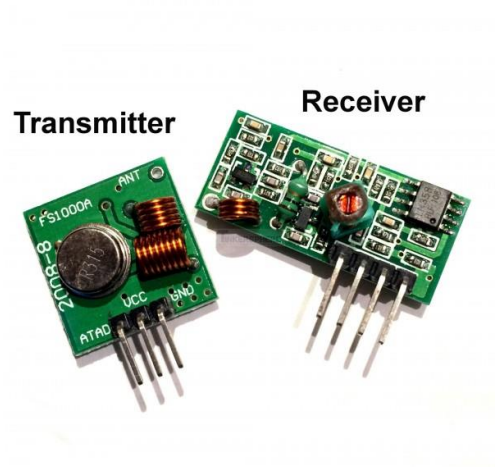


Fig.4.2 433MHz RF module [16].

4.2.1 Pin Description:

- Pin VCC is connected to the source and GND pin is to the ground pin of both transmitter and receiver module.
- Receiver's OUT pin is connected to pin 2 of Arduino.

- Transmitter's Data Pin is connected to Pin 3 of remote Microcontroller.

4.3 DC Motor

DC Motor is such an electromechanical device where electrical energy (voltage or power source) is converted into mechanical energy (produces rotational motion). They run on direct current. The Dc motor works on the principle of Lorentz force which states that "when a wire carrying current is placed in a region having magnetic field, than the wire experiences a force". This Lorentz force provides a torque to the coil to rotate. [17] In this project we have used DC gear motor. DC gear motor is nothing but an extension of DC motor where DC Motor has a gear assembly attached to it. The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM. Here geared DC motor is used for some specific reasons which are,

- The gear assembly helps us in increasing the torque and reducing the speed.
- This readymade assembly reduces the complexity and cost of designing.
- Gear motors allow the user of economical low-horsepower motors to provide great motive force at low speed such as in lifts, winches, medical tables, jacks and robotics.

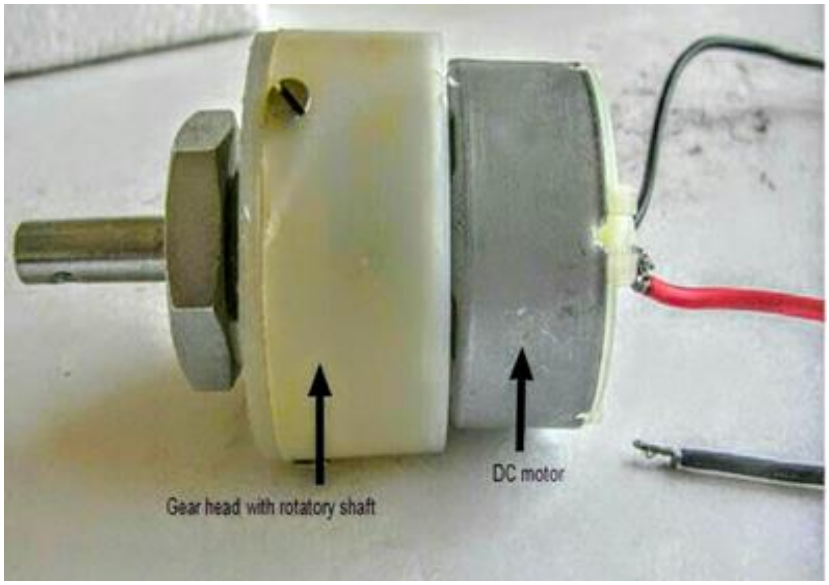


Fig. 4.3 DC motor [17]

4.4 Actuator

Here 12V linear actuators [18] are used and as the name suggests it is an electromechanical device which creates motion in a straight line. Here we have used it for some of its special specifications.

4.4.1 Specifications:

- It provides precise movement within a limited space.
- Provides maximum improvements in speed.
- Smoothness in the movement.

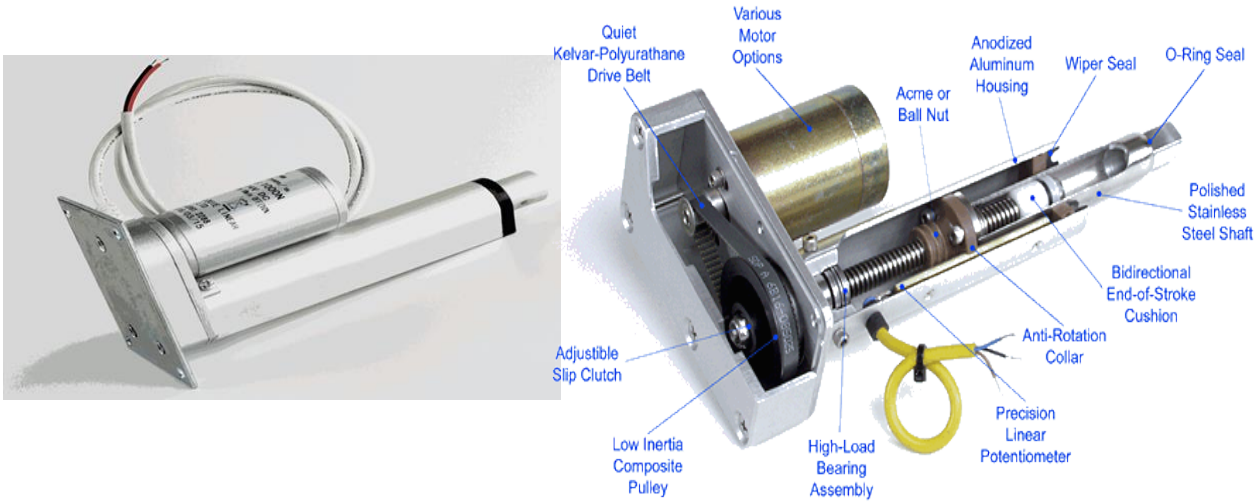


Fig. 4.4 A 12V actuator and its internal construction [18].

4.5 Motor Driver (L298N)

Motor Driver IC [19] is a bipolar module which allows DC motor to drive on either direction. Here L298N H-bridge Dual Motor Controller Module is used.

4.5.1 Specifications

- This allows us to control the speed and direction of two DC motors.
- Can control one bipolar stepper motor with ease.
- The module can be used with motors that have a voltage of between 5 and 35V DC.

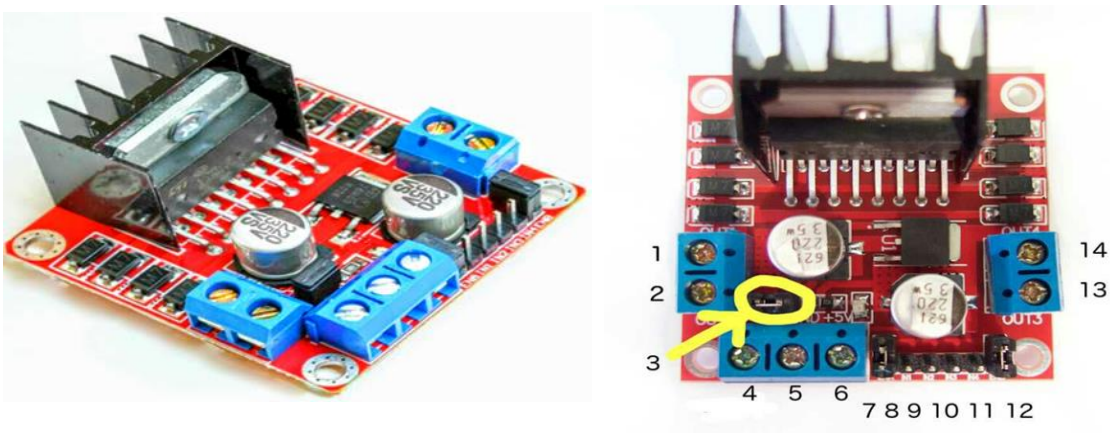


Fig. 4.5 Motor Driver L298N [19]

4.5.1 Pin Specifications

- Pins 1, 2, 13, 14 are connected to motors and in second motor driver these are connected to actuators.
- Two Enable pins are shorted and connected to VCC.
- IN1-IN4 are connected with Arduino board.

4.6 Buck Regulator

As a 12v battery is used for 12V motor and actuator, a Buck converter [20] was needed in the system as the Arduino works at 5 volt. So instead of using two power sources in the robot (which would make the system bulky and reduce the efficiency of the system) a single 12 volt power source is added from where a parallel connection was taken to a buck converter which steps down 12 volt to 5 volt.

Fig. 4.6 Buck regulator [20].

4.7 GSM Module

GSM (Global System for Mobile communication)/GPRS (Global Packet Radio Service) module is used to build up communication between computer and GSM system. The benefits of using Global System for Mobile communication (GSM) is that it is used for mobile communication in most of the countries. Global Packet Radio Service (GPRS) [21] is an extension of GSM that enables higher data transmission rate.

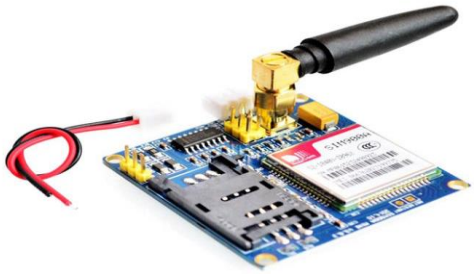


Fig. 4.7 GSM Module [22]

4.7.1 Pin Description

- Pin TXD is connected to Arduino Pin 0.
- Pin RXD in connected to Arduino Pin 1.

4.8 Metal Detector Module

Metal detector is an electronic instrument which can detect metals nearby. It works by producing electromagnet around itself. The circuit of a metal detector consists of an oscillating circuit which induces an alternating magnetic field around it. If a conducting material comes near to the module the alternating magnetic flux is cut by the metal and an eddy current is induced hence a small magnetic field is induced into the metal which is

measured as a signal output of the detector. In this project the signal is supplied to Arduino and then to GSM module which then sends a message to the operator mobile.

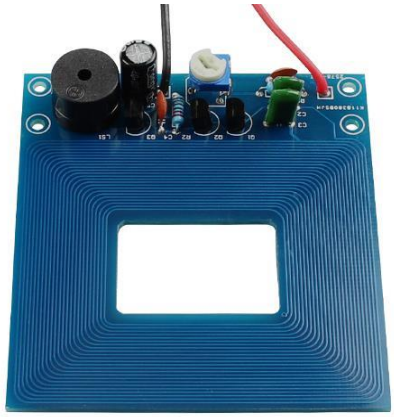


Fig. 4.8 Metal detector Module

4.9 Night Vision Camera

The robot is equipped with a wireless camera, which is very effective when the robot will be far from the operator but as the name suggests it has to operate like spy which means it has to have night mood operating system so that operator can use it at dark situations therefor here a night vision camera has been mounted on the robot instead of a standard camera, which will increase the visibility in case of no light at all.

Fig. 4.9 Camera module

CHAPTER 5

SYSTEM DEVELOPMENT AND ANALYSIS

This chapter is all about implementing the theoretical concepts into reality. Here the entire system is assembled and its performance is analyzed.

5.1 System Architecture

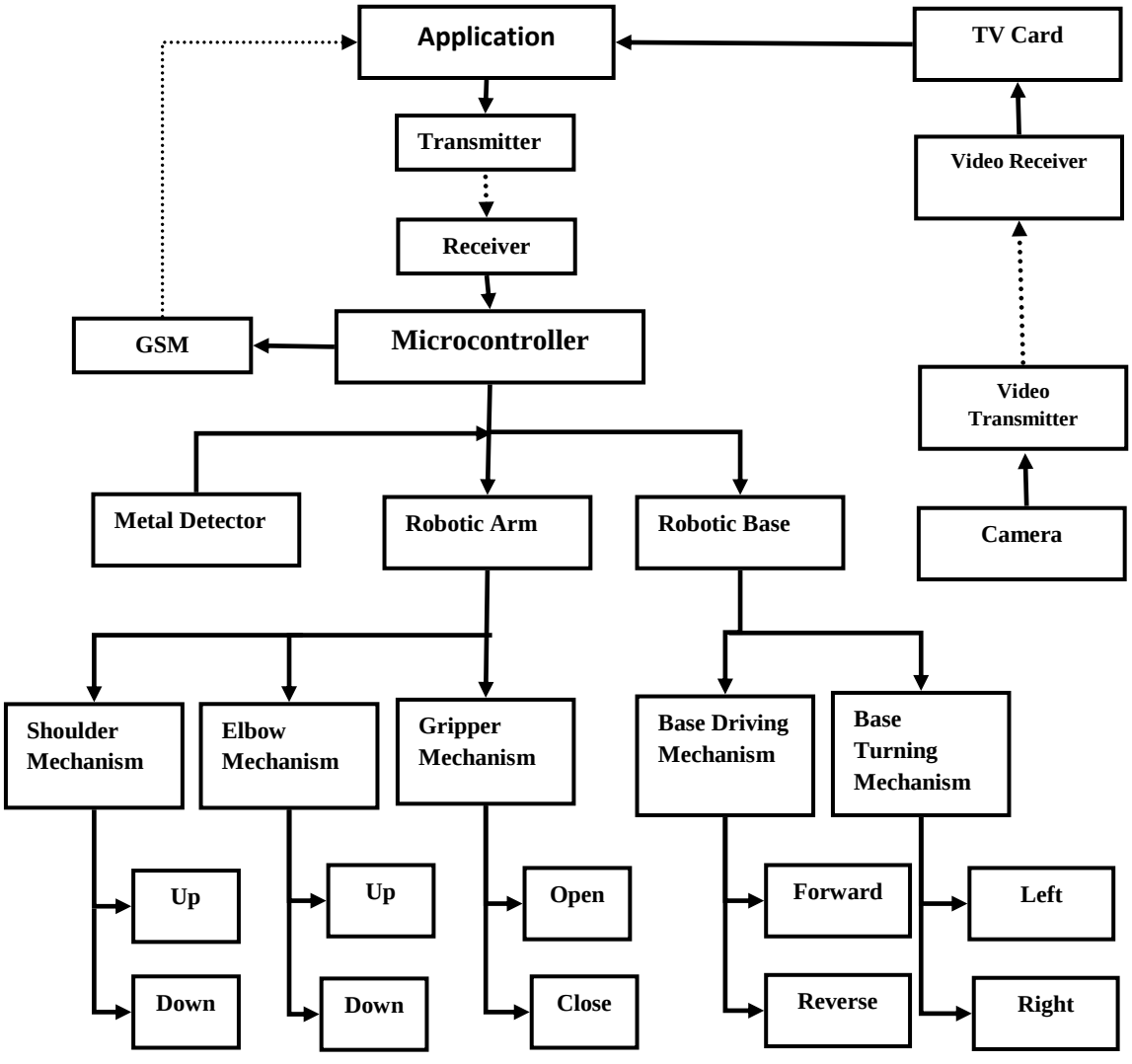


Fig. 5.1 system Architecture

The system architecture refers the entire system with all their subsystems and their process of proceeding where application block indicates all the facilities that the operator is provided with. In the architecture application communicates with all other subsystems through a wireless RF communication system which is shown in dashed line. Here microcontroller is the brain of the entire system and subsystems which coordinates between all the subsystems. Microcontroller block shows connections with metal detector, robotic base and robotic arm where robotic base has two mechanisms to work at which are forward mechanism and turning mechanism. Robotic arm has three sub blocks (shoulder, elbow and gripper mechanism) connected to it which indicates that these subsystems performs as the microcontroller indicates and themselves has two mechanisms to work at. Shoulder and elbow can operate at up and down mechanism and gripper only manages to move in vertical direction making the grip to open or close.

One of the other two subsystems work almost individually that is it does not interface with microcontroller. And the last subsystem block uses a GSM system to communicate with the operator.

5.2 Arm Development

The robotic Arm has been designed using aluminum metal strips which is available and light in weight. The power to weight ratio has been kept in mind in design of the arm. And it is strong enough to hold and move nominal weight objects.

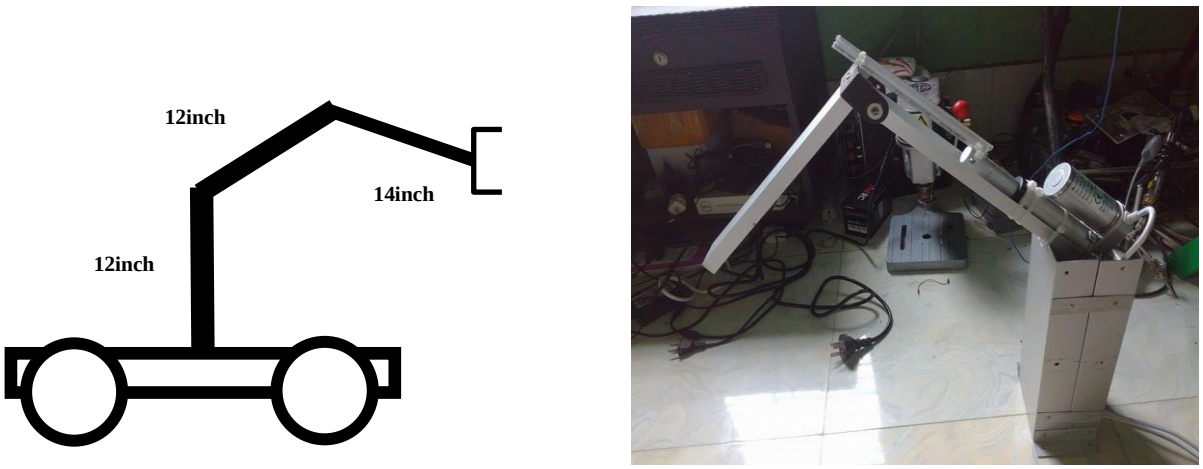


Fig. 5.2 Arm structure and measurement

Table5.1 working angle of Robotic Arm

Arm component	Starting angle	Ending angle
Shoulder	0^0	40^0
Elbow	-75^0	45^0

5.3 Transmitter Circuit

Transmitter circuit consist of two remote circuits. (1) Remote controlling base movement and (2) Remote controlling arm movement.

5.3.1 Base controlling Remote circuit

This circuit diagram explains the circuit connections of the robotic base controlling remote.

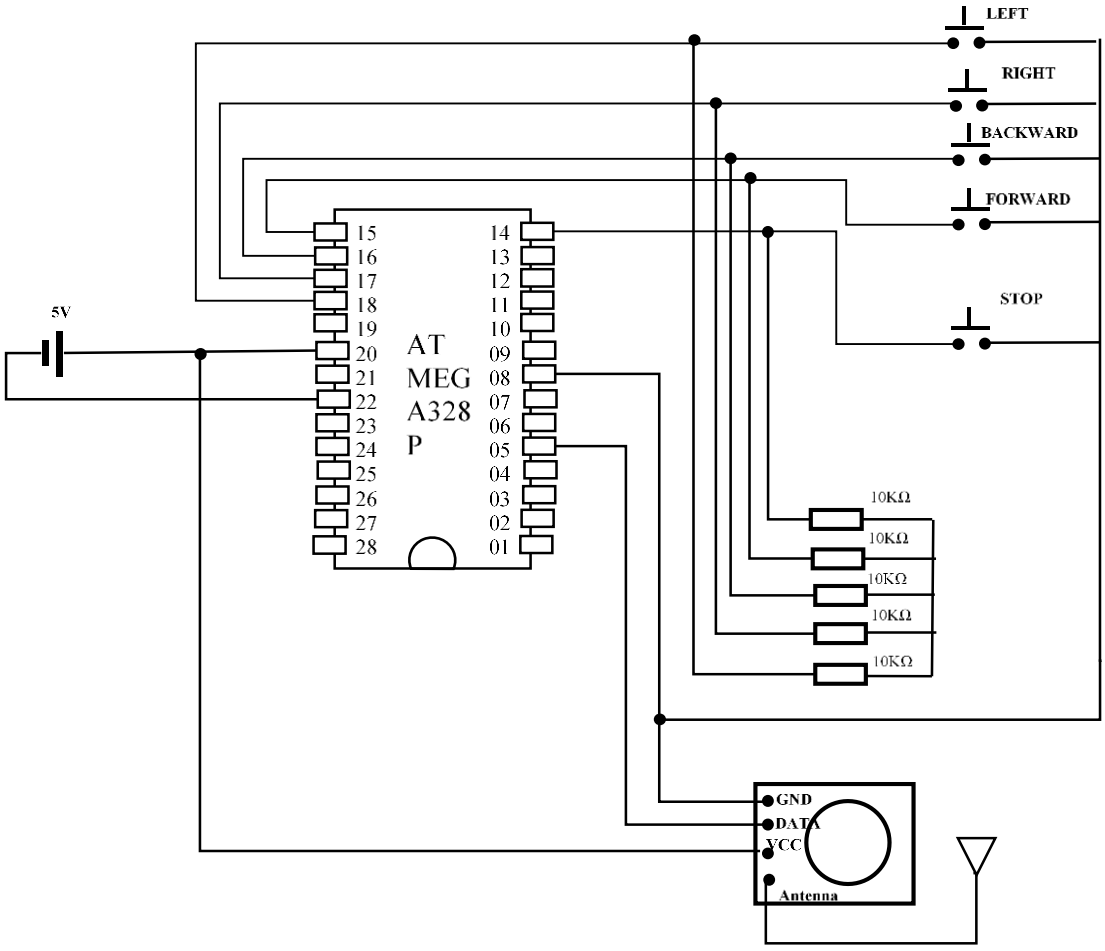


Fig. 5.3 Base controlling Remote circuit Diagram

5.3.2 Prototype of Base controlling Remote

Here the prototypic figure of the remote to control is attached

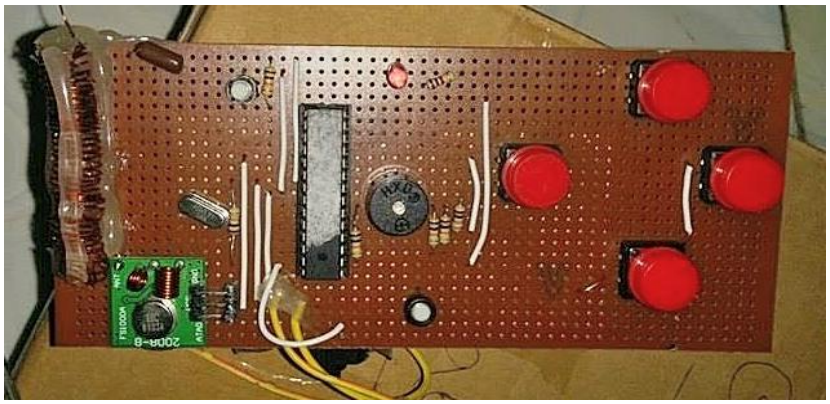


Fig. 5.4 Base Remote Prototype

5.3.3 Arm Remote circuit

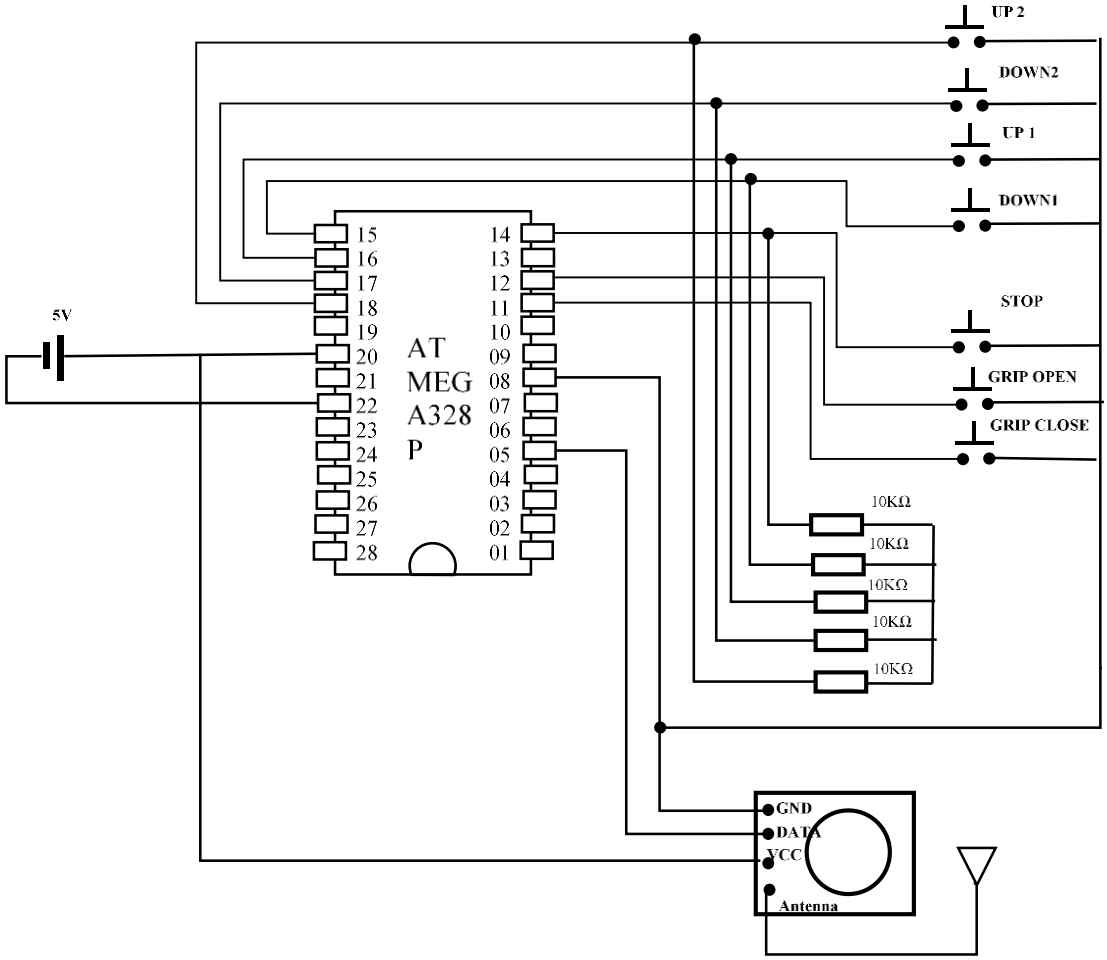


Fig. 5.5 Arm remote circuit diagram

5.3.4 Prototypic figure of Arm remote

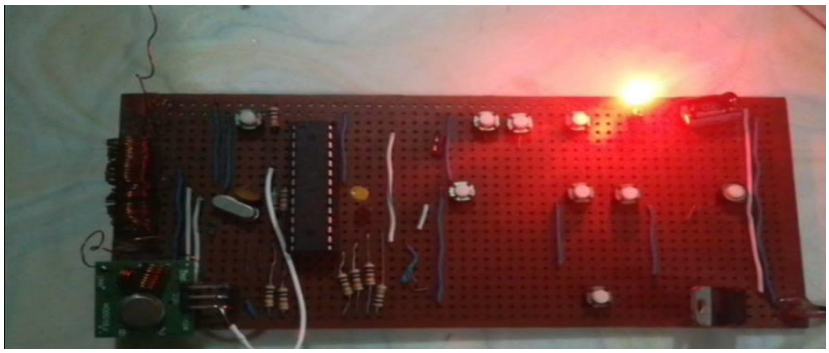


Fig. 5.6 Prototypic figure of arm remote

5.4 Receiver Circuit

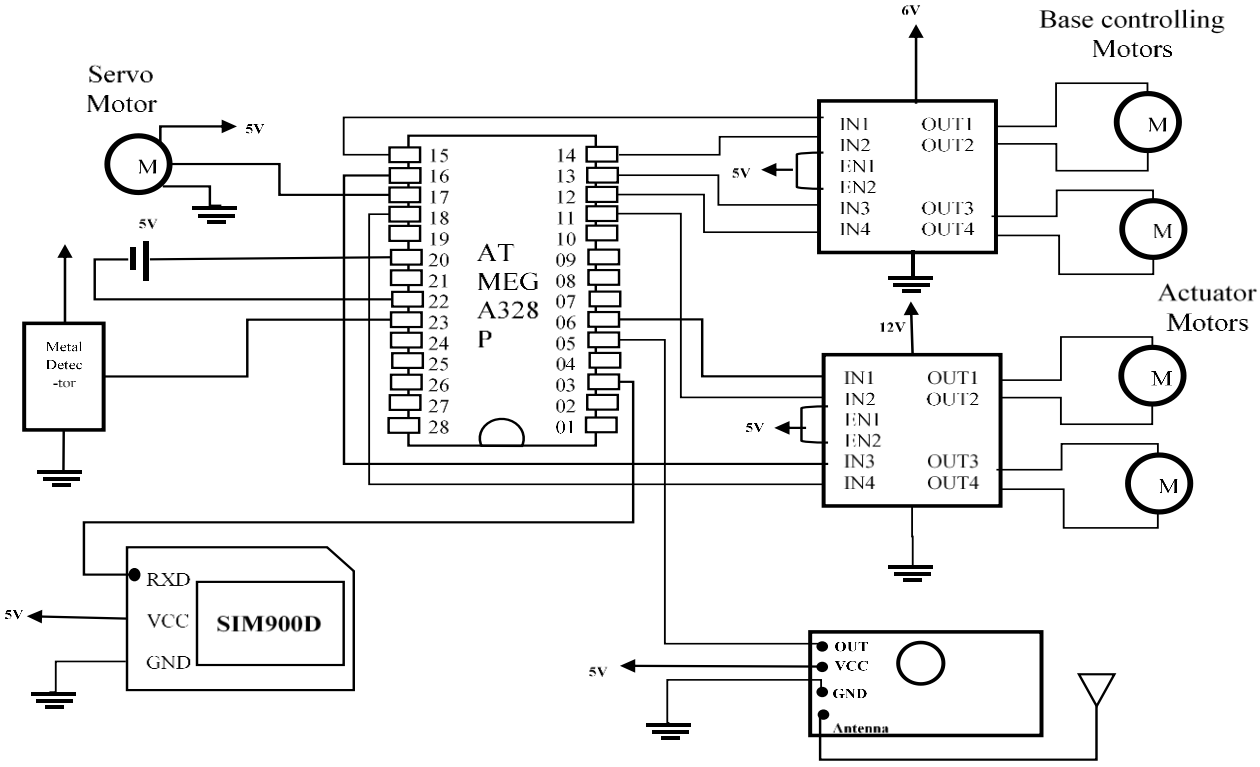
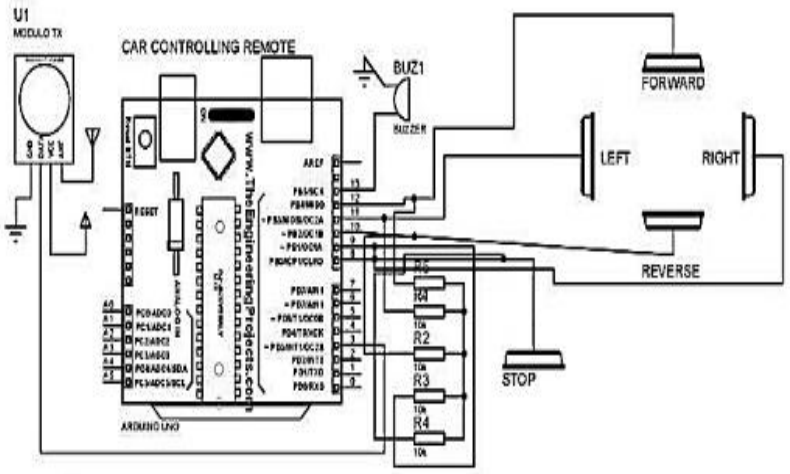
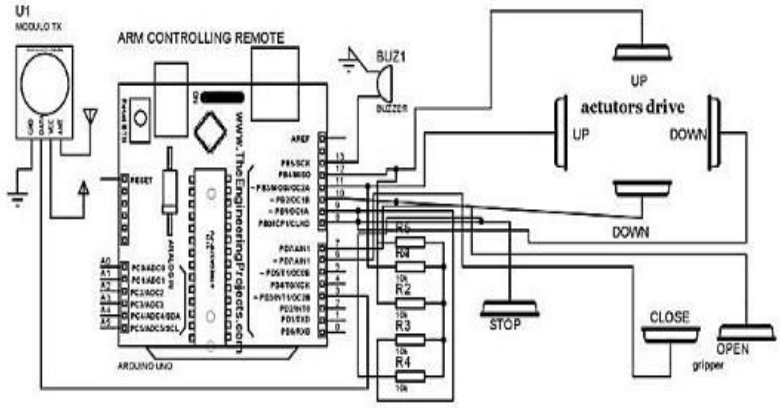
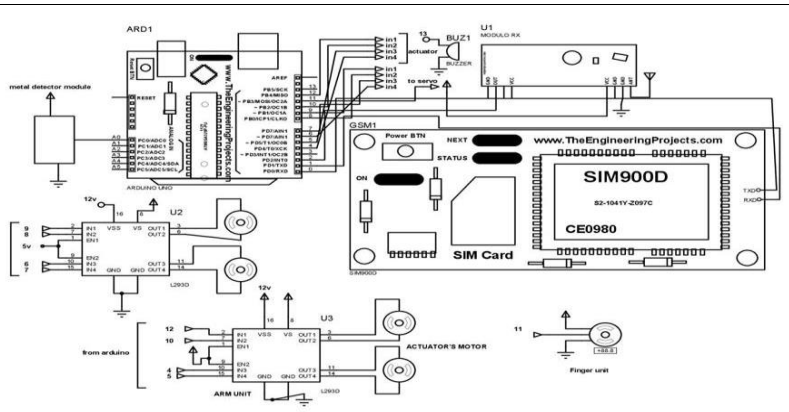


Fig. 5.7 Receiver circuit diagram

5.5 Simulation Circuit diagrams:

Table 5.2 Simulation circuit Diagrams

SLNo	Name	Figure
01	Base controlling Remote	
02	Arm Controlling remote	

03	Receiver	

5.6 Entire System Prototype

Fig. 5.8 Prototypic photograph of the Robot

5.7 Working of the Entire system

In the robot initially it when it is switched on in different sections of the base it awaits for the signal from the transmitter remote section. Initial startup of the robot vehicle energizes up the metal detector's coil which produces a magnetic field around it. When this magnetic field is cut by any metallic conductor then it sends a signal to the microprocessor which then initializes the GSM module. With the help of GSM module and a network system it sends a message to the operator's mobile.

At the same time the RF receiver awaits until it gets any signal from the transmitter. Transmitter module is combined with an encoder circuit, a transmitter circuit and an antenna. When user pushes any button on the remote it is converted into digital signal and encoded by the encoder then the encoded signal is transmitted by the transmitter and antenna.

The encoded data which was transmitted by the transmitted is received by the receiver antenna then it is decoded and sent to the microprocessor for farther processing.

According to the instructions received by the receiver the microprocessor initializes farther step which was programmed and uploaded before. When the operator presses any buttons on the base controlling remote it activates the motor driver and hence the two dc motors which controls the motion of the robot vehicle. Similarly any signal in Arm controlling remote activates the robotic arm actuators mounted on the robot vehicle.

By activating the camera and monitoring system live view is seen and according to which the robot vehicle is driven. By observing the object in front of the robot the actuator is activated and operated to grab the object and is moved to any other place if needed.

5.8 Software Used

For programming the Arduino software is used. A screenshot of the software homepage is given below,

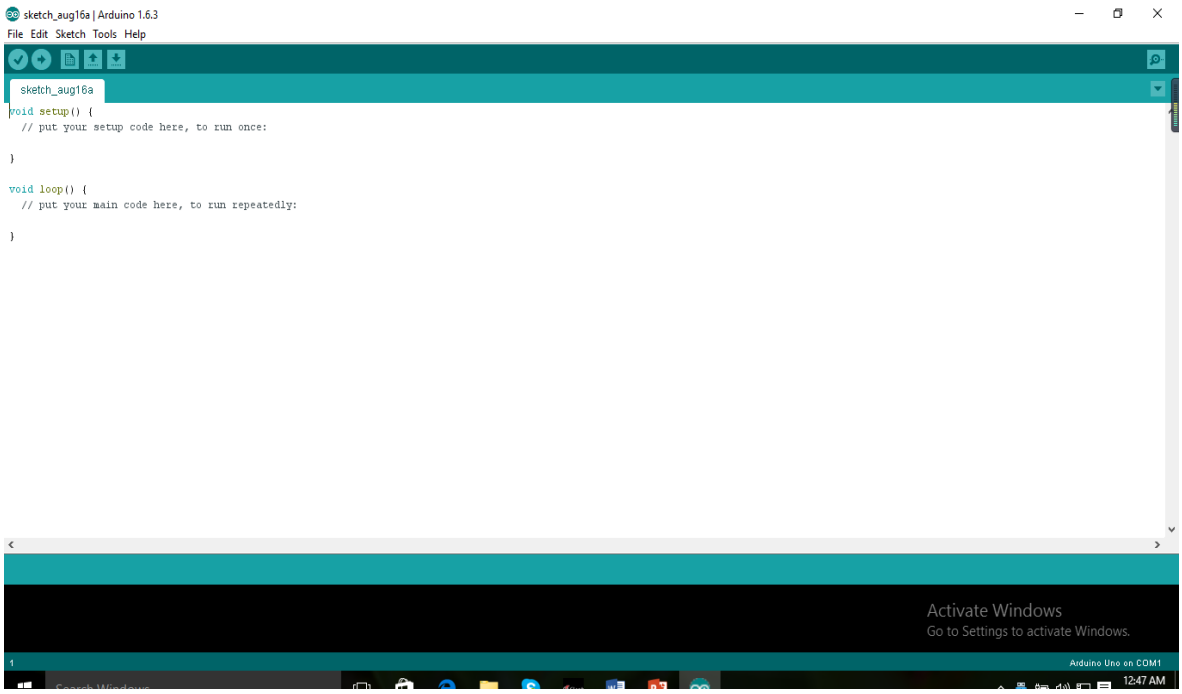


Fig. 5.9 Screenshot of Arduino Software.

CHAPTER 6

RESULT AND DISCUSSION

6.1 Introduction

Our project worked perfectly during our experimental operation though sometime it behaves slow error due to wave distortion via different noise signal. We have tested some experiments to determine the working capacity and efficiency of the robot. We have been able to view the things accurately that are currently happening in the surrounding area. Our design has not caused any sort of disturbances. The robot worked smoothly according to the command we sent from the remote section unit. We have shown the view of the area around the robot by night vision camera. By keeping the circuit easy and simple, most users will be able to use it easily. Thus we should be able to manipulate its path when necessary, to create the robot safely.

Here we have experimented some tests to find the metal detector circuit's working and accuracy. Our metal detector worked perfectly within its range and was able to send message signal to our mobile phone instantaneously. We have also observed the camera performance and working condition at night mood and it worked pretty much accurately.

6.2 Metal Detector testing

Metal detector is tested in different range and it worked appropriately when any metal was beneath the robot. The output range is noted below where we can see that it worked with short distance but did not work at long range distance.

All the values that we found in our test run is included here.

Table 6.1 Metal Detector Range of detection

SL No	Distance from metal detector (Inch)	Status
1	0.5	Worked
2	1	Worked
3	1.5	Worked
4	2	Did not work

6.2.1 Metal Detector Output

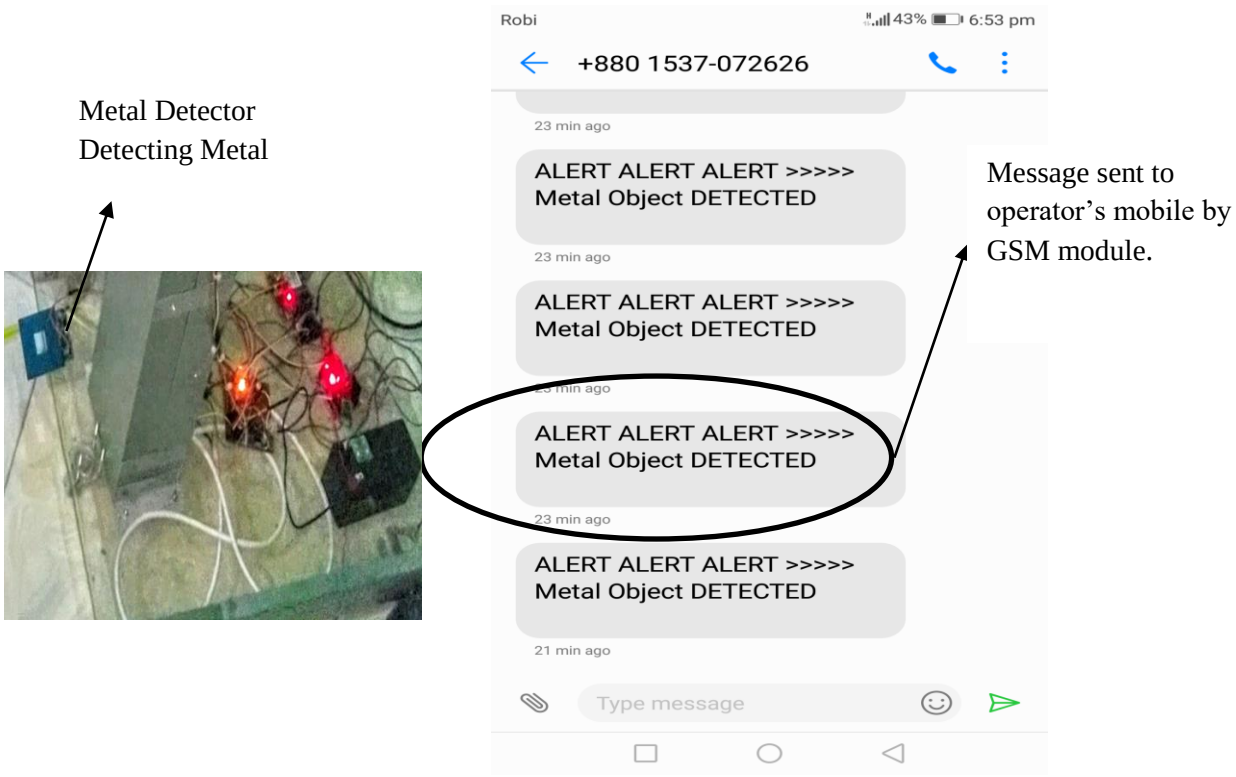


Fig. 6.1 Screenshot of Metal detected Result

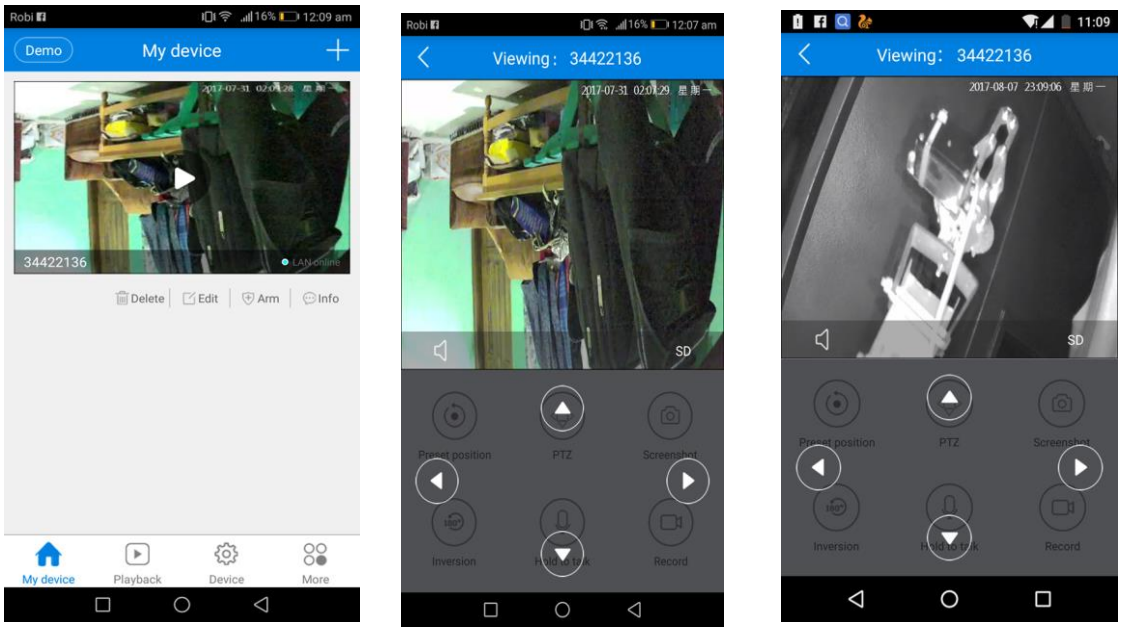
6.3 Control with RF module

RF transmitter which is connected to the microcontroller, it takes the input from the microcontroller and transmit the signal to the receiver via RF signal. By this signal we control our robot. Here given the experimental operation:

Table 6.2 RF module transmitting range

S.NO.	**Transmitter and Receiver Range (m)**	**Status**
1	2	Robot worked
2	5	Robot worked
3	8	Robot worked and disconnected after sometime
4	10	Robot did not work

6.4 Camera Performance



(a) (b) (c)

Fig. 6.2 The Camera captured Picture (a) Normal video transmitting (b) moving camera position (c) Night vision mood

6.5 Arm Performance

The robot has performed well in picking up small objects. We testes with a test object of 250gm where arm easily took the weight and lifted it up. A photograph of the arm picking up some object is attached here. We tested the prototype with much higher weights. In the test setup with the increase of weight the balance of the robot seemed to be lost. Here we measured the maximum weight which the robot can carry without any problem was 350 gm.

Fig. 6.3 Arm picking up some object

6.6 Cost Analysis

Cost of the entire project is listed in a table below.

Table 6.3 cost list of products used in project

Sl No	Product used (quantity)	Price (BDT)
1	Arduino UNO-R3	850
2	RF Module	700
3	DC motor with wheel (2)	760
4	Servo motor + gripper	2500
5	Motor driver (2)	960
6	Buck converter (2)	760
7	Actuator (2)	9600

8	Metal detector	1350
9	SIM 900D	3150
10	Night vision camera	2700
11	Resistors	20
12	Capacitors	45
13	Fiber glass	450
14	Aluminum bars	400
15	12V Battery	850
16	4V Battery (4)	240
17	PCB Board	120
Total		25,575 TK

Similar Robot TISON EOD made by US Army at 27000$ (2160000 BDT)

Another Robot made by Wai Mo Mo Khaing and Waing at 3150 $ (252000 BDT)

Where our built robot is more cost efficient.

6.7 Discussions

In this project we have developed a multitasking battlefield assistive robot which performed pretty smoothly in our test run. The battlefield assistive robot is such designed that it can be used for various purpose like short range surveillance, war field spying etc. it can also cater to the need of bomb disposal unit if needed. With some advancement in this project it can be made more efficient and multipurpose robot. Our battalion can make full use of it in the Warfield which is a crying need for today.

CHAPTER 7

CONCLUSION

7.1 Conclusion

A robot is a reprogrammable, multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety tasks. [20] Here we have designed such a multi-tasking robot reducing the drawbacks of the previous works which will provide short distance surveillance to our soldiers in hostage situations.

Conventionally, spy robots are implemented with nominal cameras which provides lacking in terms of night mood. For this reason we have added a night vision camera in this project which enables our robot to capture images at dark and wirelessly transmit them to the monitor. Moreover a metal detector is added too which will provide the soldiers information about the dangers and situations in the hostage situation.

7.2 Limitation

- It works with a limited RF signal range of 8 meter. Testing at a distance of 10meter our robot stopped.
- RF signal can be jammed by other signals.
- Actuators draw more power than ordinary DC motor, so our battery needs maintenance and recharging after a certain time.
- It needs a person to operate the robot every time.
- Its wheel system is not appropriate for zigzag surface or stairs.
- All future augmentation are the lacking of the project.
- This is not completely autonomous though in future it can be possible.

7.3 Future Work

The system that we have designed and implemented is a prototype of a war field assistive robot, which should be as compact, fast and accurate as possible. It is only being developed to ensure that the design is feasible, not impractical and can be implemented on a much larger scale in a more efficient way. Our robot is not a very maneuverable machine right now that is it may not provide the efficiency to cope with the unexpected surface or it may not have the capability to maneuver into small places, which is very important requirement of an assistive robot. But in future it can be used to design such a robot, which will be not only compact but also fast and accurate. Though the gripper we have used here has limitations to hold and carry objects but it can still perform some level of object manipulation. Hence the future enhancements may include the ability to handle a much wider range of objects. Some of these enhancements are described below.

7.3.1 Compact Design

Compact design reduces weight in robot vehicle resulting much faster operation and thus increases the accuracy and efficiency. Therefore the robot can be enhanced to be of much smaller size for the purpose of a faster and accurate operation. Besides compact sized robot gets extra facilities in case of entering into smaller spaces. And for not being spotted in term of spying, compact structure is much beneficial.

7.3.2 Quick Movement

Being an assistive robot with metal detector, it can be used as a bomb disposal robot where it will require very fast movement. This is required as the bomb disposal squad might also have very little time in checking out the bomb and then defusing it. Therefore a fast robot is necessary.

7.3.3 Multi Griper Robotic arm

The gripper that has been used here have certain limitations on picking and holding objects which can be solved by the application of multi gripper module. Placing a gripper that can be removed and replaced by another gripper can also solve this problem. This will enable the robotic arm to grip and move objects, which are complex and cannot be easily moved with a single or a basic gripper.

7.4 Future Augmentation

- The data transmission do not use any internet communication hence the range of transmission length is low. The length of data transmission can be increased by using GSM or GPRS based communications channel.
- There no conveyer belt type wheel is implemented which will cause a bit of problem in complex roads, this problem can easily be solved with a conveyer type wheel using in it.
- This mechanism can be used in UAV (Unmanned Air Vehicles) or drone.
- Here an ordinary CCTV camera is used. In future a complex IC camera can be designed with much view angle.

7.4.1 Application of Military and LAW Enforcement

Military usage of remotely controlled vehicles dates back to the first half of 20th century. Soviet red Army used remotely controlled tele tanks during 1930s in the winter war and early stages of world war 2.There were also remotely controlled cutters and experimental remotely controlled planed in the Red Army.

Remote controlled vehicles are used in law enforcement anti-military engagement for some of the same reasons. The exposure of hazards are mitigated to the person who operates the vehicles from a location of relative safety. Remote controlled vehicles are used by many Police Department bomb squads to defuse and detonate explosives.

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APPENDIX

TRANSMITTER CODE for Base controlling:

```
//NOTE :- THIS TRANSMITTER CODE IS USED WHEN YOU WANT TO CONTROL THE ROBOT VIA THE BREADBOARD REMOTE

#include <VirtualWire.h>

//Assigning controller buttons to Digital Pins

int stopMotor = 8;

int forward = 9;

int backward = 10;

int rightTurn = 11;

int leftTurn = 12;

int remotePins[]= {8,9,10,11,12};//array to store pin nos

void setup()

{

   Serial.println("setup");

   // Initialise the IO and ISR

   vw_setup(9000);            // Bits per sec

   vw_set_tx_pin(3); //Transmitter Data Pin to Digital Pin 3

   for(int i = 0; i<5 ; i++)

   {

     pinMode(remotePins[i], INPUT);

     digitalWrite(remotePins[i],HIGH);

   }
```

```
}//close setup


void loop()
{
 char *msg2;


 if(digitalRead(forward) == LOW)//if the forward button is pressed
 {
  char *msg2 = "1";//send 1 to the receiver
 // digitalWrite(13, true); // Flash a light to show transmitting
  vw_send((uint8_t *)msg2, strlen(msg2));//send the byte to the receiver
 // vw_wait_tx(); // Wait until the whole message is gone
  //digitalWrite(13, false);
 }
 if(digitalRead(backward) == LOW)//if the back button is pressed
 {
  char *msg2 = "2";///send 2 to the receiver
 // digitalWrite(13, true); // Flash a light to show transmitting
  vw_send((uint8_t *)msg2, strlen(msg2));//send the byte to the receiver
  vw_wait_tx(); // Wait until the whole message is gone
  //digitalWrite(13, false);
 }
```

```
if(digitalRead(leftTurn) == LOW)//if the left button is pressed
{
  char *msg2 = "3";//send 3 to the receiver
  //digitalWrite(13, true); // Flash a light to show transmitting
  vw_send((uint8_t *)msg2, strlen(msg2));//send the byte to the receiver
  vw_wait_tx(); // Wait until the whole message is gone
 // digitalWrite(13, false);
}
  if(digitalRead(rightTurn) == LOW)//if the right button is pressed
{
  char *msg2 = "4";//send 4 to the receiver
  //digitalWrite(13, true); // Flash a light to show transmitting
  vw_send((uint8_t *)msg2, strlen(msg2));//send the message to the receiver
  vw_wait_tx(); // Wait until the whole message is gone
  //digitalWrite(13, false);
}
if(digitalRead(stopMotor)==LOW)//if the stop button is pressed
{
 char *msg2 = "5";//send 5 to the receiver
 digitalWrite(13, true); // Flash a light to show transmitting
 vw_send((uint8_t *)msg2, strlen(msg2));//send the message to the receiver
 vw_wait_tx(); // Wait until the whole message is gone
  //digitalWrite(13, false);
}
```

```
}//close loop

  // End Of Code
```

TRANSMITTER CODE for controlling Arm

```
#include <VirtualWire.h>

//Assigning controller buttons to Digital Pins

int stopMotor = 8;

int forward = 9;

int backward = 10;

int rightTurn = 11;

int leftTurn = 12;

int grip1=5;

int grip2=6;

int remotePins[]= {5,6,8,9,10,11,12};//array to store pin nos

void setup()

{

   Serial.begin(9600);          // Debugging only

   Serial.println("setup");

   // Initialise the IO and ISR

   vw_setup(9000);             // Bits per sec

   vw_set_tx_pin(3); //Transmitter Data Pin to Digital Pin 3

   for(int i = 0; i<7 ; i++)

   {

     pinMode(remotePins[i], INPUT);

     digitalWrite(remotePins[i],HIGH);
```

```
    }
}//close setup
void loop()
{
  char *msg2;
  if(digitalRead(forward) == LOW)//if the forward button is pressed
  {
    char *msg2 = "i";//send i to the receiver
   // digitalWrite(13, true); // Flash a light to show transmitting
    vw_send((uint8_t *)msg2, strlen(msg2));//send the byte to the receiver
    //digitalWrite(13, false);
  }
  if(digitalRead(backward) == LOW)//if the back button is pressed
  {
    char *msg2 = "j";///send 2 to the receiver
   // digitalWrite(13, true); // Flash a light to show transmitting
    vw_send((uint8_t *)msg2, strlen(msg2));//send the byte to the receiver
    //digitalWrite(13, false);
  }
    if(digitalRead(leftTurn) == LOW)//if the left button is pressed
  {
    char *msg2 = "m";//send 3 to the receiver
    //digitalWrite(13, true); // Flash a light to show transmitting
    vw_send((uint8_t *)msg2, strlen(msg2));//send the byte to the receiver
```

```
 // digitalWrite(13, false);
}
if(digitalRead(rightTurn) == LOW)//if the right button is pressed
{
  char *msg2 = "n";//send 4 to the receiver
  //digitalWrite(13, true); // Flash a light to show transmitting
  vw_send((uint8_t *)msg2, strlen(msg2));//send the message to the receiver
  //digitalWrite(13, false);
}
  if(digitalRead(stopMotor)==LOW)//if the stop button is pressed
{
 char *msg2 = "o";//send 5 to the receiver
 digitalWrite(13, true); // Flash a light to show transmitting
 vw_send((uint8_t *)msg2, strlen(msg2));//send the message to the receiver
  //digitalWrite(13, false);
}
//gripping
if(digitalRead(grip1)==LOW)//if the stop button is pressed
{
 char *msg2 = "x";//send 5 to the receiver
 digitalWrite(13, true); // Flash a light to show transmitting
 vw_send((uint8_t *)msg2, strlen(msg2));//send the message to the receiver
 vw_wait_tx(); // Wait until the whole message is gone
  //digitalWrite(13, false);
```

```
 }
 if(digitalRead(grip2)==LOW)//if the stop button is pressed
 {
  char *msg2 = "z";//send 5 to the receiver
  digitalWrite(13, true); // Flash a light to show transmitting
  vw_send((uint8_t *)msg2, strlen(msg2));//send the message to the receiver
  vw_wait_tx(); // Wait until the whole message is gone
   //digitalWrite(13, false);
 }
}//close loop
 // End Of Code
```

Receiver Code

```
 #include <GSM.h>
#include <VirtualWire.h>
int led = 11;          // the pin that the LED is attached to
int brightness = 0;

 int in1 = 6;
 int in2 = 7;
 int in3 = 8;
 int in4 = 9;
 //arm drive
 int in5 = 4;
 int in6 = 5;
 int in7 = 10;
 int in8 = 12;

 int motorPin[] = { 4, 5, 10, 12, 6, 7, 8, 9};
```

```
int buttonState = 0;
void setup()
{
   Serial.begin(9600);

   pinMode(13, OUTPUT);
   pinMode(led, OUTPUT);
  pinMode(A1, OUTPUT);
  pinMode(A0, INPUT);
   vw_setup(2000);            // Bits per sec
   vw_set_rx_pin(2);    //Rx Data pin to Digital  Pin 2

   for (int i = 0; i <8; i++)
  {
        pinMode(motorPin[i], OUTPUT);
  }
}
void loop()
{
 buttonState = digitalRead(A0);
if (buttonState == HIGH)
  {
    digitalWrite(A1, HIGH);
    //sms
  Serial.println("AT+CMGF=1");    //Sets the GSM Module in Text Mode
  Serial.println("AT+CMGS=\"01811674204\"); // Replace x with mobile number
  Serial.println("ALERT ALERT ALERT >>>>> Metal Object DETECTED");// The SMS text you want to
send
  Serial.println((char)26);// ASCII code of CTRL+Z
  delay(2000);
  }
   if (vw_get_message(buf, &buflen)) // Non-blocking
   {
            int i;
            for (i = 0; i < buflen; i++)
            {
            Serial.print(buf[i]);
```

```
   if(buf[i] == '1')
  {
   forward();//go forward
   delay(100);
  }
if(buf[i] == '2')
  {

   backward();//go backward
  delay(100);
  }
   if(buf[i] == '3')
  {
   left();//go left
   delay(100);
  }
   if(buf[i] == '4')
  {
   right();//go right
   delay(100);
  }
      if(buf[i] == '5')
  {
         stopMotor();//go stop
  }
    ////////////////////////////////
  //arm drive unit
  ////////////////////////////////

    if(buf[i] == 'i')
  {

   forward1();//go backward
   delay(100);
  }
if(buf[i] == 'j')
  {
```

```
      backward1();//go backward
      delay(100);
     }
        if(buf[i] == 'm')
     {

      left1();//go backward
      delay(100);
     }
        if(buf[i] == 'n')
     {
      right1();//go backward
      delay(100);
     }

 ////////////////////////////////
/// To gripping
////////////////////////////////

if(buf[i] == ‘'x'’)//if button 1 is pressed.... i.e.forward buton
     {
     brightness = brightness++ ;
    analogWrite(led, brightness);
  if (brightness >=100 )
  {
  brightness == 100 ;
  }
  //delay(30);
   }
  if(buf[i] == 'z')//if button 1 is pressed.... i.e.forward buton
     {
   brightness = brightness-- ;
   analogWrite(led, brightness);

  if (brightness <=0)
  {
```

```
 brightness == 0 ;
 }
// delay(30);
  }
      if(buf[i] == 'o')
     {
      stop1();//go backward
      delay(100);
     }
   }
  }

}

////////////////////////////////////////////////////////////////////////////////

void forward()
{

 digitalWrite(in1,HIGH);
 digitalWrite(in2,LOW);
 digitalWrite(in3,HIGH);
 digitalWrite(in4,LOW);

digitalWrite(13, true);
 }
void backward()
{
 digitalWrite(in1,LOW);
 digitalWrite(in2,HIGH);
 digitalWrite(in3,LOW);
 digitalWrite(in4,HIGH);
 digitalWrite(13, true);
}

void left()
{
```

```
  digitalWrite(in1,LOW);
  digitalWrite(in2, HIGH);
  digitalWrite(in3,HIGH);
  digitalWrite(in4,LOW);
 digitalWrite(13, true);
}
void right()
{
    digitalWrite(in1,HIGH);
  digitalWrite(in2,LOW);
  digitalWrite(in3,LOW);
  digitalWrite(in4, HIGH);
  digitalWrite(13, true);
}
void stopMotor()
{
  digitalWrite(in1,LOW);
  digitalWrite(in2,LOW);
  digitalWrite(in3,LOW);
  digitalWrite(in4,LOW);
 digitalWrite(13, false);
}
 //arm unit
 void forward1()
{
  digitalWrite(in5,HIGH);
  digitalWrite(in6,LOW);
  digitalWrite(13, true);
  }
void backward1()
{
  digitalWrite(in5,LOW);
  digitalWrite(in6,HIGH);
  digitalWrite(13, true);
}
```

```
void left1()
{
  digitalWrite(in7,HIGH);
  digitalWrite(in8,LOW);
 digitalWrite(13, true);
}
void right1()
{
  digitalWrite(in7,LOW);
  digitalWrite(in8,HIGH);
  digitalWrite(13, true);
}
void stop1()
{
  digitalWrite(in5,LOW);
  digitalWrite(in6,LOW);
  digitalWrite(in7,LOW);
  digitalWrite(in8,LOW);
  digitalWrite(13, true);
  delay(300);
  digitalWrite(13, false);
  digitalWrite(A1, LOW);
 // brightness == 0;
 // analogWrite(led, brightness);
}
//void beep()
//{
//
//  digitalWrite(buzzer, HIGH);
//  delay(300);
//  digitalWrite(buzzer,LOW);
//  delay(100);
//}
//void silence()
//{
//
//  digitalWrite(buzzer,LOW);
```

```
//
//}

 //End Of Code
```

THE END