Chapter 1 Introduction

1.1 Overview

Robot is an electromechanical device, which automates work in many areas like industrial sectors, military application, domestic works and agriculture applications. Robotics is reliable especially in areas where human interventions is rather impossible or can cause hazardous effect on human health. Due to advancement of wireless technology, several different types of connections are introduced such as RF, GSM, WIFI. Each of the connections has their own specifications and applications. Among them Radio Frequency communication is mostly used in military appliances for harsh condition and rescue operations.

The project is designed to develop a robotic vehicle using RF technology for remote operation attached with wireless camera for monitoring purpose. The robot along with camera can wirelessly transmit real time video with night vision capabilities. This is kind of robot can be helpful for spying purpose in war fields.

At the transmitting end using push buttons, commands are sent to the receiver to control the movement of the robot either to move forward, backward and left or right etc. At the receiving end two motors are interfaced to the microcontroller where they are used for the movement of the vehicle. The RF transmitter acts as a RF remote control that has the advantage of adequate range (up to 200 meters) with proper antenna, while the receiver decodes before feeding it to another microcontroller to drive DC motors via motor driver IC for necessary work. A wireless camera is mounted on the robot body for spying purpose even in darkness.

In present context, robotics is challenging sector to deal with. On one hand, it has to keep up the growing demand from growing population and on other hand robots accounts for huge part of automation and accuracy. Moreover, in the scenario of developing country like Nepal, robotics is still difficult topic to deal with in terms of massive work force deployed, less technology and poor economic.

Therefore, we regard it as a necessity to design and develop a robot to cope up with the demands of present world and available resources. Implementation of robots in day to day-out tasks increases accuracy, reliability and efficiency of work done.

ROBORESQ is a rescue robot designed and developed solely for military and rescue operation. Powered by caterpillar wheels ROBORESQ is able to move through any terrain and send back audio video message from target location to the user. User can also send voice feedback at the target location via microphone to acknowledge victim about the rescue operation. Its lightweight and adequate dimensions help in all terrain movement and inhibits upside down locomotion as well. The IP camera attached to the chassis captures audiovisual images and sends them back to operator via router. The operator has full control of the robot there by increasing efficiency of rescue operation.

1.2 Objective

The objective of our project is:

1. Search and rescue operations after natural calamities like earthquake, landslides.

1.3 Applications

Project ROBORESQ is developed for rescue and patrolling operations, however it is applicable in other hazardous conditions like mine hazards, wildlife rescue and patrolling operations. These applications are explained as follows:

1. Earthquake rescue:

   ROBORESQ can be used in earthquake rescue. It can be driven to effected areas in search of victims by providing images back to operator. It's long range enables operator to use it from far distance and gather information easily.

2. Mine hazard rescue:

   During mine hazards ROBORESQ can make its way through rough, dirt and muds to aid search and rescue operations.

3. Military Operations:

   The rugged and compact ROBORESQ can work as utility tools in military operations. It can be used in war fields to transport medicines and essential supplies.

4. Bomb Squad:

   ROBORESQ when send to bomb prone zone provides operator with visual information about the location hence avoiding likely to happen life hazards.

5. Wildlife study:

   ROBORESQ can spy on wildlife and their habitats to provide audiovisual information through land to aid wild life study. Rare species of flora and fauna can be observed and hence preserved. Land patrolling around National parks is another job for ROBORESQ.

1.4 Problem Statement

Robots have shown themselves as the most versatile assistant to humans. Robots are participating in every task of mankind to provide service and better quality of life. They are being used in harsh conditions and critical situation where human performance come short and are prone to death. To avoid accidents and reach unreachable nooks and corners of incident location ROBORESQ fits in. Be it victims submerged under piles of walls and floors in earthquake or bunch of miners blocked inside mines ROBORESQ can be sent right away for rescue operation.

During gunshots and patrolling, soldiers are likely to get shot and they might face fatal injuries, where robots can be send to fetch audio visual information for further proceeding.

Wildlife inspection can be conducted easily with robots as they can be controlled from far distance. Flora and fauna information can be gathered without human interference with wild animals.

Destruction of a machine is affordable than human death. Thus robots are next front line soldiers in life threatening situations.

1.5 Organization of Report

The report of ROBORESQ is organized as follows:

The report begins with the first chapter where we introduce the system with background overview and explain why the necessity arose. In second chapter we have described the literature review and related research we conducted. Similarly, the third chapter has detailed description of the system architecture and methodology where the block diagram of the system is explained including all the details and functions of the system, construction of each module and its working principle. Chapter four describes in detail the procedure we followed, the result we obtained and discussions. Furthermore, chapter five covers limitation, conclusion and further advancement of our project. Lastly, all the circuit diagrams of components used, budget structure, Gantt chart are placed under the topic “Appendix”.

Chapter 2 Literature Review

The wireless era was started by two European scientists, James Clerk Maxwell and Heinrich Rudolf Hertz. In 1984, Maxwell presented the Maxwell's equations by combining the works of Lorentz, Faraday, Ampere and Gauss. He predicted the propagation of electromagnet waves in free space at the speed of light. His theory was accepted twenty years later, after Hertz validated electromagnetic wave (wireless) propagation. Hertz demonstrated RF generation, propagation and reception in the laboratory. His work then continues by Marconi after two decades. He then acquires a method for transmitting and receiving information. Marconi started to commercialize the use of electromagnet wave propagation for wireless telegraphs and allowed the transfer of information from one continent to another without physical connection. Since the cellular mobile phone system was introduced in the early 1980's, the wireless industry has gone several generations of revolutionary changes.

In 1985 802.11 technologies originated by the US Federal Communications Commission that released the ISM band for unlicensed use. In 1991, NCR Corporation with AT&T Corporation invented the precursor to 802.11 intended for use in cashier systems. The first wireless products were under the name WaveLAN.

The 802.11 standard uses a large number of patents held by many different organizations. Some have dubbed Dutch engineer Vic Hayes the "father of Wi-Fi" due to his involvement in negotiating the initial standards within the IEEE while chairing the workgroup. The Australian radio-astronomer John O'Sullivan developed a key patent used in Wi-Fi as a by-product in a CSIRO research project, "a failed experiment to detect exploding mini black holes the size of an atomic particle". In 1992 and 1996, Australian organization CSIRO obtained patents for a method later used in Wi-Fi to "unsmear" the signal.

In 1999, the Wi-Fi Alliance formed as a trade association to hold the Wi-Fi trademark under which most products are sold. In April 2009, 14 technology companies agreed to pay CSIRO $250 million for infringements on CSIRO patents. This led to Australians labeling Wi-Fi as an Australian invention, though this has been the subject of some controversy. CSIRO won a further $220 million settlement for Wi-Fi patent-infringements in 2012 with global firms in the United States required to pay the CSIRO licensing rights estimated to be worth an additional $1 billion in royalties.

There are different kinds of rescue robots and they tend to operate in certain situations only, here we have found some of the best that relates to our project and how they will help us to complete our project.

The article [2] is very helpful to our project and is very similar to what we would like to accomplish. His project gave us insight of an explosion proof design, vibration absorption, waterproof, mud proof. Above all, it gave great knowledge on how we can make it the design of thermal balance. So when in disastrous area the heat it might produce in area such as forest fires, which results in high temperature in that case batteries may be fired or motors may get damaged. It also shows how we can implement cooling system, which could be great option to have, and gave us great background on how it can be implemented.
This project objective was to detect and rescue victims from coal mine in China our objective is to look for survivors in earthquake and landslides. However they have used different kind of sensors to accommodate the coal mine disaster and they have also used high temperature resistance materials, explosion proof design which we would like to use but due to cost constrains we have been limited. They have also used wireless communication to communicate and transmit data which we have also implement in our guided access to a collection of algorithms the digital manipulation and ranging from simplest steps to advanced functions not commonly available for users of personal computers. The flow of the book provides each chapter as a single step in video transmitting, and successive chapters build upon one another, ultimately leading to a sound understanding of the topic and leaving the reader prepared for implementation. It even assists in such implementations by offering C and C++ programs and libraries that are discussed in the book.

This source [3] is useful because the robot has one camera and GPS, with which the user can point out the destination and the location from given information. The goal of our project is to create a device which can be placed on any surface and provide audiovisual information on command.
Another one of the scopes of the project is building the mechanical system for it to travel over rough terrain. The mechanical system holds the electrical equipment and the equipment for transmitting power. The transmission was selected to be a tracked transmission system because it was decided that this would be the best for negotiating uneven terrain.

The intelligent Robotics Institution of Beijing did a study about tracked transmissions. Their goal was to make a double angle adjustable tracked transmission and test that on a slope and a stair. It was originally hypothesized that the degree of freedom involved a suspension system. But form the research it could be seen that increasing the degrees of freedom should be done differently. More degrees of freedom come from adding more tracks along the platform axis. In this source, this is known as “single track”, “double track” and “triple track”. This design is superior because when the tracks are going over uneven terrain, the multi degree freedom

tracks can change their center of mass with respect of the support points, while with the single-track system, these quantities are fixed. These things can be concluded from the pool of research done in this area.

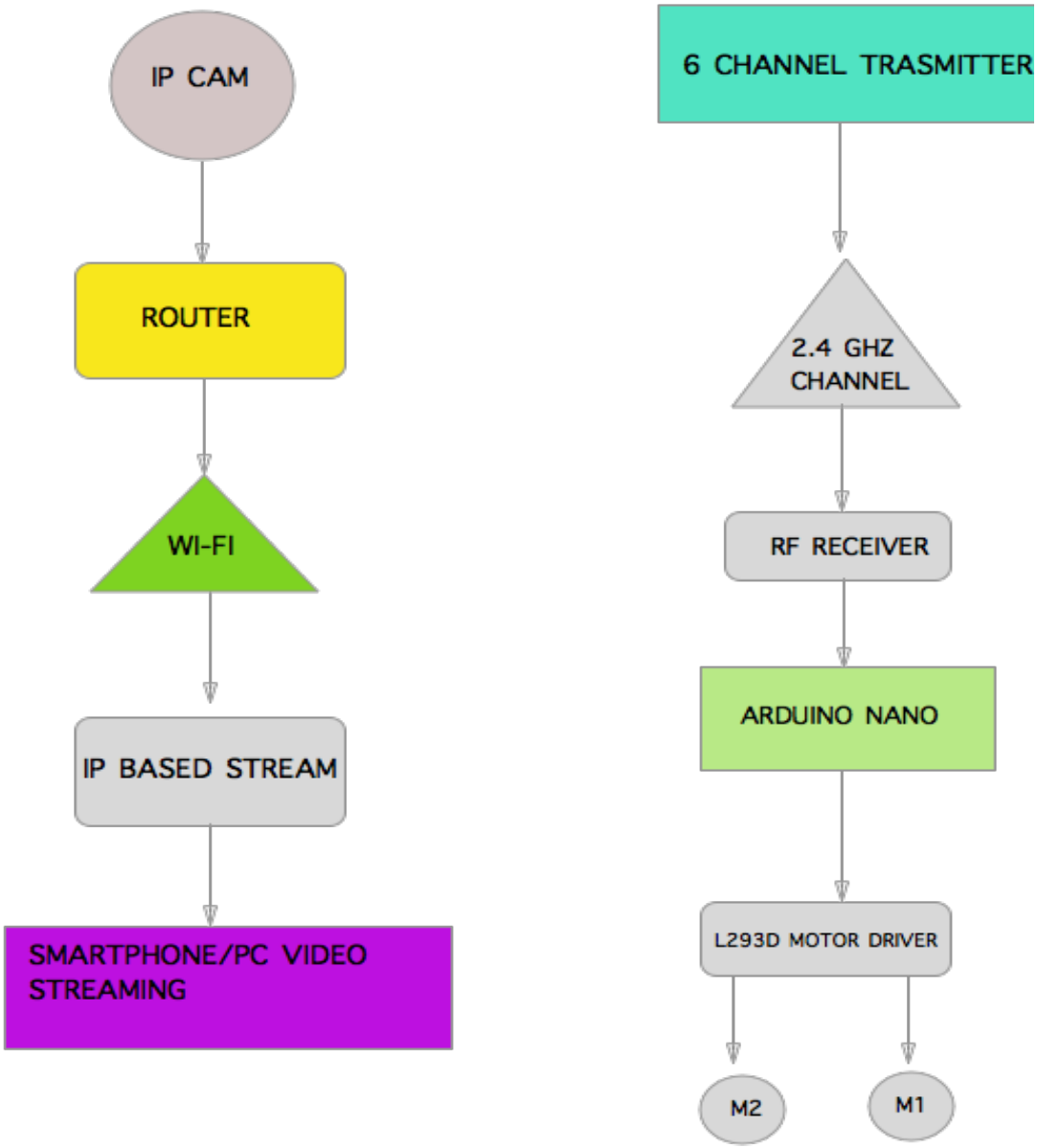
There were other things looked at from this experiment with the Intelligent Robotics Institution of Beijing. The tracked transmission needs either a belt or chain to transmit power. In this case a rubber belt was chosen, and was mated with a metal sprocket. From their testing, when the robot was tested on snow or sand, too much ground would get into transmission and elongate the belt. In this case, there was tension adjusters placed near the wheel.

The article [1] constructed an RC tank using another tracked transmission with a chain and bolts. With this arrangement, it was metal mating with metal, which meant that that process of elongation would take much longer time. With his design, there are high temperature rubber fuel hoses that surround the machine screws, therefore the benefits of having rubber come into contact with the ground is maintained.

Another one of the subjects of the project was the material section. The material section is very crucial because different materials perform differently, and with each part being made out of different material, the selection affects the overall performance of the robot.

On the society of Robots website, they recommended constructing robots with either metal like aluminum or steel, wood, plastic or composite. At first it was the notion that the plastics would be the best for use in robots. Plastics have desirable properties such as lightweight, ductility, and low cost. However, from research it was shown that even though plastics have those qualities, it does not have good rigid design strength. This means that if a rigid construction is desired, plastics will give a high deflection. Plastics do not have good bending strength either. The properties that plastic lacks are important to our project, where we need a tight construction to reduce system vibration. Plastics do not have good surface hardness, which means that it is not very resistant to repeating small impact loads. They also are not strong in the form of thin sheet.

Chapter 3 Methodology



Video transmission side Robot control side

Figure: 3.1 Block Diagram of ROBORESQ

The main aim of this project is to control the robot with wireless technology. For this purpose, we designed two separate boards. One is transmitter and another is receiver which is placed on the robot.

In the transmitter, if we press the buttons according to that some predefined data will be transferred through RF communication and the receiver will receive the data. According to the command, the robot will do the specific task i.e. FORWARD, BACKWARD, LEFT and RIGHT. And through the wireless camera, the receiver receive that information.
After receiving the command robot will stop then the robot will move in the same direction in which previously the robot is moving. For this purpose we designed programs in embedded C .In order to fulfill this application there are few steps that has been performed

1) Designing the power supply for the entire circuitry.
2) Selection of microcontroller that suits our application.
3) Development of Robot.
4) Selection of DRIVER IC.
5) Selection of wireless camera

We used DC motors operated by 12V DC power supply. In any electric motor, operation is based on simple electromagnetism. A current carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field.
Motor driver L298N is a monolithic integrated high voltage, high current four channel driver designed to accept standard DTL or TTL logic levels and drive inductive loads and switching power transistors. To simplify use as two bridges each pair of channels is equipped with an enable input. A separate supply input is provided for the logic, allowing operation at a lower voltage and internal clamp diodes are included. This device is suitable for use in switching applications at frequencies up to 5 kHz.

We have developed a remote control device. The remote acts as a client and data are sent via Radio Frequency module. The button sends the status of the switch to microcontroller through RF module over 2.4 GHz frequency up to 100-meter range. The feedback from microcontroller is sent to Arduino which then directs motor driver L298N to drive the motor accordingly.
We started the project with development of wooden chassis. We choose wood to develop our chassis because of its easy modification and installation features along with durability and reliability. The chassis was designed in such a way that robot moves in all terrain and inhabits upside down locomotion.
Proper measurement before drilling holes, labeling of side and assembling them with nails were performed. To enhance the strength of robot we added supporting frames where later we attached the IP camera, matrix board, battery and router.
After developing the chassis, we assembled the motors required for driving the vehicle. Wheels were attached to the motors and finally caterpillar track belt were fitted in the wheels.

Arduino NANO, voltage regulator, six channel transceiver we connected properly in matrix board supplied by Li-Po battery attached to chassis. The Arduino NANO controls overall performance of the robot and acts as brain. The motor driving module is connected to Arduino and drives the motors accordingly to signals provided by Arduino.

A six channel transceiver remote control operating in 2.4 GHz frequency is used to direct robot in desired direction. The upside down locomotion provides aid while moving through hazardous environment.

The IP camera is connected to the router with a LAN cable and both are powered by a high performance Li-Po battery. The router directs the audio visual information to laptop, smart phones wirelessly.

The audio visual can be observed in a smart phone as well as in laptop simultaneously which increases the number of display.

The image signal from Internet Protocol(IP) camera is fed to Wi-Fi router using LAN connection.

Audio and video is captured by IP camera analog pins and audio output is provided by speakers.

3.2 Hardware Description

3.2.1 ARDUINO NANO:

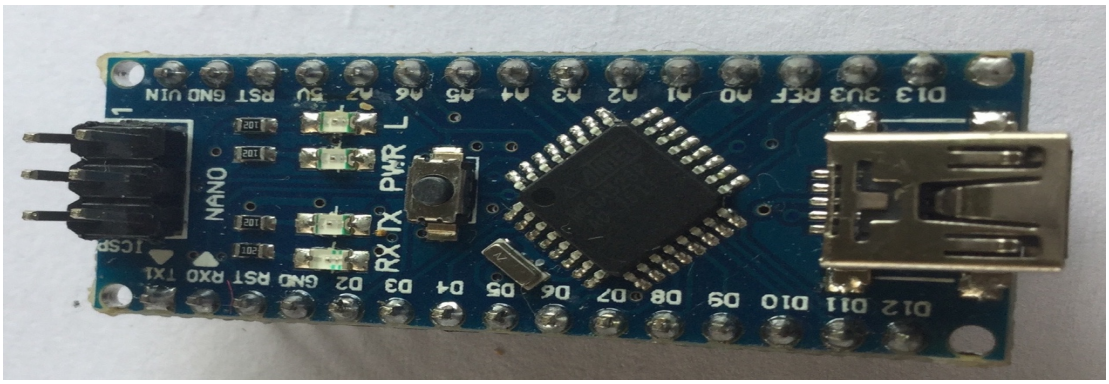


FIGURE 3.2.1 ARDUNINO NANO

Arduino Nano features native Mini-B USB port with ATMEL ATmega328 16MHz Microprocessor. Arduino Nano is easy for hardware prototyping and can be programmed using Arduino IDE desktop application using objective C language. It is small, complete, and breadboard-friendly board based on the ATmega328. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.

SPECIFICATION

1. Operating Voltage (logic level)	5 V
2. Input Voltage (recommended)	7-12 V
3. Input Voltage (limits)	6-20 V
4. Digital I/O Pins	14 (of which 6 provide PWM output)
5. Analog Input Pins	8
6. Clock Speed	16 MHz
7. Dimensions	0.73" x 1.70"

3.2.2 Internet Protocol Camera:

FIGURE 3.2.2 INTERNET PROTOCOL CAMERA

IP Camera stands for Internet Protocol Camera. It has a medium resolution 480p camera which has inbuilt wired and wireless port for webpage based Video and Audio steaming. IP camera hosts a default webpage which can be reached using the Dynamic IP assigned by the router. The devices connected to the router can access the IP camera by its IP address and login using the default username and password to view raw mpeg footage.

SPECIFICATION

1. Input Voltage — 5v 1A DC supply.
2. Output — It has in built audio/video port for streaming.

3.2.3 L298N Motor Driver:

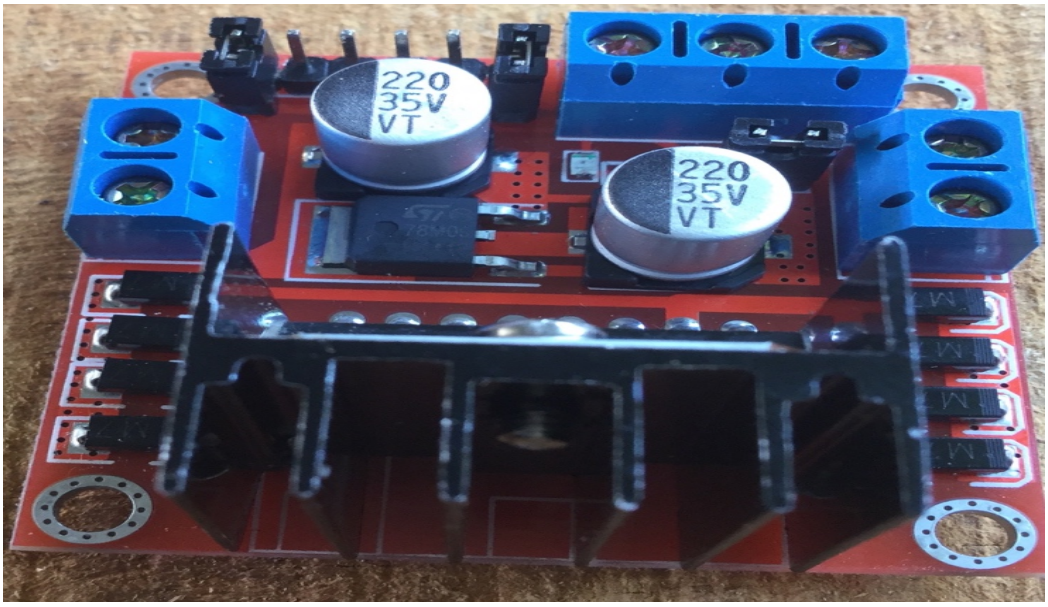


FIGURE 3.2.3 L298N MOTOR DRIVER SHIELD

SPECIFICATION

1.	Driver power supply	+5V~+46V
2.	Driver IO	2A
3.	Logic power output	+5~+7V (internal supply +5V)
4.	Logic current	0~36mA
5.	Controlling level	Low -0.3V~1.5V, high
6.	Enable signal level	Low -0.3V~1.5V, high
7.	Max power	25W (Temperature 75 Celsius)
8.	Working temperature	-25C~+130C
9.	Dimension	60mm*54mm

3.2.4 DC Geared motor:

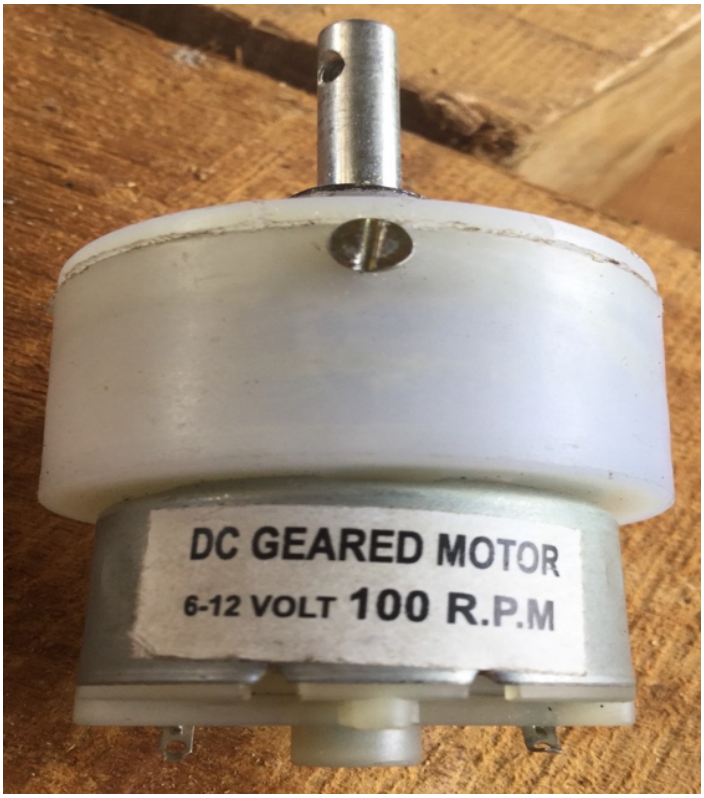


FIGURE: 3.2.4 DC GEARED MOTOR

DC Geared motor features a brushed motor with a driving gearing to decrease the RPM and increase the output torque for high torque application.

SPECIFICATON

1. Input 6-12 Volt
2. R.P.M 100

3.2.5 Wheels and track belt:

FIGURE: 3.2.5 TRACK BELT

Track belt offers all terrain movement in any condition even when the robot flips upside down. Track belt runs through the alignment wheel and driving wheel connected to the DC Geared Motor. One side features only two driving motor and two free wheel motors

SPECIFICATION

1.	Material	Rubber
2.	Length	70 cm
3.	Driving wheels diameter	8 cm
4.	Alignment wheels diameter	4cm

3.2.6 TP-Link TL-WR740N Router

FIGURE 3.2.6 TP-Link TL-WR740N Router

SPECIFICATON

1. Input type RJ-45 Ethernet Cable
2. 150 Mbps wireless data rates ideal for video streaming
3. IP based bandwidth control allows administrators to determine how much bandwidth is allocated to each PC.
4. Wireless security encryption.
5. Seamlessly compatible with 802.11b/g/n devices.

3.2.7 Six CHANNEL TRANSCEIVER:

Figure:3.2.7 Six Channel Transceiver

Hobby King 2.4Ghz six Channel TX & RX is an entry level transmitter offering the reliability of 2.4Ghz signal technology and a receiver with six channel. This transmitter requires PC to modify any of the channel variable including mixing and servo reversing.

SPECIFICATION

Frequency	2.4Ghz (Receiver & Transmitter)
Voltage	5V for Receiver and AAA X 8 for Transmitter

Chapter 4 Result and Discussion

We started the project with development of wooden chassis. We choose wood to develop our chassis because of its easy modification and installation features along with durability and reliability. The chassis was designed in such a way that robot moves in all terrain and inhabits upside down locomotion.
Proper measurement before drilling holes, labeling of side and assembling them with nails were performed. To enhance the strength of robot we added supporting frames where later we attached the IP camera, matrix board, battery and router.
After developing the chassis, we assembled the motors required for driving the vehicle. Wheels were attached to the motors and finally caterpillar track belt were fitted in the wheels.
Arduino NANO, voltage regulator, six channel transceiver we connected properly in matrix board supplied by Li-Po battery attached to chassis. The Arduino NANO controls overall performance of the robot and acts as brain. The motor driving module is connected to Arduino and drives the motors accordingly to signals provided by Arduino.
A six channel transceiver remote control operating in 2.4 GHz frequency is used to direct robot in desired direction. The upside down locomotion provides aid while moving through hazardous environment.
The IP camera is connected to the router with a LAN cable and both are powered by a high performance Li-Po battery. The router directs the audio visual information to laptop, smart phones wirelessly.
The audio visual can be observed in a smart phone as well as in laptop simultaneously which increases the number of display.

Chapter 5 Epilogue

5.1 Limitations:

Our project is designed and developed with high precision however at present it exhibits certain limitations stated as follows:

1. Operation duration:
   The continuous operational time of our robot is 30 minutes. It can be increased by increasing the number of battery used.

2. Rough surface movement:
   At present our robot can overcome obstacle of 8cm which can be increased as requirements which in turn increases size of robot.

3. Operation in hazardous condition:
   At present our robot might come short while operating in hazardous conditions as it is a wooden prototype. However, real-time surrounding information could be gathered.

4. Fire hazards:
   As ROBORESQ is made out of wooden chassis, it is prone to destruction when immersed in fire hazard zone. The camera, Arduino and all other components will be completely destroyed when immersed in fire.

5.2 Conclusion:

This project proposed a search and rescue robot that integrates camera and sensors into a device to collect real-time information for effective search and rescue operations occurred due to various man made or natural calamities.
ROBORESQ has been designed in such a way that it can fulfill the needs of military, police and armed forces. It has many applications and can be used in different scenarios. It is a prototype rescue robot with features to work on harsh conditions and rescue operations.
If the rescue robot proposed in this project is applied to real life hazardous environment, real-time surrounding information could be gathered as it is expected to increase efficiency of rescue operations by following the commands provided to it.

5.3 Future Enhancement:

Further, our robot can be upgraded by addition of various accessories as per requirements. Some of the future advancements are described as:

1. Aluminum Chassis:

   Installation of aluminum chassis will increase body strength of the robot. It will avoid corrosion and decaying increasing the life of robot.

2. Robotic Arm:

   Installation of robotic arm as per requirements will increase versatility and add more applications to the list.

3. Bomb disposal unit:

   Addition of bomb disposal tool in our robot makes it eligible as military machine to operate in bomb disposal squad.

4. Human Detection:

   Searching of victims using various sensors can be effectively monitored with addition of thermal sensors.

Appendix

GANTT CHART

SN	Task	Feb	March	April	May	June	July	Aug
1	Feasibility study							
2	Literature Survey							
3	Requirement Analysis							
4	Initial Circuit Development							
5	Testing and Debugging							
6	Final Tuning							

Table: 6.1 GRNTT CHART

BUDGET STRUCTURE

SN	Components	Quantity	Rate [RS]	Amount [RS]
1	Arduino NANO	1		
2	L298N Motor Driver	1		
3	TP-Link DSL Router	1	1500	1500
4	Caterpillar track belt	2	300	600
5	Six channel transceiver	1	5500	5500
6	2200 maH Lipo battery	1	3200	3200
7	IP camera	1	3500	3500
8	Matrix Board	1	100	100
9	Jumper Wires	20	30	600
10	DC Motors	8	375	3000
			Total	**18000/-**

Table: 6.2 BUDGET STRUCTURE

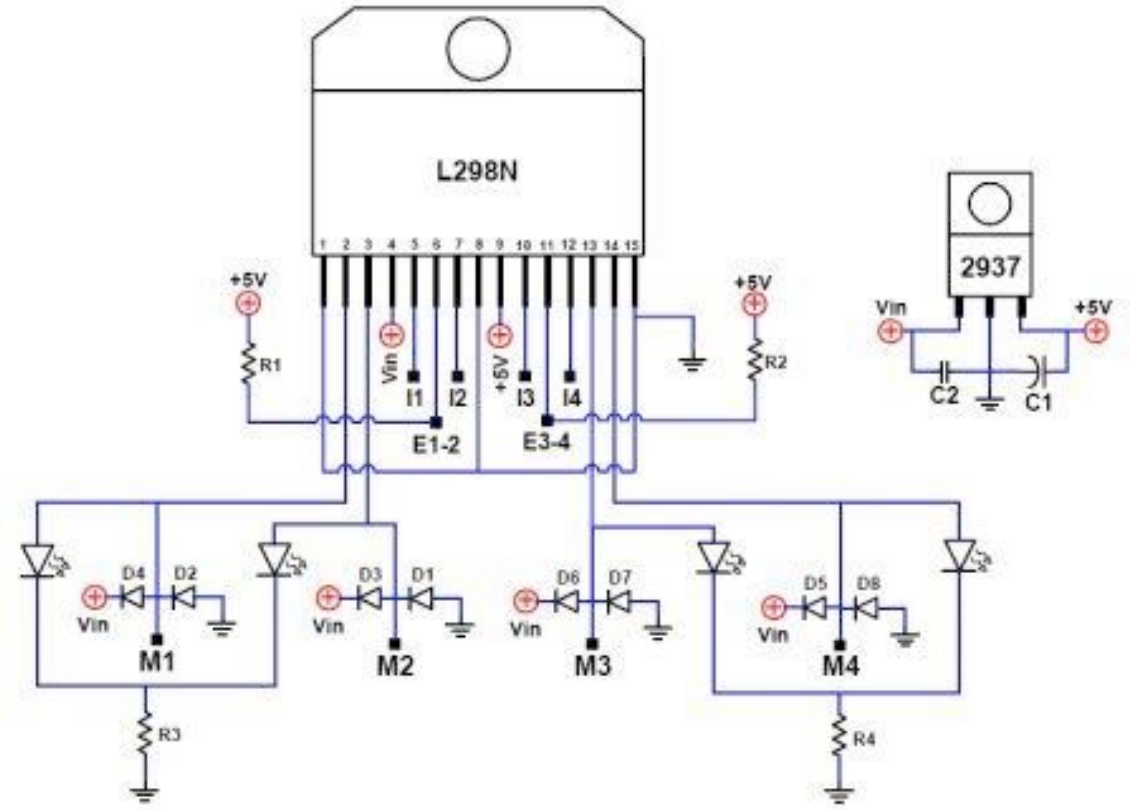


Figure: 6.1 Circuit Diagram of L298N Motor Driver

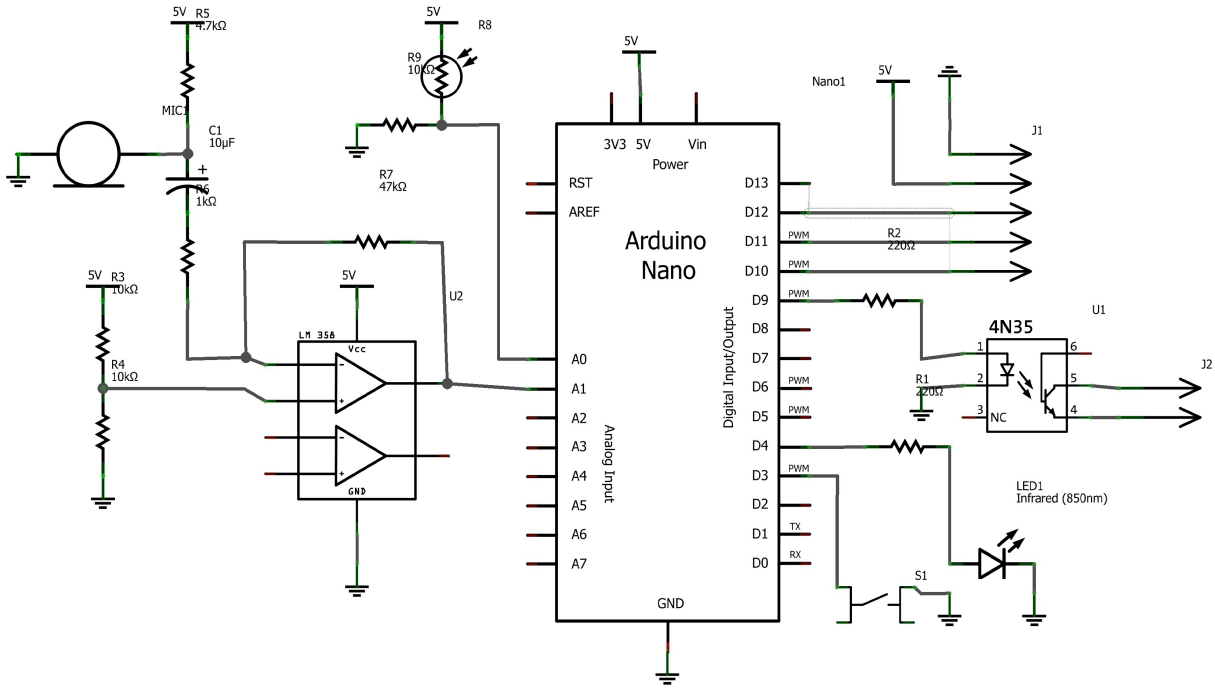


Figure: 6.2 Circuit Diagram of Arduino NANO

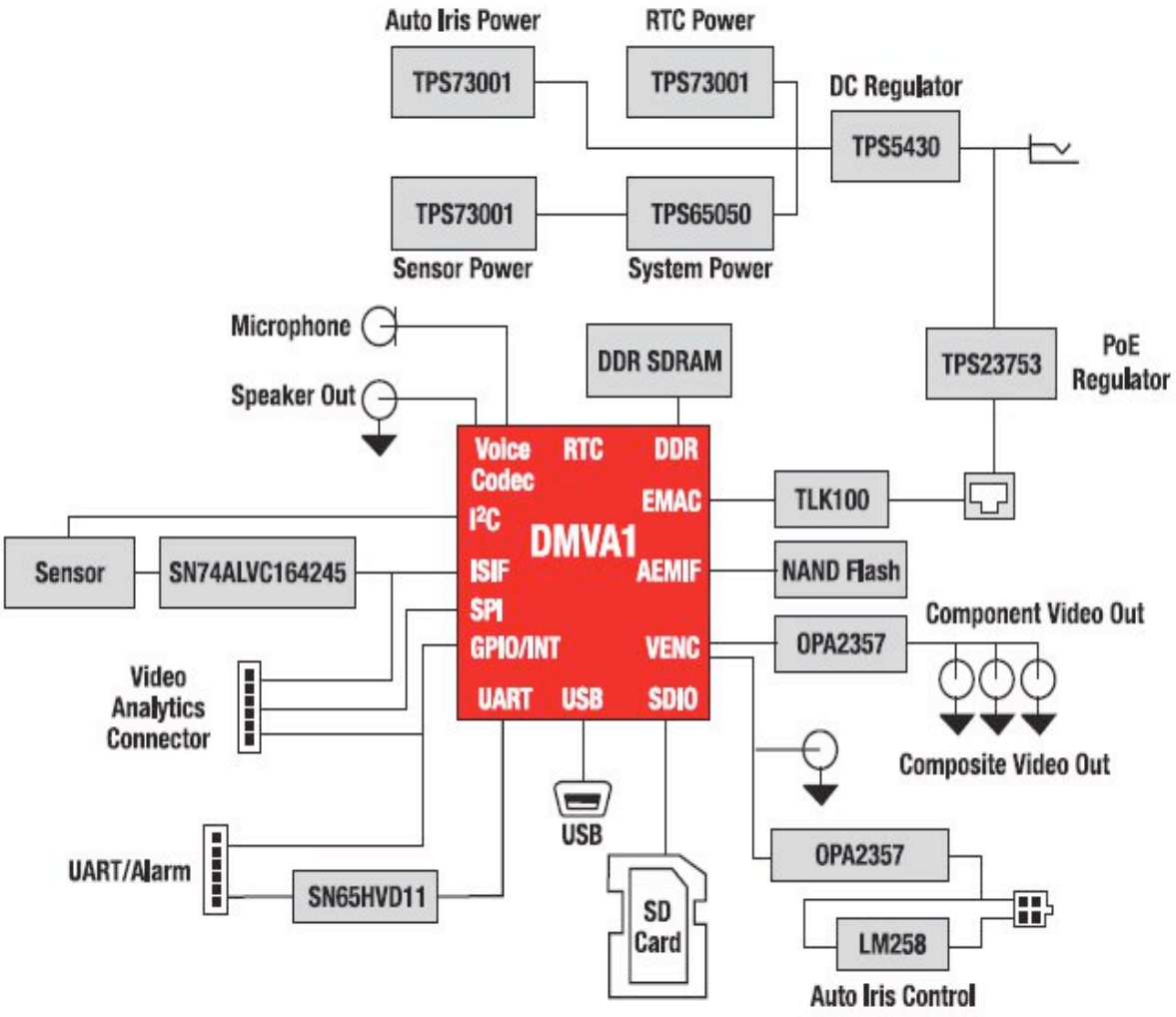


Figure: 6.3 Block Diagram of IP Camera

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[1] Microchip, “PIC16F627A/628A/648A Data Sheet”, ISO/TS 16949:2002, Microchip Technology Incorporated, USA, 2005

[2] D. Ibrahim, “Microcontroller Based Applied Digital Control”, ISBN: 0-470-86335-8, John Wiley & Sons, Ltd, England, 2006.

[3] J. Iovine, “PIC Robotics: A Beginner’s Guide to Robotics Projects Using the PICmicro”, McGraw-Hill, 2004.

[4] Kalyanee N. Kapadnis et al Int. Journal of Engineering Research and Applications ISSN : 2248-9622, Vol. 4, Issue 4(Version 2), April 2014