PROTOTYPE OF RAILWAY TRACK MONITORING AND LIVE STREAMING ROBOT

A major project report submitted to
Jawaharlal Nehru Technological University Hyderabad
in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

In

MECHANICAL ENGINEERING

Under the Guidance of

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Submitted By

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GURU NANAK INSTITUTIONS TECHNICAL CAMPUS

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2021-2022

CERTIFICATE

This is to certify that the Major-Project entitled "**PROTOTYPE OF RAILWAY TRACK MONITORING AND LIVE STREAMING ROBOT**" is being submitted by **Mr. D.ABHISHEK (19WJ5A0323)** in partial fulfilment for the award of the **Degree of Bachelor of Technology in Mechanical Engineering to the Jawaharlal Nehru Technological University Hyderabad** is a record of bonafide work carried out by them under my guidance and supervision.

The results embodied in this Major Project report have not been submitted to any other University or Institute for the award of any Degree or Diploma

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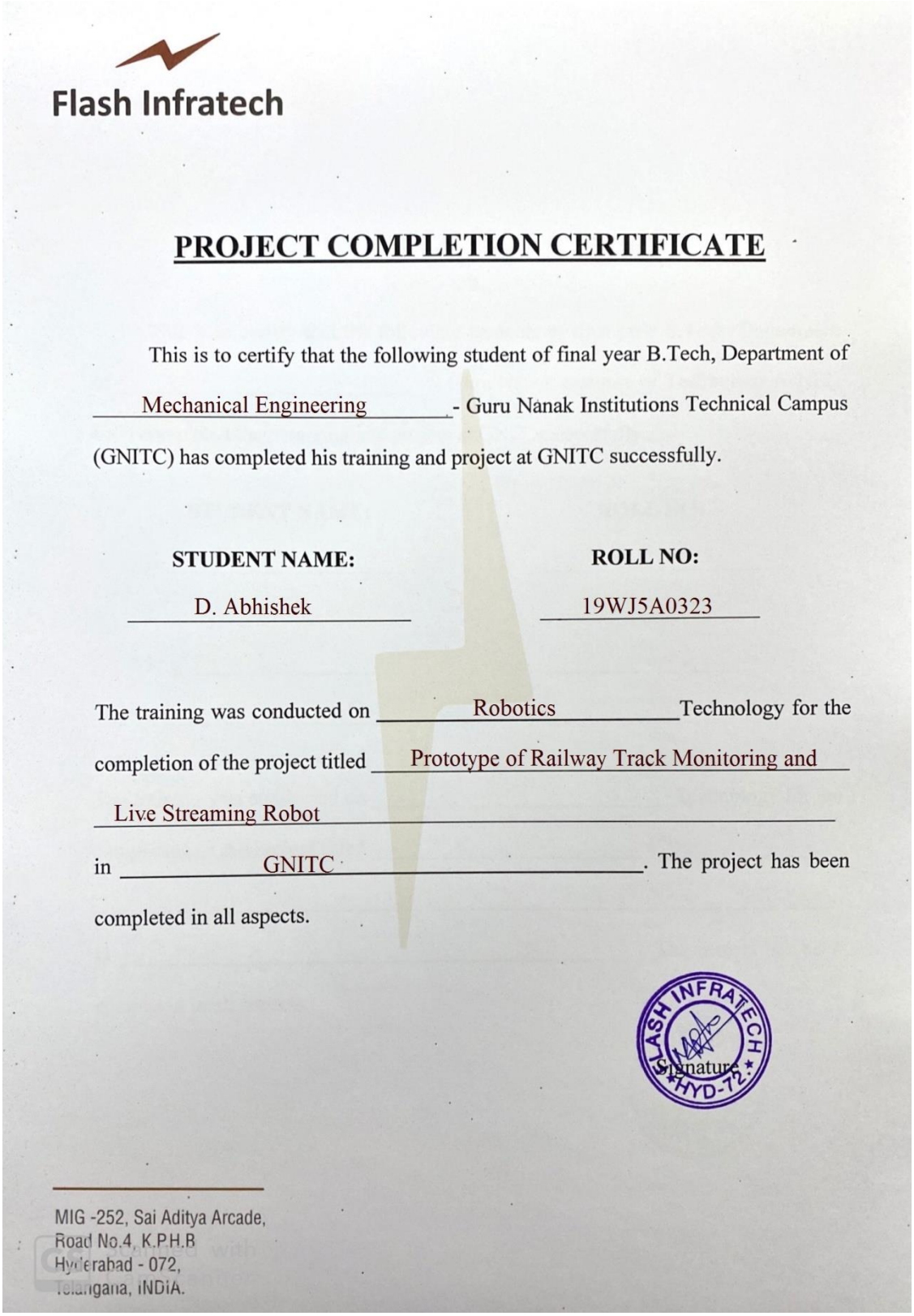
PROJECT COMPLETION CERTIFICATE



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PROJECT COMPLETION CERTIFICATE

This is to certify that the following student of final year B.Tech, Department of Mechanical Engineering - Guru Nanak Institutions Technical Campus (GNITC) has completed his training and project at GNITC successfully.

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The training was conducted on Robotics Technology for the completion of the project titled Prototype of Railway Track Monitoring and Live Streaming Robot in GNITC. The project has been completed in all aspects.

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DECLARATION

I declare that this Major Project report titled **"PROTOTYPE OF RAILWAY TRACK MONITORING AND LIVE STREAMING ROBOT"** submitted in partial fulfilment for the award of the **Degree of Bachelor of Technology in Mechanical Engineering to the Jawaharlal Nehru Technological University Hyderabad** is a record of original work carried out us under the guidance of **Mr . AVISEK TRIPATHY, Asst. Professor, Department of Mechanical Engineering** and has not formed the basis for the award of any other degree or diploma, in this or any other Institution or University. In keeping with the ethical practice in reporting scientific information, due acknowledgements have been made whenever the findings of others have been cited.

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ACKNOWLEDGEMENT

I wish to express our sincere thanks to **Dr. H. S. SAINI**, Managing Director, Guru Nanak Institutions and **Dr. KONDUGANTI VENKATA RAO** , Director, Guru Nanak Institutions Technical Campus, School of Engineering and Technology for providing us with all the necessary facilities and their support.

I place on record, our sincere thanks to **Dr. A. RAJ KUMAR,** Professor and Head of the Department, Mechanical Engineering for his whole-hearted co-operation, providing excellent lab facility, constant encouragement and unfailing inspiration.
We would like to say sincere thanks to **Mr. V. Shyamu**, Professor, Department of Mechanical Engineering for Co-ordinating Projects.

I especially thank our internal guide **Mr . AVISEK TRIPATHY**Asst. Professor, Department of Mechanical Engineering for the suggestions and constant guidance in every stage of the project. We also like to thank all of our lecturers helping us in every possible way.

On a more personal note I thank our BELOVED PARENTS and FRIENDS for their moral support during the course of our project.

Mr. D.ABHISHEK **19WJ5A0323**

ABSTRACT

The Indian Railways has one of the largest railway networks in the world. However, with regard to reliability and passenger safety Indian Railways is not up to global standards. Among other factors, cracks developed on the rails due to the absence of a timely detection and the associated maintenance pose serious questions on the security of operation of rail transport. Usually, rail tracks are inspected only at midnight and also the inspection is carried out only once in a month or lesser. Unfortunately, any emergency issues not detected within the stipulated time leads to train derailment and other safety concerns. A recent study revealed that over twenty five percent of the track length is in need of replacement due to the development of cracks on it. Manual detection of tracks is cumbersome and not fully effective owing to much time consumption and requirement of skilled technicians. This project work is aimed at addressing the above issue by developing an automatic railway track monitoring robot. This robot will help to avoid train accidents by detecting the cracks on railway tracks using ultrasonic sensor. In future it is also capable of alerting the authorities in the form of SMS messages. The IP camera will provide the live feed of the track. The live feed and the data will be updated in the railway track monitoring center. We are looking forward to incorporate GPS and GSM modules, which will send the exact location details of the crack to the railway authorities.

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CHAPTER 1

INTRODUCTION

1. INTRODUCTION

Robotics is the branch of technology that deals with the design, construction, operation and application of robots, as well as computer systems for their control, sensory feedback, and information processing. These technologies deal with automated machines that can take the place of humans in appearance, behavior, and/or cognition. Many of today's robots are inspired by nature contributing to the field of bio-inspired robotics. Robots have become a subject of great interest now-a-days. In our imagination, a robot is a machine that looks like a human being. Robots are in fact, defined as man-made mechanical devices that can move by themselves, whose motion must be modeled, planned, sensed, actuated and controlled, and whose motion behavior can be influenced by "programming". The concept of creating machines that can operate autonomously dates back to classical times, but research into the functionality and potential uses of robots did not grow substantially until the 20th century. Throughout history, robotics has been often seen to mimic human behavior, and often manage tasks in similar fashion. Today, robotics is a rapidly growing field, as technological advances continue, research, design, and building new robots do jobs that are hazardous to people such as defusing bombs, mines and exploring shipwrecks. As strange as it might seem, there really is no standard definition for a robot. However, there are some essential characteristics that a robot must have and this might help you to decide what is and what is not a robot is. It will help you to decide what features you will need to build into a machine before it can count as a robot. A robot has these essential characteristics:

- **Sensing**: First of all your robot would have to be able to sense its surroundings. It would do this in ways that are not dissimilar to the way that you sense your surroundings. Giving your robot sensors (eyes), touch and pressure sensors (hands) taste sensors (tongue) will give your robot awareness of its environment.

- **Movement**: A robot needs to be able to move around its environment. Whether rolling on wheels, walking on legs or propelling by thrusters a robot needs to be able to move. To count as a robot either the whole robot moves, like the sojourner or just parts of the robot moves, like the Canada arm.
- **Energy**: A robot needs to be able power itself. A robot might be solar powered, electrically powered, battery powered. The way your robot gets its energy will depend on what your robot needs to do.
- **Intelligence**: A robot needs some kind of "smarts." This is where programming enters the pictures. A programmer is the person who gives the robot its 'smarts.' The robot will have to have some way to receive the program so that it knows what it is to do.
- It is a system that contains sensors, control systems, manipulators, power supplies and software all working together to perform a task. Designing, building, programming and testing a robot is combination of physics, mechanical engineering, electrical engineering, structural engineering, mathematics and computing. In some cases biology, medicine, chemistry might also be involved. A study of robotics means that students are actively engaged with all of these disciplines in a deeply problem-posing, problem-solving environment.
- ISSAC ASIMOV popularized the term Robotics. Asimov is a visionary who envisioned in the 1930's the position brain for controlling robots. He invented three laws of robotics:

    1 A robot may not harm a human through action or inaction, allow human to come to harm.
    2 A robot must obey the orders given by human beings; expect such when orders conflict with the first law.
    3 A robot must protect its own existence as long as it does not conflict with first or second laws.

1.1 Characteristics :

There are some characteristics of robots given below:

- **Appearance:** Robots have a physical body. They are held by the structure of their body and are moved by their mechanical parts. Without appearance, robots will be just a software program.
- **Brain:** Another name of brain in robots is On-board control unit. Using this robot receive information and sends commands as output. With this control unit robot knows what to do else it'll be just a remote-controlled machine.
- **Sensors:** The use of these sensors in robots is to gather info from the outside world and send it to Brain. Basically, these sensors have circuits in them that produces the voltage in them.
- **Actuators:** The robots move and the parts with the help of these robots move is called Actuators. Some examples of actuators are motors, pumps, and compressor etc. The brain tells these actuators when and how to respond or move.
- **Program:** Robots only works or responds to the instructions which are provided to them in the form of a program. These programs only tell the brain when to perform which operation like when to move, produce sounds etc. These programs only tell the robot how to use sensors data to make decisions.
- **Behaviour :** Robots behavior is decided by the program which has been built for it. Once the robot starts making the movement, one can easily tell which kind of program is being installed inside the robot.

1.2 Types of Robots :

These are the some types of robots given below:

- **Articulated:** The feature of this robot is its rotary joints and range of these are from 2 to 10 or more joints. The arm is connected to the rotary joint and each joint is known as the axis which provides a range of movements.

- **Cartesian:** These are also known as gantry robots. These have three joints which use the Cartesian coordinate system i.e x, y, z. These robots are provided with attached wrists to provide rotatory motion.
- **Cylindrical:** These types of robots have at least one rotatory joints and one prismatic joint which are used to connect the links. The use of rotatory joints is to rotate along the axis and prismatic joint used to provide linear motion.
- **Polar:** These are also known as spherical robots. The arm is connected to base with a twisting joint and have a combination of 2 rotatory joint and one linear joint.
- **Scara:** These robots are mainly used in assembly applications. Its arm is in cylindrical in design. It has two parallel joints which are used to provide compliance in one selected plane.
- **Delta:** The structure of these robots are like spider-shaped. They are built by joint parallelograms that are connected to the common base. The parallelogram moves in a dome-shaped work area. These are mainly used in food and electrical industries.

1.3 Scope and limitations of robots:

The advance version of machines are robots which are used to do advanced tasks and are programmed to make decisions on their own. When a robot is designed the most important thing to be kept in mind is that What the function is to be performed and what are the limitations of the robot. Each robot has a basic level of complexity and each of the levels has the scope which limits the functions that are to be performed. For general basic robots, their complexity is decided by the number of limbs, actuators and the sensors that are used while for advanced robots the complexity is decided by the number of microprocessors and microcontroller used. As increasing any component in the robot, it is increasing the scope of the robot and with every joint added, the degree of the robot is enhanced.

1.3.1 Applications:

Different types of robots can performs different types of tasks. For example, many of the robots are made for assembly work which means that they are not relevant for any other work and these types of robots are called Assembly Robots. Similarly, for seam welding many suppliers provide robots with their welding materials and these types of robots are known as Welding Robots. While on the other hand many robots are designed for heavy-duty work and are known as Heavy Duty Robots.

There are some applications given below:

- Caterpillar plans which is aiming to develop remote-controlled machines and are expecting to develop heavy robots by 2021.
- A robot can also do Herding task.
- Robots are increasingly been used more than humans in manufacturing while in auto-industry there are more than half of the labors are “Robots”.
- Many of the robots are used as Military Robots.
- Robots have been used in cleaning up of areas like toxic waste or industrial wastes etc.
- Agricultural robots.
- Household robots.
- Domestic robots.
- Nano robots.
- Swarm robots.

1.4 Aim and Scope:

We often observe that approximately 50% of the rail accidents cause due to derailment, and 90% of these accidents cause due to cracks and sabotage on railway tracks. Those cracks are unnoticed by the track man assigned by the railway department.The principal problem has been the lack of cheap and efficient technology to detect problems in the rail tracks and of course, the lack of proper maintenance of rails which have resulted in the formation of cracks in the rails. we are proposing our

idea to minimize accidents due to cracks in railway tracks and live stream the situation of province. The Railway Track inspection robot is implemented where communication, crack detection, recognize a human being present on the railway track.We are implementing Live Tracking to avoid manual checking of cracks or wrecks on the track and detects the human being's presence on the track (if in case of suicide attempts).Along with live tracking, the robot ensure cleaning the dust on tracks by using rotating brush provided at the front area of robot, the mechanism is controlled by dc motor. The implementation of Internet of Things (IOT), which is a fast growing technology in the present times, is used for smart surveillance system i.e., live streaming using IP camera.

1.5 Basic Principle involved:

This system is used in between two stations which will detect the cracks present on the track using IP camera which can be monitored at control unit. The robot is controlled using two applications, one for video streaming and other to control the movements. Any crack it detected while monitoring, we can analyze the intensity of crack and take immediate actions to avoid any derailments. The cleaning of dust on tracks is continuous and it is ensured by a rotating brush (inwards) which is connected to the dc motor.

1.6 Problem identification Existing system of project:

According to a survey conducted through the years 2010-2017, there had been 895 people killed and 2123 people injured in a train derailment accident in India. The main cause of this accidents are the cracks on the railway track and an unstable rock level. The principal problem has been the lack of cheap and efficient technology to detect problems in the rail tracks and of course, the lack of proper maintenance of rails which have resulted in the formation of cracks in the rails and other similar problems caused by antisocial elements which expose the security of operation of rail transport. In the past, this problem has led to a number of derailments resulting in a heavy loss of life and property. Cracks in rails have been identified to be the main cause of

derailments in the past, yet there have been no cheap automated solutions available for testing purposes.

Fig 1.1: Problem identification and existing system to inspect.

The above figure no 1.1 shows the manual inspection of railway tracks, which is the existing model of inspecting the tracks. It's a most tedious and not an economical process of inspection.

1.7 PROPOSED SYSTEM OF PROJECT

In order to solve this problem, an autonomous mobile robot has been created. This robot will continuously run on the railway tracks for railway safety monitoring and save the priceless human lives in case of an accident as shown in figure no 1.2.

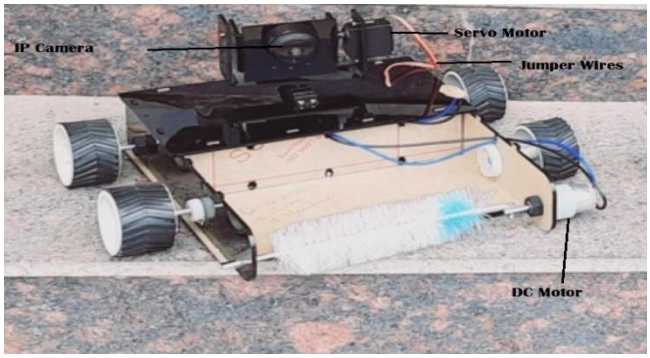

Fig 1.2: Proposed system of project.

1.8 Introduction to HC-05 module:

- It is used for many applications like wireless headset, game controllers, wireless mouse, wireless keyboard and many more consumer applications.

- It has range up to <100m which depends upon transmitter and receiver, atmosphere, geographic & urban conditions.
- It is IEEE 802.15.1 standardized protocol, through which one can build wireless Personal Area Network (PAN). It uses frequency-hopping spread spectrum (FHSS) radio technology to send data over air.
- It uses serial communication to communicate with devices. It communicates with microcontroller using serial port (USART).

1.8.1 HC-05 Bluetooth Module

HC-05 is a Bluetooth module which is designed for wireless communication as shown in figure no 1.3 and 1.4 . This module can be used in a master or slave configuration.

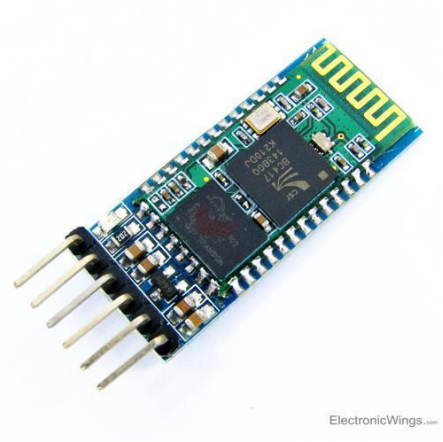

Fig1.3 : HC-05 Bluetooth Module

Fig 1.4: Pin Description

Bluetooth serial modules allow all serial enabled devices to communicate with each other using Bluetooth. It has 6 pins:

1. **Key/EN**: It is used to bring Bluetooth module in AT commands mode. If Key/EN pin is set to high, then this module will work in command mode. Otherwise by default it is in data mode.

   The default baud rate of HC-05 in command mode is 38400bps and 9600 in data mode. HC-05 module has two modes,

   - **Data mode:** Exchange of data between devices.
   - **Command mode:** It uses AT commands which are used to change setting of HC-05. To send these commands to module serial (USART) port is used.
2. **VCC**: Connect 5 V or 3.3 V to this Pin.
3. **GND**: Ground Pin of module.
4. **TXD:** Transmit Serial data (wirelessly received data by Bluetooth module transmitted out serially on TXD pin)
5. **RXD**: Receive data serially (received data will be transmitted wirelessly by Bluetooth module).
6. **State:** It tells whether module is connected or not.

1.8.2 HC-05 module Information

HC-05 has red LED which indicates connection status, whether the Bluetooth is connected or not. Before connecting to HC-05 module this red LED blinks continuously in a periodic manner. When it gets connected to any other Bluetooth device, its blinking slows down to two seconds. This module works on 3.3 V. We can connect 5V supply voltage as well since the module has on board 5 to 3.3 V regulators. As HC-05 Bluetooth module has 3.3 V level for RX/TX and microcontroller can detect 3.3 V level, so, no need to shift transmit level of HC-05 module. But we need to shift the transmit voltage level from microcontroller to RX of HC-05 module.

1.8.3 Bluetooth communication between Devices

E.g. Send data from Smartphone terminal to HC-05 Bluetooth module and see this data on PC serial terminal and vice versa as shown in figure no 1.5.

To communicate Smartphone with HC-05 Bluetooth module, smart phone requires Bluetooth terminal application for transmitting and receiving data. You can find Bluetooth terminal applications for android and windows in respective app store.

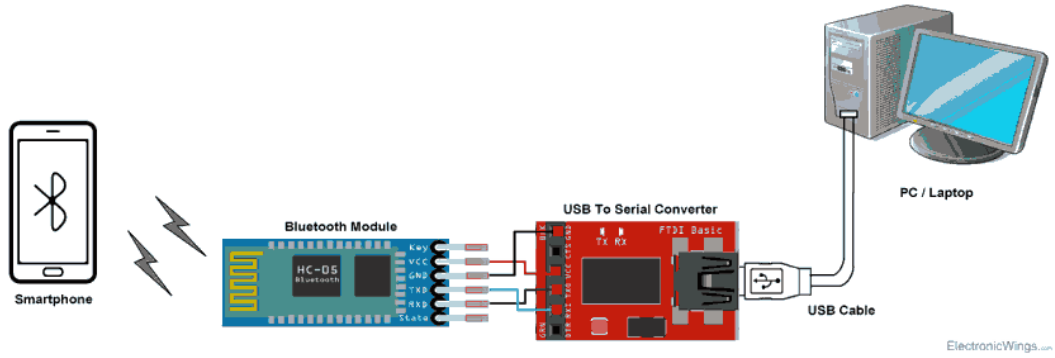

Fig 1.5 : Bluetooth communication between Devices.

1.8.4 Pair HC-05 and Smartphone:

Search for new Bluetooth device from your phone. You will find Bluetooth device with "HC-05" name. Click on connect/pair device option; default pin for HC-05 is 1234 or 0000. After pairing two Bluetooth devices, open terminal software (e.g. Teraterm, Real term etc.) in PC, and select the port where we have connected USB to serial module. Also select default baud rate of 9600 bps. In smart phone, open Bluetooth terminal application and connect to paired device HC-05. It is simple to communicate; we just have to type in the Bluetooth terminal application of Smartphone. Characters will get sent wirelessly to Bluetooth module HC-05. HC-05 will automatically transmit it serially to the PC, which will appear on terminal. Same way we can send data from PC to smart phone.

1.8.5 Command Mode

- When we want to change settings of HC-05 Bluetooth module like change password for connection, baud rate, Bluetooth device's name etc.

- To do this, HC-05 has AT commands.
- To use HC-05 Bluetooth module in AT command mode, connect “Key” pin to High (VCC).
- Default Baud rate of HC-05 in command mode is 38400bps.
- Following are some AT command generally used to change setting of Bluetooth module.
- To send these commands, we have to connect HC-05 Bluetooth module to the PC via serial to USB converter and transmit these command through serial terminal of PC.

1.9 HC-05 Bluetooth Module Interfacing with AVR ATmega16/ATmega32

Introduction

- HC-05 is a Bluetooth device used for wireless communication. It works on serial communication (USART).
- It is a 6 pin module.
- The device can be used in 2 modes; data mode and command mode.
- The data mode is used for data transfer between devices whereas command mode is used for changing the settings of the Bluetooth module.
- AT commands are required in command mode.
- The module works on 5V or 3.3V. It has an onboard 5V to 3.3V regulator.
- As the HC-05 Bluetooth module has a 3.3 V level for RX/TX and the microcontroller can detect 3.3 V level, so, no need to shift the transmit level of the HC-05 module. But we need to shift the transmit voltage level from the microcontroller to RX of the HC-05 module.
- For more information about the HC-05 Bluetooth module and how to use it, refer to the topic Bluetooth module HC-05 in the sensors and modules section.

- For information on USART in AVR ATmega16/ATmega32 and how to use it, refer the topic on USART in AVR ATmega16/ATmega32 in the ATmega inside section.

CHAPTER

2. LITERATURE REVIEW

Ch. Muneendra Rao , B. R. Bala Jaswanth and Ch. Muneendra Rao, "Crack Sensing Scheme in Rail Tracking System in Int. Journal of Engineering Research and Applications", January 2014. The presented system helps to detect the flaws in the rail track using ultrasound testing method. When the crack is detected, respective coordinates are send to the nearest station. This recording and sending of coordinates is done by GPS and GSM module. Ultrasonic technique is the most effective system it even detects minor cracks and also calculates the growth rate of the crack. The growth rate can be detected after several observations at regular intervals. The drawback of the system was that the security while sending the data was not considered.[1]

Pranav Lad, Mansi Pawar, "Evolution of Railway Track Crack Detection System in IEEE procedings", 2016.The core of the proposed crack detection scheme consists of a Light Emitting Diode (LED)-Light Dependent Resistor (LDR) assembly that functions as the rail crack detector. The principle involved in crack detection is the concept of LDR. In the proposed design, the LED will be attached to one side of the rails and the LDR to the opposite side. During normal operation, when there are no cracks, the LED light does not fall on the LDR and hence the LDR resistance is high. Subsequently, when the LED light falls on the LDR, the resistance of the LDR gets reduced and crack get detected. The drawback of the system is that track is occupied and also the result get affected due to sunlight.[2]

Sireesha R, Ajay Kumar B, Mallik Arjunaiah G and Bharath Kumar B, "Broken Rail Detection System using RF Technology in "SSRG International Journal of Electronics and Communication Engineering,volume-2 issue 4-April 2015.In the given system, the robot is designed for finding cracks in the railway tracks. The microcontroller is interfaced with Robot, ZigBee, GPS, LCD and Crack Sensor. The IR sensor senses the voltage variations from the crack sensor and then it gives the signal to the microcontroller. It checks the variations in the voltage of the measured value with the threshold value. If it detects the crack in the railway track, it immediately gets the exact location information using Global Positioning System (GPS) and Global System for mobile (GSM) and sends that location and crack information to the control section. The main drawback is that the results of IR sensor are not accurate in light. The energy efficiency of the system is low.[3]

prof. p. navaraja "crack detection system for railway track by using ultrasonic and pir sensor", in International Journal of Advanced Information and Communication Technology ,volume-1, issue-1, may 2014.This paper proposes a secure data transmission scheme based on digital watermarking technique. The sensor node calculates the hash value of sensitive data, which collected at two different times. Then, the sensitive data are embedded into the hash value as watermark information according to the digital watermark algorithm.[4]

"Designing of Improved Monitoring System for Crack Detection on Railway Tracks "Author- Nilisha Patil1 , Dipakkumar Shahare, Shreya Hanwate, Pranali Bagde, Karuna Kamble, Prof. Manoj Titre. Published-April 2021 In this paper, we present an automated system based on microcontroller and sensors to overcome the problem of faults in tracks and to identify the moving object or animal on the tracks. The system designed is an autonomous robot consist of PIR and Ultrasonic sensors, coupled with GPS and GSM for providing the real time alert.[5]

"Detection of Crack in Railway Track using Ultrasonic Sensors" Author- Anushree B.S, Priyasha Purkayastha, Anjali Girgire, Anjana K,Ruma Sinha. Published-May 2017 This paper a crack detection system is proposed which detects the crack without human intervention and sends the location of fault to the authorized personnel using GSM. Crack detection by this method can be done during both day and night time and exact location of fault can be obtained.[6]

"Automatic Railway Track Crack Detection System" Author- Rahul Singh, Leena Sharma, Vandana Singh , Vivek Kr. Singh. Published- May 2020. Aims of designing a railway crack detection system (RCDS) using Ultrasonic Sensor, The GSM (Global System for Mobile Communications), GPS (Global Positioning System) and Arduino based module whose implementation is an efficient method of detecting the cracks which is present in the tracks and thus avoiding derailment of the trains.[7]

"Railway Track Crack Detection" Author- Arun Kumar R, Vanishree K, Shweta K, Nandini C, Shweta G. Published-2020 This project discusses a Railway track crack detection using sensors and is a dynamic approach which combines the use of GPS tracking system to send alert messages and the geographical coordinate of location. Arduino Microcontrollers used to control and coordinate the activities of this device. The main aim of the project is to design the railway crack detection using ultrasonic sensors.[8]

CHAPTER
3. METHODOLOGY

DESCRIPTION:

Railway track monitoring and live streaming robot is remotely controlled robot, equipped with Bluetooth module and an IP camera . It travels along the track in search of cracks, removes dirt present on track by sweeping with brush which is driven by motor. The major connections and methodology involved are illustrated below fig number 3.1:

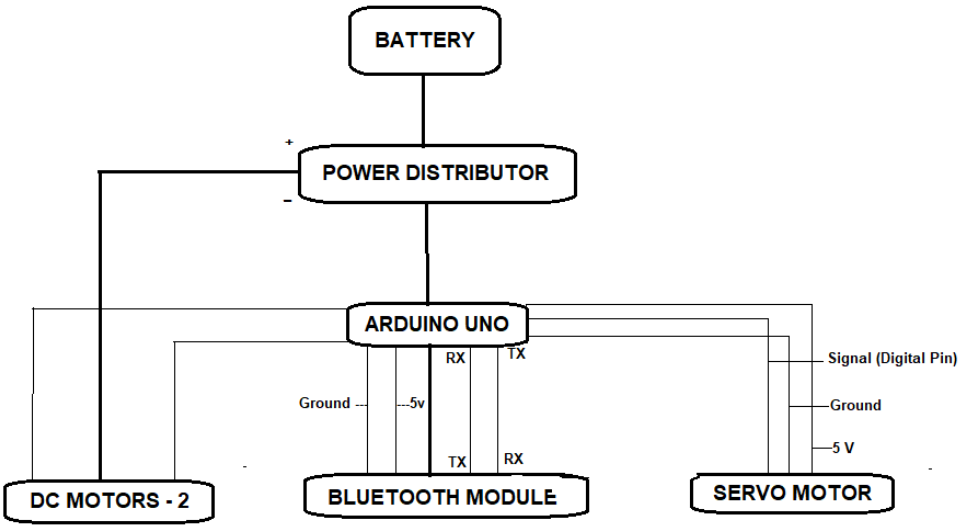

Fig 3.1: Block diagram of railway track monitoring robot

3.1 Battery to Arduino :

Connect the black lead from the battery connector to one of the Arduino's ground pins (GND), and connect the lead from the toggle switch to Arduino's Vin pin. Connection of the Battery is done . Now the Arduino Uno will turn on when the switch is closed and turn off when it is open.

3.2 Motor Drivers to Arduino :

Connected 5V and ground to 5V and ground of Arduino. The block diagram is shown in below figure number 3.2.

We made connections as follows :

- Input 1 to pin 8 of Arduino
- Input 2 to pin 9 of Arduino

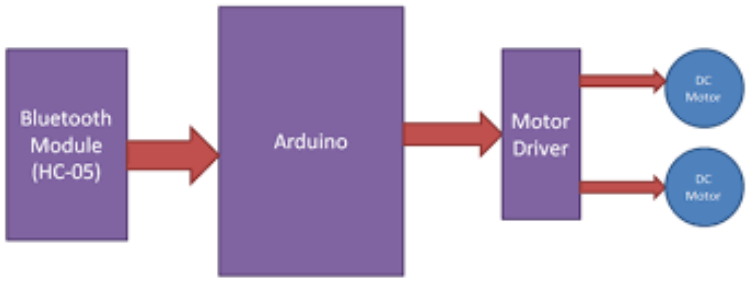

Fig 3.2 : Block diagram of motor drive of robot

3.3 Servo Motors to Arduino :

Servo motors have three wires: power, ground, and signal. The power wire is typically red, and should be connected to the 5V pin on the Arduino board. The ground wire is typically black or brown and should be connected to a ground pin on the Arduino board. Here we have connected the six pins of servomotor (i.e, 3 pins of each Motor) to the output pins of Arduino (Digital Pins).

3.4 Bluetooth Module to Arduino :

- RXD - Serial Data Receive Pin. Used for serial input. 3.3V logic
- TXD - Serial Data Transmit Pin. Used for serial output. 3.3V logic
- GND - Ground
- VCC - +5V.

The connections are made as follows:

- RXD ---> TX
- TXD ---> RX
- GND ---> GND
- VCC ---> 5V

CHAPTER 4

HARDWARE DESCRIPTION

Actuators: An actuator is a component of a machine that is responsible for moving and controlling a mechanism or system It consists of two DC motors as actuators that provide reverse and forward motion to the robot.

Receiver Unit: The robot also consists of a receiver unit that receives the command signals for controlling the motors and thus the robot unit.

Control Unit: It consists of are mote transmitter unit consisting of a micro controller, encoder, and an RF module and a receiver unit embedded on the circuit consisting of an RF receiver module, a micro controller, and a decoder.

4. ELECTRONIC COMPONENTS:

- DC motors – 3
- Wireless IP camera
- Servo Motors - 2
- Arduino board
- Lithium Polymer Battery
- Bluetooth Module

4.1 Arduino board

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 16MHz 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 Atmega1602 (Atmega8u2 up to version R2) programmed as a USB-toserial converter. Revision 2 of the Uno board has a resistor pulling the BU2 HWB line to ground,

making it easier to put into DFU mode. Revision 3 of the board has the following new features:

- Pinout: added SDA and SCI pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin, that is reserved for future purposes. Stronger RESET circuit. At mega 16U2 replace the 8U2. "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.

4.1.1 Schematic and Reference Design

EAGLE files; arduino-uno-Rev3-reference-design.zip. (NOTE works with Eagle 6.0 and newer) Schematic: Arduino uno Rev3-schematic.pdf Note: The Arduino reference design can use an Atmega8, 168, or 328, Current models use an ATmega328, but an AT mega is shown in the schematic for reference. The pin configuration is identical on all three processors.

4.1.2 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 God and Vin pin headers of the POWER connect to the board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the SV pin may supply less than five volts and the board may be unstable. If using more then 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 6 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 3.3volt supply generated by the on-board regulator. Maximum current draw is 50 mA. GND: Ground pins

4.1.3 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).

4.1.4 Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pin Mode (), digital Write (), and digital Read () 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 k ohms. 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. See the attach Interrupt () function for details.

- **PWM:** 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analog Write () 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, 7 the LED is on, when the pin is LOW, it's off. The Uno has 6 analog inputs, labelled AD through AS, each of which provide 10 bits of resolution (. 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 analog Reference () 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 analog Reference ().
    - **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. See also the mapping between Arduino pins and ATmega328 ports. The mapping for the Atmega8, 168, and 328 Is identical.

4.1.5 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 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-toserial chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also supports 12C (TWT) and SP1 communication. The Arduino software includes a Wire library to simplify use of the 12C bus; see the documentation for details. For SPI communication, use the SPI library.

4.1.6 Programming

The Arduino Uno can be Uno from the Tools programmed with the Arduino software (down- 8 load). Select "Arduino Board menu (according to the microcontroller on your board). For details, see the reference and tutorials. The ATmega328 on the Arduino Uno comes pre burned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files). You can also bypass the bootloader and program the microcontroller through the ICSP (In Circuit Serial Programming) header; see these instructions for details. The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available. The ATmega1602/8U2 is loaded with a DFU bootloader, which can be activated by: On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the BU2. On Rev2 or later boards: there is a resistor that pulling the BU2/16U2 HWB line to ground, making it easier to put into DFU mode. You can then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Unix) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU bootloader). See this user-contributed tutorial for more information.

4.1.7 Automatic (Software) Reset

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 (OTR) of the ATmega8U2/1602 is connected to the reset line of the ATmega328 via a 100 nF 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 (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. 9 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 labelled "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. The Arduino Uno has a resettable polyfused that protects your computer's USB ports.

4.1.8 USB

Over current Protection 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.

4.1.9 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-mill spacing of the other ins.

4.1.10 Applications

There are hundreds of applications forATMEGA328P:

- Used in ARDUINOUNO,ARDUINO NANO and ARDUINO MICRO boards.
- Industrial control systems.
- SMPS and Power Regulation systems.
- Digital data processing.
- Analog signal measuring and manipulations.
- Embedded systems like coffee machine, vending machine.
- Motor control systems.
- Display units.
- Peripheral Interface system.

4.2 DC Motor

A same DC machine can be used as a motor or generator is same as that of the DC Generator. In our project we are using 4 dc motor as shown in fig no 4.1.

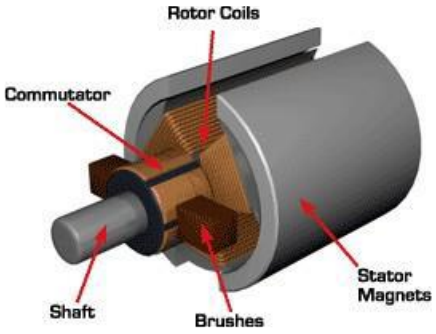

Fig 4.1: Schematic diagram of DC motor.

4.2.1 Working principle of DC motor

A motor is an electrical machine which converts electrical energy into mechanical energy. The principle of working of a DC motor is that "when a current carrying conductor is placed in a magnetic field, it experiences a mechanical force". The direction of this force is given by Fleming's left hand rule and its magnitude is given by

F= magnetic flux density (B)*current(I)*length(L).

Fleming's left hand rule: if we extend index finger, middle finger and thumb of our left hand, perpendicular to each other, and direction of magnetic field is represented by index finger, direction of current is represented by middle finger, and then the thumb represents the direction of the force experienced by the current carrying conductor.

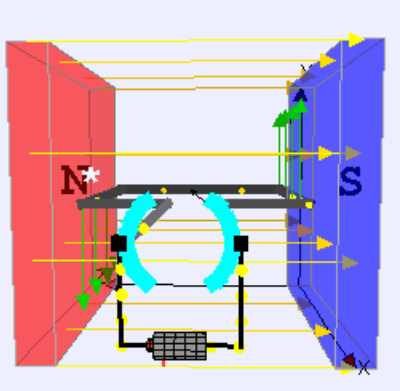

Fig 4.2 : Working priciple of DC motor.

Above figure 4.2 helps in understanding the working principle of a DC motor. When armature windings are connected to DC supply, current sets up in the winding. Magnetic field maybe provided by field winding (electromagnetism) or by using permanent magnets. In this case, current carrying armature conductors experience force due to the magnetic field, according to the principle stated above.

Commutator is made segmented to achieve unidirectional torque. Otherwise, the direction of force would have reversed every time when the direction of movement of conductor is reversing the magnetic field. This is how a DC motor works.

4.2.2 Motor Driver

L298D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L298D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L298D IC. Dual H-bridge Motor Driver integrated circuit (IC).

4.2.3 Concept

It works on the concept of H-bridge. H-bridge is a circuit which allows the voltage to be flown in either direction. As you know voltage need to change its direction for being able to rotate the motor in clockwise or anticlockwise direction, hence H-bridge IC are ideal for driving a DC motor.

In a single l298d chip there two h-Bridge circuit inside the IC which can rotate two dc motor independently. Due its size it is very much used in robotic application for controlling DC motors. Given below is the pin diagram of a L298D motor controller.

There are two Enable pins on l298d. Pin 1 and pin 9, for being able to drive the motor, the pin 1 and 9 need to be high. For driving the motor with left H-bridge you need to enable pin 1 to high. And for right H-Bridge you need to make the pin 9 to high. If anyone of the either pin1 or pin9 goes low then the motor in the corresponding section will suspend working. It's like a switch.

Max RPM	100 rpm
Input Voltage	6-12 V

Table 4.1 :Specifications of Dc motor

4.3 Bluetooth module

HC-05 module is an easy-to-use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore 04-External single chip Bluetooth system with CMOS technology and with AFH(Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm. Hope it will simplify your overall design/development cycle.

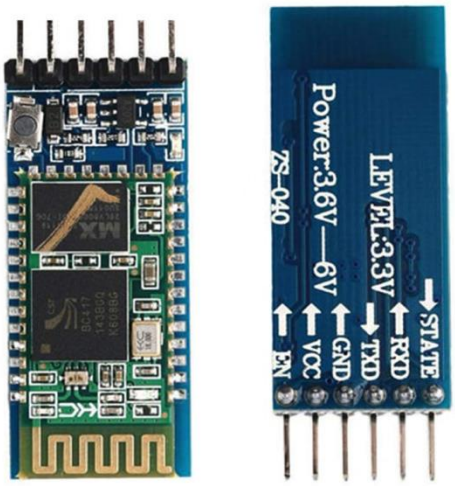

Fig no 4.3: Bluetooth Module.

4.3.1 Specifications:

The fig.2.3 illustrates the following specifications:

- Typical -80dBm sensitivity
- Up to +4dBm RF transmit power
- Low Power 1.8V Operation ,1.8 to 3.6V I/O
- PIO control
- UART interface with programmable baud rate
- With integrated antenna
- With edge connector

4.3.2 Working principle:

A Bluetooth technology is a high-speed low powered wireless technology link that is designed to connect phones or other portable equipment together. It is a specification (IEEE 802.15.1) for the use of low power radio communications to link phones, computers and other network devices over short distance without wires. Wireless signals transmitted with Bluetooth cover short distances, typically up to 30 feet (10 meters).

It is achieved by embedded low cost transceivers into the devices. It supports on the frequency band of 2.45GHz and can support upto 721KBps along with three voice channels. This frequency band has been set aside by international agreement for the use of industrial, scientific and medical devices (ISM).rd-compatible with 1.0 devices. Bluetooth can connect up to "**eight devices"** simultaneously and each device offers a unique 48 bit address from the IEEE 802 standard with the connections being made point to point or multipoint. Bluetooth Network consists of a Personal Area Network or a piconet which contains a minimum of 2 to maximum of 8 bluetooth peer devices- Usually a single master and upto 7 slaves. A master is the device which initiates communication with other devices. The master device governs the communications link and traffic between itself and the slave devices associated with it. A slave device is the device that responds to the master device. Slave devices are required to synchronize their transmit/receive timing with that of the masters. In addition, transmissions by slave devices are governed by the master device (i.e., the master device dictates when a slave device may transmit). Specifically, a slave may only begin its transmissions in a time slot immediately following the time slot in which it was addressed by the master, or in a time slot explicitly reserved for use by the slave device.

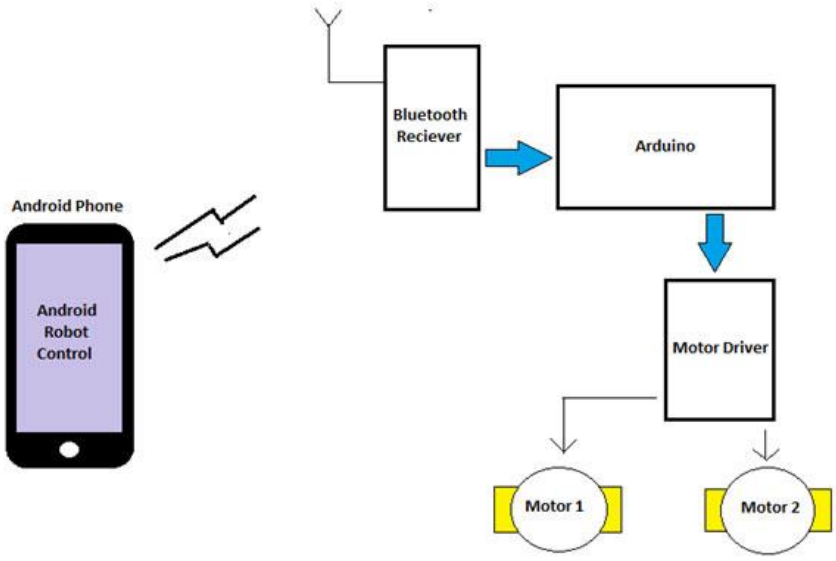

Fig no 4.4 : Bluetooth connection between mobile and robot

As shown from the fig 4.4 Robot is controlled by using Android mobile phone instead of any other method like buttons, gesture etc. Here only needs to touch button in android phone to control the car in forward, backward, left and right directions. So here android phone is used as transmitting device and Bluetooth module placed in car is used as receiver. Android phone will transmit command using its in-built Bluetooth to car so that it can move in the required direction like moving forward, reverse, turning left, turning right and stop.

4.4 IP camera:

An IP camera, or Internet protocol camera, is a type of digital security camera that receives and sends video footage via an IP network. They are commonly used for surveillance. Unlike analog closed-circuit television cameras (CCTV), IP cameras do not require a local recording device, only a local network. IP cameras connect to a network in the same way that phones and computers. IP camera shown in fig 4.5

Fig no 4.5: IP camera

4.5 HOW DO NETWORKED IP CAMERAS WORK?

Analog and analog-over-digital security cameras require a coaxial video cable in order to transmit footage to a digital video recorder (DVR). On the other hand, an IP security camera can transmit footage over a wireless connection. Specifically, IP cameras

connect to a network video recorder (NVR) via Wi-Fi, an Ethernet cable, or USB. An IP camera captures footage in high definition—resolution can be as high as 16 megapixels, depending on the camera model. Each IP camera comes equipped with a processing chip, which compresses the video footage as it is recorded. What's that mean? Well, the higher the camera resolution, the more data each video recording contains. High-resolution images require more storage space and more bandwidth for data transmission than lower-quality images. To transmit HD images over a network, IP cameras must compress the files, or make the files smaller, to avoid consuming too much bandwidth. Modern compression standards like h.264 and MPEG-4 mean that there is either no drop, or just a small drop in frame rate and resolution when the footage finally reaches your phone or computer.

A wireless network, or Wi-Fi network, sends and receives data to a wireless modem. Phones, computers, some TVs, game consoles, and other security devices are all connected via Wi-Fi, and your IP camera is no different. One way to view an IP camera's footage is by entering its IP address in a web browser. Keep in mind that the IP address must be static. Some Internet providers supply their customers with dynamic IP addresses that change from time to time. You'll want to speak with your provider about a static IP address to ensure you can access your IP camera. A wired network connects an IP camera to the network via an Ethernet cable. This setup is considered the most secure, as there is little chance for signal interference or unauthorized access. Expect the fastest data transmission speeds with Ethernet, as a wired connection is much more efficient than Wi-Fi. A typical connection is shown in figure 4.6 below.

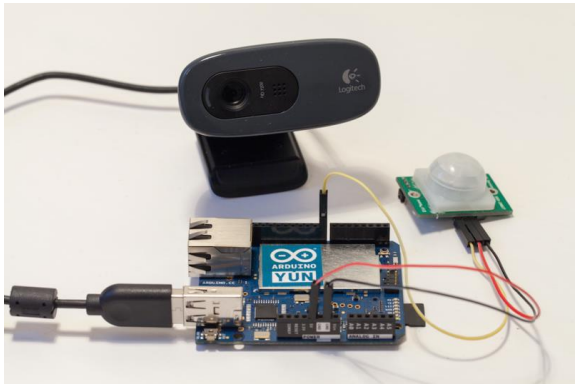

Fig no 4.6 :Basic connection between camera and Arduino

4.6 Servo motor:

There are four main components inside of a hobby servo, a DC motor, a gearbox, a potentiometer and a control circuit. The DC motor is high speed and low torque but the gearbox reduces the speed to around 60 RPM and at the same time increases the torque. The potentiometer is attached on the final gear or the output shaft, so as the motor rotates the potentiometer rotates as well, thus producing a voltage that is related to the absolute angle of the output shaft. In the control circuit, this potentiometer voltage is compared to the voltage coming from the signal line. If needed, the controller activates an integrated H-Bridge which enables the motor to rotate in either direction until the two signals reach a difference of zero. A servo motor is controlled by sending a series of pulses through the signal line. The frequency of the control signal should be 50Hz or a pulse should occur every 20ms. The width of pulse determines angular position of the servo and these type of servos can usually rotate 180 degrees (they have a physical limits of travel)as shown in fig 4.7 below.

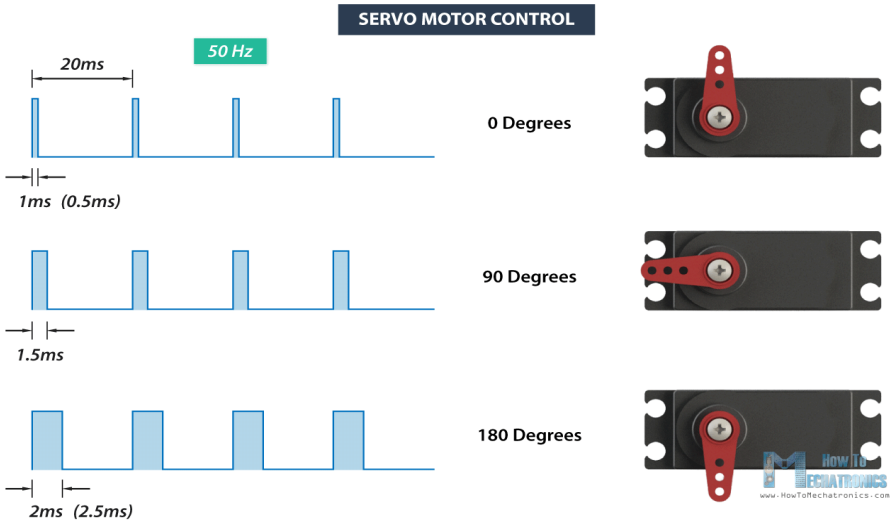

Fig no 4.7: Servo motor control

Generally pulses with 1ms duration correspond to 0 degrees position, 1.5ms duration to 90 degrees and 2ms to 180 degrees. Though the minimum and maximum duration of the pulses can sometimes vary with different brands and they can be 0.5ms for 0 degrees and 2.5ms for 180 degrees position. Connection is established as shown in figure 4.8.

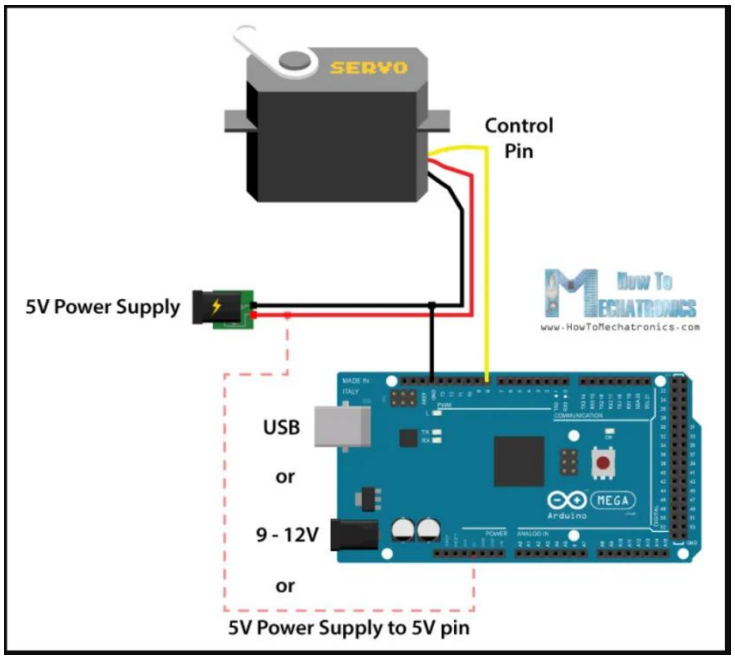

Fig no 4.8 : Connection between servo motor and Arduino

4.6.1 MG996R Servo technical specifications:

Stall Torque	11kg.cm @4.8v, 13kg.cm @6V
Operating Voltage	4.8 – 7.2V
No Load Current	220mA @4.8V, 250mA @6V
Stall Current	650mA
Max Speed	60 degrees in 0.20s
Weight	55g

Table no 4.2: Specifications of Servo motor

4.6.2 Arduino Servo Motor Control

Let's put the above said to test and make a practical example of controlling a hobby servo using Arduino. I will use the MG996R which is a high-torque servo

featuring metal gearing with stall torque of 10 kg-cm. The high torque comes at a price and that's the stall current of the servo which is 2.5A. The running current is from 500mA to 900mA and the operating voltage is from 4.8 to 7.2V. We simply need to connect the control pin of the servo to any digital pin of the Arduino board, connect the Ground and the positive wires to the external 5V power supply, and also connect the Arduino ground to the servo ground.

4.7 Lithium polymer battery:

A lithium polymer battery or more correctly lithium-ion polymer battery (abbreviated variously as LiPo, LIP, Li-poly and others), is a rechargeable battery of lithium-ion technology in a pouch format. Unlike cylindrical and prismatic cells, LiPo come in a soft package or pouch, which makes them lighter but also lack rigidity. The denomination "lithium polymer" has caused confusion among battery users. It may be interpreted in two ways. Originally, "lithium polymer" stood for a developing technology using a polymer electrolyte instead of the more common liquid electrolyte. The result is a "plastic" cell, which theoretically could be thin, flexible, and manufactured in different shapes, without risk of electrolyte leakage. This technology has not been fully developed and commercialized, and research is ongoing.

The second meaning appeared when some manufacturers started applying the "polymer" denomination to lithium-ion cells in pouch format. This is the most extended use nowadays, where "polymer" went from indicating a "polymer electrolyte" to mean a "polymer casing", that is, the soft, external pouch. While the design is usually flat, and lightweight, it is not a true polymer cell, as the electrolyte is still in liquid form, albeit it may be "plasticized" or "gelled" through a polymer additive.

These cells are sometimes known as "LiPo", however, from the technological point of view, they are the same as the ones marketed simply as "Li-ion", as the underlying electrochemistry is the same. A typical battery is shown in below figure 4.9.

Fig no 4.9 : Lithium Polymer Battery

Voltage:	**11.1v**
Capacity:	**2000mAh**

Table no 4.3: Specifications of battery.

4.8 Jumper wires

Generally, jumpers are tiny metal connectors used to close or open a circuit part. They have two or more connection points, which regulate an electrical circuit board.

Their function is to configure the settings for computer peripherals, like the motherboard. Suppose your motherboard supported intrusion detection. A jumper can be set to enable or disable it.

Jumper wires (as shown in figure 4.10)are electrical wires with connector pins at each end. They are used to connect two points in a circuit without soldering.

You can use jumper wires to modify a circuit or diagnose problems in a circuit. Further, they are best used to bypass a part of the circuit that does not contain a resistor and is suspected to be bad.

This includes a stretch of wire or a switch. Suppose all the fuses are good and the component is not receiving power; find the circuit switch. Then, bypass the switch with the jumper wire.

Fig no 4.10 : Jumper wires.

4.9 MECHANICAL COMPONENTS:

- Wheels (2WD)
- Acrylic sheets
- Brush (for cleaning dust)

4.9.1 Wheels (2wd)

A wheel is a circular component (as shown in figure 4.11) that is intended to rotate on an axial bearing. The wheel is one of the main components of the wheel and axle which is one of the six simple machines. Wheels, in conjunction with axles, allow heavy objects to be moved easily facilitating movement or transportation while supporting a load, or performing labor in machines. Wheels are also used for other purposes, such as a ship's wheel, steering wheel, potter's wheel and flywheel. Common examples are found in transport applications. A wheel greatly reduces friction by facilitating motion by rolling together with the use of axles. In order for wheels to rotate, a moment needs to be applied to the wheel about its axis, either by way of gravity, or by the application of another external force or torque.

Depending on the design and requirements, standard wheels are used especially for classical methods of driving and steering while orient able and ball wheels are included in the same category and user for balancing a robot. Omni directional wheels are very good for driving and steering and are used when the robot should have the ability to move in all directions.

Fig no 4.11: Wheels.

4.9.2 Acrylic sheets

Acrylic is a transparent plastic material with outstanding strength, stiffness, and optical clarity. Acrylic sheet is easy to fabricate, bonds well with adhesives and solvents, and is easy to thermoform. It has superior weathering properties compared to many other transparent plastics.

Acrylic sheet exhibits glass-like qualities—clarity, brilliance, and transparency—but at half the weight and many times the impact resistance of glass. From durable signs and skylights, to eye-catching retail store fixtures, displays and shelves, acrylic plastics provide outstanding versatility, durability, and aesthetic qualities.

4.9.3 Brush

The cleaning of dust on tracks is continuous and it is ensured by a rotating brush (inwards) which is connected to the dc motor. A brush is shown below figure 4.12.

Fig no 4.12: Brush

CHAPTER

5. SOFTWARE DESCRIPTION

ARDUINO IDE

The Arduino Integrated Development Environment (IDE) is a cross- platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards. The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User- written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. Code has been written in C language and include all necessary functions in order to make the robot function accordingly.

Many CAD users dismiss schematic capture as a necessary evil in the process of creating PCB layout but we have always disputed this point of view. With PCB layout now offering automation of both component placement and track routing, getting the design into the computer can often be the most time-consuming element of the exercise. And if you use circuit simulation to develop your ideas, you are going to spend even more time working on the schematic. ISIS has been created with this in mind. It has evolved over twelve year's research and development and has been proven by thousands of users worldwide. The strength of its architecture has allowed us to integrate first conventional graph based simulation and now – with PROTEUS VSM – interactive circuit simulation into the design environment. For the first time ever it is possible to draw a complete circuit for a micro-controller based system and then test it interactively, all from within the same piece of software. Meanwhile, ISIS retains a host of features aimed at the PCB designer, so that the same design can be exported for

production with ARES or other PCB layout software. For the educational user and engineering author, ISIS also excels at producing attractive schematics like you see in the magazines. Other general features include: Runs on Windows 98/Me/2k/XP and later. · Automatic wire routing and dot placement/removal. Powerful tools for selecting objects and assigning their properties. · Total support for buses including component pins, inter-sheet terminals, module ports and wires. · Bill of Materials and Electrical Rules Check reports. · Net list outputs to suit all 45 popular PCB layout tools.

LABCENTER ELECTRONICS for the 'power user', ISIS incorporates a number of features which aid in the management of large designs. Indeed, a number of our customers have used it to produce designs containing many thousand components.

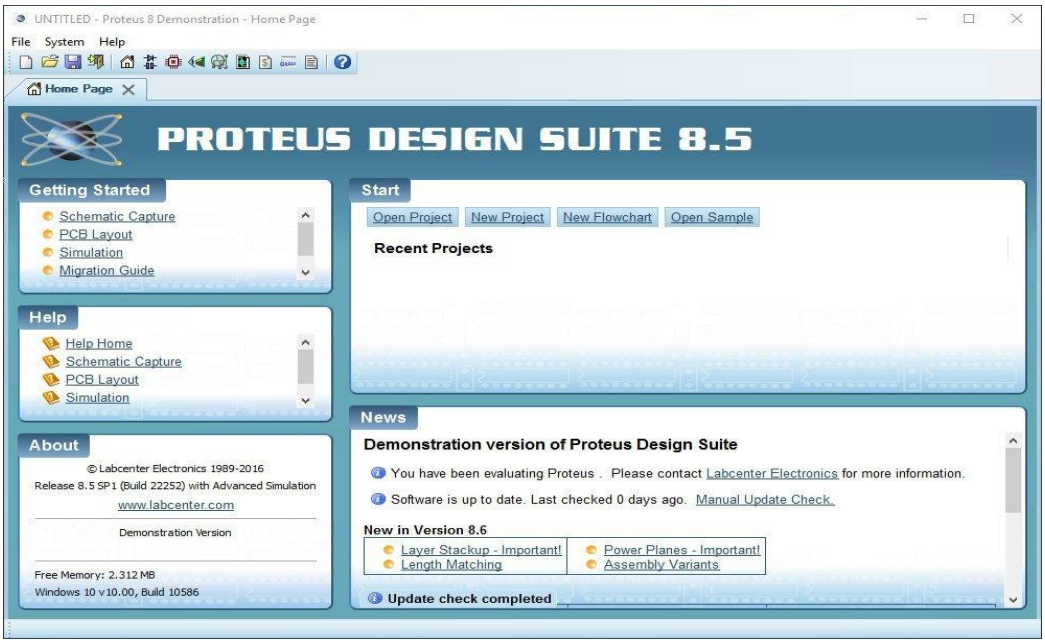

Fig no 5.1 : Proteus design suite 8.5 window.

Figure 5.1 shows a Proteus design suite 8.5 window. Hierarchical design with support for parameterized component values on sub-circuits. Design Global Annotation allowing multiple instances of a sub-circuit to have different component references. · Automatic Annotation - the ability to number the components automatically. · ASCII Data Import - this facility provides the means to automatically bring component stock

codes and costs into ISIS design or library files where they can then be incorporated or even totaled up in the Bill of Materials report.

5.1 ISIS and PCB Design

Users of ARES, or indeed other PCB software will find some of the following PCB design specific features of interest: · Sheet Global Net Properties which allow you to efficiently define a routing strategy for all the nets on a given sheet (e.g. a power supply needing POWER width tracks). · Physical terminals which provide the means to have the pins on a connector scattered all over a design. Support for heterogeneous multi-element devices. For example, a relay device can have three elements called RELAY: A, RELAY: B and RELAY: C. RELAY: A is the coil whilst elements B and C are separate contacts. Each element can be placed individually wherever on the design is most convenient. · Support for pin-swap and gate-swap. This includes both the ability to specify legal swaps in the ISIS library parts and the ability to back-annotate changes into a schematic. A visual packaging tool which shows the PCB footprint and its pin numbers alongside the list of pin names for the schematic part. This facilitates easy and error free assignment of pin numbers to pin names. In additional, multiple packaging's may be created for a single schematic part. A full chapter is provided on how to use ISIS and ARES together.

5.2 ISIS and Simulation

ISIS provides the development environment for PROTEUS VSM, our revolutionary interactive system level simulator. This product combines mixed mode circuit simulation, ISIS 3 microprocessor models and interactive component models to allow the simulation of complete microcontroller based designs. ISIS provides the means to enter the design in the first place, the architecture for real time interactive simulation and a system for managing the source and object Code associated with each project. In addition, a number of graph objects can be placed on the schematic to enable conventional time, frequency and swept variable simulation to be performed. Major features of PROTEUS VSM include:

True Mixed Mode simulation based on Berkeley SPICE3F5 with extensions for digital simulation and true mixed mode operation. Support for both interactive and graph based simulation· CPU Models available for popular microcontrollers such as the PIC and 8051 series.

Interactive peripheral models include LED and LCD displays, a universal matrix keypad, an RS232 terminal and a whole library of switches, pots, lamps, LEDs etc. Virtual Instruments include voltmeters, ammeters, a dual beam oscilloscope and a 24 channel logic analyzer. On-screen graphing - the graphs are placed directly on the schematic just like any other object. Graphs can be maximized to a full screen mode for cursor based measurement and so forth. Graph 46 Based Analysis types include transient, frequency, noise, distortion, AC and DC sweeps and Fourier transform. An Audio graph allows playback of simulated waveforms. Direct support for analogue component models in SPICE format. Open architecture for 'plug in' component models coded in C++ or other languages. These can be electrical. Graphical or a combination of the two. Digital simulator includes a BASIC-like programming language for modeling and test vector generation. A design created for simulation can also be used to generate a netlist for creating a PCB - there is no need to enter the design a second time.

5.3 ISIS and Networks

ISIS is fully network compatible, and offers the following features to help Network Managers:

- Library files can be set to Read Only. This prevents users from messing with symbols or devices that may be used by others.

- ISIS individual user configuration in the windows registry. Since the registry determines the location of library files, it follows that user can have individual USERDVC.LIB files in their personal or group directories.

5.4 XCTUXBEE

XCTU is a free multi-platform application designed to enable developers to interact with Digi RF modules through a simple-to-use graphical interface. It includes new tools that make it easy to setup, configure and test XBee® RF modules. XBee : According to Digi "XBee modules are embedded solutions providing wireless end-point connectivity to devices. These modules use the IEEE 802.15. 4 networking protocol for fast point-to-multipoint or peer-to-peer networking.

- High power (up to 1-Watt) for extreme RF line-of-sight range up to 105 km (65miles)
- Low power (+13dBm/20 mW) for EU and battery-optimized applications.

5.5 Programming Arduino

Once Arduino IDE is installed on the computer, connect the board with computer using USB cable. Now open the Arduino IDE and choose the correct board by selecting Tools>Boards>Arduino/Genuine Uno, and choose the correct Port by selecting Tools>Port. Arduino UNO is programmed using Arduino programming language based on wiring. To get it started with Arduino UNO board and blink the built-in LED, load the example code by selecting Files>Examples>Basics>Blink. Once the example code (also shown below) is loaded into your IDE, click on the 'upload' button given on the top bar. Once the upload is finished, you should see the Arduino's built-in LED blinking. Below is the example code for blinking.

5.6 Arduino – Installation

After learning about the main parts of the Arduino UNO board, we are ready to learn how to set up the Arduino IDE. Once we learn this, we will be ready to upload our program on the Arduino board. In this section, we will learn in easy steps, how to set up the Arduino IDE on our computer and prepare the board to receive the program via USB cable.

Step 1: About Arduino board First you must have your Arduino board (you can choose your favorite board) and a USB cable. In case you use Arduino UNO, Nano, Arduino

Mega 2560 you will need a standard USB cable (A plug to B plug), the kind you would connect to a USB printer as shown in the following image.

Step 2: Download Arduino IDE Software You can get different versions of Arduino IDE from the Download page on the Arduino Official website. You must select your software, which is compatible with your operating system (Windows, IOS, or Linux). After your file download is complete, unzip the file.

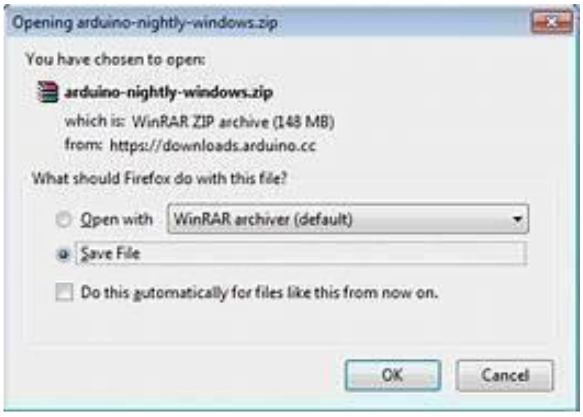

Fig no 5.2: Saving Arduino

Step 3: Power up your board. The Arduino UNO, Mega and Arduino Nano automatically draw power from either, the USB connection to the computer or an external power supply. If you are using an Arduino Decimal, you have to make sure that the board is configured to draw power from the USB connection. The power source is selected with a jumper, a small piece of plastic that fits onto two of the three pins between the USB and power jacks. Check that it is on the two pins closest to the USB port. Connect the Arduino board to your computer using the USB cable. The green power LED (labeled PWR) should glow.

Step 4: Launch Arduino IDE After your Arduino IDE software is downloaded, you need to unzip the folder. Inside the folder, you can find the application icon with an infinity label (application.exe). Double-Click the icon to start the IDE.

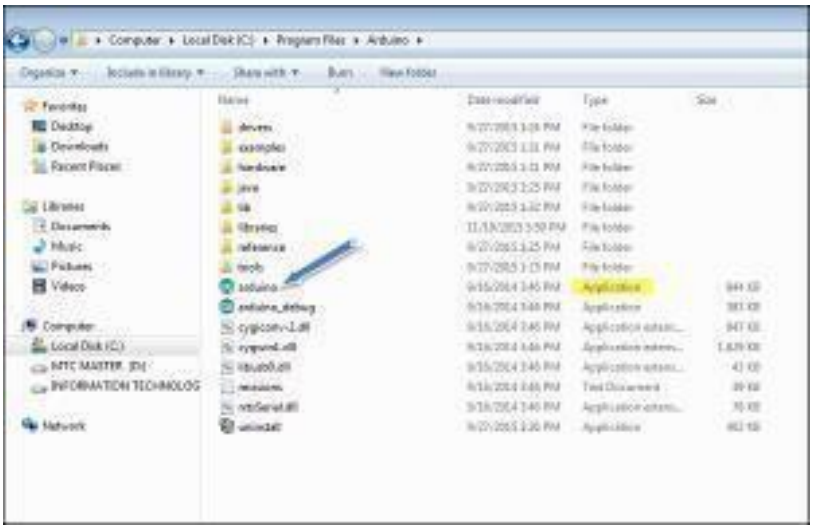

Fig no 5.3: Launching Arduino Application.

Step 5: Open your first project 1. ONCE THE SOFTWARE STARTS, YOU HAVE TWO OPTIONS: 2. REATE A NEW PROJECT. 3. OPEN An EXISTING PROJECT 4. To create a new project, select File --> New

Step 6: Select your serial port 1. Select the serial device of the Arduino board. Go to Tools -> Serial Port menu. 2. This is likely to be COM or higher (COM1 and COM2 are 33 usually reserved for hardware serial ports). 3. To find out, you can disconnect your Arduino board and re-open the menu, the entry that disappears should be of the Arduino board. 4. Reconnect the board and select that serial port.

Step 7: Upload the program to your board

CHAPTER

6. SOURCE CODE

```
#include <Servo.h>;
int a=90,b;
int servoPin=3;
Servo servosweep,servo2;
void setup() {
  // put your setup code here, to run once:
Serial.begin(9600);
//motor1
pinMode(4,OUTPUT);
pinMode(5,OUTPUT);
//motor2
pinMode(6,OUTPUT);
pinMode(7,OUTPUT);
pinMode(3,OUTPUT);
pinMode(9,OUTPUT);
servosweep.attach(servoPin);
servo2.attach(9);
servosweep.write(90);
servo2.write(90);
}
void forward(){
//motor1()
digitalWrite(5,HIGH);
digitalWrite(4,LOW);
//motor2
digitalWrite(7,HIGH);
digitalWrite(6,LOW);
}
void backward()
{
//motor1
digitalWrite(5,LOW);
digitalWrite(4,HIGH);
//motor2
digitalWrite(7,LOW);
digitalWrite(6,HIGH);
}
void right(){
//motor1
digitalWrite(5,LOW);
digitalWrite(4,HIGH);
//motor2
```

```
digitalWrite(7,HIGH);
digitalWrite(6,LOW);
}
void left(){
//motor1
digitalWrite(5,HIGH);
digitalWrite(4,LOW);
//motor2
digitalWrite(7,LOW);
digitalWrite(6,HIGH);
}
void stops(){
//motor1
digitalWrite(4,LOW);
digitalWrite(5,LOW);
//motor2
digitalWrite(6,LOW);
digitalWrite(7,LOW);
}
void loop() {
// put your main code here, to run repeatedly:
if(Serial.available()>0)
{
char ch=(char)Serial.read();
if(ch=='F')
{
forward();
}
else if(ch=='B')
{
backward();
}
else if(ch=='L')
{
left();
}
else if(ch=='R')
{
right();
}
else if(ch=='S')
{
stops();}
else if (ch =='a'){
a=a+5;
servosweep.write(a);
```

```
b=a;
}
else if (ch=='b'){
  b=b-5;
  servosweep.write(b);
  }
else if (ch=='c'){
servo2.write(20);
}
else if (ch=='d'){
servo2.write(100);
}
else if (ch=='e'){
 servo2.write(160);
}

}

}
```

CHAPTER
7. IMPLEMENTATION

We have used Arduino Uno for our project which is one of the models of 8 bit microcontroller.

Arduino code is written in C++ with an addition of special methods and functions.

We coded for the following components which are connected to the Arduino board-

- Servo motors.
- Bluetooth Module.
- Motor Drivers Module.

This system is used in between two stations which will detect the cracks present on the track using IP camera which can be monitored at control unit.

The robot is controlled using two applications, one for video streaming and other to control the movements. Any crack it detected while monitoring, we can analyze the intensity of crack and take immediate actions to avoid any derailments. The cleaning of dust on tracks is continuous and it is ensured by a rotating brush (inwards) which is connected to the dc motor as shown in below figure 7.1.

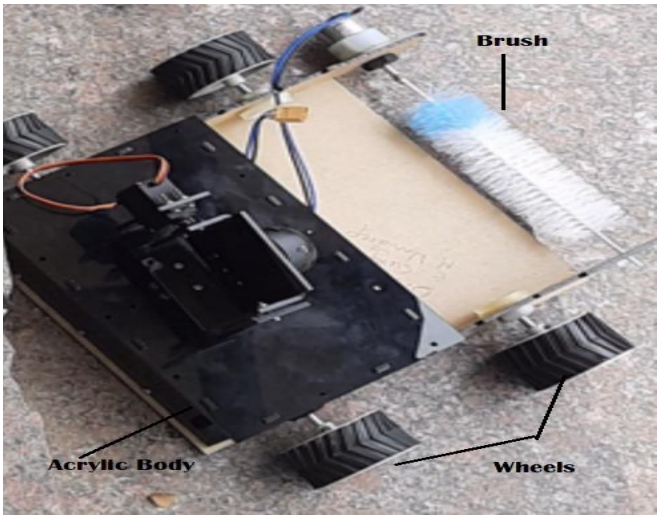

Fig no 7.1 : Prototype of railway track motoring and live streaming robot.

7.1 Flow chart

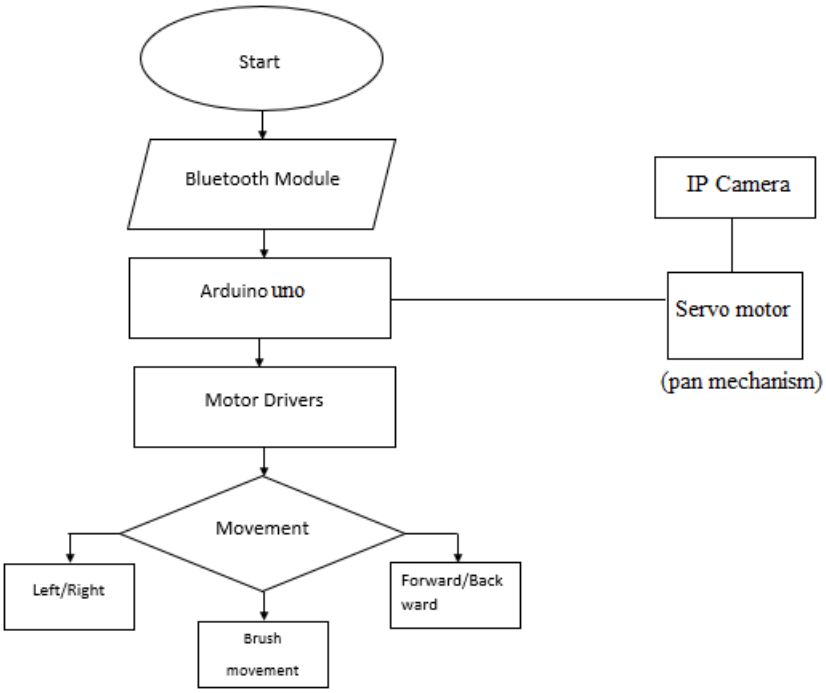

Fig no 7.2 : Flow chart illustrating the working of robot.

The above fig shows the flow chart of railway track monitoring and live streaming robot. From the figure it is clear that robot movement is controlled using mobile phone through bluetooth module. This enables the communication bewteen the user and robot. This robot is also capable of cleaning the dust particles spread over the way. The main aspect is to live stream the situation of tracks through IP camera. The live streaming can be seen on the screen of smartphone connected to the robot. This all functions are properly executed using the code written and loaded in Arduino Uno. This is how we implement the robot prototype.

7.1.1 Setup for 2 Servo Motors Connected to Arduino for Pan Mechanism

Servo motors have three wires: power, ground, and signal. **The power wire is typically red, and should be connected to the 5V pin on the Arduino board**. The ground wire is typically black or brown and should be connected to a ground pin on the Arduino board.

Here we have connected the six pins of servomotor (i.e, 3 pins of each Motor) to the output pins of Arduino (Digital Pins).

- Setup for Motor Drivers. Connected 5V and ground to 5V and ground of Arduino.

We Connected Input 1 to pin 8 of Arduino & Connect Input 2 to pin 9 of Arduino

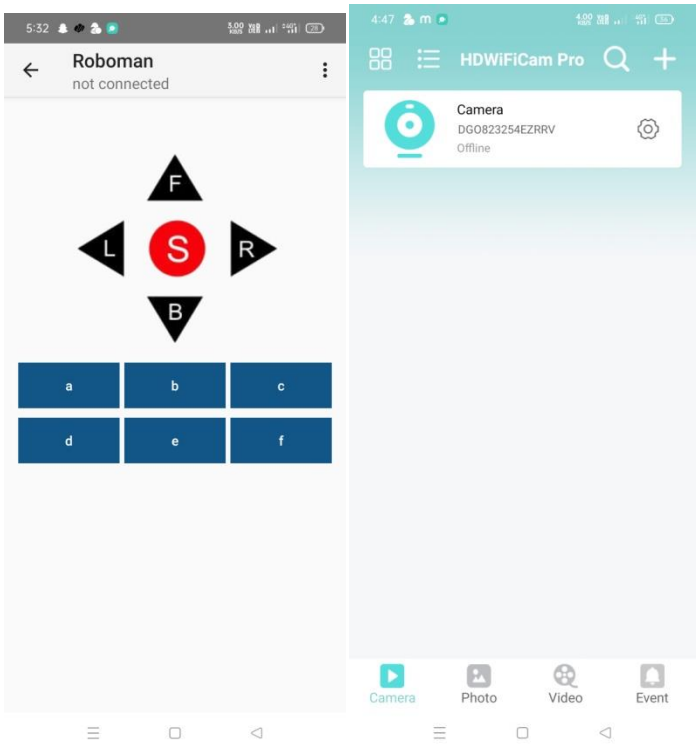

Fig no 7.3: User interfaces to control the robot.

The following user interfaces as shown in fig are used to control and move the robot.

7.1.2 Buttons and their functions

- F - Moves forward
- B - Moves backward
- R - Moves right
- L - Moves left
- a &b - Pan mechanism
- c - 20^{o} wide angle
- d - 100^{o} wide angle
- e - 160^{o} wide angle

CHAPTER
8. RESULTS AND DISCUSSIONS

From the execution of this system and after analyzing the results we came to know that following are some of the key factors over which the systems functionality depends. Our Railway Track Monitoring & Live Streaming Robot Works according to the program dumped into the microcontroller of the Arduino board from the Arduino Compiler. A Technician from the control room will have live visuals of the railway track by means of the IP camera to monitor the railway track to avoid derailment of trains. The Robot is also capable of cleaning the dust by inward sweeping mechanism employed by a DC motor.

Following screenshots gives idea about how system is executing and how we are getting proper results. Robot continuously monitors the track and sends the visuals to head office.

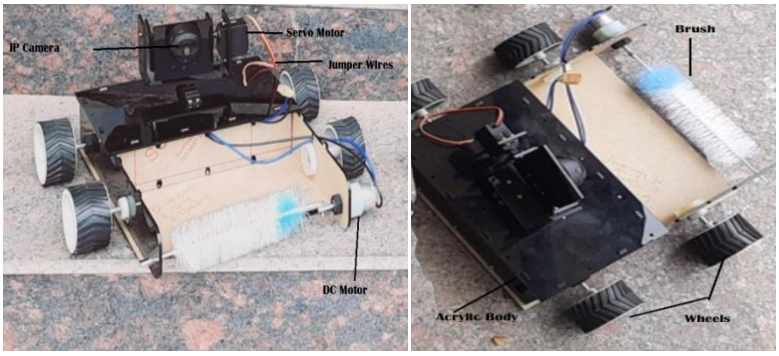

Fig no 8.1: Prototype of railway track monitoring and live streaming robot.

8.1 Disadvantages

- Using Lithium Polymer Batteries is not economical.
- It is not possible to collect heavy trash material.
- Constant attention is required by the technician.

8.2 FUTURE SCOPE

- Adding GPS and GSM modules and other sensors (Ultra sonic Sensor/ IR sensor) to convert this robot to an autonomous robot, which will send the exact location details of the crack to the railway authorities automatically.
- Also solar panel can be added to drive the robot energy efficiently and to reduce usage of Lithium(Li)-Polymer Batteries.
- This prototype is developed further taking standard dimensions of railway track and wheels.

CHAPTER
9. CONCLUSION

The railway is the most commonly used mode of transportation by the people and for goods. The transport system must always be secure. Utilising the benefit of embedded system we can build a system which helps the cause of safe travel. The proposed system is an amalgamation of the conventional method of crack detection and the innovative method of live video streaming and IOT. This robot is the most effective and economic inspection method than the traditional methods which are time consuming and tedious. Most of the rail derailments are occurred due to no timely inspection of the track, this can be easily achieved using this robot. The entire system is placed on a four wheeler bot which travels along the rails. The process is done at a periodic rate to check for cracks so that causalities can be avoided entirely. The entirety of the model is to ensure that defective rails can be found in time to stop derailment of trains, to save the loss of lives and property.

CHAPTER

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