RAILWAY TRACK CRACK DETECTION SYSTEM

PROJECT REPORT

ABSTRACT

Nowadays, our country India has one of the top largest networks in the world. But as per reliability and Safety parameter we do not have to reach positively with Global standards. Many accidents in railway line is due to the railway track fault. These accidents cause gross damage to our vital property. So, it required more effort for improvement of reliability and Safety standards. The aim in design an autonomous vehicle for railway track fault detection using some components like ULTRASONIC sensor which is used to detect crack on rail line after detecting crack it is also required to detect fault location it is fulfilled by GPS. This project also explains the summation of an ultrasonic to keep in a continuous record the material without interruption in nobility during run-time. The location of the fault is defined by the value of longitude and latitude coordinates from GPS module. This location is sent to pre-defined number by using GSM through SMS. In our whole system the central component is Arduino. The autonomous crack detection vehicle is powered by solar panel and battery. So, it is very energy efficient system.

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LIST OF ABBREVATIONS

GPS	Global Positioning System
GSM	Global System for Mobile Communication
USB	Universal Serial Bus
IDE	Arduino Integrated Development Environment

LED	Light Emitting Diode
LCD	Liquid Crystal Display
TXD	Transmit Data
RXD	Receive Data
DC	Direct Current
IOT	Internet of Things

LIST OF TABLES

CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

The Indian Railways is one of the world's largest railway networks with more than 1,15,000 Km of track length on a route of 67,312 Km distributing its reach to almost every part of the country. However, in case of reliability and passenger safety, there are areas where improvements can be done and new technologies can be used to reduce the chances of railway hazards. Because of regular use of railway tracks, cracks are developing on the tracks. Due to lack of regular monitoring of the railway tracks, cracks are getting neglected and this is leading to a huge accident.

A recent study showed that more than 25% of the tracks are in need of replacement due to the development of cracks on them. Manual detection of tracks is cumbersome and not fully effective owing to much time consumption and requirement of skilled technicians. So, the idea is to develop a system that can detect the cracks, bends and missing tracks automatically and can inform the railway department about the cracks and its present location so that it is easy to track the bot as well as the cracks or bends.

1.2 OBJECTIVE

The main objective is to locate the gaps in the railroad tracks and to determine if there are any hazards in the tracks to avoid and dissuade accidents. This type of model provides a costeffective solution to the railroad crack detection problem by using a ultrasonic sensor and a IR sensor joint that responds to the exact situation of the faulty track, as well as forwarding the information to the control room via SMS, so that any incidents can be gridlocked.

1.3 EXISTING SYSTEM

In the existing system, techniques such as visual inspection, video transmission, and Magnetic field methods can identify the cracks on the railway tracks. Physical checking is one of the earliest method in which all the necessary components will be scanned manually. This process is commonly used in India, despite generating the worst outcome. A camera is used for continuous monitoring of the track while streaming content. In this procedure small cracks and a high-cost system cannot be seen. The current passes through the railway track for detection of flaws in the eddy current method and the results produced not accurate. Many of these

techniques require a lot of processing power and an extremely long period of time, making the robot's speed slow and therefore uncomfortable.

Figure 1.3 Manual crack detection by human

1.4 LITEREACTURE REVIEW

1) **Designing of Improved Monitoring System for Crack Detection on Railway Tracks Author- Nilisha Patil1 , Dipakkumar Shahare1 , Shreya Hanwate1 , Pranali Bagde1 , Karuna Kamble1 , Prof. Manoj Titre2. 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.

2) **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

3) **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.

4) **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.

1.5 PROPOSED SYSTEM

The proposed system surpassed the existing system limitations used to identify defective railroad tracks. We use Arduino UNO board in this proposed system. Arduino is an integrated open source development environment, which simplifies coding considerably. The system proposed is consisting of an ultrasonic sensor designed to detect cracks and ultrasonic sensors used to detect obstacles. The motor controller L293D helps to power the DC motors. The Arduino controller is primarily used for controlling the sensor outputs and is used for the transmission of information through GSM module, the purpose of which is to send the signal to the base station whenever a crack or obstacle is detected via an SMS. Using the GPS module, the exact latitude and longitudinal direction of the faulty track is obtained. In this device subtle cracks that are not visible to the naked eye can also be observed. The proposed system is therefore productive and minable

1.6 PROBLEM STATEMENT

A broken train speaks about one of the world's major causes of more expensive and dangerous rail accidents. Taking into account incidents in general, all considered in us alone, for every three days there is more than one major demolition, consistently over 10 years. Accessible interventions when the broken track clashes in different countries are disrupted do not sufficiently help to understand the political, social and ecological effects. In the current framework, when the track is open, the framework is forced to hurry up and out along the track at irregular intervals. Often, it will send an exception flag to the technician using a remote

module just in case something stands out divided on the line. Divisions are detected by IR sensors and the error flag is conveyed.

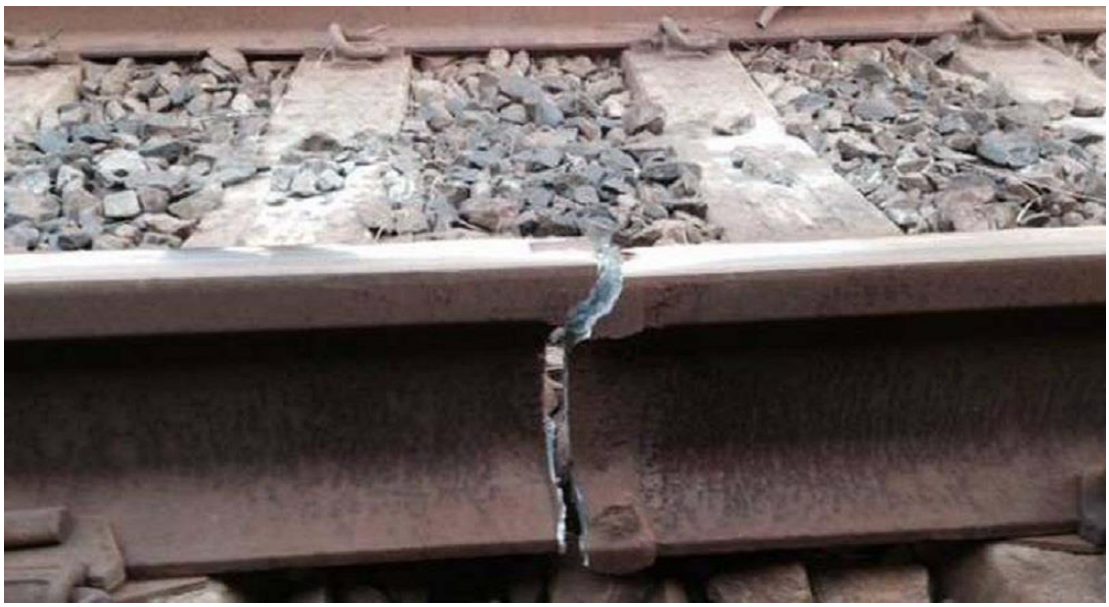

Figure 1.6 Railway crack on the Track

CHAPTER 2

APPLICATIONS

2.1 PROJECTS BENEFITS

Provides real-time monitoring of and detection of any crack or objects on railway tracks and in case of detection sends information with the location to the receiver side using GPS module via GSM.

Nowadays in the current railway systems, it is becoming necessary to have safety elements in order to avoid accidents.

The auto crack detection method is more efficient in the technical field

Quick response is achievedSimple in construction

Easy to maintain and repair

Cost of the unit is less when compared to other

No fire hazard problem due to over loading

Comparatively the operation cost is less

Continuous operation is possible without stopping

Automatic alert system to the station master

The signal transmission is wireless transmission.

2.2 REAL TIME APPLICATION

The vehicle draws power from the battery. The optical sensor is used to detect the crack in the railway track. Suppose any crack in the track, the vehicle automatically stop and activates the FM transmitter circuit.

Cordless identification to the station master:-This unit can also be used to intimate the nearest railway station. The FM receiver circuit is fixed in the room of the station master.

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work.We have completed the project work with the limited time successfully.

The RAILWAY TRACK CRACK DETECTING SYSTEM is working with satisfactory conditions. We are able to understand the difficulties in maintaining the tolerances and also quality. We have done to our ability and skill making maximum use of available facilities.

2.3 FUTURE DEVELOPMENT

Infrared transmitter is one type of the LED which emits infrared rays generally called IR transmitter. Ultrasonic sensor is used to detect the crack in the rail track with measuring the distance from track to sensor. Ultrasonic technique is the most effective method which detects cracks on a railway track.

Camera can be used to check the obstacle present the railwaytrack.

CHAPTER 3

HARDWARE DESCRIPTION

3.1 ARDUINO UNO MICROCONTROLLER

Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software. It consists of a circuit board, which can be programed (referred to as a microcontroller) and a

ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board.

The key features are −

- Arduino boards are able to read analog or digital input signals from different sensors and turn it into an output such as activating a motor, turning LED on/off, connect to the cloud and many other actions.
- You can control your board functions by sending a set of instructions to the microcontroller on the board via Arduino IDE (referred to as uploading software).
- Unlike most previous programmable circuit boards, Arduino does not need an extra piece of hardware (called a programmer) in order to load a new code onto the board. You can simply use a USB cable.
- Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program.
- Finally, Arduino provides a standard form factor that breaks the functions of the micro-controller into a more accessible package.

3.1.1 ARDUINO BOARD

Arduino UNO is a microcontroller board based on the ATmega328P . It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), 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.. You can tinker with your UNO without worring too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The UNO board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The UNO board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

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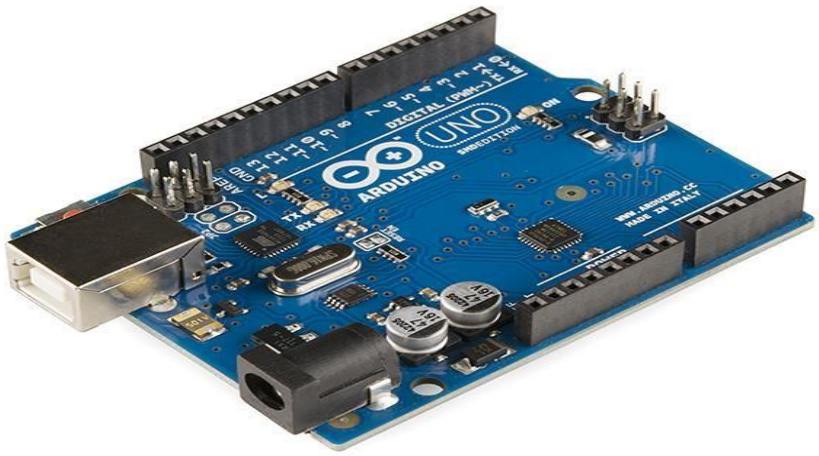


Figure 3.1.1 Arduino board

4.1.2 SPECIFICATIONS

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	54 (of which 15 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	20 Ma
DC Current for 3.3V Pin	50 Ma
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz
LED_BUILTIN	13

Length	101.52 mm
Width	53.3 mm
Weight	37 g

Table 4.1.2 Arduino specification

3.1.3 PIN CONFIGURATION

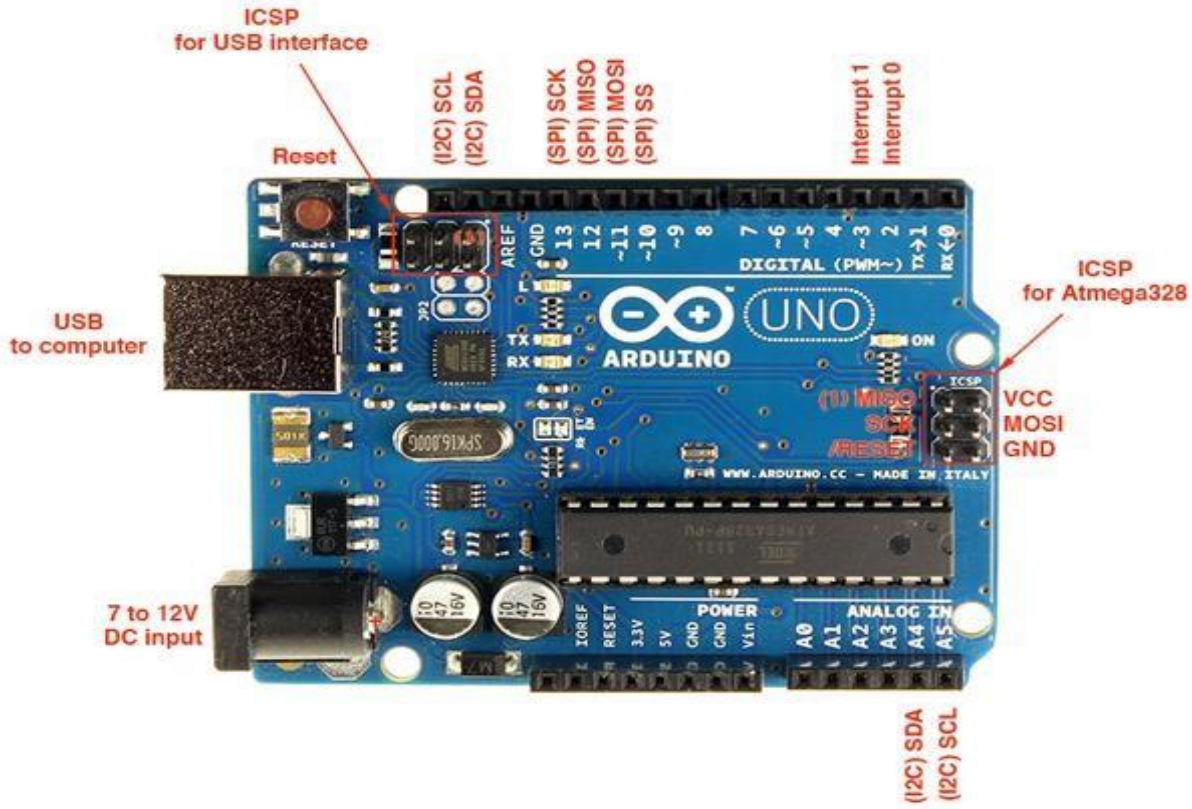


Figure. 3.1.3 Arduino Board Pin Diagram

- **Pin 3.3V & 5V**

These pins are used for providing o/p regulated voltage approximately 5V. This RPS (regulated power supply) provides the power to the microcontroller as well as other components which are used over the Arduino mega board. It can be attained from Vin-pin of the board or one more regulated voltage supply-5V otherwise USB cable, whereas another voltage regulation can be offered by 3.3V0-pin. The max power can be drawn by this is 50mA.

- **GND Pin**

The Arduino mega board includes 5-GND pins where one of these pins can be used whenever the project requires.

- **Reset (RST) Pin**

The RST pin of this board can be used for rearranging the board. The board can be rearranged by setting this pin to low.

- **Vin Pin**

The range of supplied input voltage to the board ranges from 7volts to 20volts. The voltage provided by the power jack can be accessed through this pin. However, the output voltage through this pin to the board will be automatically set up to 5V.

- **Serial Communication**

The serial pins of this board like TXD and RXD are used to transmit & receive the serial data. Tx indicates the transmission of information whereas the RX indicates receive data. The serial pins of this board have four combinations. For serial 0, it includes Tx (1) and Rx (0), for serial 1, it includes Tx(18) & Rx(19), for serial 2 it includes Tx(16) & Rx(17), and finally for serial 3, it includes Tx(14) & Rx(15).

- **External Interrupts**

The external interrupts can be formed by using 6-pins like interrupt 0(0), interrupt 1(3), interrupt 2(21), interrupt 3(20), interrupt 4(19), interrupt 5(18). These pins produce interrupts by a number of ways i.e. Providing LOW value, rising or falling edge or changing the value to the interrupt pins.

- **LED**

This Arduino board includes a LED and that is allied to pin-13 which is named as digital pin 13. This LED can be operated based on the high and low values of the pin. This will give you to modify the programming skills in real time.

- **AREF**

The term AREF stands for Analog Reference Voltage which is a reference voltage for Analog inputs

- **Analog Pins**

There are 16-analog pins included on the board which is marked as A0-A15. It is very important to know that all the Analog pins on this board can be utilized like digital I/O pins. Every Analog pin is accessible with the 10-bit resolution which can gauge from GND to 5 volts.

But, the higher value can be altered using AREF pin as well as the function of Analog Reference ().

- **I2C**

The I2C communication can be supported by two pins namely 20 & 21 where 20pinsignifies Serial Data Line (SDA) which is used for holding the data & 21-pin signifies Serial Clock Line (SCL) mostly utilized for offering data synchronization among the devices.

- **SPI Communication**

The term SPI is a serial peripheral interface which is used to transmit the data among the controller & other components. Four pins like MISO (50), MOSI (51), SCK (52), and SS (53) are utilized for the communication of SPI.

- **Dimensions**

The dimension of Arduino Mega 2560 board mainly includes the length as well as widths like 101.6mm or 4 inch X 53.34 mm or 2.1 inches. It is comparatively superior to other types of boards which are accessible in the marketplace. But, the power jack and USB port are somewhat expanded from the specified measurements.

- **Shield Compatibility**

Arduino Mega is well-suited for most of the guards used in other Arduino boards. Before you propose to utilize a guard, confirm the operating voltage of the guard is wellsuited with the voltage of the board. The operating voltage of most of the guards will be 3.3V otherwise 5V. But, guards with high operating voltage can injure the board.In addition, the distribution header of the shield should vibrate with the distribution pin of the Arduino board. For that, one can connect the shield simply with the Arduino board & make it within a running state.

3.2 ULTRASONIC SENSOR

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e. the sound that humans can hear). Ultrasonic sensors have two main components: the transmitter (which emits the sound

using piezoelectric crystals) and the receiver (which encounters the sound after it has travelled to and from the target).

Figure 3.2 Ultrasonic sensor

3.2.1 SPECIFICATION

The sensing range lies between 40 cm to 300 cm.

The response time is between 50 milliseconds to 200 milliseconds.

The Beam angle is around $5^{0.}$

It operates within the voltage range of 20 VDC to 30 VDC

Preciseness is ±5%

The frequency of the ultrasound wave is 120 kHz

Resolution is 1mm

The voltage of sensor output is between 0 VDC – 10 VDC

The ultrasonic sensor weight nearly 150 grams

Ambient temperature is -25^{0}C to $+70^{0}$C

The target dimensions to measure maximum distance is 5 cm × 5 cm

3.2.2 PIN CONFIGURATION

VCC – This pin has to be connected to a power supply +5V.

TRIG – This pin is used to receive controlling signals from the Arduino board. This is the triggering input pin of the sensor

ECHO – This pin is used for sending signals to the Arduino board where the Arduino calculates the pulse duration to know the distance. This pin is the ECHO output of the sensor.

GND – This pin has to be connected to the ground.

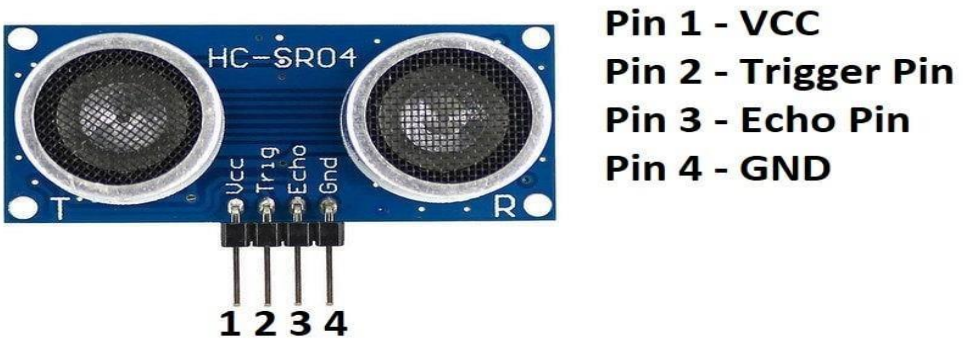


Figure 3.2.2 pin diagram of ultrasonic

3.2.3 WORKING PRINCIPLE

- In general, an ultrasonic sensor has two sections which are the transmitter and receiver. These sections are closely placed so that the sound travel in a straight line from the transmitter to the target and travels back to the receiver.
- Making sure to have minimal distance between transmitter and receiver section delivers minimal errors while calculations.
- These devices are also termed ultrasonic transceivers because both the transmitter and receiver sections are combined in a single unit which considerably minimizes the PCB footprint.

- Here, the sensor operates as a burst signal and it is transmitted for some period. Later the transmission, there exists a **silent period** and this period is termed **response time**. The response time indicates that it is waiting for the reflected waves.

3.3 GPS MODULE

GPS receivers are generally used in smartphones, fleet management system, military etc. for tracking or finding location.

Global **P**ositioning **S**ystem (GPS) is a satellite-based system that uses satellites and ground stations to measure and compute its position on Earth.

GPS is also known as Navigation System with Time and Ranging (NAVSTAR) GPS. GPS receiver needs to receive data from at least 4 satellites for accuracy purpose. GPS receiver does not transmit any information to the satellites.

This GPS receiver is used in many applications like smartphones, Cabs, Fleet management etc.

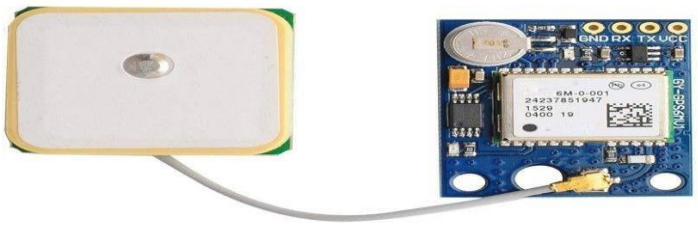


Figure 3.3 GPS Module

3.3.1 SPECIFICATION

Name	Example	Units	Description
Message ID	$GPGGA		GGA Protocol Header
UTC Time	184241.000		hhmmss.sss
Latitude	1829.9639		ddmm.mmmm
N/S Indicator	N		N=North, S=South
Longitude	07347.6174		dddmm.mmmm
E/W Indicator	E		E=East, W=West
Position Fix Indicator	1		Fix GPS SPS mode
Satellites Used	05		Range 0 to 12

HDOP	2.1		Horizontal Dilution of Precision
MSL Altitude	607.1	Meters	Mean Sea Level
Units	M	Meters	
Geoid Separation	64.7	Meters	
Units	M	Meters	
Age of Diff. Corr.	-		Null field if DGPS is not used
Diff. Ref Station ID	0000		
Checksum	*7C		
Carriage return Line Feed	<CR><LF>		End of message transmission

Table 3.3.1 GPS Specification

3.3.2 PIN CONFIGURATION

Figure 3.3.2 pin configuration of GPS

3.3.3 WORKING PRINCIPLE

GPS receiver uses a constellation of satellites and ground stations to calculate accurate location wherever it is located.

These GPS satellites transmit information signal over radio frequency (1.1 to 1.5 GHz) to the receiver. With the help of this received information, a ground station or GPS module can compute its position and time.

GPS receiver receives information signals from GPS satellites and calculates its distance from satellites. This is done by measuring the time required for the signal to travel from satellite to the receiver.

DISTANCE = SPEED * TIME

Where,

Speed = Speed of Radio signal which is approximately equal to the speed of light i.e. $3 * 10^8$

Time = Time required for a signal to travel from the satellite to the receiver.

By subtracting the sent time from the received time, we can determine the travel time.

3.4 GSM MODULE

Digital cellular technology like GSM (Global System for Mobile Communication) is used to transmit mobile data as well as voice services. This concept was implemented at Bell Laboratories using a mobile radio system in 1970.

As the name suggests, it is the standardization group name that was established in the year1982 to make a general European mobile telephone standard. This technology owns above 70% of the market share of the digital cellular subscriber around the world.

This technology was developed by using digital technology. At present, GSM technology supports above 1 billion mobile subscribers around the world in the above 210 countries. This technology provides voice and data services from fundamental to complex. This article discusses an overview of GSM technology.

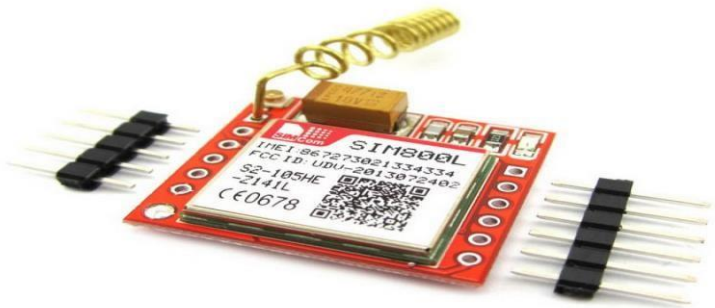


Figure 3.4 GSM Module

3.4.1 SPECIFICATION

FEATURES	DETAIL
Power Input	3.4V to 4.5V
Operating Frequency	EGSM900 and DCS1800
Transmitting Power Range	2V for EGSM900 and 1W for DCS1800
Data Transfer Link	Download: 85.6kbps, Upload:42.8kbps
SMS	MT, MO, CB, Text and PDU mode.
Antenna Support	Available
Audio Input/output	Available
Serial Port	I2C and UART
Serial Debug Port	Available

Table 3.4.1 GSM specification

3.4.2 PIN CONFIGURATION

Figure 3.4.2 Pin Diagram of GSM

Pin Number	Pin Name	Description
1	NET	External antenna attachment pin
2	VCC	Power supply pin, 3.4V to 4.4V input
3	RST	Reset pin, pull low for 100ms to perform hard reset
4	RXD	Serial data input
5	TXD	Serial data output

6	GND	Module ground reference
7, 8	SPK	Speaker differential output
9, 10	MIC	Microphone differential input
11	DTR	Serial data terminal ready pin, pull high to enable sleep mode
12	RING	Interrupt output, active low

Table 3.4.2 Pin configuration

3.4.3 WORKING PRINCIPLE

The SIM card mounted GSM modem upon receiving digit command by SMS from any cell phone sends that data to the MC through serial communication. While the program is executed, the GSM modem receives the command 'STOP' to develop an output at the MC, the contact point of which are used to disable the ignition switch.

3.5 DC MOTOR

A DC motor is a electric motor that runs on direct current power. In an electric motor, the operation is dependent upon simple electromagnetism. A current-carrying conductor generates a magnetic field, when this is then placed in an external magnetic field, it will encounter a force proportional to the current in the conductor and to the strength of the external magnetic field. It is a device that converts electrical energy to mechanical energy. It works on the fact that a current-carrying conductor placed in a magnetic field experiences a force that causes it to rotate with respect to its original position. Practical DC Motor consists of field windings to provide the magnetic flux and armature which acts as the conductor.

Figure 3.5 DC Motor

3.5.1 SPECIFICATIONS

- RPM: 200.
- Operating Voltage: 12V DC
- Gearbox: Attached Plastic (spur)Gearbox
- Shaft diameter: 6mm with internal hole
- Torque: 2 kg-cm
- No-load current = 60 mA(Max)
- Load current = 300 mA(Max).

3.5.2 FEATURES

200 RPM 12V DC geared motors widely use for robotics applications. Very easy to use and available in standard size. Also, you don't have to spend a lot of money to control motors with an Arduino or compatible board. The most popular L298N H-bridge module with onboard voltage regulator motor driver can be used with this motor that has a voltage of between 5 and 35V DC or you can choose the most precise motor diver module from the wide range available in our Motor divers category as per your specific requirements.

Nut and threads on the shaft to easily connect and internally threaded shaft for easily connecting it to the wheel.DC Geared motors with robust metal gearbox for heavy-duty applications, available in the wide RPM range and ideally suited for robotics and industrial

applications.Very easy to use and available in standard size. Nut and threads on the shaft to easily connect and internally threaded shaft for easily connecting it to the wheel.

CHAPTER 4
SOFTWARE DESCRIPTION

4.1 ARDUINO IDE

The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as **Windows, Mac OS X, and Linux**. It supports the programming languages C and C++. Here, IDE stands for **Integrated Development Environment**.

The program or code written in the Arduino IDE is often called as sketching. We need to connect the Genuino and Arduino board with the IDE to upload the sketch written in the Arduino IDE software. The sketch is saved with the extension '.ino.'

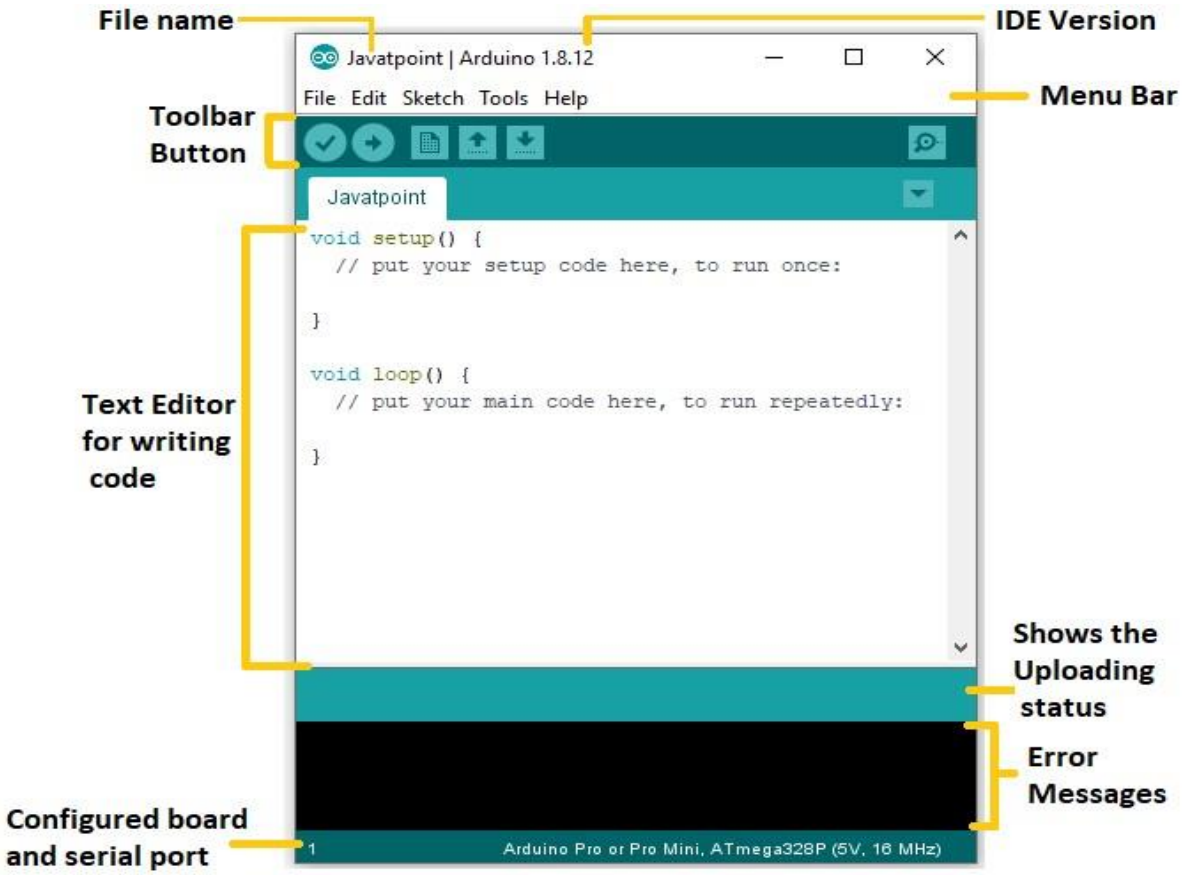


Figure 4.1 Arduino IDE

Upload

The Upload button compiles and runs our code written on the screen. It further uploads the code to the connected board. Before uploading the sketch, we need to make sure that the correct board and ports are selected.

We also need a USB connection to connect the board and the computer. Once all the above measures are done, click on the Upload button present on the toolbar.

The latest Arduino boards can be reset automatically before beginning with Upload. In the older boards, we need to press the Reset button present on it. As soon as the uploading is done successfully, we can notice the blink of the Tx and Rx LED.

If the uploading is failed, it will display the message in the error window.

We do not require any additional hardware to upload our sketch using the Arduino Bootloader. A **Bootloader** is defined as a small program, which is loaded in the microcontroller present on the board. The LED will blink on PIN 13.

Open

The Open button is used to open the already created file. The selected file will be opened in the current window.

Save

The save button is used to save the current sketch or code.

New

It is used to create a new sketch or opens a new window.

Verify

The Verify button is used to check the compilation error of the sketch or the written code.

Serial Monitor

The serial monitor button is present on the right corner of the toolbar. It opens the serial monitor.

New

The New button opens the new window. It does not remove the sketch which is already present.

Open

It allows opening the sketch, which can be browsed from the folders and computer drivers.

Save

The save button is used to save the current sketch. It also saves the changes made to the current sketch. If we have not specified the name of the file, it will open the '**Save As...**' window.

4.2 ARDUINO TOOLS

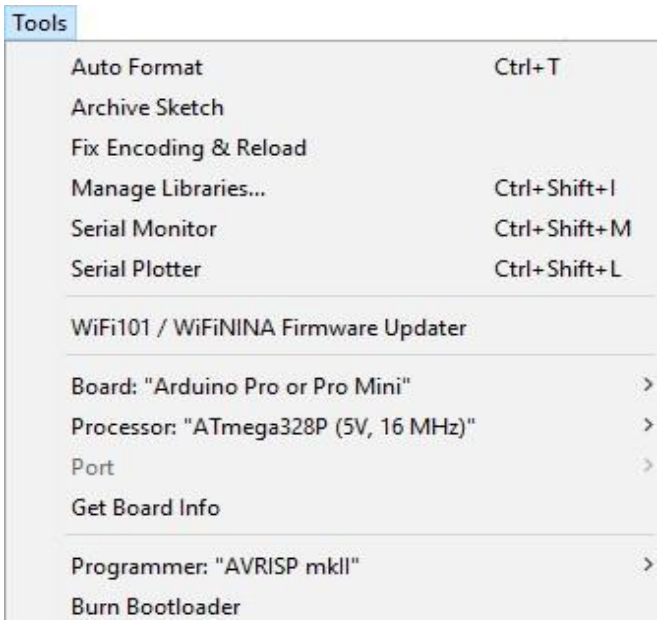


Figure 4.2 Arduino Tools

Auto Format

The Auto Format button is used to format the written code. For example, lining the open and closed curly brackets in the code.

Archive Sketch

The copy of the current sketch or code is archived in the .zip format. The directory of the archived is same as the sketch.

Fix Encoding and Reload

This button is used to fix the inconsistency between the operating system char maps and editor char map encoding.

Manage Libraries...

It shows the updated list of all the installed libraries. We can also use this option to install a new library into the Arduino IDE.

Serial Monitor

It allows the exchange of data with the connected board on the port.

Serial Plotter

The Serial Plotter button is used to display the serial data in a plot. It comes preinstalled in the Arduino IDE.

WiFi101/WiFiNINA Firmware Updater

It is used to check and update the Wi-Fi Firmware of the connected board.

Board

We are required to select the board from the list of boards. The selected board must be similar to the board connected to the computer.

Processor

It displays the processor according to the selected board. It refreshes every time during the selection of the board.

Port

It consists of the virtual and real serial devices present on our machine.

Get Board Info

It gives the information about the selected board. We need to select the appropriate port before getting information about the board.

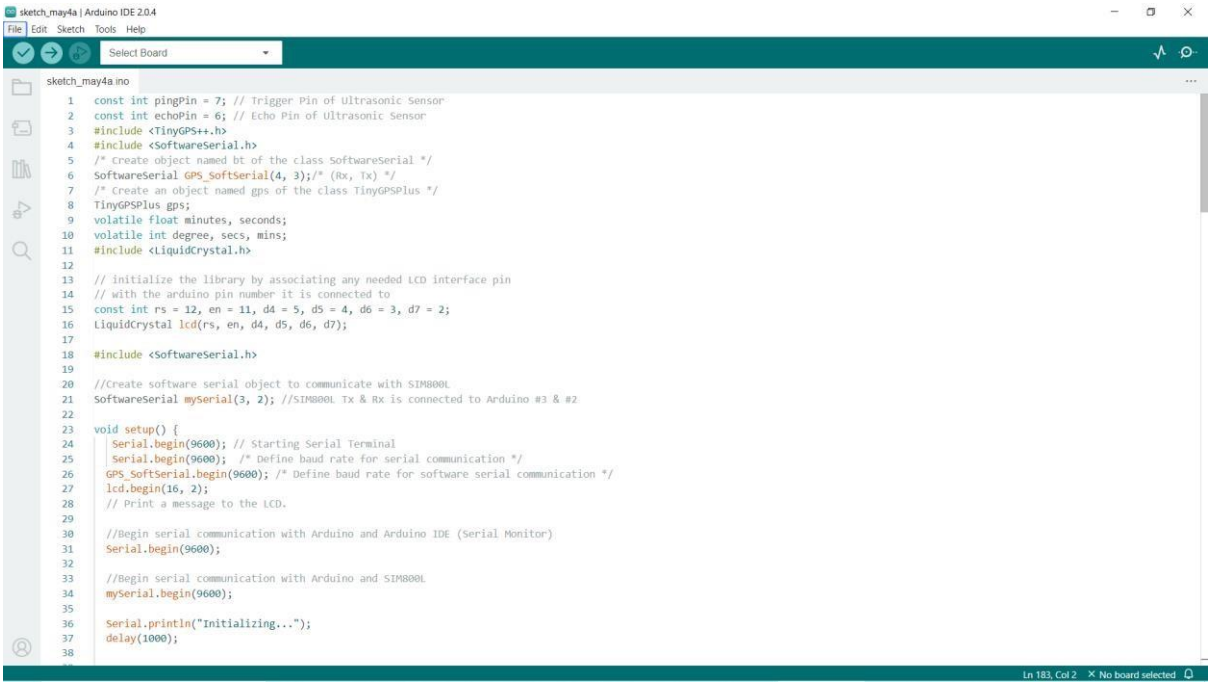
Programmer

We need to select the hardware programmer while programming the board. It is required when we are not using the onboard USB serial connection. It is also required during the burning of the Bootloader.

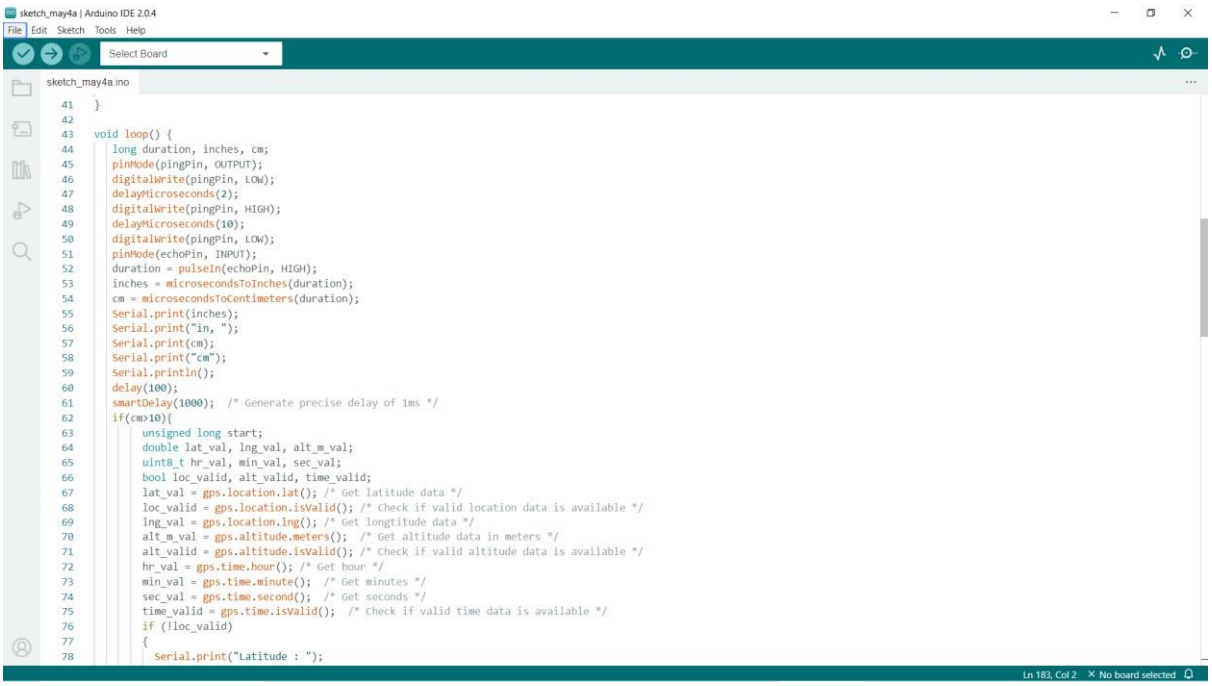
Burn Bootloader

The Bootloader is present on the board onto the microcontroller. The option is useful when we have purchased the microcontroller without the bootloader. Before burning the bootloader, we need to make sure about the correct selected board and port.

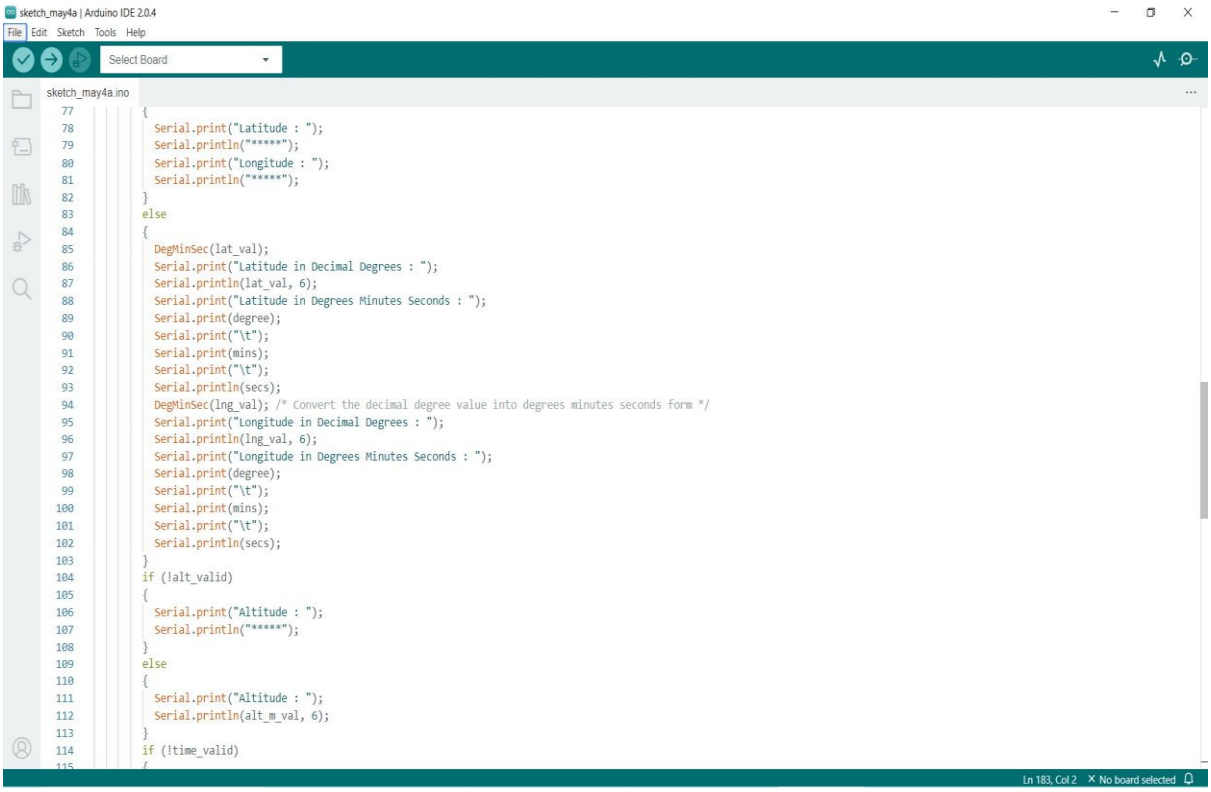
4.3 ARDUINO PROGRAM




```
const int pingPin = 7; // Trigger Pin of Ultrasonic Sensor
const int echoPin = 6; // Echo Pin of Ultrasonic Sensor
#include <TinyGPS++.h>
#include <SoftwareSerial.h>
/* Create object named bt of the class SoftwareSerial */
SoftwareSerial GPS_SoftSerial(4, 3);/* (Rx, Tx) */
/* Create an object named gps of the class TinyGPSPlus */
TinyGPSPlus gps;
volatile float minutes, seconds;
volatile int degree, secs, mins;
#include <LiquidCrystal.h>

// initialize the library by associating any needed LCD interface pin
// with the arduino pin number it is connected to
const int rs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);

#include <SoftwareSerial.h>

//Create software serial object to communicate with SIM800L
SoftwareSerial mySerial(3, 2); //SIM800L Tx & Rx is connected to Arduino #3 & #2

void setup() {
  Serial.begin(9600); // Starting Serial Terminal
  Serial.begin(9600);  /* Define baud rate for serial communication */
 GPS_SoftSerial.begin(9600); /* Define baud rate for software serial communication */
 lcd.begin(16, 2);
 // Print a message to the LCD.

 //Begin serial communication with Arduino and Arduino IDE (Serial Monitor)
 Serial.begin(9600);

 //Begin serial communication with Arduino and SIM800L
 mySerial.begin(9600);

 Serial.println("Initializing...");
 delay(1000);
```




```
}

void loop() {
  long duration, inches, cm;
  pinMode(pingPin, OUTPUT);
  digitalWrite(pingPin, LOW);
  delayMicroseconds(2);
  digitalWrite(pingPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(pingPin, LOW);
  pinMode(echoPin, INPUT);
  duration = pulseIn(echoPin, HIGH);
  inches = microsecondsToInches(duration);
  cm = microsecondsToCentimeters(duration);
  Serial.print(inches);
  Serial.print("in, ");
  Serial.print(cm);
  Serial.print("cm");
  Serial.println();
  delay(100);
  smartDelay(1000);  /* Generate precise delay of 1ms */
  if(cm>10){
      unsigned long start;
      double lat_val, lng_val, alt_m_val;
      uint8_t hr_val, min_val, sec_val;
      bool loc_valid, alt_valid, time_valid;
      lat_val = gps.location.lat(); /* Get latitude data */
      loc_valid = gps.location.isValid(); /* Check if valid location data is available */
      lng_val = gps.location.lng(); /* Get longtitude data */
      alt_m_val = gps.altitude.meters();  /* Get altitude data in meters */
      alt_valid = gps.altitude.isValid(); /* Check if valid altitude data is available */
      hr_val = gps.time.hour(); /* Get hour */
      min_val = gps.time.minute();  /* Get minutes */
      sec_val = gps.time.second();  /* Get seconds */
      time_valid = gps.time.isValid();  /* Check if valid time data is available */
      if (!loc_valid)
      {
       Serial.print("Latitude : ");
```


sketch_may4a | Arduino IDE 2.0.4
File Edit Sketch Tools Help
Select Board
sketch_may4a.ino
{
Serial.print("Latitude : ");
Serial.println("*****");
Serial.print("Longitude : ");
Serial.println("*****");
}
else
{
DegMinSec(lat_val);
Serial.print("Latitude in Decimal Degrees : ");
Serial.println(lat_val, 6);
Serial.print("Latitude in Degrees Minutes Seconds : ");
Serial.print(degree);
Serial.print("\t");
Serial.print(mins);
Serial.print("\t");
Serial.println(secs);
DegMinSec(lng_val); /* Convert the decimal degree value into degrees minutes seconds form */
Serial.print("Longitude in Decimal Degrees : ");
Serial.println(lng_val, 6);
Serial.print("Longitude in Degrees Minutes Seconds : ");
Serial.print(degree);
Serial.print("\t");
Serial.print(mins);
Serial.print("\t");
Serial.println(secs);
}
if (!alt_valid)
{
Serial.print("Altitude : ");
Serial.println("*****");
}
else
{
Serial.print("Altitude : ");
Serial.println(alt_m_val, 6);
}
if (!time_valid)
Ln 183, Col 2
No board selected

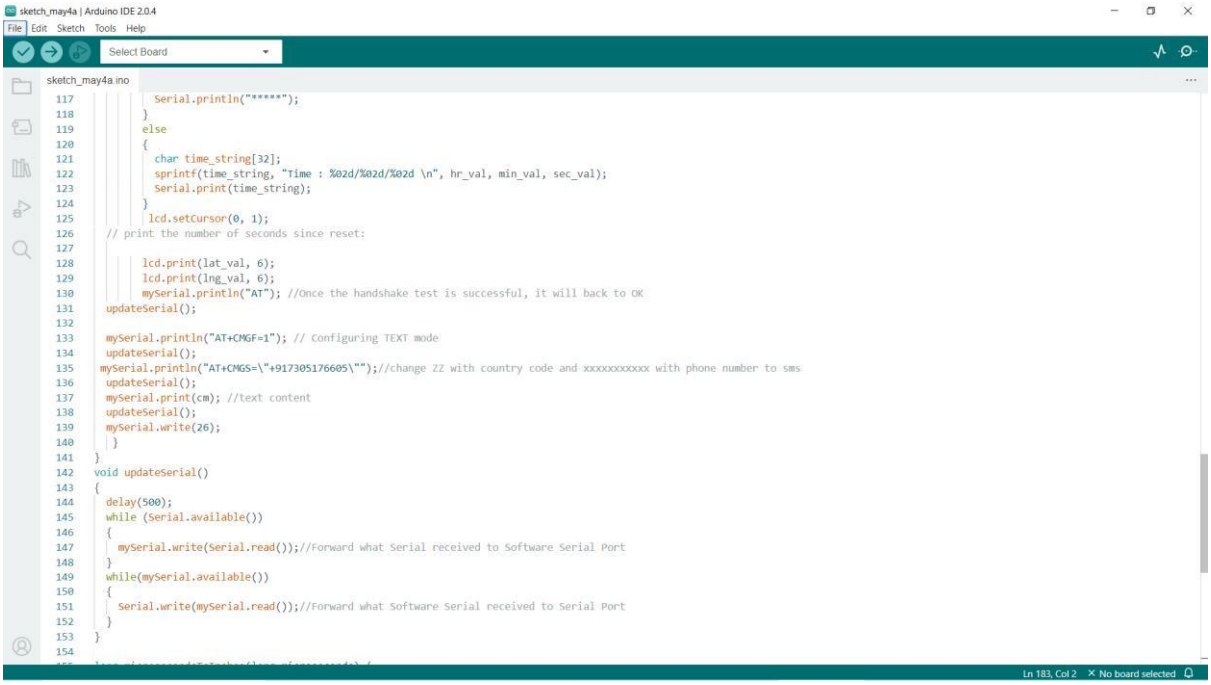

sketch_may4a | Arduino IDE 2.0.4
File Edit Sketch Tools Help
Select Board
sketch_may4a.ino
Serial.println("*****");
}
else
{
char time_string[32];
sprintf(time_string, "Time : %02d/%02d/%02d \n", hr_val, min_val, sec_val);
Serial.print(time_string);
}
lcd.setCursor(0, 1);
// print the number of seconds since reset:
lcd.print(lat_val, 6);
lcd.print(lng_val, 6);
mySerial.println("AT"); //Once the handshake test is successful, it will back to OK
updateSerial();
mySerial.println("AT+CMGF=1"); // Configuring TEXT mode
updateSerial();
mySerial.println("AT+CMGS=\"+917305176605\"");//change ZZ with country code and xxxxxxxxxx with phone number to sms
updateSerial();
mySerial.print(cm); //text content
updateSerial();
mySerial.write(26);
}
}
void updateSerial()
{
delay(500);
while (Serial.available())
{
mySerial.write(Serial.read());//Forward what Serial received to Software Serial Port
}
while(mySerial.available())
{
Serial.write(mySerial.read());//Forward what Software Serial received to Serial Port
}
}
Ln 183, Col 2
No board selected

Figure 4.3 Arduino program

Arduino programming involves writing code to control the behavior of an Arduino board. Here are some steps to get started with Arduino programming:

- Install the Arduino IDE: The Arduino IDE is a software platform used to program Arduino boards. Download and install the latest version of the IDE from the official Arduino website.
- Connect the Arduino board: Connect the Arduino board to your computer using a USB cable.
- Open the IDE: Open the Arduino IDE on your computer.
- Select the board and port: In the Tools menu, select the board and the port of the Arduino board that you are using.
- Write the code: Write the code for your project using the Arduino programming language. The code is written in the Arduino IDE's editor.
- Verify and upload the code: Verify that your code compiles without any errors by clicking the "Verify" button. If the code compiles without errors, upload the code to the Arduino board by clicking the "Upload" button.
- Test the code: Once the code is uploaded to the board, test the behavior of the board to ensure that it is working as intended.

FEATURES

- Arduino boards are able to read analog or digital input signals from different sensors and turn it into an output such as activating a motor, turning LED on/off, connect to the cloud and many other actions.
- You can control your board functions by sending a set of instructions to the microcontroller on the board via Arduino IDE (referred to as uploading software).
- Unlike most previous programmable circuit boards, Arduino does not need an extra piece of hardware (called a programmer) in order to load a new code onto the board. You can simply use a USB cable.Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program.

CHAPTER 5

PROJECT DESCRIPTION

5.1 WORKING PRINCIPLE

Ultrasonic sensor is used to detect the crack in the rail track with measuring the distance from track to sensor. Ultrasonic technique is the most effective method which detects cracks on a railway track. An android application will be developed to intimate about the rail cracks. As and when a rail crack is detected by the crack detection system, the corresponding loco pilot will be intimated through a pop-up message. This pop- up notification service will be implementing with the help of GPS module.

There are two provisions in the project for ultrasonic sensor units equipped on the opposing sides of the vehicle. This unit is used for the initiation / deactivation of GSM transmission unit if there is a crack in the path

5.2 METHODOLOGY

The mechanism shown here is the detection by sensors of a faulty rail track and the transmission of the report via an SMS to the nearest control tower if a faulty track is identified. We use two sources in this module, which is the IR-sensor and the ultrasonic sensor.

The ultrasonic sensor induces ultrasonic waves of sound which reach the target and return. Should the object have a crack, the time forced to return the echoes signal can vary. Test range= (high-level time* sound velocity (340M / S)/2) by using a method. The IR sensor mainly works relied on luminance that falls on the sensor. Both devices are allocated set standards.

When the check reaches the defined value, it stops and the faulty track's latitude and longitude location is collected using the GPS device, and sent via the GSM modulation to the base station.

Ultrasonic rail check is usually limited to lower speeds of about 20-30 mph which reduces the ability to test several tracks consistently. Additionally, using the presently available evaluation equipment, many of the most significant deficiencies that may develop in the track head may be very harder to detect.

One justification for using traditional NDT for slow inspection speeds is the need to combine the transducer and track using liquid or dry coupling components. Regardless of the length given to it the vehicle stops.

For eg, if the duration is less than 15 and higher than 10, we set a 20-second interval and if the vehicle is less than 10 and higher than 5, then we have a set of around 100 seconds. If the length reaches 5 cm the vehicle completely stops. These three requirements will only be fulfilled when the item in stop mode is available in its path

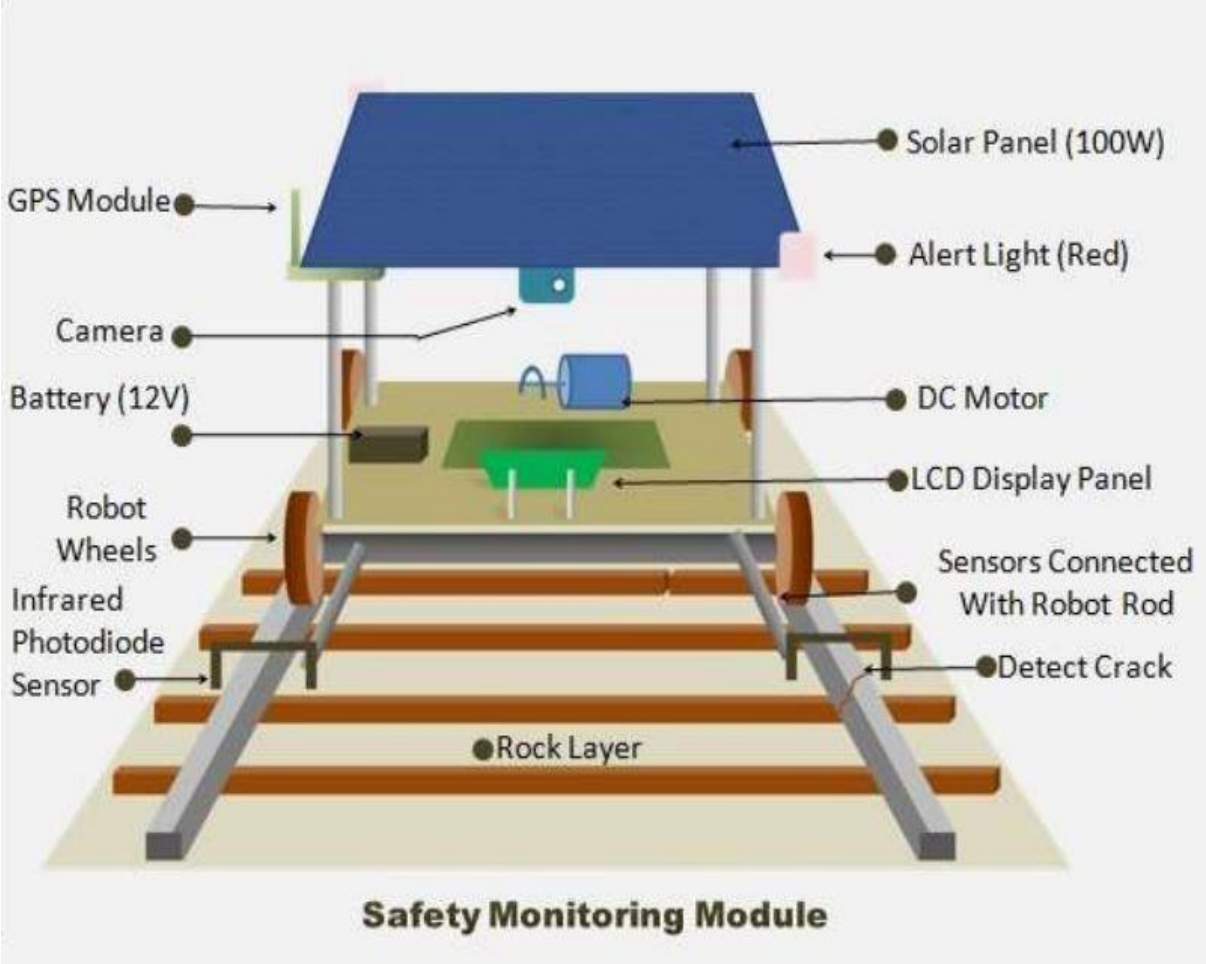


Figure 5.2 Model

5.2.1 FLOW CHART

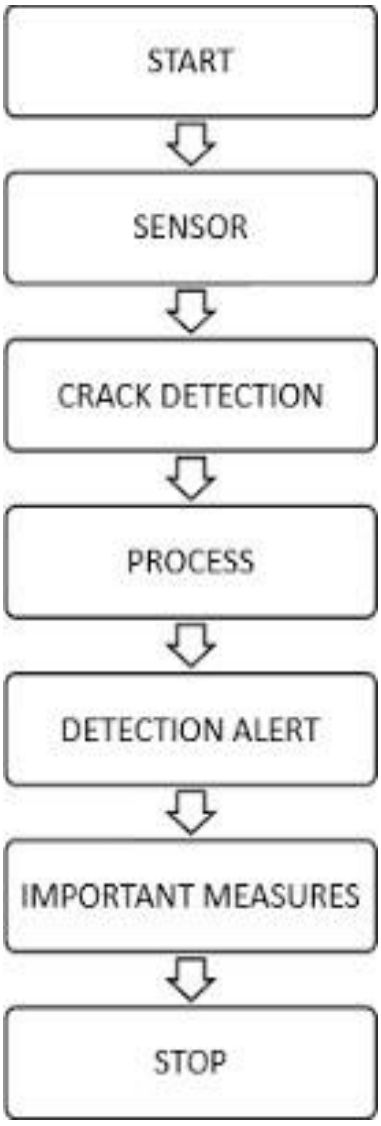


Figure 5.2.1 Flow chart

PROCESS

1. Initially the tracks are being continuously monitored with the help of sensor, which is used to detect the crack in the track.

2. This monitoring is done with the help of ultrasonic sensorin order to sense the minor changes also which can be quite difficult with other sensors.

3. Whenever the crack gets detected with the help of ultrasonic sensor it passes the alert of crack found to the Arduino microcontroller.

4. The Arduino microcontroller will perform the process assigned to it accordingly.

5. The process mainly includes positioning, sending and alerting through the help of GPS module.

6. As the message gets delivered to the Railway Authority, the alert is to be taken into account and important measures must be taken by them in order to avoid future incidents and miss happenings which can lead to loss of human life and also to major injuries.

5.3 BLOCK DIAGRAM

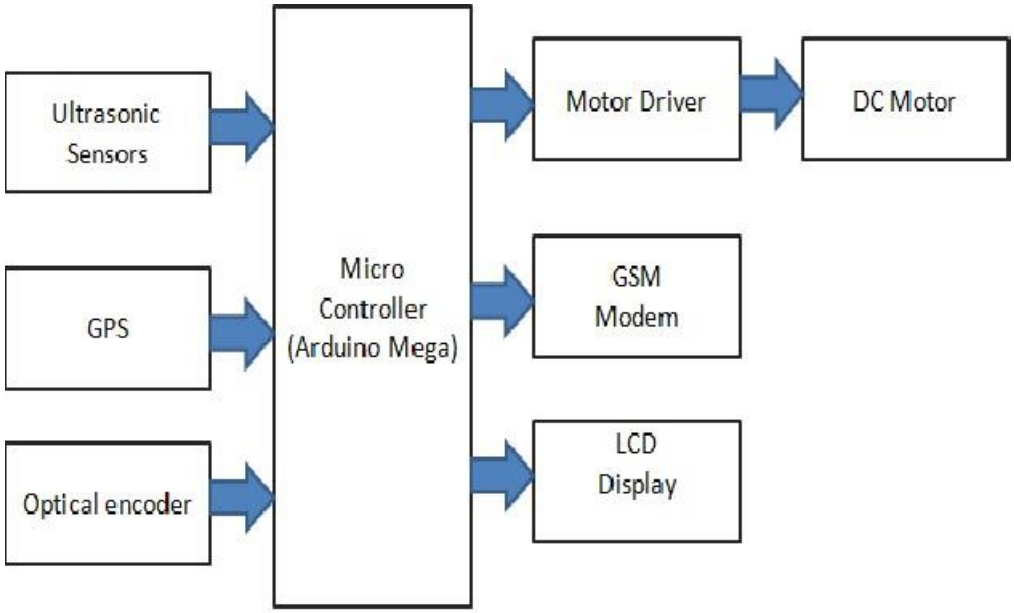


Figure 5.3 Block diagram

5.4 ARCHITECTURE

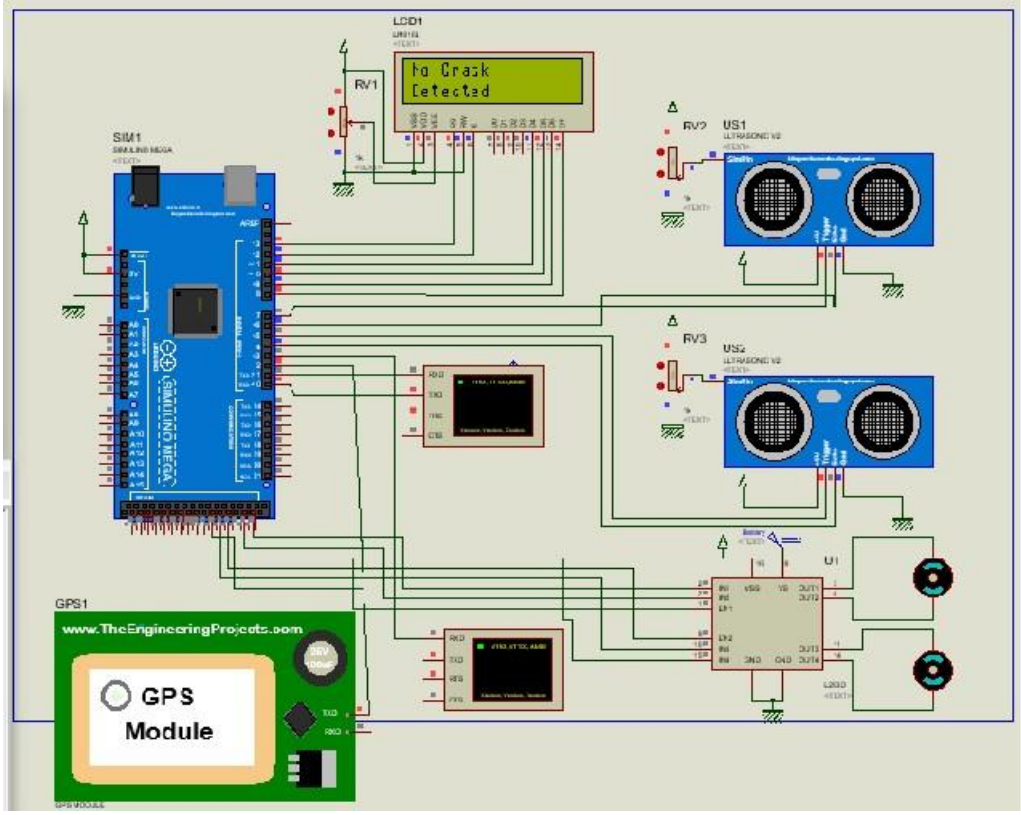


Figure 5.4 Cricuit diagram

5.5 BENEFITS

- Accuracy: FEM can provide accurate results for complex problems with non-linear behaviour, irregular geometries, and non-uniform material properties.
- Efficiency: FEM can handle problems with a large number of degrees of freedom and provide results quickly compared to other analytical methods.
- Flexibility: FEM is a versatile technique that can be used to solve a wide range of problems in different fields of engineering and physics.
- Optimization: FEM can be used to optimize the design of systems by analyzing their behaviour under different conditions and identifying areas that need improvement.
- Visualization: FEM results can be visualized using software tools, such as contour plots, animations, and graphs. This allows engineers to easily understand and interpret the results and make informed design decisions.
- Cost-effective: FEM is often more cost-effective than physical testing, as it reduces the need for costly prototypes and testing equipment.

- Risk reduction: FEM allows engineers to identify potential problems and risks before the physical system is built, reducing the risk of failure and the associated costs.

5.5.1 APPLICATIONS

- AUTOMATIC CRACK CHECKING

- Rail Crack detection is the process of detecting a crack in the structures using any

- The suggested method uses successively radiometric, geometric and contextual information. The vehicle draws power from the battery. The optical sensor is used to detect the crack in the railway track. Suppose any racks are in thetrack the vehicle will automatically stop.

- WIRELESS APPLICATION

- Wireless application protocol (WAP) is the communications protocol that is used for wireless data access through the most mobile wireless network.

- WAP

- Enhances wireless specification interoperability and facilitates instant connectivity between interactive wireless devices (such as mobile phones) and the Internet. Wireless Application Protocol is a technical standard for the accessing information over a mobile wireless network. A WAP browser is web browser for mobile devices such as mobile phones that uses the protocols. Though WAP is a new technology, but it reuses the concepts found in the Internet.

- RAILWAY TRACK DAMAGE DETECTION APPLICATIONS

- A railway damage detection and measurement system using neural networks. Railway- defects and damages often cause train accidents. Experimental result shows that this neural network based measurement system has high precision and is suitable for online railway damage detection and measurement applications. A list of methods used to detect flaws in railways: Ultrasound -is the most popular method. Eddy current inspections – great for surface flaw & near surface flaws. Magnetic Particle Inspection- used for detailed manual inspections. Ultrasonic sensor is used to detect the crack on the railway track by not receiving the echo from the track; if the echo sound is received then no crack is detected on the track. The output of ultrasonic sensors is given to the microcontroller, which is connected to the GPS, motor driver IC.

5.6 EXPERIMENTAL SETUP

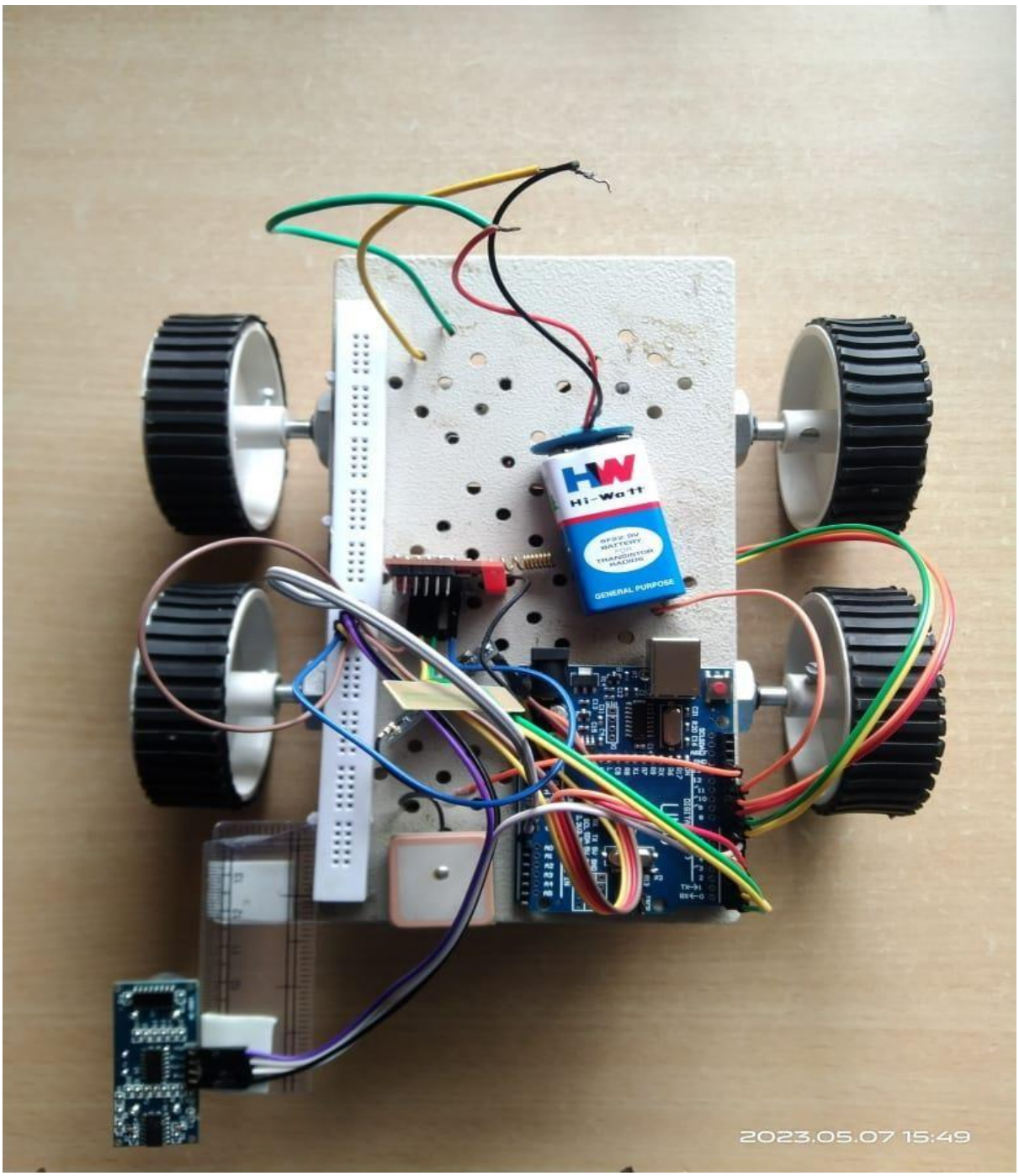


Figure 5.6 Experimental Setup

CHAPTER 6

CONCULUSION

The approach taken is capable, if there are any, of detecting flaws and obstacles on the surface. The method proposed has lots of advantages over conventional detection approaches that include minimal cost, reduced energy consumption, efficient detection system without human involvement and shorter analytical times.

With this prototype, train collisions and derailments can be easily prevented to save many lives. It is also very beneficial for railroad operations testing units.

And we can also notice the position failure and the system used in this, and also the location data is sent to the default mobile number.

So that this enables us in rail line preservation and control as well. When we use the detector model for monitoring and we can claim that it is a fusion energy vehicle.

The result shows that this exciting new technology will keep increasing the efficiency of the safety features for rail infrastructure.

We can prevent accidents of up to 70% by enforcing these functionalities in the real-time implementation. Areas where manual testing is not feasible with this vehicle, such as in shallow coalmines, mountainous areas and thick and deep forests regions, can be easily carried out.

When this vehicle is used for railway inspections and breakage detection, automatic SMS will be sent to a predetermined mobile number if cracks or abnormalities are identified by the device sensors.

This will lead without errors to the management and control of the state of the railway tracks, and thus to the preservation of the tracks in good condition.

CHAPTER 7

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