RAILWAY TRACK INSPECTION ROBOT

PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report titled **"RAILWAY TRACK INSPECTION ROBOT"** is the bona-fide work of **JAWAHAR R, SEENIVASAN R, PRADHAP JAIHIND K, GNANAMOORTHI S,** who carried out the project work under my supervision. Certified further, that to the best of my knowledge the work reported here in does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

The increasing number of accidents on railway tracks due to cracks and obstacles poses a significant threat to passenger safety. To address this issue, this project proposes an **IOT-based Railway Crack Detector System** designed to monitor track conditions in real-time and prevent accidents. The system uses two **proximity sensors** to detect cracks in the railway tracks and an **ultrasonic sensor** to identify objects or obstructions on the track path. A **GPS module** is integrated for real-time location tracking, allowing immediate pinpointing of detected faults.

The system is built around an **Arduino Uno microcontroller** that processes input from the sensors and manages operations. A **relay** module controls the **DC motor** of a robot, which moves along the tracks. If a crack or obstacle is detected, the robot halts by deactivating the relay, and an **alarm** is triggered for immediate indication. The status is displayed on an **LCD screen** and also transmitted via **IOT** to a mobile device or remote monitoring system, ensuring quick response and preventive action.

This automated monitoring solution enhances railway safety, enables early detection of faults, and reduces the chances of derailments and collisions, making it a practical and efficient tool for modern railway maintenance.

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LIST OF ABBREVIATIONS

GSM-	**G**lobal **S**ystem **F**OR **M**obile **C**ommunication
IOT-	**I**nternet **O**f **T**hings
GPS-	**G**lobal **P**ositioning **S**ystem
IP-	**I**nternet **P**rotocol
LED-	**L**ight **E**mitting **D**iode
LCD-	**L**iquid **C**rystal **D**isplay
SIM-	**S**ubscriber **I**dentity chip **M**emory
NC-	**N**ormally **C**losed
NO-	**N**ormally **O**pen

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CHAPTER 1

INTRODUCTION

The increasing number of accidents on railway tracks due to cracks and obstacles poses a significant threat to passenger safety. To address this issue, this project proposes an **IOT-based Railway Crack Detector System** designed to monitor track conditions in real-time and prevent accidents. The system uses two **proximity sensors** to detect cracks in the railway tracks and an **ultrasonic sensor** to identify objects or obstructions on the track path. A **GPS module** is integrated for real-time location tracking, allowing immediate pinpointing of detected faults.

The system is built around an **Arduino Uno microcontroller** that processes input from the sensors and manages operations. A **relay** module controls the **DC motor** of a robot, which moves along the tracks. If a crack or obstacle is detected, the robot halts by deactivating the relay, and an **alarm** is triggered for immediate indication. The status is displayed on an **LCD screen** and also transmitted via **IOT** to a mobile device or remote monitoring system, ensuring quick response and preventive action.

This automated monitoring solution enhances railway safety, enables early detection of faults, and reduces the chances of derailments and collisions, making it a practical and efficient tool for modern railway maintenance.

1.1 MOTIVATION AND INCITEMENT:

Railways are one of the most widely used modes of transportation due to their efficiency and affordability. However, the safety of railways remains a major concern, especially in countries with extensive rail networks. Accidents caused by cracks in railway tracks and unexpected obstacles on the track are common and can lead to severe damage, loss of life, and disruptions in service. Manual inspection of tracks is time-consuming, labour-intensive, and prone to human error.

To overcome these limitations, this project presents an **IOT-enabled Railway Crack Detection System** using a robotic vehicle equipped with smart sensors. The robot is integrated with **proximity sensors** to detect cracks or separations in the rails and an **ultrasonic sensor** to sense objects or obstructions on the track. A **GPS module** provides real-time location data, enabling precise tracking of fault locations.

The system is powered by an **Arduino Uno microcontroller**, which processes sensor data and controls the **relay** that operates the **DC motor** driving the robot. Upon detection of a crack or obstacle, the relay cuts off the motor, halting the robot, and activates a **buzzer alarm** to alert authorities. The information is displayed on an **LCD screen** and simultaneously sent to a mobile application via **IOT** for real-time remote monitoring.

This smart system automates track monitoring, improves the speed and accuracy of fault detection, and enhances overall railway safety by reducing dependency on manual inspections.

1.2 ARDUINO UNO:

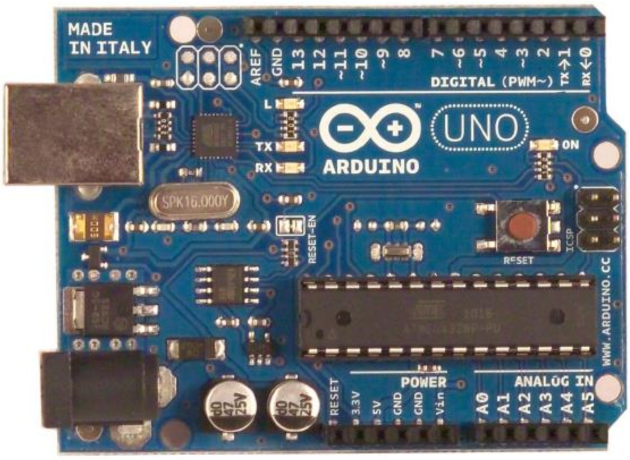


Fig.no 1.1- Arduino Uno

Arduino is a single-board microcontroller to make using electronics in multidisciplinary projects more accessible. The hardware [Fig.no 1.1- Arduino Uno] consists of an open-source hardware board designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM. The software consists of a standard programming language compiler and a boot loader that executes on the microcontroller.

Arduino boards can be purchased pre-assembled or as do-it-yourself kits. Hardware design information is available for those who would like to assemble an Arduino by hand. It was estimated in mid-2011 that over 300,000 official Arduinos had been commercially produced.

Power:

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

1.3 PWM DC MOTOR SPEED CONTROLLER:

Fig.no 1.2-PWM DC motor speed controller

A DC motor speed controller is a device that regulates the speed of a DC motor by adjusting the voltage or current supplied to it. In the railway track inspection robot project, a PWM (Pulse Width Modulation) DC motor controller is used to control the speed and direction of the DC motors

The DC motor speed controller with PWM (Pulse Width Modulation) capability allows for precise control of the DC motors' speed and direction. By adjusting the duty cycle of the PWM signal, the controller regulates the average voltage supplied to the motors, enabling smooth speed control. The Arduino Uno generates the PWM signal, which is sent to the DC motor speed controller [Fig.no 1.2-PWM DC motor speed controller], allowing for efficient and precise control of the robot's movements. By varying the duty cycle, the robot can accelerate, decelerate, or maintain a consistent speed, ensuring stable and accurate navigation along the railway tracks.

1.4 ESP WIFI-MODULE:

Fig.no 1.3- ESP WI-FI module

The ESP Wi-Fi module is a wireless communication module that enables Wi-Fi connectivity in electronic projects. In the railway track inspection robot project, The ESP Wi-Fi module allows the robot to transmit data, such as inspection results and sensor readings, to a remote server or mobile device via Wi-Fi. The module communicates with the Arduino Uno, which sends data to be transmitted wirelessly. The [Fig.no 1.3- ESP WI-FI module] provides a convenient and efficient way to transfer data, facilitating remote inspection and analysis of railway tracks.

The ESP Wi-Fi module enables wireless communication and data transmission between the robot and a remote server or mobile device. The module transmits data collected by the robot's sensors, such as track anomalies and obstacles, to authorized personnel in real-time. This allows for remote monitoring and control of the robot, facilitating efficient inspection and maintenance of railway tracks. The ESP Wi-Fi module's wireless connectivity enables seamless data transfer, enhancing the robot's functionality and usability.

1.5 DC MOTOR:

Fig.no 1.4- DC motor

DC motors are used to propel the robot along the railway tracks, enabling it to navigate and inspect the tracks efficiently. The DC motors [Fig.no 1.4- DC motor] provide the necessary torque and speed to move the robot, allowing it to traverse complex track sections and varying terrain. Controlled by the PWM DC motor controller and Arduino Uno, the DC motors enable precise speed and direction control, ensuring smooth and stable movement. This enables the robot to collect accurate data and inspect the tracks thoroughly, facilitating efficient maintenance and ensuring railway safety.

CHAPTER 2

2.1 LITERATURE SURVEY:

A Review on Deep Learning Techniques for Railway Infrastructure Monitoring: [Maria Di Summa; Maria Elena Griseta; Nicola Mosca; Cosimo Patruno; Massimiliano Nitti]

In the last decade, thanks to a widespread diffusion of powerful computing machines, artificial intelligence has been attracting the attention of the academic and industrial worlds. This review aims to understand how the scientific community is approaching the use of deep-learning techniques in a particular industrial sector, the railway. This work is an in-depth analysis related to the last years of the way this new technology can try to provide answers even in a field where the primary requirement is to improve the already very high levels of safety.

An Effective Deep Multitask Learning Architecture for Rail Crack Detection: [Shijin Meng; Senyun Kuang; Zheng Ma; Yanliang Wu]

Studying automated rail surface defect detection methods instead of manual inspections can not only save time and cost, but also increase the safety of railway transport. Consequently, many methods have been developed, which utilize convolutional neural networks (CNNs) in order to automatically detect rail surface defects. In these works, however, little attention has been paid to the detection of rail surface crack defects. The rail surface crack defect is actually an early defect that, if not detected and maintained in time, can result in worse defects. In order to detect crack defects on the rail surface rapidly and accurately, we propose an effective deep multitask learning architecture.

Autonomous railway crack detector robot for bangladesh: SCANOBOT: [Nagib Mahfuz; Omor Ahmed Dhali; Safayet Ahmed; Mehen Nigar]

An automatic railway track crack detector system for Bangladesh Railway has been proposed here which aims in building a robot that can detect and analyze any kind of crack on the railway line and send the coordinates of that faulty line to the concerned authority. This robot includes two ultrasonic sensors, GPS, GSM modules, and Arduino Mega based crack detection assembly which is cost effective and robust to facilitate better safety standards in railways. As soon as the robot passed through a crack that might cause the derailment of a train, the ultrasonic sensors sense that and generate a signal. Then this signal is fed into the Arduino Mega. At that point, with the assistance of GSM and GPS modules, an alert SMS consist of the geographic coordinate of that damaged track is sent to the nearby railway authority who can easily take necessary steps to resolve the problem before any major accident occurs. This will save several trains in Bangladesh from an unwanted discontinuity from the rail track.

Automated Masonry crack detection with Faster R-CNN: [Borja Marin; Keith Brown; Mustafa S. Erden]

Inspection of masonry buildings, typically railway bridges, for crack detection is currently performed by humans under tedious and sometimes dangerous working conditions. Over the past years, computer vision based techniques have been developed to automate structure visual inspections. These techniques could be integrated with (semi) autonomous drone surveillance to collect images of assets for full automation of simultaneous inspection and crack detection in railway bridges. In this study we have adopted the architecture of Faster R-CNN object detectors to provide crack detection in images. In this architecture, we have tested three networks (Mobilenetv2, Resnet50 and ZF512) to be utilized as feature extractors in a limited resource system for crack detection. We propose a new way of performing detection that we call Progressive Detection to increase the robustness of detection, considering otherwise only partially detected cracks. Since one of the main goals of visual inspection is checking the health of every single defect, we have revisited binary classification of images with and without cracks from a detection point of view, with the objective of minimizing crack missing rates.

2.2 PROBLEM STATEMENT:

- To design a railway track inspection robot to find track is cracked/damaged
- There has been an increase in railway accidents, which are primarily the result of track issues. This might be due to a misalignment, a crack in one of the track's sides, or another issue with the track.

2.3 THESIS OUTLINE:

The research work presented in the thesis is structured into eight chapters, the introduction to the project is discussed in Chapter 1. The literature survey, and Problem statement are explored in Chapter 2. In chapter 3, the working principle of existing and proposed system are explained. In Chapter 4 the software implementation is explained with android studio to create the app. Then hardware implementation discussed in the Chapter 5.In chapter 6, software description with the Arduino ide. Then in chapter 7, project result and discussion full mechanism were explained. Finally, Chapter 8 concludes findings from this work.

CHAPTER 3
WORKING PRINCIPLE

3.1 INTRODUCTION:

The railway track inspection robot is a revolutionary solution that transforms the way railway infrastructure is maintained. Designed to autonomously inspect railway tracks, detect anomalies, and report issues, this robot is equipped with advanced sensors, including metal proximity and ultrasonic sensors. These sensors enable the robot to navigate along tracks, identifying defects, obstacles, and anomalies with precision. The robot's real-time data transmission capabilities via Wi-Fi or GSM facilitate prompt analysis and monitoring, allowing for swift action to be taken in case of any issues. One of the key benefits of this robot is its predictive maintenance capabilities, which significantly reduce downtime and costs associated with manual inspections and repairs.

By identifying potential issues before they become major problems, the robot helps prevent accidents, reduces maintenance costs, and increases the overall efficiency of railway operations.

The autonomous operation of the robot also improves safety by minimizing the need for human inspectors to physically inspect tracks, often in hazardous environments. With its potential applications in railway maintenance, track monitoring, and obstacle detection, this robot provides a reliable and efficient solution for maintaining railway infrastructure. By leveraging cutting-edge technology, the railway track inspection robot enhances safety, reduces costs, and improves overall efficiency, making it an invaluable asset for railway operators and maintenance teams. By adopting this technology, railway operators can improve safety, reduce costs, and increase efficiency, ultimately providing better services to passengers and freight customers.

3.2 EXISTING SYSTEM:

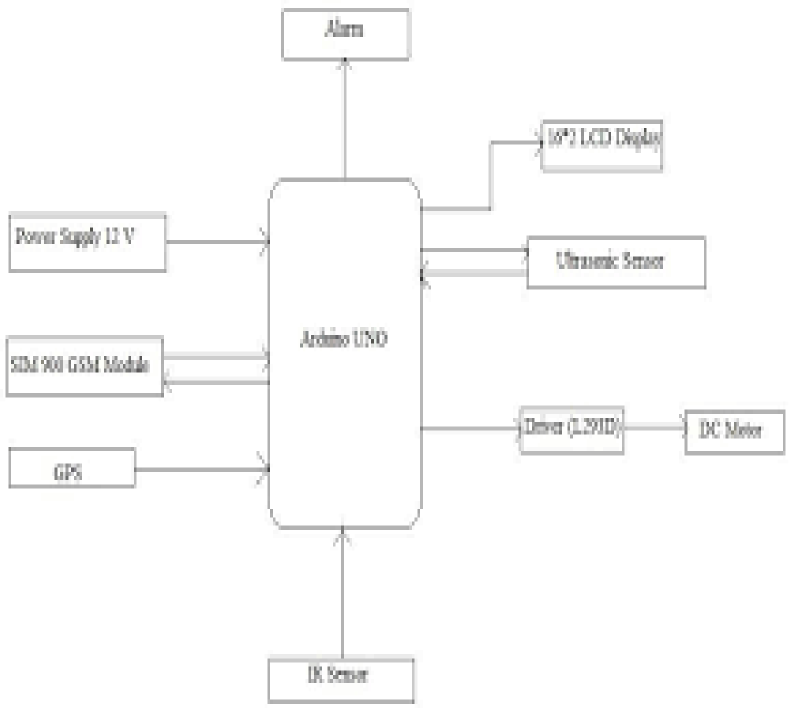


Fig.no 3.1- Block diagram of existing system

In the existing railway infrastructure, the detection of cracks or obstacles on the tracks is primarily done through manual inspection and patrolling by railway personnel. Track inspectors walk or travel along the tracks at regular intervals to identify physical damage, misalignments, cracks, or foreign objects. In some advanced rail networks, ultrasonic flaw detection machines or ground-penetrating radar (GPR) systems are used to scan and analyse the internal condition of the tracks. However, these machines are expensive, complex, and require skilled operators.

Some systems also use visual inspection with cameras mounted on trains, which record footage for later analysis. While helpful, this method is not real-time and still requires human interpretation. Additionally, there is little or no integration with IOT or GPS-based location tracking, making fault identification and communication to authorities slower and less efficient.

The main drawbacks of the existing system include:

- High dependency on manual labour and human accuracy
- Time-consuming and not suitable for real-time monitoring
- Delayed detection and response to cracks or obstacles
- Lack of automation and limited use of modern communication technologies
- High cost of advanced detection equipment

3.3 PROPOSED SYSTEM:

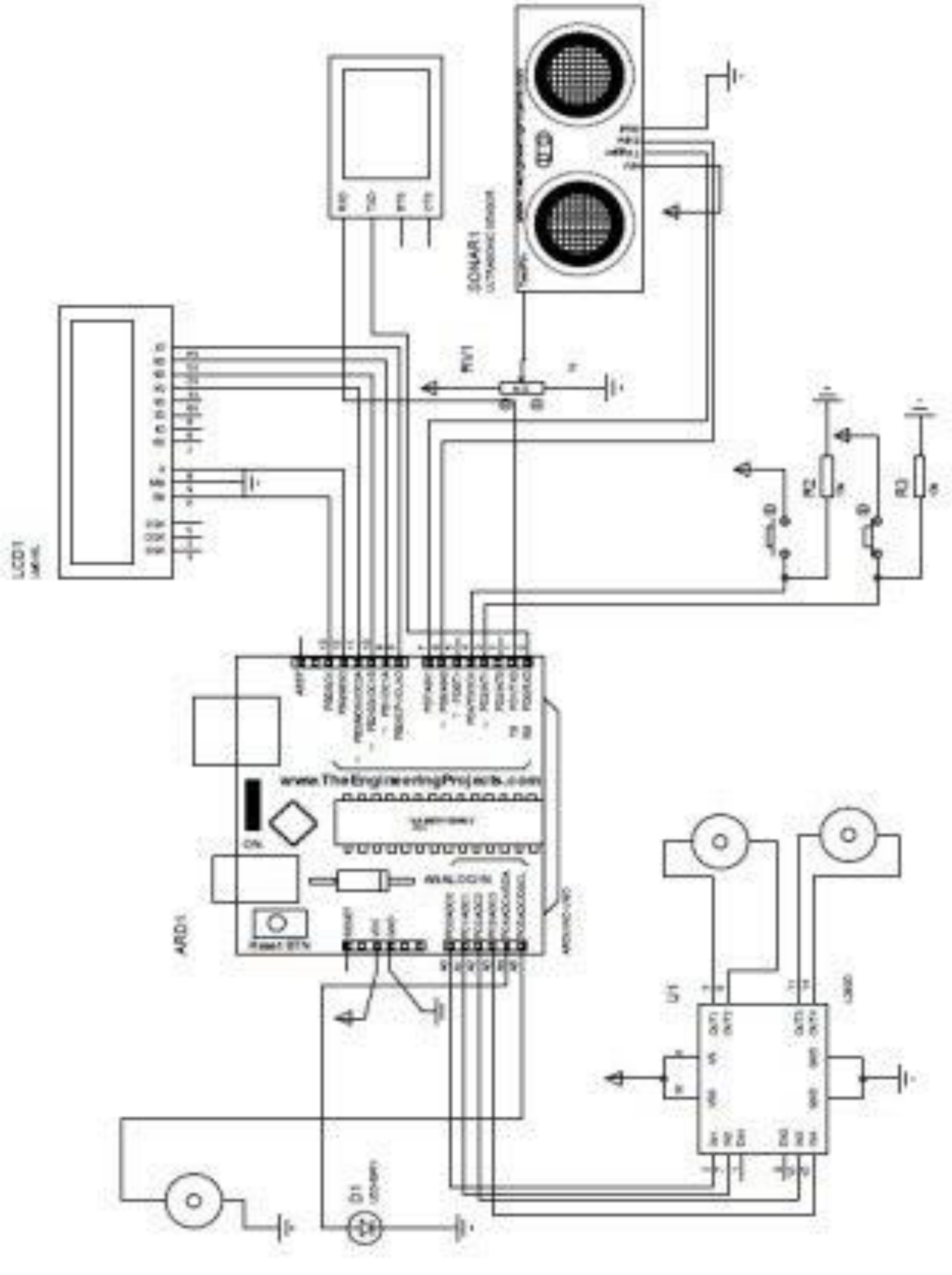


Fig.no 3.2- Circuit diagram of proposed system

The proposed system [Fig.no 3.2- Circuit diagram of proposed system] aims to overcome the limitations of traditional track inspection methods by introducing an automated, IOT-enabled robotic railway crack detection system. This smart robot moves along the railway tracks and continuously monitors the track condition using proximity sensors to detect cracks and an ultrasonic sensor to detect objects or obstacles in its path.

The robot is powered by an Arduino Uno microcontroller, which serves as the brain of the system. When a crack or obstacle is detected, the system immediately triggers an alarm, displays the alert on an LCD, and cuts off power to the DC motor via a relay, effectively stopping the robot to prevent further movement over the damaged section.

After the detection of the track damage, it send an alert message to the **RAILWAY CRACK DETECTION APPLICATION** with the accurate location. Then it is easy to rectify the damaged track

Key features of the proposed system include:

- Real-time crack and obstacle detection using sensors
- Automatic stopping of the robot upon fault detection
- If the track is damaged, Then it send an alert message as crack damage detected
- If the object is detected in front of the system, Then it send an alert message as object detected
- If the track is good and there is no obstacle front of the system, Then that will be at the normal state

GPS-based location tracking for accurate fault report.

BLOCK DIAGRAM:

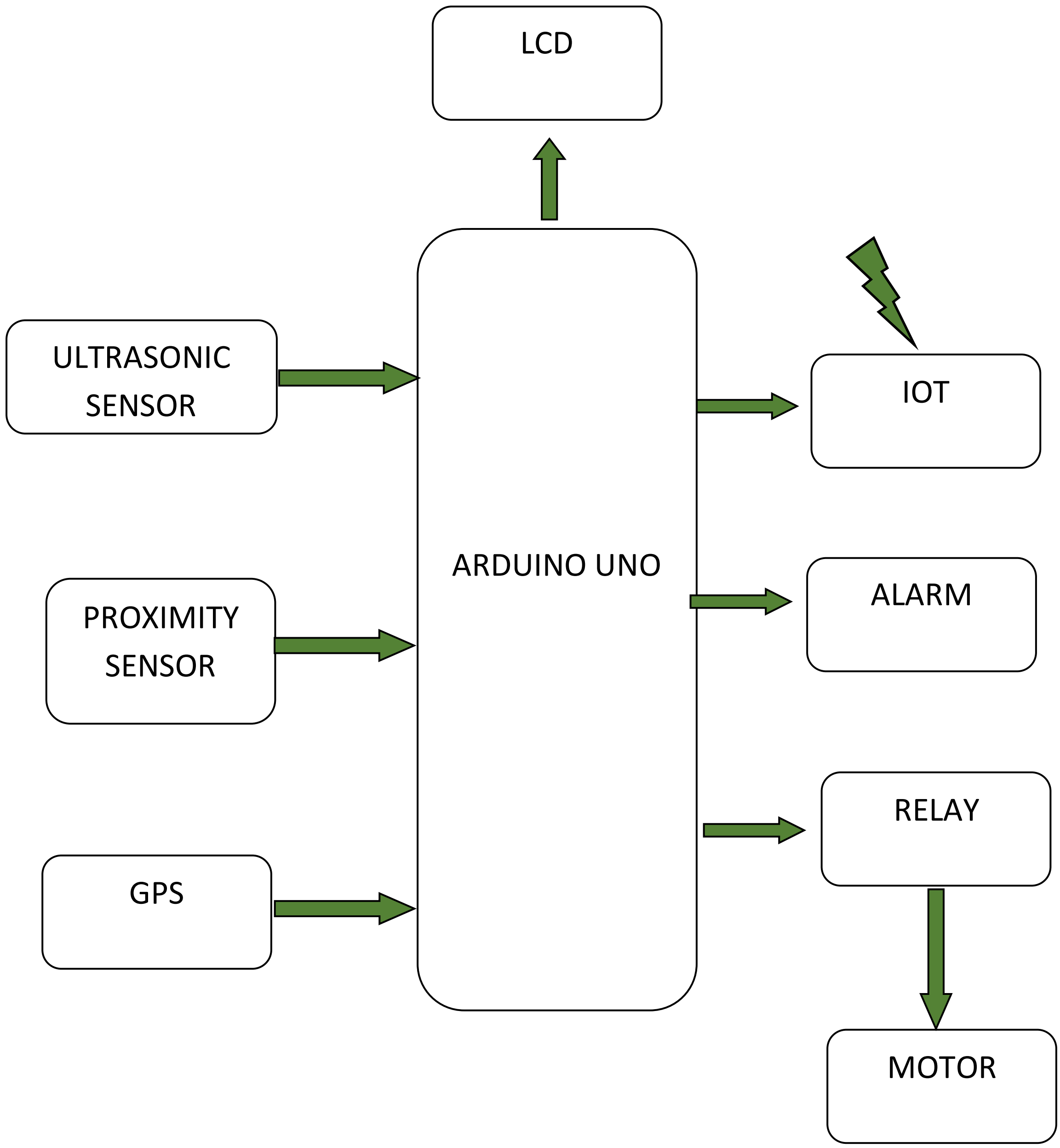


Fig.no 3.3- Block diagram of proposed system

The Arduino Uno serves as the central control unit, processing data from various sensors. The metal proximity sensor and ultrasonic sensor detect track anomalies and obstacles, sending signals to the Arduino Uno. The Arduino Uno then controls the DC motors via the PWM DC motor controller, propelling the robot along the tracks. The ESP Wi-Fi module and GSM module enable wireless communication, transmitting inspection data and alerts to authorized personnel. Power supply blocks provide power to each component, ensuring smooth operation. This integrated system enables efficient and accurate inspection of railway tracks.

3.4 SUMMARY:

Thus it send the alert message to the developed app, that helps us detect the damaged or cracked track, which send the accurate location of the damaged part of the railway track, here I [Fig.no 3.3- Block diagram of proposed system] proposed a metal proximity sensor which is more accurate than IR sensor.

The increasing number of accidents on railway tracks due to cracks and obstacles poses a significant threat to passenger safety. To address this issue, this project proposes an iot-based railway crack detector system designed to monitor track conditions in real-time and prevent accidents.

CHAPTER 4

SOFTWARE IMPLEMENTATION

4.1 INTRODUCTION:

Android Studio is a free, open-source integrated development environment (IDE) for building Android apps. It provides a comprehensive set of tools for designing, coding, testing, and debugging Android applications. With features like code completion, debugging tools, and project management, Android Studio streamlines the app development process. It supports various programming languages, including Java, and C++, and allows developers to create apps for Android devices, including smartphones, tablets, and wearables. Android Studio is widely used by developers to create a wide range of Android apps, from simple tools to complex enterprise applications.

4.2 ANDROID STUDIO:

Android Studio is a windowed environment. To make the best use of limited screen real-estate, and to keep you from being overwhelmed, Android Studio displays only a small fraction of the available windows at any given time. Some of these windows are context-sensitive and appear only when the context is appropriate, while others remain hidden until you decide to

show them, or conversely remain visible until you decide to hide them. To take full advantage of Android Studio, you need to understand the functions of these windows, as well as how and when to display them. In this chapter, we’re going to show you how to manage the windows within Android Studio.One of the essential functions of any integrated development environment (IDE) is navigation. Android projects are typically composed of many packages, directories, and files, and an Android project of even modest complexity can contain hundreds of such assets. Your productivity with Android Studio will depend in large measure on how comfortable you are navigating within these assets and across them. In this chapter, we're also going to show you how to navigate in Android Studio.

Finally, we'll show you how to use the help system within Android Studio. To take full advantage of this chapter, open the HelloWorld project we created in Chapter 1. If this project is already open in Android Studio, you're ready to go. Please refer to Figure 2-1 as we discuss the following navigation features.

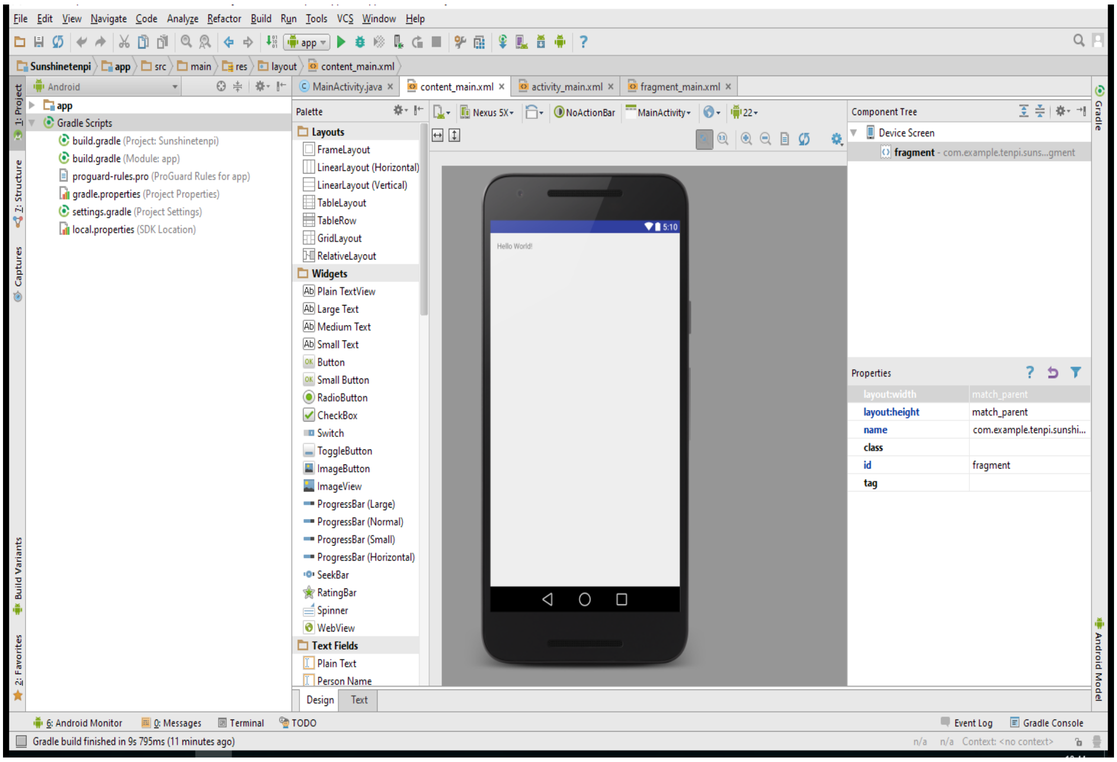


Fig.no 4.1- Android studio

The Editor:

The primary purpose of any IDE is to edit files. As one would expect, the window that allows users to edit files in Android Studio is located in the center pane of the IDE. The Editor [Fig.no 4.1- Android studio] window is unique among windows in that it is always visible and always located in the center pane.

- In fact, the Editor window is such a pervasive feature of Android Studio that from here on out, we refer to it simply as the Editor. All the other windows in Android Studio are called tool windows and cluster in side panes (left, bottom, and right) around the Editor. The Editor is a tabbed window, and in this respect it resembles a contemporary web browser. When you open a file from one of the tool windows, from a keyboard shortcut, or from a context menu, the file displays as a tab of the Editor.
- As you already discovered when you built your first project, HelloWorld, the MainActivity.java and the activity_main.xml files were automatically loaded in the Editor as tabs. Android Studio tries to anticipate which files you're likely to start editing, and then opens them automatically as tabs in the Editor upon completion of the New Project Wizard. Virtually any file may be opened in the Editor, though raw image
- and sound files cannot (yet) be edited from within Android Studio. You may also drag and drop a file from a tool window onto the Editor; doing this opens the file as a tab in the Editor.
- Along the top of the Editor are the Editor tabs. Along the left margin of the Editor is the gutter, and along the right margin of the Editor is the marker bar. Let's examine each in turn.

Editor Tabs:

To navigate among Editor Tabs in Android Studio, use the Alt+Right-Arrow | Ctrl+Right-Arrow or Alt+Left-Arrow | Ctrl+Left-Arrow keys. Of course, you may always select an Editor tab with your mouse. The Editor tabs' options are located in the main menu bar at Window ➤ Editor Tabs. Any action you select from this menu applies to the currently selected tab. Roll your mouse over the MainActivity.java tab and right-click (Ctrl-click on Mac) it. In the resulting context menu, [Fig.no 4.2- Editor Tab] you will notice many of the same options that you discovered in Window ➤ Editor Tabs. From this context menu, select the Tabs Placement submenu. The menu options Top, Bottom, Left, and Right allow you to move the tabs bar. Moving the tabs bar to the right or left accommodates more visible tabs, though at the expense of screen real-estate.

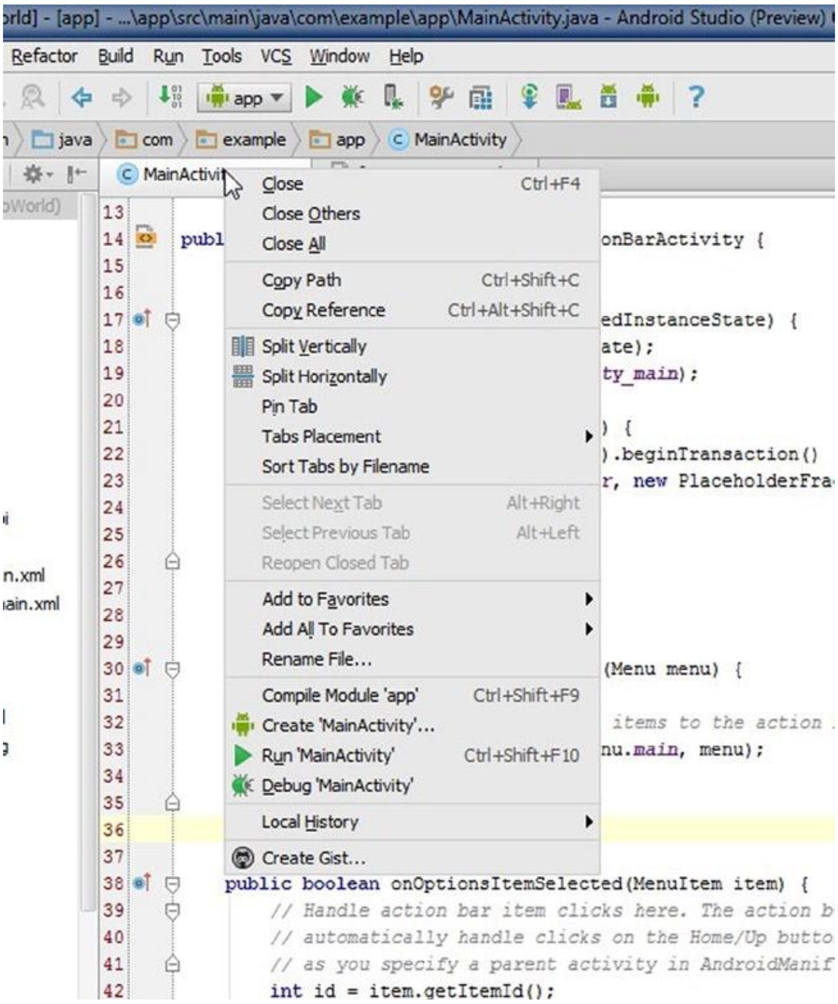


Fig.no 4.2- Editor tab

CHAPTER 5

HARDWARE IMPLEMENTATION

5.1 COMPONENTS:

COMMUNICATION:

In this railway track inspection robot project, the Arduino Uno plays a crucial role as the brain of the system. It processes data from various sensors, including the metal proximity sensor and ultrasonic sensor, to detect tracks, obstacles, and anomalies. The Arduino Uno controls the DC motors via the PWM DC motor controller, enabling the robot to navigate along the tracks. It also integrates with the ESP Wi-Fi module for real-time data transmission and the GSM module for remote reporting. The Arduino Uno's microcontroller capabilities allow it to execute programmed instructions, making decisions based on sensor data, and controlling the robot's movements. By leveraging the Arduino Uno's processing power and versatility, the robot can efficiently inspect railway tracks, detect issues, and report anomalies, ultimately enhancing safety and reducing maintenance costs.

LCD DISPLAY:

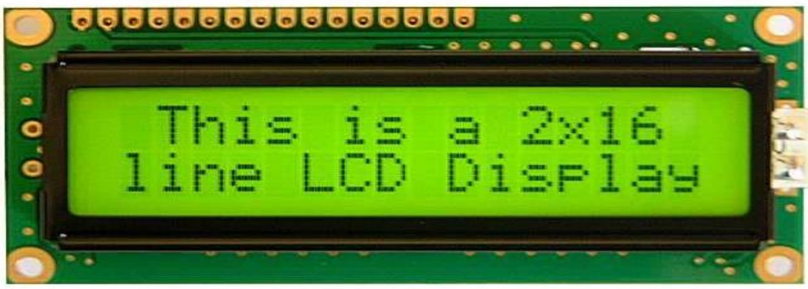


Fig.no 5.1- LCD display

An [Fig.no 5.1- LCD display] can be used to provide real-time information about the robot's status, sensor readings. The LCD display can show data such as crack detected, normal, object detected, allowing users to monitor the robot's performance and receive critical information. By displaying sensor data and system status, the LCD display enhances the robot's usability and facilitates troubleshooting, enabling users to quickly identify and address issues. The LCD display can be connected to the Arduino Uno, which processes and displays the relevant information, providing a user-friendly interface for monitoring and controlling the robot.

BUZZER:

Fig.no 5.2- Buzzer

A buzzer is an audio signaling device that produces a loud, high-pitched sound to alert or notify users of specific events or conditions. In electronic projects, buzzers are often used to provide audible feedback or warnings. They can be triggered by a microcontroller, such as the Arduino Uno, to signal events like anomalies, errors, or completed tasks. Buzzers [Fig.no 5.2- Buzzer] are commonly used in applications where visual alerts may not be sufficient, providing an additional layer of notification to ensure users are informed.

The buzzer can be connected to the Arduino Uno, which triggers the buzzer when anomalies, obstacles, or track defects are detected. The buzzer serves as an audible warning system, alerting users to potential problems, allowing for prompt action to be taken.

RELAY:

Fig.no 5.3- Relay

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit which can be completely separate from the first

A relay can be used to control high-power devices or circuits, such as the DC motors, by isolating the control signal from the high-power circuit. The relay [Fig.no 5.3- Relay] can be connected to the Arduino Uno, which sends a control signal to the relay, switching it on or off to control the DC motors. This allows for efficient and safe control of the robot's movements. Relays provide electrical isolation, protecting the Arduino Uno from potential damage due to high current or voltage. By using a relay, the robot can reliably control its motors, ensuring smooth and precise movement along the railway tracks.

5.2 POWER SUPPLY:

A battery works on the oxidation and reduction reaction of an electrolyte with metals when two dissimilar metallic substances, called electrode, are placed in a diluted electrolyte, oxidation and reduction reaction take place in the electrodes respectively depending upon the electron affinity of the metal of the electrodes. As a result of the oxidation reaction, one electrode gets negatively charged called cathode and due to the reduction reaction, another electrode gets positively charged called anode. The cathode forms the negative terminal whereas anode forms the positive terminal of a battery to understand the basic principle of battery properly, first, we should have some basic concept of electrolytes and electrons affinity. Actually, when two dissimilar metals are immersed in an electrolyte, there will be a potential difference produced between these metals.

It is found that, when some specific compounds are added to water, they get dissolved and produce negative and positive ions. This type of compound is called an electrolyte. On the other hand, the metal with high electron affinity will release electrons and these electrons come out into the electrolyte solution and are added to the positive ions of the solution. In this way, one of these metals gains electrons and another one loses electrons. As a result, there will be a difference in electron concentration between these two metals.

5.3 GSM:

GSM stands for Global System for Mobile communication [Fig.no 5.4- GSM module]. Today, GSM is used by more than 800 million end users spread across 190 countries which represents around 70 percent of today's digital wireless market. So, let's see how it works. GSM or Global System for Mobile Communications is the most popular wireless cellular communication technique, used for public communication.

Fig.no 5.4- GSM module

In GSM, geographical area is divided into hexagonal cells whose side depends upon power of transmitter and load on transmitter (number of end user). At the center of cell, there is a base station consisting of a transceiver (combination of transmitter and receiver) and an antenna.

5.3.1 FUNCTION OF GSM:

Mobile station (MS): It refers for mobile station. Simply, it means a mobile phone.

Base transceiver system (BTS): It maintains the radio component with MS.

Base station controller (BSC) Its function is to allocate necessary time slots between the BTS and MSC.

Home location register (HLR): It is the reference database for subscriber parameter like subscriber's ID, location, authentication key etc.

Visitor location register (VLR): It contains copy of most of the data stored in HLR which is temporary and exist only until subscriber is active

Equipment identity register (EIR): It is a database which contains a list of valid mobile equipment on the network.

Authentication center (AuC): It perform authentication of subscriber.

5.3.2 WORKING OF GSM:

GSM is combination of IDMA (Time Division Multiple Access), EDMA (Frequency Division Multiple Access) and Frequency hopping Initially, GSM use two frequency bands of 25 MHz width: 890 to 915 MHz frequency band for up-link and 935 to 960 MHz frequency for down link, Later on, two 75 MHz band were added. 1710 to 1785 Milz for up-link and 1805 to 1880 MHz for down-link, up-link is the link from ground station to a satellite and down-link is the link from a satellite down to one or more ground stations of receivers, GSM divides the 25 MHz band into 124 channels each having 200 KHz width and remaining 200 KIIz, is left unused as a guard band to avoid interference

GSM or Global System for Mobile Communications is the most popular wireless cellular communication technique, used for public communication. The GSM standard was developed for setting protocols for second generation (20) digital cellular networks.

Global System for Mobile Communications (GSM) uses a combination of Time Division Multiple Access (TDMA) and Frequency Division Multiple Access (FDMA) Frequency Division Multiple Access: It involves dividing a frequency band into multiple bands such that ench sub-divided frequency band is allotted to a single subscriber, FDMA in GSM divides the 25MHz bandwidth into

124 carrier frequencies each spaced 200 KHz apart. Each base station is allotted one or more carrier frequencies.

Although GSM or 2G communication network is still the preferred network for many subscribers, especially in developing countries like India, owing to its availability and it being economic, yet different communication technologies like Universal Mobile Telecommunications System (UMTS) and Long Term Evolution (LTE) technologies were developed. While UMTS provides 3rd generation wireless communication standards, LTE provides 4th generation wireless communication standards. So, this is a basic tutorial about GSM communication network. In the last para, I have mentioned about the emerging communication network, LTE. Any information regarding this technique is welcome in the below comments.

The network is structured into a number of discrete sections:

The Base Station Subsystem (the base stations and their controllers).the Network and Switching Subsystem (the part of the network most similar to a fixed network). This is sometimes also just called the core network

The GPRS Core Network (the optional part which allows packet based Internet connections).

The Operations support system (OSS) for maintenance of the network.

5.3.3 SIM:

One of the key features of GSM is the Subscriber Identity Module, commonly known as a SIM card. The SIM is a detachable smart card containing the user's subscription information and phone book. This allows the user to retain his or her information after switching handsets. Alternatively, the user can also change operators while retaining the handset simply by changing the SIM. Some operators will block this by allowing the phone to use only a single SIM

5.4 METAL PROXIMITY SENSOR:

A metal proximity sensor is a type of sensor that detects the presence or absence of metal objects within a certain range. It works on the principle of electromagnetic induction, where a coil generates a magnetic field that is disrupted by the presence of metal. When a metal object enters the detection range, the sensor's output changes, triggering a signal. Metal proximity sensors are commonly used in industrial automation, robotics, and security systems for detecting metal objects, monitoring machinery, and controlling processes. In the railway track inspection robot project, the metal proximity sensor helps detect anomalies or foreign metal objects on the tracks.

5.4.1 WORKING PRINCIPLE:

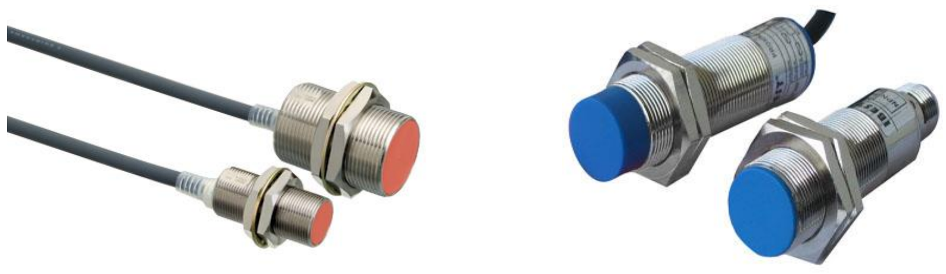


Fig.no 5.5-Proximity sensor

A metal proximity sensor [Fig.no 5.5-Proximity sensor] is a type of sensor that detects the presence or absence of metal objects. In the railway track inspection robot project, the metal proximity sensor is used to detect the presence of railway tracks, allowing the robot to navigate and inspect the tracks accurately. The sensor works by generating a magnetic field and detecting changes in the field when metal is present. When the sensor detects the metal tracks, it sends a signal to the Arduino Uno, which processes the data and controls the robot's movements. The metal proximity sensor is a crucial component of the robot, enabling it to stay on track and perform inspections efficiently.

In the railway track inspection robot project, the metal proximity sensor is used to detect the presence of railway tracks, enabling the robot to navigate and stay on track. The sensor detects the metal rails and sends signals to the Arduino Uno, which processes the data and controls the robot's movements. This ensures the robot remains aligned with the tracks, allowing for accurate inspection and data collection. The metal proximity sensor's detection capabilities help the robot maintain its course, even in complex or curved track sections, ensuring efficient and reliable inspection of railway infrastructure.

5.5 ULTRA SONIC SENSOR:

An ultrasonic sensor is a type of proximity sensor that uses high-frequency sound waves to detect objects and measure distances. It works by emitting ultrasonic waves and measuring the time it takes for the waves to bounce back from an object. The sensor calculates the distance based on the time delay and speed of sound. Ultrasonic sensors are commonly used in robotics, automation, and industrial applications for obstacle detection, distance measurement, and level sensing. In the railway track inspection robot project, the ultrasonic sensor helps detect obstacles or anomalies on the tracks, ensuring safe and efficient inspection.

5.5.1 WORKING PRINCIPLE:

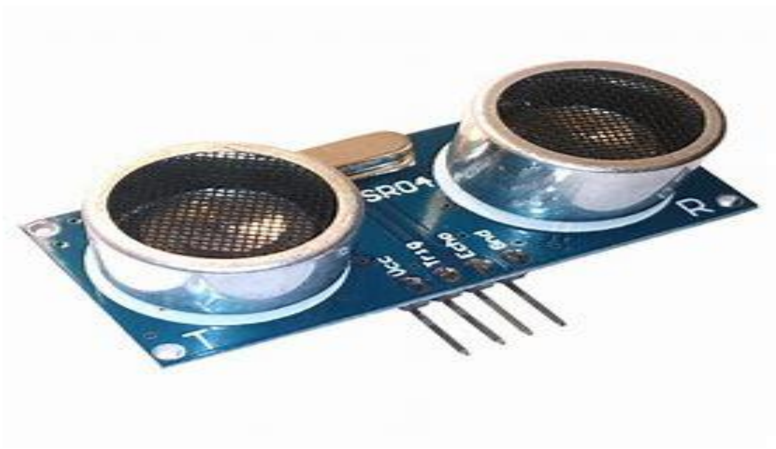
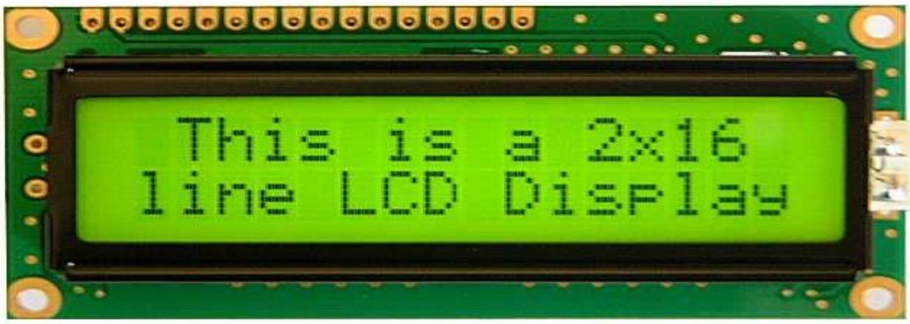


Fig.no 5.6- Ultrasonic sensor

The ultrasonic sensor plays a crucial role in detecting obstacles on the tracks. It uses high-frequency sound waves to measure distance and detect objects, such as rocks, debris, or other foreign objects, that may be present on the tracks. The ultrasonic sensor [Fig.no 5.6- Ultrasonic sensor] sends signals to the Arduino Uno, which processes the data and controls the robot's movements accordingly. By detecting obstacles, the ultrasonic sensor helps prevent accidents and damage to the robot, ensuring safe and efficient inspection of railway tracks. The sensor's data can also be transmitted via the ESP Wi-Fi module or GSM module for remote monitoring and analysis.

5.6 LCD DISPLAY:



An LCD display can be used to provide real-time information about the robot's status, sensor readings. The LCD display can show data such as crack detected, normal, object detected, allowing users to monitor the robot's performance and receive critical information. By displaying sensor data and system status, the LCD display enhances the robot's usability and facilitates troubleshooting, enabling users to quickly identify and address issues. The LCD display can be connected to the Arduino Uno, which processes and displays the relevant information, providing a user-friendly interface for monitoring and controlling the robot.

5.6.1 LCD 16*2 PIN OUT:

The 16x2 LCD pin out is mentioned below.

Pin1 (Ground/Source Pin): This is a GND pin of display, used to connect the GND terminal of the microcontroller unit or power source.

Pin2 (VCC/Source Pin): This is the voltage supply pin of the display, used to connect the supply pin of the power source.

Pin3 (V0/VEE/Control Pin): This pin regulates the difference of the display, used to connect a changeable POT that can supply 0 to SV

Pin4 (Register Select/Control Pin): This pin toggles among command or data register, used to connect a microcontroller unit pin and obtains either 0 or 100 data mode, and 1 command mode).

Pin5 (Read/Write/Control Pin): This pin toggles the display among the read or writes operation, and it is connected to a microcontroller unit pin to get either 0 or 1 (0-Write Operation, and 1 Read Operation).

Pin 6 (Enable/Control Pin): This pin should be held high to execute Read/Write process, and it is connected to the microcontroller tumit & constantly held high.

Pins 7-14 (Data Pins): These pins are used to send data to the display. These pins are connected in two-wire modes like 4-wire mode and 8-wire mode. In 4-wire mode, only four pins are connected to the microcontroller unit like to 3, whereas in 8-wire mode, 8-pins are connected to microcontroller unit like 0 to 7.

Pin15 (+ve pin of the LED): This pin is connected to +5V

Pin 16 (-ve pin of the LED): This pin is connected to GND

CHAPTER 6

SOFTWARE DESCRIPTION

6.1 ARDUINO IDE:

The Arduino Integrated Development Environment - or Arduino Software (IDE) contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them. Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information.

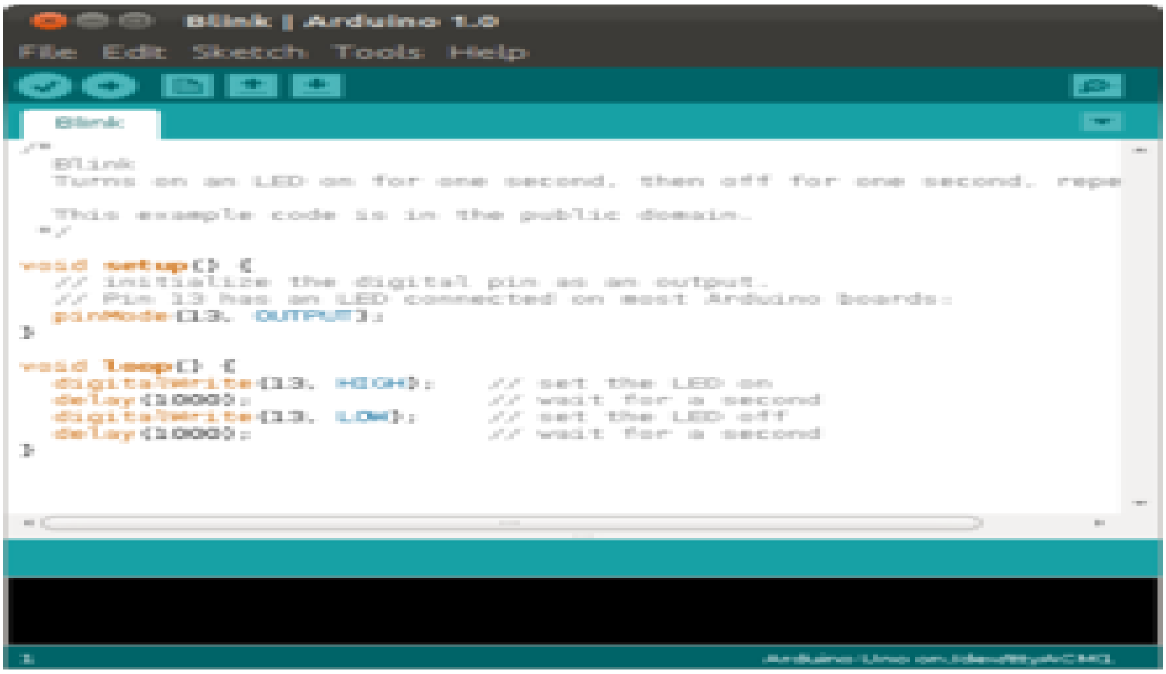


Fig.no 6.1- Arduino ide

The bottom right hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

NB: Versions of the Arduino Software (IDE) [Fig.no 6.1- Arduino ide] prior to 1.0 saved sketches with the extension. It is possible to open these files with version 1.0, you will be prompted to save the sketch with the .in no extension on save

6.2 EMBEDDED C PROGRAM LANGUAGE:

Earlier, many embedded applications were developed using assembly level programming. However, they did not provide portability. This disadvantage was overcome by the advent of various high-level languages like C. Pascal, and COBOL. However, it was the C language that got extensive acceptance for embedded systems, and it continues to do so. The C code written is more reliable, scalable, and portable; and in fact, much easier to understand. Embedded C Programming is the soul of the processor functioning inside each and every embedded system we come across in our daily life, such as mobile phones, washing machines, and digital cameras. Each processor is associated with embedded software. The first and foremost thing is the embedded software that decides to function of the embedded system. Embedded C language is most frequently used to program the microcontroller.

6.2.1 EMBEDDED SYSTEM PROGRAMING:

As we discussed earlier, the designing of an embedded system can be done using Hardware & Software. For instance, in a simple embedded system, the processor is the main module that works like the heart of the system. Here a processor is nothing but a microprocessor, DSP, microcontroller, CPLD & FPGA. All these processors are programmable so that it defines the working of the device.

An Embedded system program allows the hardware to check the inputs & control outputs accordingly. In this procedure, the embedded program may have to control the internal architecture of the processor directly like Timers, Interrupt Handling, I/O Ports, serial communications interface, etc.

So embedded system programming is very important to the processor. There are different programming languages are available for embedded systems such as C, C++, assembly language, JAVA, JAVA script, visual basic, etc. So this programming language plays a key role while making an embedded system but choosing the language is very essential.

Steps to Build an Embedded C Program

There are different steps involved in designing an embedded c program like the following.

- Comments
- Directives of Processor
- Configuration of Port
- Global variables
- Core Function/Main Function
- Declaration of Variable
- The logic of the Program

6.2.2 MAIN FACTORS OF EMBEDDED C:

The main factors to be considered while choosing the programming language for developing an embedded system include the following

Program Size:

Every programming language occupies some memory where embedded processor like microcontroller includes an extremely less amount of random access memory.

Speed of the Program:

The programming language should be very fast, so should run as quickly as possible. The speed of embedded hardware should not be reduced because of the slow-running software.

Portability:

For the different embedded processors, the compilation of similar programs can be done.

- Simple Implementation
- Simple Maintenance
- Readability
- The advantages of embedded c programming include the following
- It is very simple to understand.
- It executes a similar task continually so there is no requirement for changing hardware like additional memory otherwise storage space.
- It executes simply a single task at once
- The cost of the hardware used in the embedded c is typically so much low
- The applications of embedded are extremely appropriate in industries
- It takes less time to develop an application program

6.2.3 APPLICATIONS OF EMBEDDED C:

- The applications of embedded c programming include the following.
- Embedded C programming is used in industries for different purposes
- The programming language used in the applications is speed checker on the highway, controlling of traffic lights, controlling of street lights, tracking the vehicle, artificial intelligence, home automation, and auto intensity control
- We hope that we have been successful in providing an easy and approachable way for the beginners of Embedded C programming.

CHAPTER 7

RESULTS AND DISCUSSIONS

7.1 AUTOMATED MECHANISM:

The railway track inspection robot project features an advanced automated mechanism that enables efficient and accurate inspection of railway tracks. This mechanism leverages cutting-edge technologies, including sensors, microcontrollers, and wireless communication, to detect anomalies, obstacles, and track irregularities. The automated mechanism ensures precise control, real-time data transmission, and prompt action, enhancing railway safety and reducing maintenance costs.

7.1.1 COMPONENTS OF THE AUTOMATED MECHANISM:

- **SENSORS:**

The robot is equipped with metal proximity sensors and ultrasonic sensors. These sensors detect anomalies, obstacles, and track irregularities, providing critical data for the automated mechanism.

- **ARDUINO UNO:**

The microcontroller serves as the brain of the automated mechanism, processing sensor data, controlling robot movements, and transmitting data wirelessly.

- **PWM DC MOTOR CONTROLLER:**

The motor controller regulates DC motor speed and direction, ensuring precise movement and control.

- **ESP WI-FI MODULE AND GSM MODULE:**

These modules enable wireless data transmission and remote monitoring, allowing authorized personnel to receive real-time updates and alerts.

7.1.2 WORKING PRINCIPLE OF THE AUTOMATED MECHANISM:

- **INITIALIZATION:**

  The robot is placed on the railway tracks and initialized. The sensors begin detecting anomalies and track irregularities.

- **SENSOR DATA PROCESSING:**

The Arduino Uno processes sensor data, analysing it to determine the presence of anomalies or obstacles.

- **ROBOT MOVEMENT CONTROL:**

Based on sensor data, the Arduino Uno controls the robot's movements, ensuring precise navigation and inspection.

- **REAL-TIME DATA TRANSMISSION:**

The ESP Wi-Fi module or GSM module transmits inspection data, anomalies, and alerts to authorized personnel or servers in real-time.

- **ALERT AND NOTIFICATION SYSTEM:**

Authorized personnel receive real-time updates, enabling prompt action and proactive maintenance.

7.1.3 KEY FEATURES OF THE AUTOMATED MECHANISM:

- **AUTONOMOUS MOVEMENT:**

The robot moves along the tracks autonomously, guided by sensors and programmed instructions.

- **PRECISE CONTROL:**

The PWM DC motor controller ensures precise speed and direction control, enabling the robot to navigate complex track sections.

- **REAL-TIME MONITORING:**

Authorized personnel can monitor the inspection process in real-time, receiving updates and alerts as needed.

- **DATA ANALYSIS:**

The Arduino Uno analyses sensor data, enabling the robot to detect anomalies and track irregularities accurately.

7.2 ALERT MECHANISM:

The alert mechanism is designed to notify authorized personnel of anomalies, obstacles, or track irregularities detected by the robot's sensors. This mechanism ensures timely intervention, preventing accidents and reducing downtime.

7.2.1 COMPONENTS OF THE ALERT MECHANISM:

- **SENSORS:**

  Metal proximity sensors and ultrasonic sense detect anomalies, obstacles, and track irregularities.

- **ARDUINO UNO:**

  The microcontroller processes sensor data and triggers alerts when anomalies are detected.

- **ESP WIFI MODULE AND GSM MODULE:**

  These modules enable wireless transmission of alerts to authorized personnel.

7.2.2 WORKING PRINCIPLE OF THE ALERT MECHANISM:

- **ANOMALY DETECTION:**

  Sensors detect anomalies, obstacles, or track irregularities and transmit data to the Arduino Uno.

- **DATA PROCESSING:**

  The Arduino Uno processes sensor data and determines the severity of the anomaly.

- **ALERT TRIGGERING:**

If an anomaly is detected, the Arduino Uno triggers an alert, which is transmitted wirelessly via the ESP Wi-Fi module or GSM module.

- **NOTIFICATION:**

Authorized personnel receive alerts, enabling prompt action and proactive maintenance.

7.2.3 TYPES OF ALERTS:

- **SMS ALERTS:**

GSM module sends SMS alerts to authorize personnel.

- **EMAIL ALERTS:**

ESP Wi-Fi module sends email alerts to authorized personnel.

- **REAL-TIME NOTIFICATIONS:**

Authorized personnel can receive real-time notifications through mobile apps or web portals.

7.2.4 BENEFITS OF THE ALERT MECHANISM:

- **TIMELY INTERVENTION:**

Alerts enable prompt action, preventing accidents and reducing downtime.

- **PROACTIVE MAINTENANCE:**

Early detection of anomalies enables proactive maintenance, reducing costs and improving efficiency.

- **IMPROVED SAFETY:**

Alerts ensure railway safety by detecting potential hazards and enabling prompt action.

7.3 RAILWAY TRACK INSPECTION ROBOT:

7.3.1 BLOCK DIAGRAM:

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

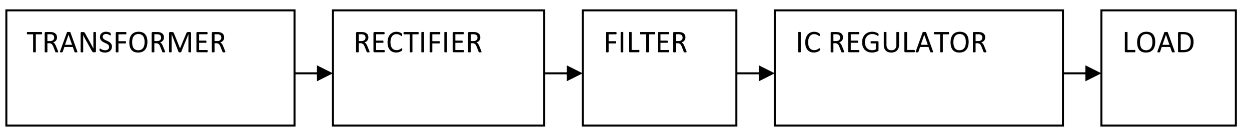


Fig.no 7.1-Block diagram (Power supply)

7.3.2 WORKING PRINCIPLE:

TRANSFORMER:

The potential transformer will step down the power supply voltage (0-230V) to (0-9V & 15-0-15V) level. Then the secondary of the potential transformer will be connected to the precision rectifier, which is constructed with the help of op–amp. The advantages of using precision rectifier are it will give peak voltage output as DC, rest of the circuits will give only RMS output.

BRIDGE RECTIFIER:

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners. Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.The path for current flow is from point B through D1, up through RL, through D3, through the secondary of the transformer back to point B. this path is indicated by the solid arrows. Waveforms (1) and (2) can be observed across D1 and D3.

One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through RL, through D2, through the secondary of T1, and back to point A. This path is indicated by the broken arrows. Waveforms (3) and (4) can be observed across D2 and D4. The current flow through RL is always in the same direction. In flowing through RL this current develops a voltage corresponding to that shown waveform (5). Since current flows through the load (RL) during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit. This may be shown by assigning values to some of the components shown in views A and B. assume that the same transformer is used in both circuits. The peak voltage developed between points X and y is 1000 volts in both circuits. In the conventional full-wave circuit shown—in view A, the peak voltage from the center tap to either X or Y is 500 volts. Since only one diode can conduct at any instant, the maximum voltage that can be rectified at any instant is 500 volts.

The maximum voltage that appears across the load resistor is nearly-but never exceeds-500 v0lts, as result of the small voltage drop across the diode. In the bridge rectifier shown in view B, the maximum voltage that can be rectified is the full secondary voltage, which is 1000 volts. Therefore, the peak output voltage across the load resistor is nearly 1000 volts. With both circuits using the same transformer, the bridge rectifier circuit produces a higher output voltage than the conventional full-wave rectifier circuit.

7.3.3 IC VOLTAGE REGULATORS (7805, 7812, 7912):

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

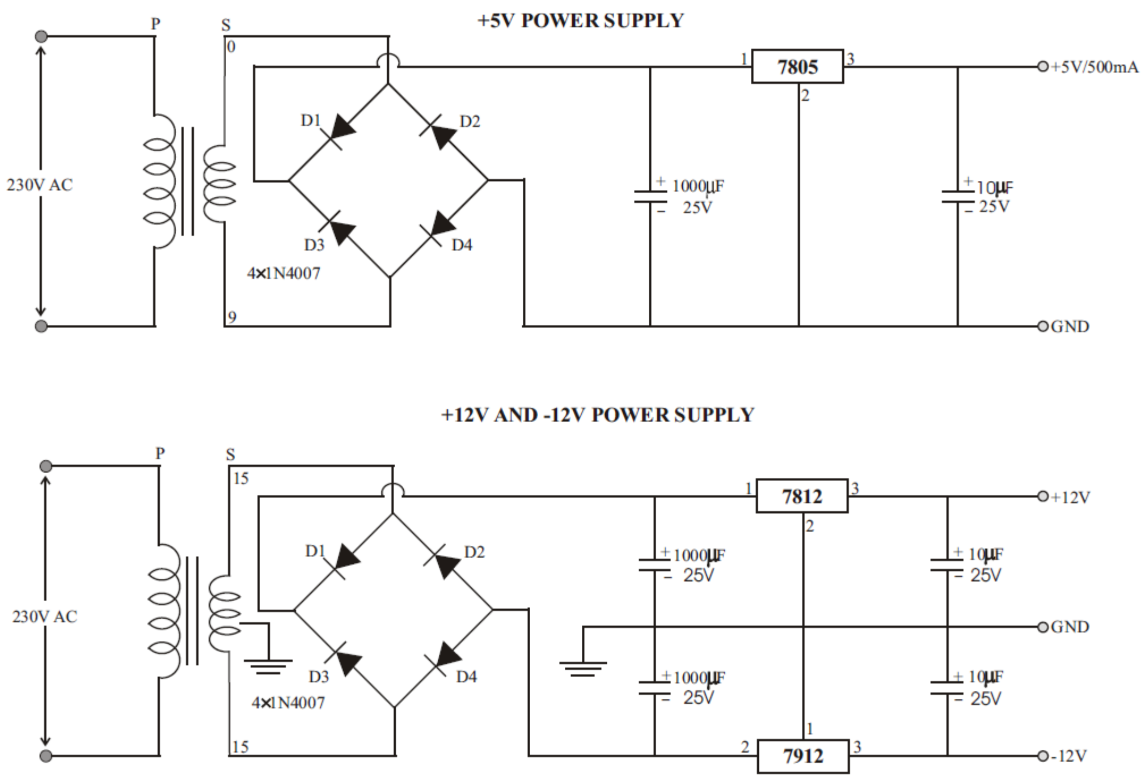


Fig.no 7.2-IC VOLTAGE REGULATORS

A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground.

The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages.

7.3.4 ALARM WITH DRIVER CIRCUIT:

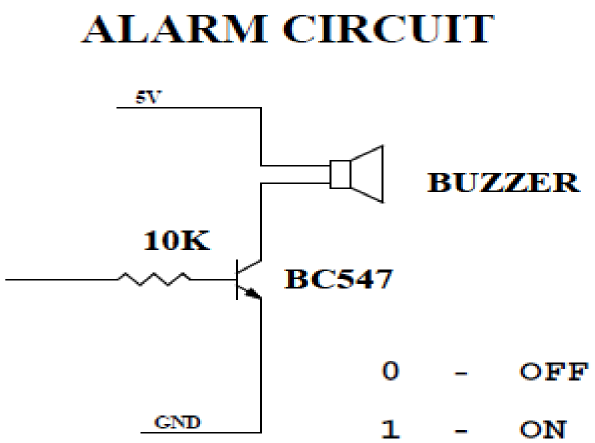


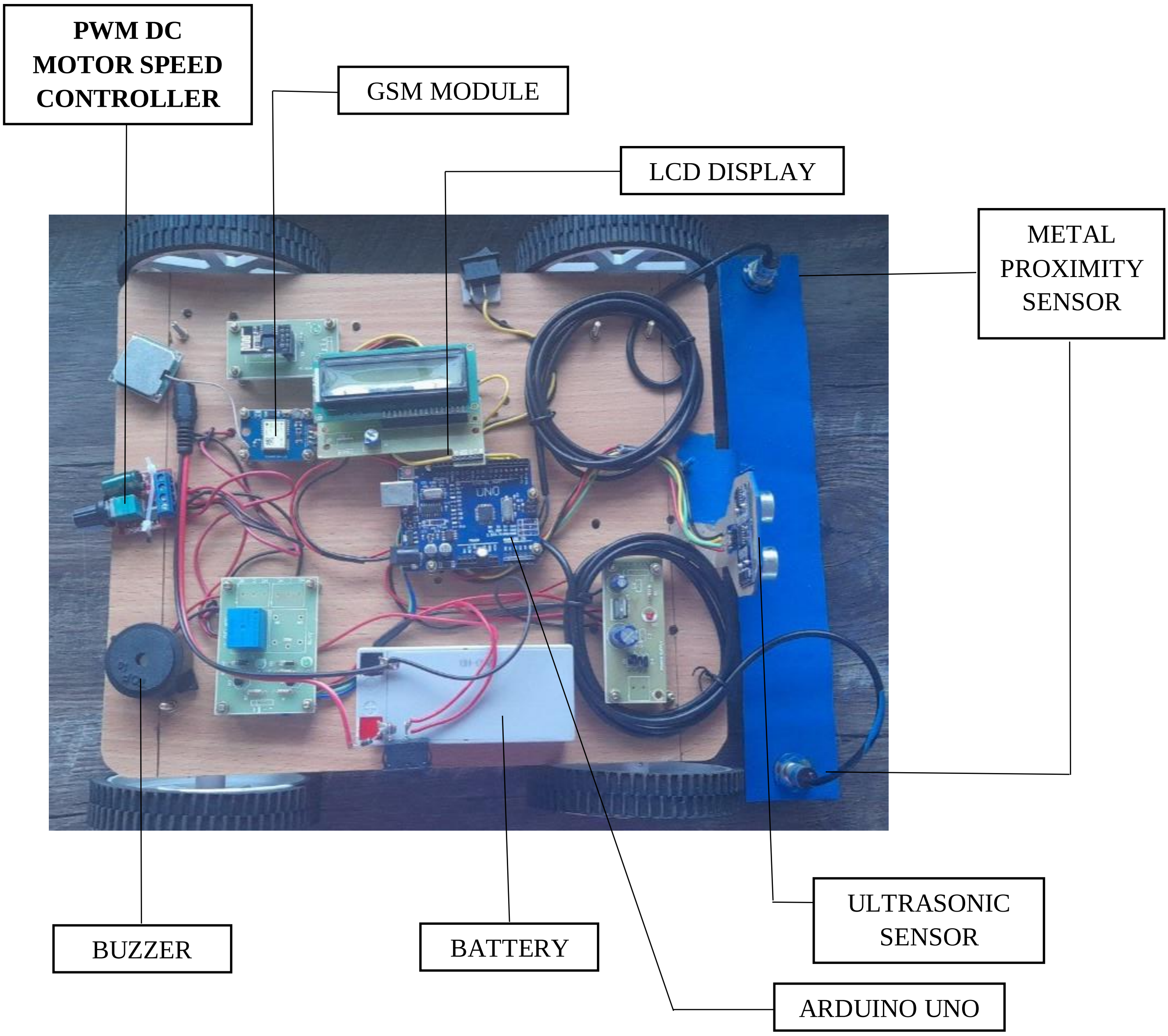
Fig.no 7.3-Alarm circuit

7.3.5 CIRCUIT DESCRIPTION:

The circuit is designed to control the buzzer. The buzzer ON and OFF is controlled by the NPN transistor (BC 547). The buzzer is connected in the transistor collector terminal.

When high pulse signal is given to base of the transistors it will be turned on and now alarm get ground so it will be on. If low pulse is given to the NPN transistor base means it will be off and also alarm goes to the off state.

7.3.6 OUTPUT FOR RAILWAY TRACK INSPECTION:



7.3.7 OUTPUT IN DEVELOPED APP:

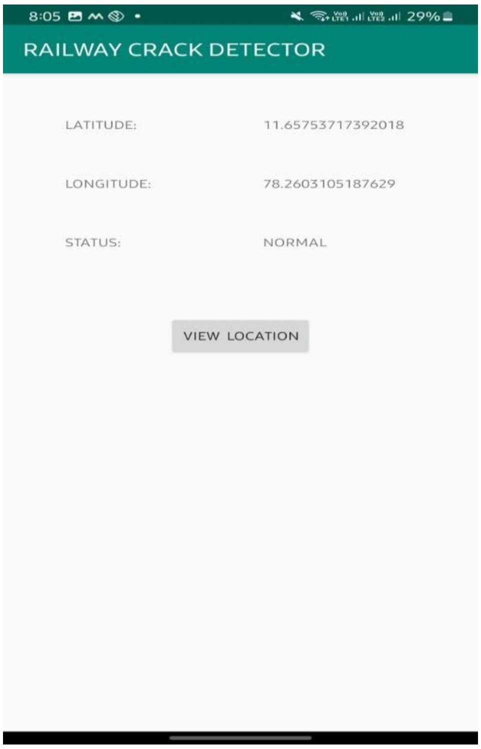


Fig.no 7.4-NORMAL STATE

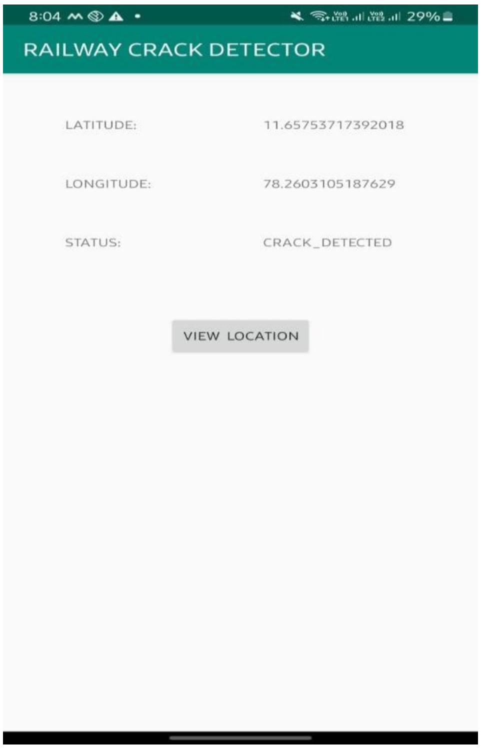


Fig.no 7.5-OBJECT DETECTED

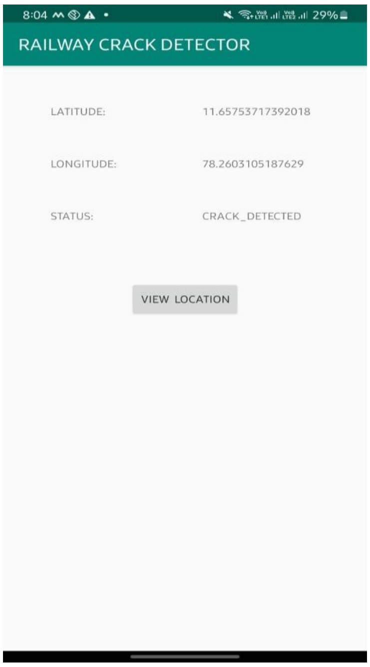


Fig.no 7.6-CRACK DETECTED

CHAPTER 8

8.1 CONCLUSION:

The proposed **Railway Crack Detector using IOT** provides an efficient, cost-effective, and automated solution for ensuring railway track safety. By integrating **proximity sensors**, **ultrasonic sensor**, **GPS**, **Arduino Uno**, and **IOT technology**, the system effectively detects cracks and obstacles on the railway tracks in real-time and immediately alerts the concerned authorities.The robot halts automatically when a fault is detected, activates an alarm for local indication, and displays the issue on an LCD screen. Simultaneously, the GPS location of the detected fault is sent to a mobile application through IoT for quick response. This eliminates the limitations of traditional manual inspections, reduces human error, and enhances railway safety.

Overall, the system plays a vital role in preventing accidents, improving maintenance efficiency, and providing a smart, reliable alternative to conventional railway monitoring methods.

8.2 FUTURE IMPROVEMENT:

The railway track inspection robot project can be further enhanced with several advancements. Integrating advanced sensors like cameras and GPS can provide more comprehensive inspection capabilities. Implementing machine learning algorithms can enable anomaly detection and predictive maintenance, while cloud-based data analysis can offer real-time insights and trend analysis. Improving autonomous navigation systems and real-time video streaming can enhance inspection efficiency and accuracy.

Developing an enhanced alert system with customizable notifications and escalation procedures can ensure prompt action. Additionally, integrating the robot's data with maintenance systems, implementing solar power, and designing robots for improved mobility can increase sustainability and effectiveness. Advanced data analytics capabilities can also provide valuable insights into track conditions and maintenance needs, ultimately improving the robot's overall performance in inspecting railway tracks.

APPENDIX:

The above copyright notice and this permission notice shall be included in all copies or substantial portions of the software.

```
#include <TinyGPS++.h>

#include <Wire.h>

#include <SoftwareSerial.h>

#include <LiquidCrystal.h>

LiquidCrystal lcd(8, 9, 10, 11, 12, 13);

#define r 6

#define alm 5

#define prox A2

#define prox2 A3

#define sw 4


#define u1_triger_high digitalWrite(A0, HIGH)

#define u1_triger_low digitalWrite(A0, LOW)

#define ultra1 A1


unsigned char count;

unsigned a = 0;

int sec = 0, secc = 0, yy,ult;

char g, aq = 0;

char lat[25], lon[25];

static const int RXPin = 2, TXPin = 3;

static const uint32_t GPSBaud = 9600;

TinyGPSPlus gps;
```

```
SoftwareSerial ss(RXPin, TXPin);
#define REPORTING_PERIOD_MS 1000
uint32_t tsLastReport = 0;
unsigned long previousMillis = 0;
const long interval = 1000;
void setup() {
  pinMode(prox, INPUT);
  pinMode(prox2, INPUT);
  pinMode(r, OUTPUT);
  pinMode(alm, OUTPUT);
  digitalWrite(r, LOW);
  pinMode(sw, INPUT_PULLUP);
  pinMode(A0, OUTPUT);
  pinMode(A1, INPUT);
  Serial.begin(9600);
  ss.begin(GPSBaud);
  lcd.begin(16, 2);
  lcd.setCursor(0, 0);
  lcd.print("----------------");
  lcd.setCursor(0, 1);
  lcd.print("----------------");
  delay(2000);
  lcd.clear();
}
void loop() {
  if (digitalRead(sw) == LOW) {
    aq = 1;
```

```
} else {
  aq = 0;
}
while (ss.available() > 0) {
  gps.encode(ss.read());
  if (gps.location.isUpdated()) {
    // GPS data updated
  }
}
unsigned long currentMillis = millis();
if (currentMillis - previousMillis >= interval) {
  previousMillis = currentMillis;
  sec++, secc++;
}
// Check ultrasonic distance
 ult = read_ultrasonic1();
lcd.setCursor(0, 0);
lcd.print("DIS:");
Lcd_Decimal3(4, 0, ult);
// Proximity or ultrasonic object detection
if ((digitalRead(prox) == HIGH) || (digitalRead(prox2) == HIGH)) {
  a = 3;
  digitalWrite(r, LOW);
  digitalWrite(alm, HIGH);
  lcd.setCursor(0, 1);
  lcd.print(" CRACK_DETECTED ");
} else if (ult < 15) {
```

```
    a = 4;
    digitalWrite(r, LOW);
    digitalWrite(alm, HIGH);
    lcd.setCursor(0, 1);
    lcd.print(" OBJECT_DETECTED");
  } else {
    a = 0;
    digitalWrite(r, HIGH);
    digitalWrite(alm, LOW);
    lcd.setCursor(0, 1);
    lcd.print("     NORMAL     ");
  }

  if (sec > 5) {
    http_send();
    sec = 0;
  }
}

void http_send() {
  Serial.print("send to iot");

  if (aq == 1) {
    Serial.print(gps.location.lat(), 6);
    Serial.print(",");
    Serial.print(gps.location.lng(), 6);
  } else {
```

```
    Serial.print("11.65753717392018,78.2603105187629");
  }

  Serial.print(",");
  if (a == 3) {
    Serial.print("CRACK_DETECTED");
  } else if (a == 4) {
    Serial.print("OBJECT_DETECTED");
  } else {
    Serial.print("NORMAL");
  }

  Serial.write(0x0d);  // carriage return
  Serial.write(0x0a);  // newline
}

unsigned int read_ultrasonic1() {
  int ultrasonic = 0;
  u1_triger_low;
  delay(1);
  u1_triger_high;
  delay(10);
  u1_triger_low;
  ultrasonic = pulseIn(ultra1, HIGH) / 56.0;
  return ultrasonic;
}
void Lcd_Decimal3(unsigned char com, unsigned char com1, unsigned int val) {
```

```
  unsigned int Lcd_h, Lcd_hr, Lcd_t, Lcd_o;
  lcd.setCursor(com, com1);
  Lcd_h = val / 100;
  Lcd_hr = val % 100;
  Lcd_t = Lcd_hr / 10;
  Lcd_o = Lcd_hr % 10;

  lcd.setCursor(com, com1);
  lcd.write(Lcd_h + 0x30);
  lcd.setCursor(com + 1, com1);
  lcd.write(Lcd_t + 0x30);
  lcd.setCursor(com + 2, com1);
  lcd.write(Lcd_o + 0x30);
}
```

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