School

of

Electronics and Communication Engineering

Mini Project Report

on

RAILWAY TRACK CRACK DETECTION SYSTEM

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CERTIFICATE

This is to certify that project entitled **" Railway Track Crack Detection System"** is a bonafide work carried out by the student team of **" 1.Harsha S Hiregoudar (USN: 01FE20BEC183) 2. Kiran Hanamagoudar (USN: 01FE20BEC214) 3. Sneha Kumari (USN: 01FE20BEC272) 4. Sneha S Anchekar (USN: 01FE20BEC291")** **The project report has been approved as it satisfies the requirements with respect to the mini project work prescribed by the university curriculum for BE (V Semester) in School of Electronics and Communication Engineering of KLE Technological University for the academic year 2022-2023.**

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-Harsha S Hiregoudar
Kiran Hanamagoudar
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Sneha S Anchekar

ABSTRACT

From one region to another region most of the goods are transported through the means of railway mode of transportation.It is only due to its low transportation cost,fastness, reliablility and less chance of accidents.Lots of people prefer railways rather than roadways for a long distance travel as trains are very much comfortable and fare is also low.Therefore due to these reasons it is necessary to provide a safety to the tracks of railways.Hence for this purpose we are making a raspberry pi micro controller based robot that is capable of locating faults or cracks in the tracks and protect the trains from any accidents.Earlier this process was done manually,which is expensive,slow and also raise labour safety issues associated with railway tracks.Hence for this project we are interfacing Raspberry Pi 3B+ microcontroller with IR sensor (which will detect the crack),Buzzer(for alarm),GPS6MV2(for the geographical location of the crack),GSM800A(for sending message of crack detected to the pre registered mobile number).We are designing a bot over here which will be motor driven.

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Chapter 1

Introduction

In recent years, we have seen a drastic influence of robotics in scientific and technological fields.Robotic technologies are being highly used in the field of education and entertainment.Railway track crack detection systems are designed to identify and assess cracks on railway tracks. These systems typically use sensors, such as ultrasonic or infrared sensors, to detect cracks and other defects in the tracks. The detected cracks are then evaluated for their severity and appropriate action is taken, such as repairing or replacing the tracks. This can help prevent accidents and ensure the safe operation of trains.This introduces a robot which will have the ability to detect the crack on the track.The robot is capable of detecting cracks with the help of infrared sensor .It is complex and challenging

task to assign a robot with a task of detecting cracks over railway tracks.The robot is designed in such an order that it will be motor driven with the help of vnc viewer(Raspberry Pi Os).Vnc viewer provides a platform to input the signals from components and then converts them into actual commands for the system to work.The software does it by assigning the gpio pins to all the interfaced components and enabling it to work.

1.1 Motivation

With the progress in technologies, there has been a large advancement with respect to the availability of robots. Now-a-days robots can be easily designed and incorporated with sensors and motors as well as interface with a desktop computer for robust programming experience. Robotic parts can be easily acquired at a low cost and can be achieved in less time.The best way to interact with the rapidly advancing technological world is the use of desired Robotic technologies.The need of crack detection robot is increasing day by day as more accuracy is not observed manually and A robot with these capabilities would definitely inculcate interest in people to experiment with robots. Apart from that,with the use of this robot we are saving time and energy of the people who were earlier assigned for the same.Practical applications of a crack detecting robot is numerous.Along with this as there is increase in population ,the need for railways mode of transportation is increasing day by day.So it is mandatory to provide safety measures to the tracks of railways.So we aim to automate this process by designing Railway Track Crack Detection System.

1.2 Objectives

The primary objective of the bot is to take inputs from the infrared sensor in a user friendly manner and give the signal to buzzer and dc motor. More elaborate and procedural objectives in order are as followed:
1.Acquiring accurate geographical location of the crack detected on railway tracks.
2.Fitting the bot into work space in the right scale and at the right position.
3.Moving through the entire work space and generating signal i.e, the railway tracks.
4.Passing the commands to the micro-controller.
5.After reception of commands dc motor must stop moving and the gps should locate the geographical coordinates.
6.The sensor must detect the cracks whenever there is a discontinuity in the path of tracks.

1.3 Literature survey

1.3.1 Railway Track Crack Detection

A new technology is needed that will be robust, efficient, and stable for both crack detection in railway tracks and object detection. In this project, a railway track crack detection system using sensors is discussed. This dynamic approach combines the use of GPS tracking system to send alert messages and the geographical coordinates of the location. Arduino microcontrollers are used to control and coordinate the activities of this device.It is a matter of great sorrow that the railway tracks in our country are very prone to accidents. As a result, a vast number of accidents occur every year, and we lose a huge number of lives as a consequence. These accidents are due to the primitive type of railway tracks that are in use in our country.In the previously existing system, the work was done manually, but the proposed system has a robot that runs automatically on the tracks. The system uses an LED and LDR sensor assembly, but the main disadvantage is that the LED and LDR must be placed opposite to each other and the environment must be perfect to detect the track. To overcome this disadvantage, sensors are used in the proposed system, which will accurately detect cracks. The existing system is slow, tedious,

and time-consuming. The proposed system uses a GSM and GPS module, which will provide the real-time location or coordinates in the form of a short message service (SMS) to the nearest railway station.

1.3.2 Railway Track Crack Detection Vehicle

This track detection vehicle system is an electronics device that detects cracks

in

een listed. The techniques that have been incorporated in our project with justification is also included.

• Chapter 5: Results and Discussions
This chapter includes the conclusion and results of implementation.

• Chapter 6: Conclusion
This is the concluding chapter that includes project closure and epilogue along with the future scope of our project.

Chapter 2

System design

In this Chapter, we infer the High level functional block diagram,description of the functional block diagram, the design alternatives for our project and come up with the best-suited final design for implementation.

2.1 Functional Block Diagram

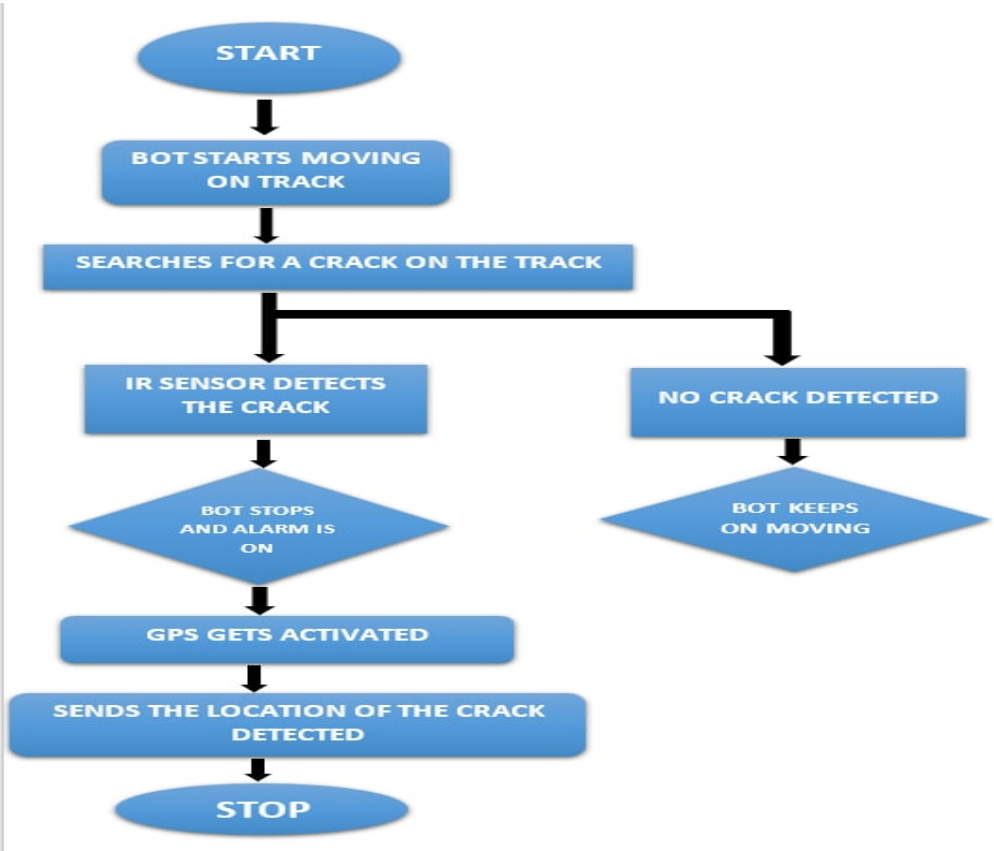


Figure 2.1 : Flow Chart

2.2 Design alternatives

There are several different approaches that can be used for railway track crack detection. Some potential solutions include:
1.Visual inspection: In this approach, trained personnel inspect railway tracks visually to identify any cracks or other types of damage. This can be done manually, using handheld tools such as mirrors and flashlights, or with the aid of specialized equipment such as drones or track geometry cars.
2.Non-destructive testing (NDT): NDT methods use specialized equipment to detect cracks and other types of damage in railway tracks without causing any damage to the tracks themselves. These methods can include ultrasonic testing, magnetic particle testing, and eddy current testing, among others.
3.Sensors: Sensors can be installed along railway tracks to continuously monitor for cracks and other types of damage. These sensors can use various technologies, such as strain gauges, piezoelectric sensors, or optical sensors, to detect changes in the condition of the tracks. The sensor data can then be analyzed to identify potential problems and alert maintenance personnel.

2.3 Final design

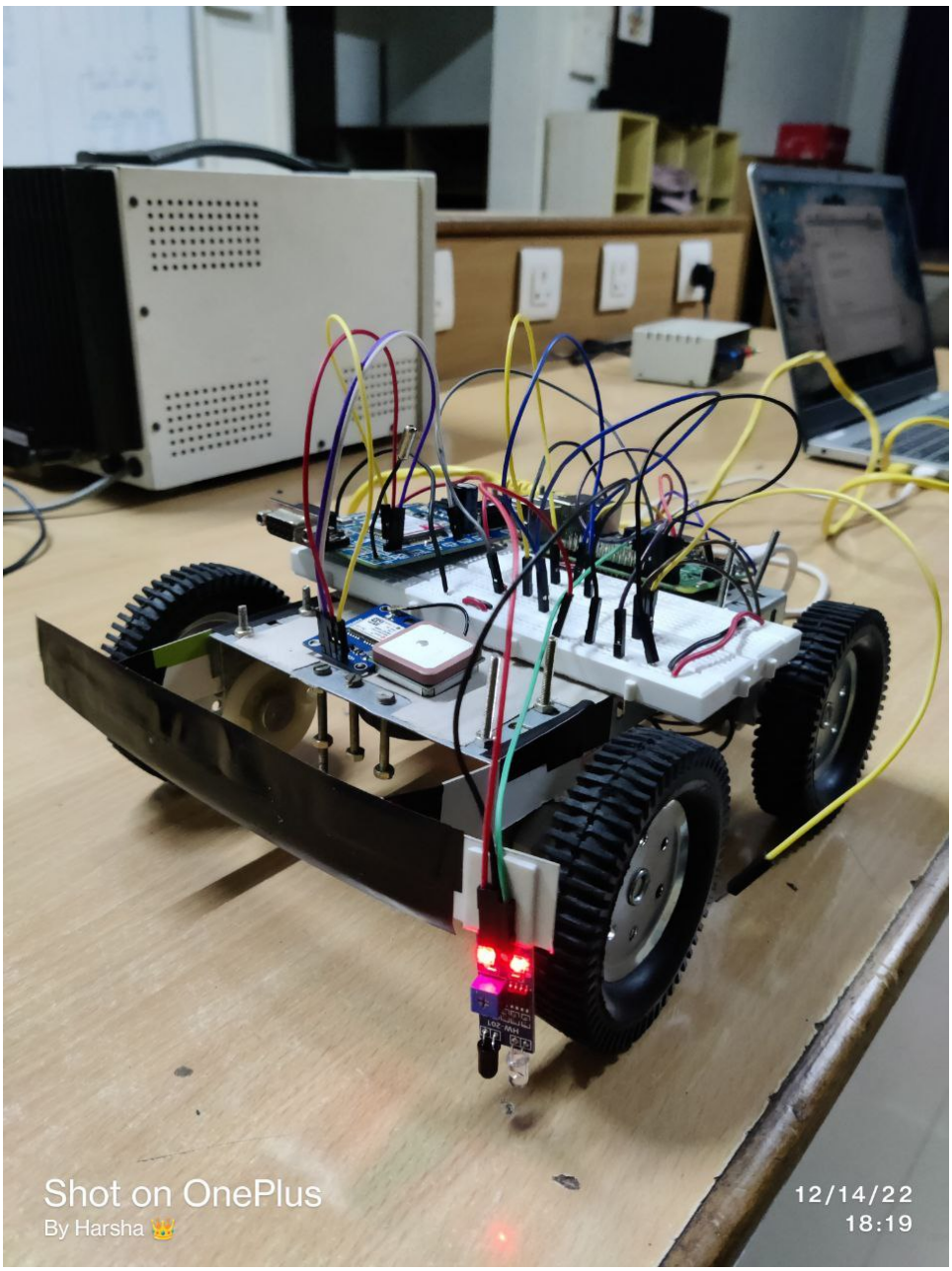


Figure 2.2 : Final Design

Using infrared sensors and a Raspberry Pi for railway track crack detection could be a good solution because it would allow for continuous, automated monitoring of the tracks. Infrared sensors are able to detect changes in temperature, which can be an indication of a crack or other issue with the track. The Raspberry Pi, on the other hand, is a small, inexpensive computer that can be used to process the sensor data and alert operators if a potential problem is detected. This approach would be less labor-intensive and potentially more accurate than using manual inspections.

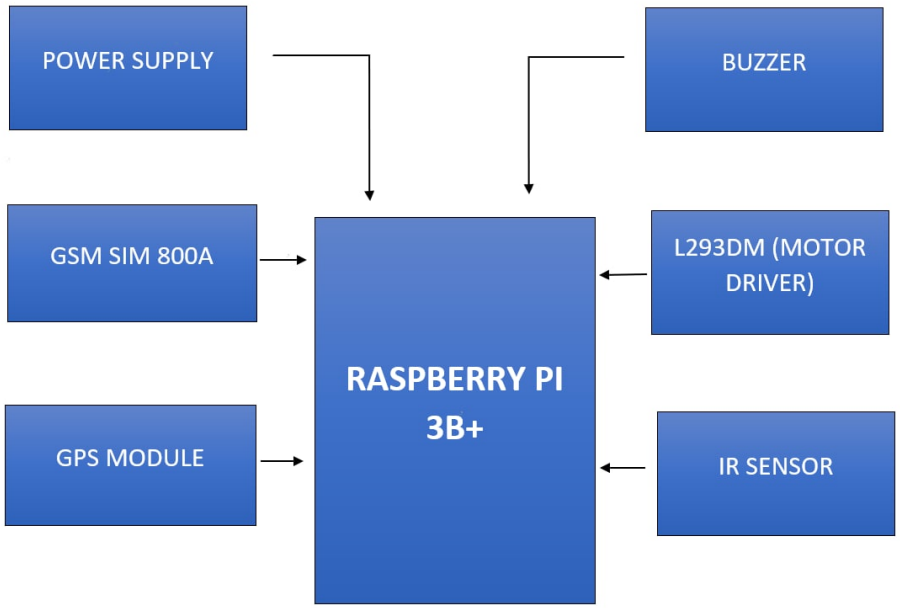
Chapter 3

Implementation details

In this Chapter, we infer the detailed information about implementation. It also includes specifications used to design and propose the final system architecture. The algorithm and flowchart give the birds-eye view of the functionalities achieved.

3.1 Specifications and final system architecture

Table 3.1 : Design Specification



BLOCK DIAGRAM OF RAILWAY TRACK CRACK DETECTION SYSTEM

Table 3.2 : Functional Specification

SL.NO	COMPONENT	FUNCTIONAL SPECIFICATIONS
1.	Raspberry pi 3B+	This system uses the IR sensor to detect cracks in its path. When a crack is detected, the Raspberry Pi uses the information from the IR sensor to determine the best course of action and sends a signal to the motor driver to move the system around the crack. At the same time, we have used the GPS module that is constantly sending the system's location information to the Raspberry Pi. The Pi processes this information and uses it to track the system's movements.
2.	IR Sensor	The IR sensor is a proximity sensor that uses infrared light to detect cracks in its field of view. We have used this system to detect cracks in its path and trigger the DC motor to move the system around them.
3.	Buzzer	We have used buzzer to send alarm when the crack is detected.
4.	DC Motor	We have used two DC Motors in our project. The DC motor is used to move the system. It is controlled by the Raspberry Pi via a motor driver, which receives signals from the Pi and converts them into the appropriate electrical signals to drive the motor.
5.	L293DM Motor driver	We have used this to drive the dc motor which is used to run the wheels of the bot on the track. We can also use it to increase or decrease the speed of the bot.
6.	GPS6MV2 Module	We have used this to locate the geographical co-ordinates of the crack detected for the further actions.
7.	GSM800A Sim Module	We have used this module to send a message of crack Detected to a pre-registered mobile number.

3.2 Algorithm

1. Define machine dimensions(width(w), height(h)), work space dimensions, home point location.
2.The ir sensor should be kept in such a way so that it should
b
d be in perfect alignment with the tracks.
3.Then the robot is loaded onto the work space with appropriate scale ,orientation at right location.
4.If there is a crack detected, the buzzer is on and the dc motor will stop working.
5.If there is no crack detected,then the functions are ignored.

6.After the detection of crack, the geographical coordinated of the cracks will be recorded.

Chapter 4

Optimization

In this Chapter, we infer the detailed information about optimization, its importance, and its advantages. Different types and levels of optimization techniques have been listed. The techniques that have been incorporated in our project with justification is also included.

4.1 Introduction to optimization

Optimization refers to the process of finding the best possible solution to a problem within a set of constraints. This typically involves making choices or decisions that maximize some desired outcome, such as maximizing profit, minimizing cost, or maximizing efficiency. Optimization problems can be found in many different fields, from engineering and economics to computer science and operations research.There are many different methods for solving optimization problems, including mathematical programming, heuristics, and metaheuristics. These methods can be applied to a wide range of problems, from simple, single-variable problems to complex, multi-variable problems with multiple constraints and objectives.Optimization is an important tool for improving the performance and efficiency of systems in many different fields, and it is used in a wide range of applications, from scheduling and logistics to resource allocation and decision making.The purpose of Optimization is to achieve the "desired" design relative to the constraints.

4.2 Types of Optimization

Path optimization
- Area optimization
- Cost optimization
- Code optimization
- Memory optimization

4.3 Selection and justification of optimization method

Path optimization: Path optimization refers to the process of finding the most efficient or cost-effective route for a system to follow in order to perform a specific task. In the case of a railway track crack detection system, path optimization could involve finding the best route for the system to follow in order to efficiently scan the entire railway track for cracks.There are many different methods that could be used for path optimization in a railway track crack detection system. Some possible approaches include:
1.Genetic algorithms: Genetic algorithms are a type of optimization method that uses principles of natural selection and evolution to find the best possible solution to a problem. In the case of a railway track crack detection system, a genetic algorithm could be used to generate and evaluate different potential routes for the system to follow, and then select the best route based on certain criteria, such as the total distance traveled or the time required to scan the entire track.
2.Ant colony optimization: Ant colony optimization is a type of optimization method that is inspired by the behavior of ants searching for food. In the case of a railway track crack detection system, an ant colony optimization algorithm could be used to simulate the behavior of ants searching for cracks on the railway track, and then use the collective knowledge of the simulated ants to find the most efficient route for the system to follow.
3.Particle swarm optimization: Particle swarm optimization is a type of optimization method that is inspired by the behavior of birds or fish swarming together. In the case of a railway track crack detection system, a particle swarm optimization algorithm could be used to simulate the behavior of a flock of birds or a school of fish searching for cracks on the railway track, and then use the collective knowledge of the simulated particles to find the most efficient route for the system to follow.

Area optimization: Area optimization in a railway
track crack detection system would refer to the process of finding the

most efficient or cost-effective way to cover the entire railway track surface with the crack detection system. This could involve identifying the optimal placement and orientation of the infrared sensors used by the system, as well as determining the most efficient scanning pattern or route for the system to follow in order to scan the entire track surface.There are many different methods that could be used for area optimization in a railway track crack detection system. Some possible approaches include:
1.Monte Carlo simulation: Monte Carlo simulation is a statistical method that can be used to model and analyze complex systems. In the case of a railway track crack detection system, a Monte Carlo simulation could be used to generate and evaluate different potential sensor placements and scanning routes, and then select the best configuration based on certain criteria, such as the coverage of the track surface or the time required to scan the entire track. 2.Spatial optimization: Spatial optimization is a type of optimization that focuses on finding the best possible solution to a problem that involves spatial data or geographic information. In the case of a railway track crack detection system, spatial optimization could be used to identify the optimal placement and orientation of the infrared sensors, taking into account factors such as the geometry of the track, the location of obstacles, and the distance between sensors. 3.Combinatorial optimization: Combinatorial optimization is a type of optimization that focuses on problems with discrete or combinatorial variables, such as the selection of items from a set or the assignment of tasks to resources. In the case of a railway track crack detection system, combinatorial optimization could be used to determine the most efficient scanning route for the system to follow, taking into account the placement and orientation of the sensors, the distance between sensors, and the constraints on the possible routes.

Code Optimization:

1.Dead Code Elimination

2.Use of Functions

3.Multi-threading

4.Using hardware delay, as much as possible

Cost Optimization

1.We have used IR sensor instead of using Ultrasonic sensor.

2.We have used two dc motors instead of using four for the movement of bot.

Memory Optimization

1.We have used memory-efficient programming language, such as Python, to write the crack detection software. Python is known for its simplicity and ease of use, and has a large community of developers who can help with any issues you encounter.

Chapter 5

Results and discussions

In this Chapter, we infer the results of the software simulation ,hardware implementation and the dimensions of the proof of concept.

5.1 Result Analysis

When an IR sensor is placed near a railway track, it emits a beam of infrared light that reflects off the track surface and back to the sensor. The sensor measures the intensity of the reflected light, and uses this information to detect changes in the track surface that may indicate the presence of cracks.
The IR sensor can also be used to detect changes in the temperature of the track surface, which can also be an indication of cracks. For example, a crack in the track can cause a local increase in temperature due to the friction of the wheels of trains passing over it. The IR sensor can detect these changes in temperature and alert the system to the presence of a crack.

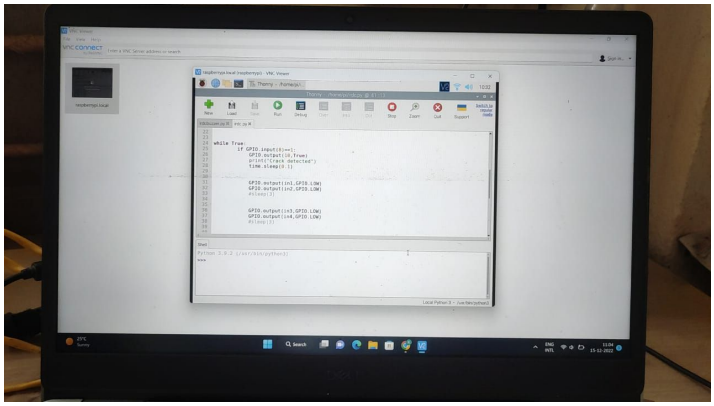
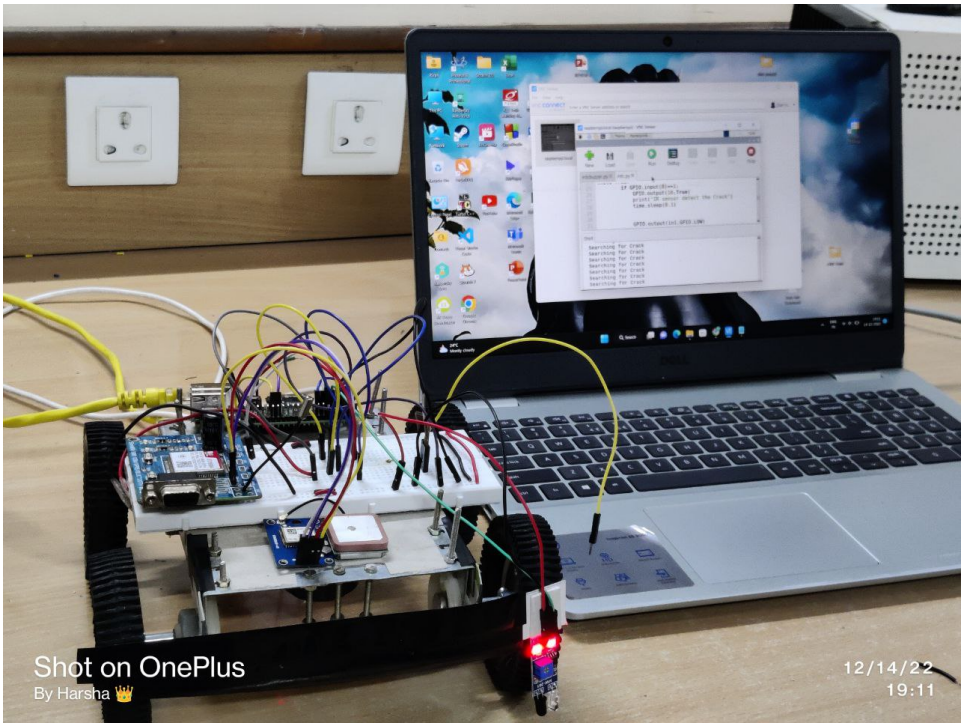


Figure 5.1 : View of VNC Viewer



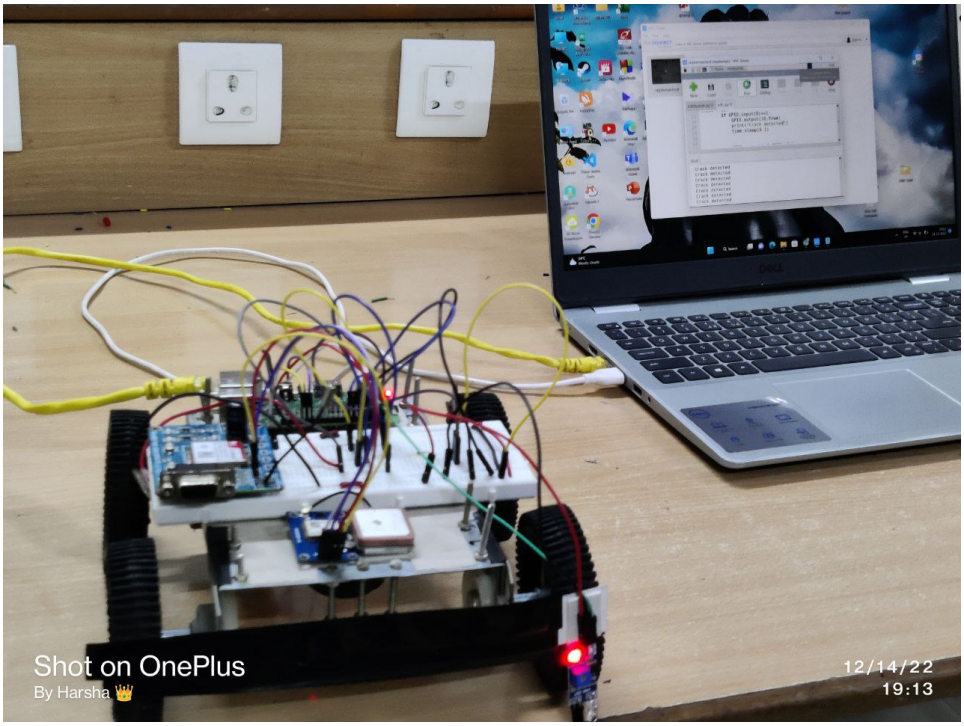


Figure 5.3 : Final Implementation

5.2 Accuracy

Accuracy Test : There are several methods that can be

used to test the accuracy of an IR sensor in a crack detection system. Some potential approaches include:

1.Laboratory testing: In a controlled laboratory environment, the IR sensor can be tested against known samples of cracked and uncracked materials, such as railway track sections with known crack patterns. The sensor can be used to measure the reflected light from these samples, and the results can be compared to the known characteristics of the samples to determine the accuracy of the sensor.

2.Field testing: The IR sensor can also be tested in real-world conditions, such as on an operational railway track. In this case, the sensor can be used to scan the track and collect data on the reflected light and temperature of the track surface. The results can then be compared to a reference dataset of known crack patterns, or to visual inspections of the track by trained personnel, to determine the accuracy of the sensor.

3.Performance metrics: In addition to comparing the results of the IR sensor to known samples or reference data, the accuracy of the sensor can also be evaluated using performance metrics such as precision, recall, and F1 score. These metrics can provide a more quantitative measure of the accuracy of the sensor, and can help to identify any areas where the sensor may be particularly prone to errors.

Results:

Overall, it is important to carefully design and test a crack detection system using an IR sensor to minimize these sources of error and ensure its accuracy and reliability. This may involve testing the system in a variety of environmental conditions, using multiple sensors and algorithms to verify the results, and providing training and support for operators to ensure proper use of the system.

Chapter 6

Conclusions and future scope

This is the concluding chapter that includes project closure and epilogue along with the future scope of our project.

6.1 Conclusion

In conclusion, a railway track crack detection system using an IR sensor, Raspberry Pi, buzzer, and GPS module can be an effective and cost-efficient way to monitor railway tracks and identify potential problems. The IR sensor can be used to detect changes in temperature or reflectivity that may indicate the presence of cracks, and the Raspberry Pi can be used to process the data from the sensor and trigger the buzzer to alert operators to the presence of a crack. The GPS module can be used to provide the location of the crack, allowing for quick and easy identification and repair. By carefully selecting the right hardware and software and using cost-efficient techniques for data transmission, you can create a reliable and effective crack detection system that can help keep railway tracks in good condition and prevent potential accidents.

6.2 Future scope

There are many potential future developments and applications for a railway track crack detection system, such as: 1.Improved sensors and algorithms for crack detection: As technology continues to advance, sensors and algorithms for crack detection may become more sensitive and accurate, allowing for the detection of smaller and more subtle cracks in railway tracks.

2.Real-time monitoring and alert systems: With the use of advanced sensors and communication systems, it may be possible to create a real-time monitoring and alert system that can instantly notify operators of the presence of a crack, allowing for immediate action to be taken.

3.Integration with other railway track maintenance systems: A crack detection system could be integrated with other railway track maintenance systems, such as track inspection vehicles or track geometry measurement systems, to provide a more comprehensive view of the condition of the tracks.

4.Use of drones for track inspection: Drones equipped with sensors and cameras could be used for track inspection, allowing for more efficient and cost-effective crack detection.

Overall, the future of railway track cra

ck detection looks promising, with many potential developments and improvements that can help keep railway tracks in good condition and prevent potential accidents.

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