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IoT Based Visual Defect Detection in Railway Tracks

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Abstract: *This paper proposes the design of crack finding robot in the railway tracks. In India rail transportation engage a major pose in asset with the essential transportation to maintain necessities of a briskly emergent financial system. At present, India possesses the 4th major railway network in the globe.It has proven inappropriate for the control system currently use in Indian railways. Therefore, there is a need to have new technology which will be vigorous, well organised and stable for both crack detection in railway track as well as object or things detection. A robust monitoring system has been suggested and clarified in this paper to address the shortcomings of the existing rail surveillance system to detect cracks of the railway tracks. To detect cracks & damages in railway tracks. To design & develop IoT enabled Robo. To inform Railway Controller about cracks & damaged track information when detected by the robot. To send all the information through wireless communication based devices. Designing the project to overcome this problem.*

Keywords: Crack Identification, Ultrasonic Sensors, Node MCU ESP8266 Wi-Fi Module, Safety Management, GPS Sensor, Railway Supervision

I. INTRODUCTION

Railway is one of the most significant transportation modes of our country but it is a matter of great sorrow that, railway tracks of our country are very prone. That's why, a vast number of accidents are occurred every year due to this primitive type of railway tracks and as the consequences of those accidents we lose huge number of lives every year. These types of incidents motivate us to think over the above mentioned issue and take necessary steps to protect those lives. Through our proposed system, we need to establish more modern and secure railway system. Besides this, there is no such type of technology or system in our country which can stop the collision between two trains coming from the opposite direction of each other on the same track. We actually think over this matter and motivated to do so. Moreover natural disaster can throw any object on the rail track which cannot be removed very quickly in the remote area. We thought if our system can detect those object or barrier and inform to the control room then they can take necessary steps 3 to avoid accident. Figure1 depicts the crack on track. The Rail transport is growing at a rapid pace in India. It is one of the major mode of transport but still our facilities are not that accurate, safer as compared to international standards.

Figure 1: Crack On Railway Track

Figure 2: Object On The Railway Tracks

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A survey on the internet states that about 60% of all the railway accidents is due to derailments, recent measurements shows that about 90% are due to cracks on the rails. Hence, it is not safer for Human Life. This needs to be at the utmost attention. These goes unnoticed and the properly maintenance of tracks is not done.

In previously existing system, the work is to be done manually, but the proposed system has a robot which will run automatically on the tracks. System having LED and LDR sensor assembly, but the main disadvantage is that the LED and LDR must be placed opposite to each other and also the environment needs to be perfect to detect the track. To overcome this disadvantage, here sensors are used, which will detect the crack accurately. The existing system is slow, tedious and time consuming. This system has GSM and GPS module which will give the real time location or coordinates in the form of Short Message Service (SMS) to the nearest railway station.

II. OBJECTIVE

The main objective is to locate the gaps in the railroad tracks and to determine if there are any hazards in the tracks toavoid accidents. This type of model provides a cost-effective solution to the railroad crack detection problem by using a ultrasonic sensor 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 as well as forwarding the information to the control room via SMS, so that any incidents can be avoid.

III. 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 are 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.

3.1 Drawbacks

- Oral communication through telephonic and telegraphic conversations.
- Manual detection.
- Requires man power.
- Time taking process.

Figure 3: Manual Crack Detection By Human

IV. 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 IR sensors used to detect obstacles. The motor controller L293D helps to power the DC motors. The Arduino controller

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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.

V. REQUIRED COMPONENTS

5.1 Arduino Uno

Figure 4: Aurdino Uno

Arduino is an open source programmable circuit board based on top of easy to use hardware and software. The above Figure 7 depicts aarduino uno. It is tough in nature and can support the peripherals efficiently. It is centered on ATmega328. It has 14 digital input/output pins 6 analog inputs, a USB connection, a power jack, an ICSP header, and a reset button. The power essential to run the board can supply through connecting it to the laptop using a USB cable or plugging an ACDC power supply.

5.2 Node MCU

NodeMCU ESP8266 Wi-Fi Module: NodeMCU is an open source development board and firmware based in the widely used ESP8266 -12E WiFi module. It allows you to program the ESP8266 WiFi module with the simple and powerful LUA programming language or Arduino IDE.

Figure 5: Node MCU

5.3 Ultrasonic Sensor

Figure 6: Ultrasonic Sensor

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The ultrasonic sensor is an electronic device that detects a specific object's distance by generating ultrasound sound waves and transforms the sound transmitted into an electrical signal waves. Ultrasonic waves can travel quicker than electrical signal (i.e., sound which could be listened by humans). The ultrasonic sensor HC SR04 has a module of 4 pins whose pin names are Vcc, trigger, ground and echo.

5.4 GSM Module

The figure shown below is the module GSM SIM 900 (Global mobile communication system). A GSM module is a designated device with a serial link, USB, Bluetooth or a mobile phone which offers support for GSM modems. A GSM module allows programs like SMS to transmit and receive messages over the modem interface.

Figure 7: GSM Module

5.5 GPS Module

The Global Positioning System is denoted as GPS, It is a satellite communication system used to identify a path of an object on the earth. A GPS receiver measures its location precisely by transmitting the signals sent by GPS satellites well above Earth. The position is then shown on a latitude and longitude view or map view.

Figure 8: GPS Module

5.6 DC Motor

A DC motor is the device which is used to convert Electrical power to a mechanical power. The DC motor speed can be regulated by a dynamic supply voltage, or by adjusting the current strength in its field windings. The stronger the voltage at the input, the greater the engine velocity. The concept proposed uses 2 direct current motors of 300 rpm.

Figure 9: DC Motor

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5.7 Motor Driver

The Motor Driver is a module for monitoring the motor movements as well as the speed of the engines. The motorcontroller shown here is the L293D IC. The L293D is a motor controller with 16 pin IC. This motor controller is engineered to supply the bidirectional drive current between 5 V and 36 V at voltages.

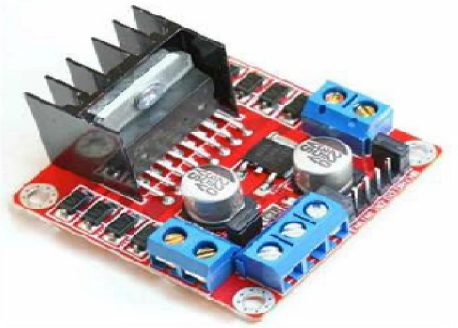

Figure 10: Motor Driver Module

5.8 Battery

A rechargeable battery is an energy storage device that can be charged again after being discharged by applying DC current to its terminals. Rechargeable batteries allow for multiple usages from a cell, reducing waste and generally providing a better long-term investment in terms of dollars spent for usable device time.

Figure 11: Battery

VI. WORKING PRINCIPLE

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.

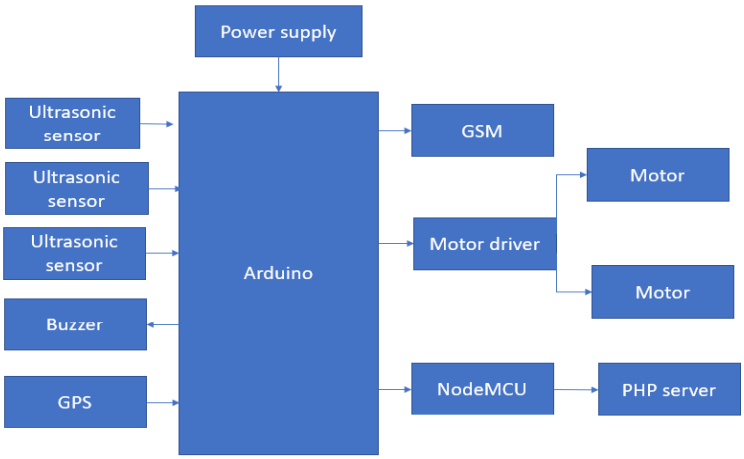

Figure 12: Block Diagram

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6.1 Process of the Rail Track System

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 sensor in 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.

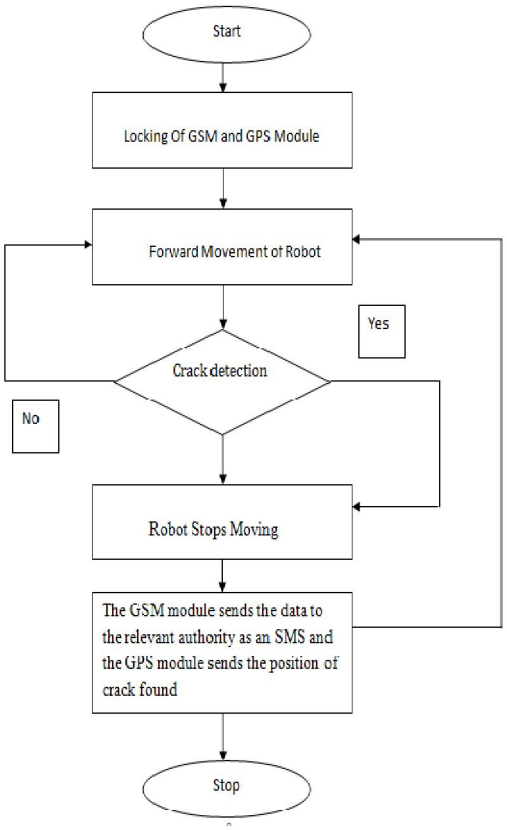

Figure 13: Flowchart for Monitoring Vehicles

VII. APPLICATION AND ADVANTAGES

7.1 Application

- Automatic detection of crack on railway track

7.2 Advantages

There are some advantages of this Project. Which are listed below -

- The auto crack detection method is more efficient in the technical field.
- Quick response is achieved.

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- Simple in construction.
- Easy to maintain and repair.
- Cost of the unit is less when compared to other.

VIII. IMPLEMENTATION

Here the proposed model is made up of hardware which was previously explained in the description of the system design hardware.

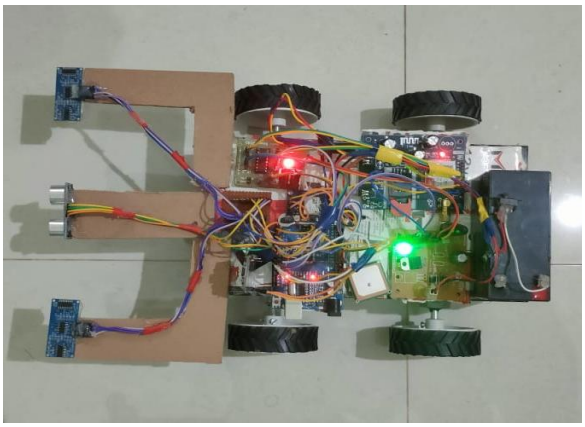

Figure 14: Proposed Model

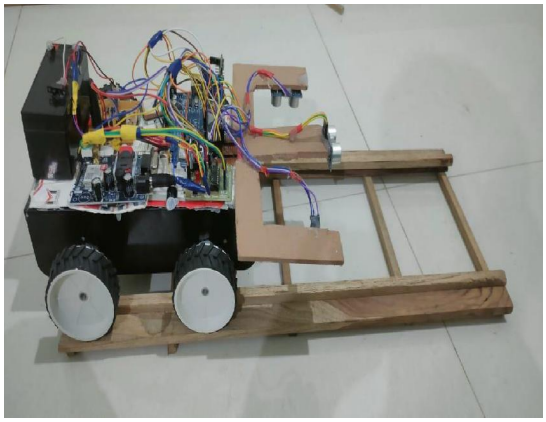

Figure 15: Proposed Model With Wooden Track

IX. RESULT

The following figure shows that the SMS obtained on the mobile phone with the latitudinal and longitudinal position at the point where a crack or obstacle is detected.

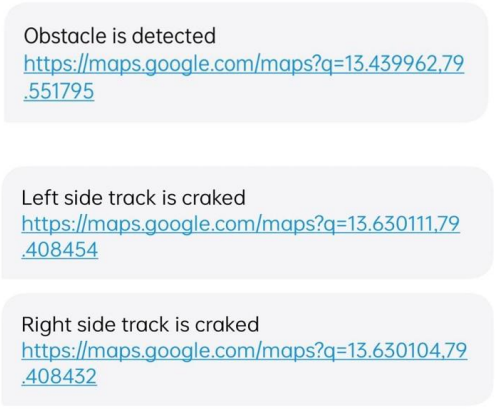

Figure 16: SMS Received In The Mobile Phone

8.1 Output Screen on Browser

http://vehicle14086.wizzie.tech/

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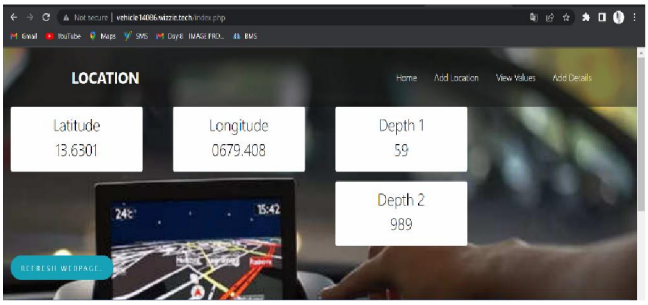

Figure 17: Defect Detected Location Details

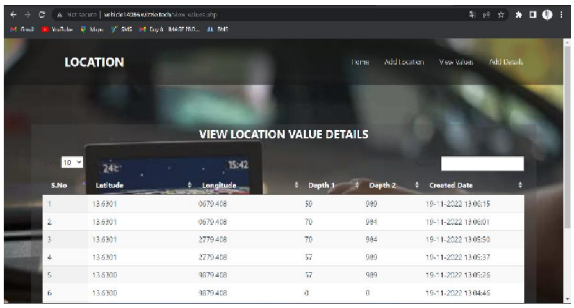

Figure 18: List of Locations Detected

GPS location site on the Google map

Crack detected on right side https://maps.google.com/maps?q=13.362180,79.557450

Crack detected on left side https://maps.google.com/maps?q=13.439176,79.553306

Obstacle detected on track https://maps.google.com/maps?q=13.301038,79.580287

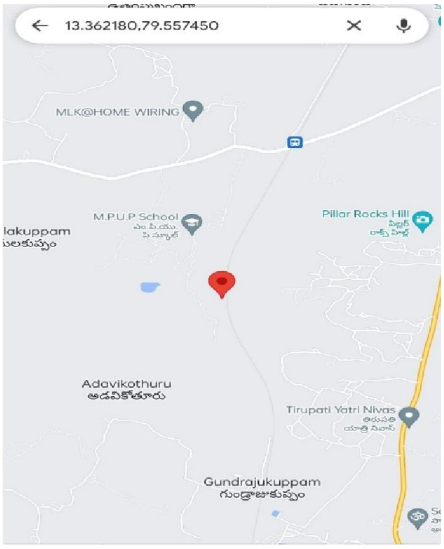

Figure 19: Location Of Right Track Detected In Map

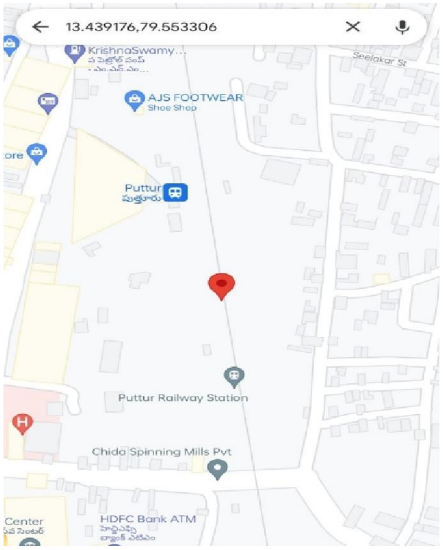

Figure 20: Location Of Left Track Detected In Map

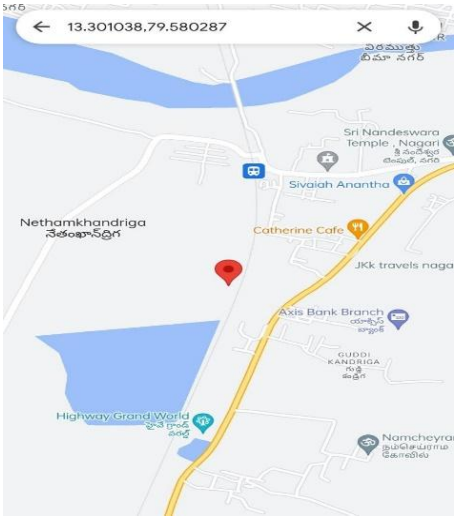

Figure 21: Location Of Obstacle Detected In Google Map

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X. CONCLUSION

By using this automatic vehicle for purpose of railway track inspection and crack detection, it will have a great impact in the maintenance of the tracks which will help in preventing train accidents to a very large extent. The regions where manual inspection is not possible, like in deep coal mines, mountain regions and dense thick forest regions can be easily done using this vehicle. By using this vehicle for the purpose of railway track inspection and crack detection and automated SMS will be sent to pre-defined phone number whenever the vehicle sensors detect any crack or deformation. This will help in maintenance and monitoring the condition of railway tracks without any errors and thereby maintaining the tracks in good condition, preventing train accidents to very large extent railway track crack detection autonomous vehicle is designed in such a way that it detects the cracks or deformities on the track which when rectified in time will reduce train accidents.

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