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Automated Railway Track Crack Detection System

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Abstract
Indian railways are often called the lifeline of the nation. It not only transports passengers and goods but also connects the entire nation to one single thread. Indian railways are Asia's largest network and furthermore stands as the second largest network in the whole world which is driven under a solitary administration. Also, in our country most of the commercial transportation are carried out by railway network as it is the cheapest mode of transportation preferred over all other means of transportation. However, when it comes to reliability, dependability, and passenger safety, the Indian Railways is not up to the global standards. Being such a vast network, for it to operate flawlessly, constant monitoring and inspection is mandatory. Currently, railway track inspection and monitoring is mostly done manually which is time consuming and may not always generate accurate data regarding the railway track conditions. There are high chances of human error and moreover practically it's impossible to inspect and monitor the railway track manually as it runs over thousands of kilo meters in length. Amongst the other factors, often cracks are developed on the railway tracks due to absence of timely detection and oversight. Hence the project work aims to design an automated railway track crack detection system which is a robust and an efficient system to detect the cracks. The proposed framework utilizes GPS system along with GSM module, NodeMCU and Ultrasonic sensor for transmitting and receiving messages during a faulty condition. This work proposes a dynamic approach towards the issue of cracks on the track using an ultrasonic sensor that utilizes its transmitter and receiver for detecting the faulty section on the track so that maintenance can be done as soon as possible. Using a GSM module and a web interface, the fault data can be remotely transmitted to the railway safety management center and it also incorporates the area data which is obtained by embedded GPS receiver.

Keywords: *ESP 8266 NodeMCU,Ultrasonic Sensors, GPS Module, GSM Module, Motor Driver, Web Based Control.*

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I. INTRODUCTION

In today's world, transportation being one of the biggest drainers of energy, its sustainability and safety are issues of importance. Indian railways is the fourth largest railway network in the world. The rail transport is growing at a rapid pace in India. It is one of the major modes of transportation but still our facilities are not that accurate and safer as compared to the international standards. Improper maintenance and the currently irregular and manual track line monitoring mistake from workers is also a problem in the Indian Railways. The major problem is that there is no efficient and cost-effective technology to detect problems in the rail tracks and the lack of proper maintenance is also a factor. Hence it is not safe for human life. So these problems should be considered with utmost attention. In the previously existing systems, the inspections used to be done manually, but the proposed system has a vehicle which will run on the tracks. This model is a prototype for detecting cracks on railway tracks. It 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 or the provided number. With this proposed system the exact location of the faulty rail track can be easily located, so that many lives can be saved. Proposed system is small and is efficient to use.

The rule objective is to identify the cracks on the rail line track. This model proposes a reasonable response for the issue of railroad track break acknowledgment utilizing ultrasonic sensor gathering which tracks the specific area of flawed track. The GSM module will then signal the closest control room or the registered mobile number through a SMS and arrangement are done to block the rail route and repair the faulty track as soon as possible.

The current framework of rail route tracks is studied physically which uses LED (Light Emitting Diode) and LDR (Light Dependent Resister) sensors on the tracks. Visual investigation is the most seasoned strategies wherein the parts are filtered outwardly. In India this technique is utilized broadly in spite of the fact that it produces least fortunate outcome. This examination doesn't give the ideal yield under the awful climate

condition. The current framework has a delay in passing the data and also utilizes telephonic correspondence which isn't so quick and exact.

The proposed robotic vehicle overcomes the limits of the current framework that are utilized for the recognition of flawed tracks. The ultrasonic sensor estimates the distance between the track and the sensor. In the event that any cracks are detected on the track, location coordinates of that spot are sent to the closest station or control room using GPS and GSM.

For an efficient control and monitoring of the robotic vehicle a web server is implemented with the help of NodeMCU which is an open-source platform based on ESP8266 which can connect objects and let data transfer using the Wi-Fi Protocol. The information about the crack and its location can be accessed by the respective control stations through this web server.

II. SYSTEM WORKING

This project work aims to design an automated railway track crack detection system. The proposed framework utilizes GPS system along with GSM module, NodeMCU and Ultrasonic sensor for transmitting and receiving messages during a faulty condition. The NodeMCU is activated initially, followed by the ultrasonic sensor and all the other modules. The ESP8266 NodeMCU creates a personal hotspot to which we connect our mobile device. A personal web page IP address is provided within the Arduino code which is opened with the help of Google Chrome in the mobile device. Web page provides various control functions to move and stop the vehicle as shown in Figure 1. It also displays alert messages and the location information of the place where crack has been detected. Signals from the ultrasonic sensor and the to and fro information signals from web page are primary control actions. Taking location coordinates from GPS module and sending it to GSM Module are the secondary control actions.

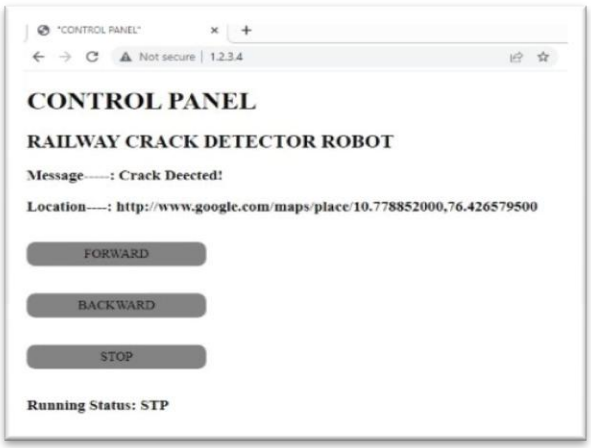

Figure 1:Webpage Based Control

Getting back to the the working, when a crack is detected by the ultrasonic sensor, the ultrasonic sensor sends the information signals to the micro controller. At that instant an information signal is sent to the motor driver to stop the motor from rotating. Also, at that time a signal is sent to the web page indicating the crack being detected. The location coordinates of the place where crack has been detected is sent to the micro controller. From the NodeMCU the location coordinate information is sent to the web-based controller and the GSM Module. From the GSM module the location coordinates are sent to the mobile number which is included within the Arduino code. Location information appears in mobile messaging app as a Google Map link which can be accessed with the help of Google Map app or its website. After properly alerting the concerned authorities the vehicle motion can be controlled whether to move forward or backward depending of the crack situation.

III. BLOCK DIAGRAMOF PROPOSED SYSTEM

The block diagram of the system designed is shown in Figure2.An ESP8266 Node MCU is the central control unit for the implementation of both crack detection as well as vehicular motion. There is a web-based control provided to control vehicular motion. An Ultrasonic sensor is used to determine the cracks which may have developed on the railway track and output is sent to micro controller. The geographical coordinates of the place where crack has been detected by the ultrasonic sensor is determined by the GPS module and location coordinates are sent to the specified number with the help of a GSM Module. The LCD displays various

information regarding the system performance. The motor driver(L293D) takes input from the micro controller and DC Motor rotation is controlled accordingly.

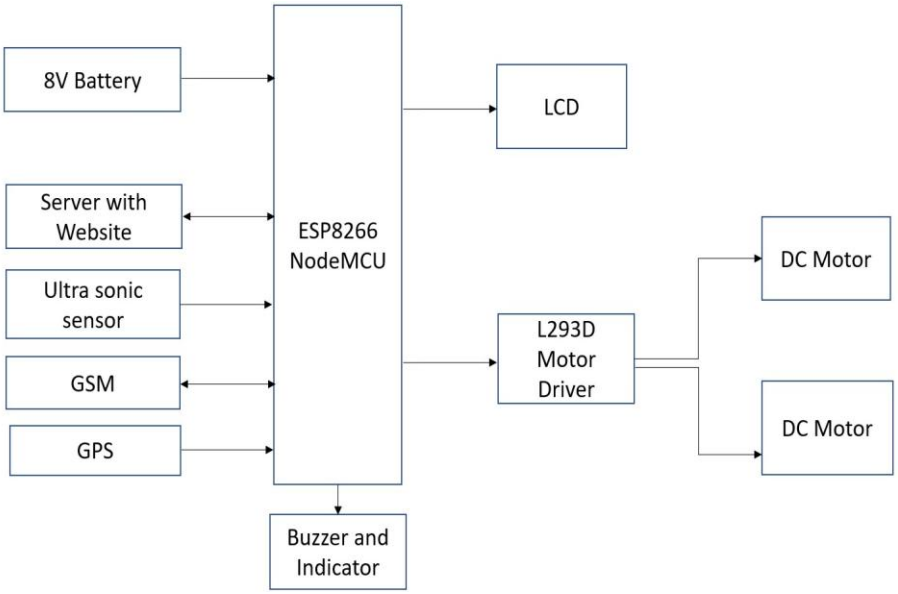

Figure 2:Block diagram of Automated Railway Track Crack Detection System

IV. CIRCUIT SCHEMATIC

A Wi-Fi and Bluetooth compatible ESP 8266 NodeMCU is the brain of this project. The NodeMCU present in the circuit is an essential component for displaying the values. It facilitates real time monitoring and control of the vehicle parameters on a specially developed web interface for controlling vehicular motion and also to know status of the vehicle. The ESP8266 NodeMCU has several General-Purpose Input Output (GPIO) pins to which various modules and sensor is connected as shown in Figure 3.

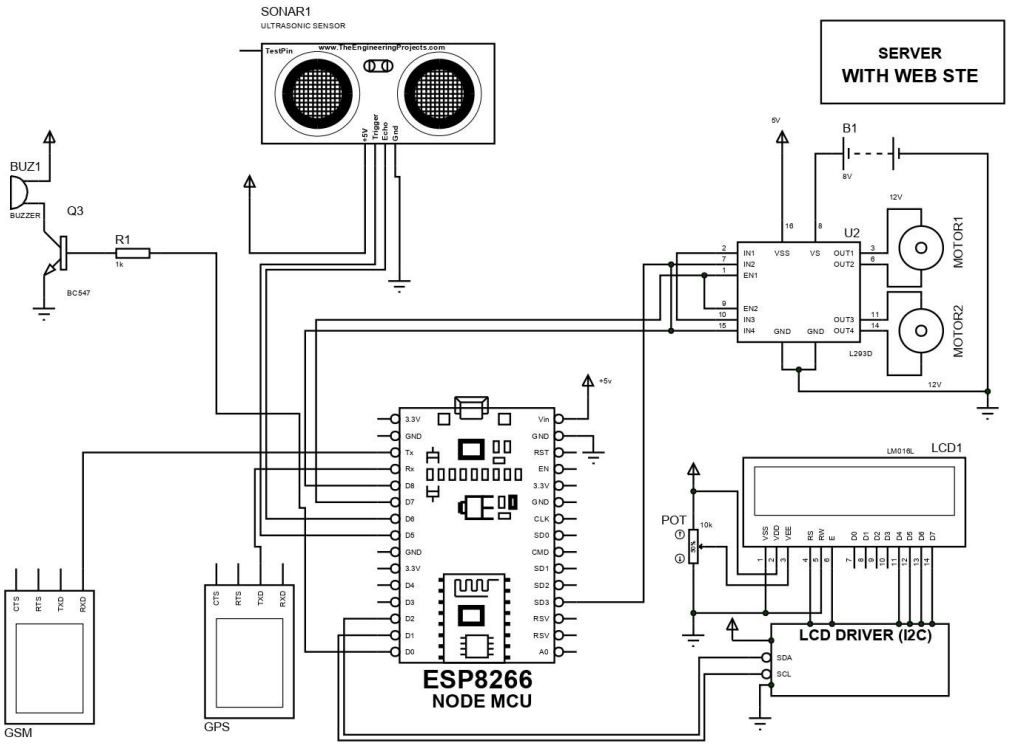

Figure 3:Circuit schematic of proposed system

The ultrasonic sensor gives in one input signal through the D6 pin based on whether the threshold value has been exceeded or not and takes output signal to trigger ultrasonic signals through D5 pin of NodeMCU. The GPS module is connected to the receiving terminal of NodeMCU and the GSM module is connected to the transmitting pin of NodeMCU. These both modules together help to determine the location coordinates of the place where crack has been developed and sent those location coordinates to the registered mobile number in the Arduino code.

The Motor Driver IC is connected to the D7, D8 and SD3 pin of the NodeMCU. Motor driver helps to control the of rotation of the two 12V DC Motor used. It can also vary the speed of the motor. It is a 16pin IC with 8 pins on each side dedicated to control each motor.It works on H-Bridge principle. Depending on the value of the input and enable the motor will rotate in either clockwise or anti clockwise direction with full speed or with less speed, when enable is provided with PWM.

An output from the D8 pin of NodeMCU is given to the buzzer whenever there is a crack which is detected. The LCD displays various information data while operation of the system.All these modules, sensor, micro controller, the web page, etc, they all work in synchronism to achieve a proper operation of the system.

V. SOFTWARE IMPLEMENTATION

The software implementation part includes programming NodeMCU. All the programming for the ESP8266 NodeMCU is written in the Arduino Integrated Development Environment platform in C programming language. The Ultrasonic sensor is interfaced with Arduino board which converts the analog voltage values from sensor to corresponding units. The GSM and GPS module interfaced with NodeMCU to determine location of the fault and sent location coordinates to specified number provided in the Arduino code. The LCD module is interfaced with the Arduino board so as to display various information. The program algorithm depicting the system operation is shown in Figure 4.

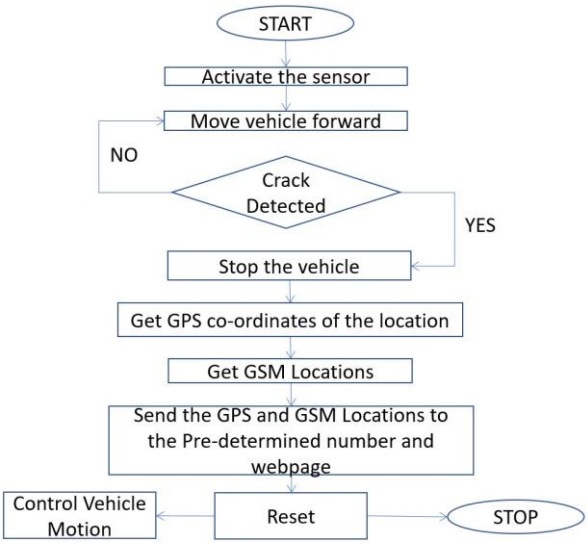

Figure 4:Program Algorithm

A web interface is designed using HTML (Hyper Text Markup Language) for real time monitoring of vehicle status and its control. The webpage developed can be accessed on any browser. The Node MCU is capable of acting as a Wi-Fi module thus facilitating the access to internet. Besides displaying the control parameters, it also displays the status of vehicle, whether the vehicle is in forward motion, backward motion or at stop condition. It also displays alert message on the webpage whenever the crack is detected along with the location coordinates link which can be accessed through Google Map. The code for webpage development is written using the two programming languages, HTML (Hyper Text Markup Language) and CSS (Cascading Style Sheets), both of which are very different from C which is used to program the rest of the hardware. Any smart device which has access to internet can be used to monitor the parameters in the webpage. Thus, it is integrated to Internet of Things (IoT).

VI. COMPONENTS

Different functional components are integrated together in this project so as to ensure successful operation of the accident detection system. Components used in this project are listed below:

i. ESP8266 Node MCU
ii. SIM900A GSM Module

iii. NEO6MV2 GPS Module
iv. Ultrasonic Sensor
v. L293D Motor Driver IC
vi. 16*2 LCD Module
vii. 12V DC Motor
viii. 5V Buzzer

VII. THE SIMULATION

Simulation of motion control of the robotic vehicle and crack alert is shown in Figure 5. Proteus 8.1 Professional is used for the simulation. Arduino UNO is used as the main micro controller. L293D motor driver IC is interfaced with Arduino for controlling the motion of wheels. LCD display will show the information about the direction of motion and crack alert.

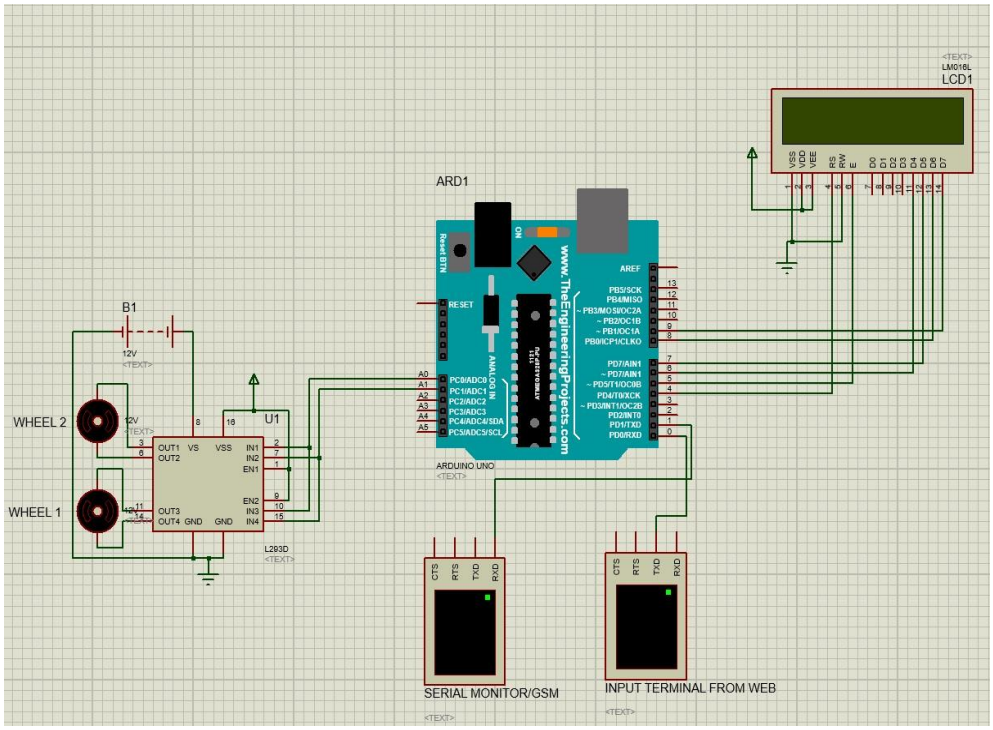

Figure 5:Simulation of Robotic Vehicle

In this simulation part we are giving control command in the serial monitor for the motion of the vehicle. *F Command for the forward movement, *B command for the backward movement, *S command for the vehicle to stop. Whenever a *R command is called the vehicle stops and LCD displays detection of crack and the default location.The coding of this part of simulation is done in Arduino IDE software.

VIII. SIMULATION RESULTS

The simulation results shown in Figure 6is displayed in a virtual monitor. This shows the details about the vehicle motion and when crack command is called, the location coordinates of the crack is shown and message alert is sent to the registered mobile number.

Figure 6:Simulation output

IX. HARDWARE IMPLEMENTATION

The hardware model of Automated Railway Track Fault Detection system has been developed as shown in Figure 7 and Figure 8. A rechargeable battery has been provided onto which the NodeMCU and the motor driver IC are placed. The GSM module is positioned in such a way that its antenna position can be varied for maximum signal transmission. Also, the GPS module along with its antenna is placed in such a way to receive proper signals from satellites. LCD display is mounted onto the front portion of the vehicle so that its more convenient for us to observe the information displayed. All the modules along with the NodeMCU, motor driver, battery, ultrasonic sensor is mounted onto the movable robot. The ultrasonic sensor is mounted on the robotic vehicle in such a way that the distance between ultrasonic sensor and the track is constant except for the portion where the crack has been provided.

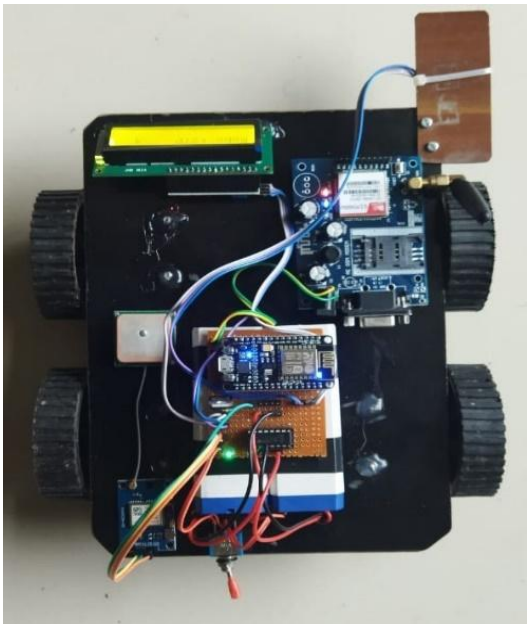

Figure 7:Hardware Setup

A miniature model of railway track was developed as shown in Figure 8. One rail of the track has been provided with a small crack. The robotic vehicle is operated on this railway track. The tracks have grooves which helps to properly position the robotic vehicle onto the tracks.

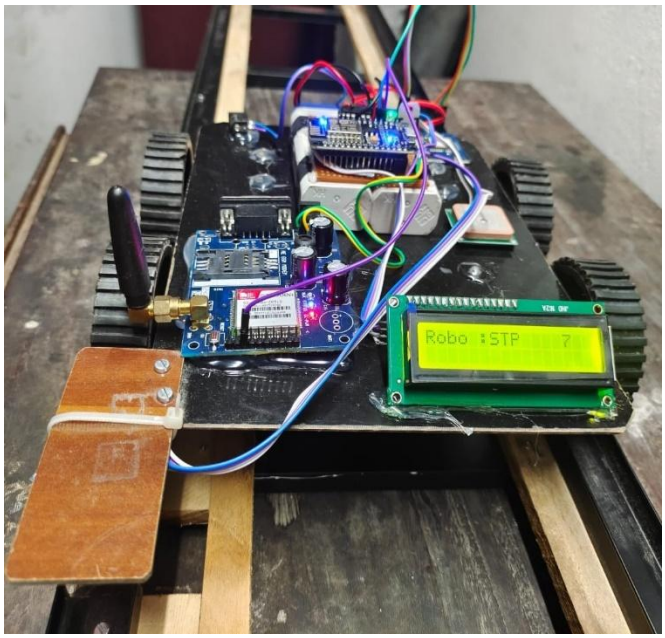

Figure 8:Robotic Vehicle on Miniature Railway Track

Alert messages are sent to the registered mobile numbers provided in the Arduino code as shown in the Figure 9. The alert messages appear in the form of a link, which can be accessed through Google Maps.

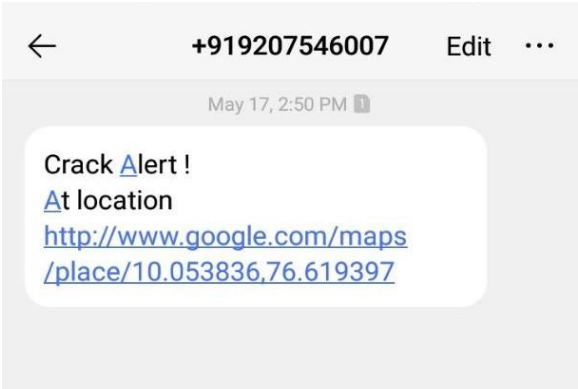

Figure 9:Alert Message in Mobile

X. CONCLUSION

Derailment of trains occurs mainly due to cracks on railway tracks. Due to the manualinspections which are carried out in the existing systems, the process becomes time consuming aswell as uneconomical.The proposed system being robust and cost-effective helps to detect thesecracks as well as improves the accuracy of crack identification in rails. An automated systemis designed for railway track security by developing a micro controller-based robot. This devicebrings a digital solution for real-time crack identification which is a huge treat for thousands ofpeople who are using trains as a major mode of transportation in their daily life. The crack canbe detected without any error. In the long run, it will facilitate better safety standards for railwaytracks and provide effective testing infrastructure for achieving better results in the future. Aneffective solution to avoid the accidents caused by the cracks on the railway track is implementedin this project work.

REFERENCES

[1]. Prof. Z.V. Thorat and Nikhil Ranjane, "Automatic Railway Track Crack Detection System Using GSM GPS",in IEEE International Conference, 2020.
[2]. SarathChandran.P and Karthika.M, "Track system requirements, Railway Group Standards, GC/RT5021",inRailway Safety and Standard BoardLimited, London, October2019.
[3]. S.Bhagyalakshmi, A.Maya, V.RavikumarPandi, "Automated Railway Track Fault Detection using Solar Powered Electric Vehicle",Second International Conference on Electrical, Computer and Communication Technologies(ICECCT), 2019.
[4]. Jubayer Jalil and M. B. I. Reaz, "Accident detection and reporting system using GPS, GPRS and GSM technology",in IRJET, October 2019.

[5]. Qiao Jian-hua, Li Lin-sheng and Zhang Jinggang, "Design of Rail Surface Crack-detecting System Based on Linear CCD Sensor", inIEEE International Conference on Networking, Sensing and Control, 2018.
[6]. RanuDewangan and Pratibhadevi Umesh, "Automatic Accident Control System on Railway Tracks", International Journal of Advanced Researchin Electronics and CommunicationEngineering (IJARECE), July 2016.
[7]. RinkeshKumar Yadav, Rohini Temkar, "Combined Iot and Cloud Computing Solution for Railway Accident Avoidance", inInternational Research Journal of Engineering and Technology (IRJET), June 2017.
[8]. L. Beales, "IOT Based Accident Prevention and Monitoring System in Railways", in International Research Journal of Engineering andTechnology (IRJET), June 2017.
[9]. K.Divya and R.Anjugam, "Railway Safety Monitoring System using Ultrasonic and IR Sensor", in IJSRD- International Journal for Scientific Research Development, 2018.
[10]. N.Karthick, R.Nagarajan, S.Suresh and R. Prabhu, "Implementation of Railway Track Crack Detection and Protection", International JournalOf Engineering And Computer Science,2017.