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Development of Railway Track Crack Detection System using Arduino

Prof. Najma Siddiqui[1], Prof. Akil Ahmed[1], Tejas Thakre[2], Sujyot Jibhe[2], Yogesh Karnake[2], Samir Sheikh[2], Yash Sangole[2], Sohelraza Sheikh[2]

[1]Assistant Professor, Department of Electrical Engineering, Anjuman College of Engineering and Technology, Nagpur, Maharashtra, India

[2]Students, Department of Electrical Engineering, Anjuman College of Engineering and Technology, Nagpur, Maharashtra, India

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ABSTRACT

The Indian Railways has one of the largest railway networks in the world, criss- crossing over 1,15,000 km in distance, all over India. However, with regard to reliability and passenger safety Indian Railways is not up to global standards. Among other factors, cracks developed on the rails due to absence of timely detection and the associated maintenance pose serious questions on the security of operation of rail transport. A recent study revealed that over 25% of the track length is in need of replacement due to the development of cracks on it. Manual detection of tracks is cumbersome and not fully effective owing to much time consumption and requirement of skilled technicians. This paper is aimed towards addressing the issue by developing an automatic railway track crack detection system with the proliferation of Internet of Things (IoT). It is possible to collect massive amount of data for localization and tracking of Railway Fault Detection.

Keywords: Railway Track, Crack detection, Automatic Robot, Sensor and Controller, GSM & GPS etc.

I. INTRODUCTION

Railway is an essential and cheapest mode of transport in India and is considered superior to all other modes of transport. Reading daily newspapers, we come across many railway accidents. Railway accidents are more dangerous than other traffic accidents both in terms of severity and mortality, etc. Therefore, more efforts are needed to improve security.

Railway safety is an important part of railway traffic all over the world. Failures that lead to accidents tend to receive widespread media attention even when the railroad is not at fault, and create an ineffective image of the railroad among the public that often encourages immediate reforms. Indian Railways has one of the largest railway networks in the world, spanning over 1,15,000 km across India. But in terms of reliability and passenger safety, Indian Railways is not up to

global standards. Among other things, the cracks on the rails caused by the lack of timely detection and related maintenance raise serious questions about the safety of rail traffic. A recent study revealed that more than 25% of the track length needs to be replaced due to cracks. Manual identification of traces is cumbersome and not fully effective because it takes a lot of time and requires skilled technicians. This project work aims to solve the problem by developing an automatic track slotting system with the proliferation of LCD screens. A huge amount of data can be collected to locate and trace rail faults.

The aim of the project is to help the relevant railway administrations to strengthen their safety culture and develop monitoring tools necessary for modern safety management. Railway crossings are very unique, special, and potentially dangerous and at the same time unavoidable in the world. Here, two different entities with completely different responsibilities, fields of activity and activity meet and come together with the aim of providing a service to the road user. In this project we use an ultrasonic sensor to detect cracks in railways. When a crack is detected, its status is sent to the control room via the LCD screen. An infrared sensor is then used in the measurement process. This system is designed to operate a railway safety monitoring system with an Arduino Uno (ATmega328), ultrasonic sensors and an LCD display.

II. PROBLEM STATEMENT

The main problem was the lack of cheap and effective technology to detect problems in the tracks and of course the lack of proper maintenance of the tracks, which caused the formation of cracks in the tracks, etc. similar problems caused by antisocial factors that threaten the safety of rail traffic. In the past, this problem has caused several derailments resulting in many casualties and property. In the past, track cracks were identified as the main cause of derailment, but no inexpensive automated solutions were available for testing.

Derailment is one of the leading causes of the most expensive and dangerous derailments worldwide. Considering derailments in general, the United States alone averages more than one major derailment every three-day period, consistently for more than a decade.

Fig. 1: Crack on track

Fig. 2: Manual Crack Detection

III.PROPOSED METHODOLOGY

This system involves the design of crack finding robot for finding cracks in railway tracks. This system uses controller for interfacing the robotic vehicle and crack detection sensor. The sensing device senses the voltage variations from the crack sensor and then it gives the signal to the microcontroller. The microcontroller checks the voltage variations between measured value and threshold value and controls the robot according to it.

Our concept deals with one of the cost and efficient method to avoid train accidents by formulate

solutions to the problem of railway crack finding. This technique is used for outside of base station to avoid the drastic condition of Indian railway networks from stopping down still more; an automated system which does not rely upon the manual labor is fetched into bright.

It proposes a cost effective solution to the problem of robust railway crack detection scheme (RRCDS) by utilizing AT mega microcontroller, ultrasonic sensors, buzzer, IOT assembly to ensure robustness, repeatability and easy implementation, the principle idea has been kept very simple. ultrasonic sensors is used to detect the crack. In order to locate current position of the crack detected, iot service is used. To communicate the received information, IOT module is used. Using this message sent wirelessly to appropriate authority. Then an alarm rings with the help of buzzer indicating the detection of crack, thereby they track the exact location of track damage immediately so that many lives will be saved.

The robotic model is interfaced with the microcontroller with the help of SPDT relays and driver IC. If any crack occurs in the rail, the robot will be stopped and then an alarm will be raised and LCD display raise error detection messages in same time IOT module also send the information over internet or control room.

IV.BLOCK DIAGRAM

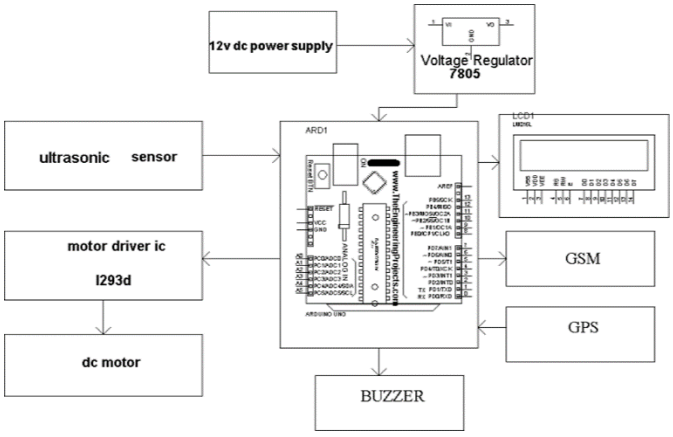

Fig. Fig. 3: Block Diagram

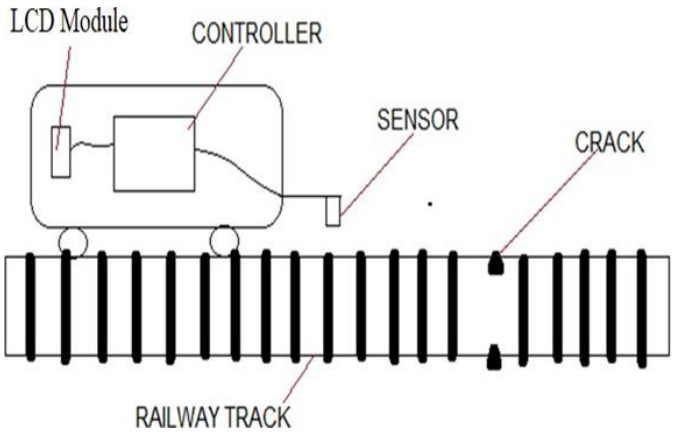

Fig. 4: Experimental Diagram

V. WORKING

The model has an arduino board that acts as an interface between the infrared sensors, the passive infrared sensors and the LCD screen. The whole system is integrated in a four-wheeled LCD robot/vehicle that travels between the railway tracks. The robot is programmed to move forward with an infrared sensor attached to the left, right and front lanes to detect obstacles which detect a road break. Arduino is programmed with Arduino IDE and connected with various devices such as motor driver needed to move our robot forward and backward. LCD display module to send messages to higher authorities, infrared sensor to detect cracks, inches our project has two sets of railway model installed on both sides of the ultrasonic sensors units.

The project block diagram which contains following process-

1. Initially the tracks are being continuously monitored with the help of sensor, which is used to detect the crack in the track.
2. This monitoring is done with the help of ultrasonic sensorin order to sense the minor changes also which can be quite difficult with other sensors.

3. Whenever the crack gets detected with the help of ultrasonic sensor it passes the alert of crack found to the Arduino microcontroller.
4. The Arduino microcontroller will perform the process assigned to it accordingly.
5. The process mainly includes positioning, sending and alerting through the help of GPS module.
6. Once the message is sent to the railway authority, the alarm must be heeded and important action must be taken to prevent future crashes and accidents that could result in loss of life and serious injury.

VI.COMPONENTS DESCRIPTION

The block diagram of the desired system is shown in fig.3. There are two modules
1) Monitoring System, 2) Train System

1) Monitoring System

This system is in moving position. We pass this system before the train is passed. We have to use three sensors. One ultrasonic sensors used for line follow and to detect the obstacle on the track and two ultrasonic sensors are used for measuring the perpendicular distance and according to that convey message to controller whether the crack or any obstacle is detected.

First we set some threshold range of distance. When the distance is increased or decreased then definitely there is any obstacle or crack. There is synchronization between the monitoring system and train system, so this information of crack detection is send to train system which is implemented on railway and all the stations between the source station and destination station. There is also Bluetooth connectivity for data access.

2) Train System

Train System is placed on the train. It consists of controller module, GSM module and GPS connectivity. This is in synchronization with monitoring system. When it get signal that is track is detected then will be stop.

- **Arduino Uno**

The Arduino Uno is an open source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc.[2][3] The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.[1] The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable.[4] It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo.

Fig. 5: Arduino Uno

- **Adapter**

An adapter or adaptor is a device that converts attributes of one electrical device or system to those of an otherwise incompatible device or system. Some modify power or signal attributes, while others merely adapt the physical form of one connector to another.

Fig. 6: Adapter

- **Liquid crystal display**

This device can be use to display any message, status or also can be use for debugging purpose. In this project it indicates the status of cracks.

Fig. 7: Liquid crystal display

- **L293D Motor Driver Board**

The most common method to drive DC motors in two directions under control of a computer is with an H-bridge motor driver. H-bridges can be built from scratch with bi-polar junction transistors (BJT) or with field effect transistors (FET), or can be purchased as an integrated unit in a single integrated circuit package such as the L293. The L293 is simplest and inexpensive for low current motors, for high current motors, it is less expensive to build your own H-bridge from scratch.

Fig. 8. L293D Motor Driver Board

- **Ultrasonic Sensor**

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity.

Fig. 9. Ultrasonic Sensor

- **DC motor**

DC motor is an electrical machine that utilizes electric power resulting in mechanical power output. Normally the motor output is a rotational motion of the shaft. The input may be direct current supply or alternating supply. But in case of DC motor direct current is used. The mechanism of dc motor is like a bar wound with wire is placed in between 2 magnets having North and South Pole. When it is provided with electric supply the wire becomes energized resulting in rotational motion which leads to rotational output. The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances.

Fig. 10. DC motor

- **GSM Module**

GSM (Global System for Mobile Communications, originally Groupe Spécial Mobile). GSM is a TDMA based wireless network technology developed GSM phones make use of a SIM card to identify the user's account. The use of the SIM card allows GSM network users to quickly move their phone number from one GSM phone to another by simply moving the SIM card

Fig. 11 GSM Module

- **GPS Module**

The Global Positioning System (GPS) is a satellite-based navigation system made up of at least 24 satellites. GPS works in any weather conditions, anywhere in the world,
24 hours a day, with no subscription fees or setup charges.

Fig. 12 GPS Module

VII.RESULTS

The "Railway Track Crack Detection using Arduino" project aims to detect cracks on railway tracks using an Arduino microcontroller. The ultrasonic sensor detects the distance between the sensor and the rail, and any significant variation in this distance indicates the presence of a crack on the track. The system then alerts the railway authorities through a GSM module, providing them with the exact location of the crack, so they can take necessary measures to repair it and prevent any potential accidents. The project has been successful in detecting cracks with high accuracy and has the potential to improve railway safety significantly.

- Video display units display relevant information according to the controller's response to the supplied situations.
- The controller makes it easier for the driver to operate and permits the engines to move.
- The GSM module is then turned on, and it transmits the message to closest stations instructing them to perform the appropriate action.
- The sensors are turned on and can reliably identify fractures or other obstructions.
- When a crack is found, the word "cracked" will appear on the LED display.

The subsequent patterns suggests the Crack Detected or impediment found on the Arduino show display screen.

Fig.13.Crack Detected

The following figure shows that SMS received on cellular telephones are inside the latitudinal and longitudinal areas where a crack or impediment is located.

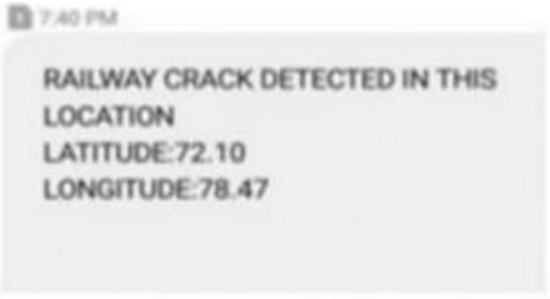

Fig.14. Information Received in the mobile Phone

The proposed device introduces GSM-primarily based era, to prevent train injuries. An GSM module with a

sensor tool hooked up at every quit of the train. Whilst the teach starts off the tune, the signal breaks and a notification is given to the engine driving force and an emergency brake is applied. The main cause of the paintings is to avoid train accidents with out manual electricity.

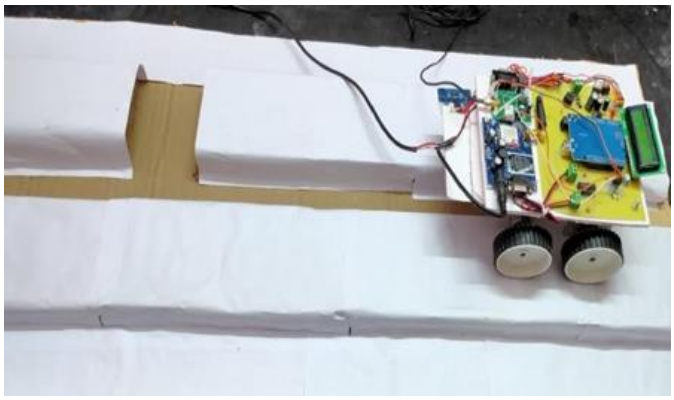

Fig.15. Project Image

VIII. CONCLUSION

The proposed Arduino based rail crack detection system has the potential for detecting the cracks in the rail track including minor cracks automatically without any human intervention. There are many advantages with the proposed system as compared with traditional detection techniques. The advantages includes fast detect and reporting system, less cost, low power consumption and less analysis time. Also the easy availability of the components and the simplicity of idea make the proposed system ideal for implementation on a large scale with very little initial investment. Therefore it can work efficiently and effectively under working condition. By this proposed model, we will easily avoids the accidents occurs by the track side crack which will help us for saving many lives.

In this project we have designed a cost effective, low-power embedded system, which facilitate better safety standards for rail tracks for preventing railway accidents due to cracks and obstacles on railway tracks. The Prototype of testing railway model can efficiently detect cracks and obstacles on railway tracks. The result shows that this new innovative technology will increase the reliability of safety systems in railway transport. By implementing these features in real time application, we can avoid accidents up to approximately 70%.

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