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A survey on Smart Railway Track Fault Detection Using IOT

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ABSTRACT
Indian Railways is the largest railway network in Asia and additionally world's second largest network operated underneath a single management. Due to its large size it is difficult to monitor the cracks in tracks manually. This paper deals with this problem and detects cracks in tracks with the help of ultrasonic sensor attached to moving assembly with help of stepper motor. Ultrasonic sensor allows the device to moves back and forth across the track and if there is any fault, it gives information to the cloud server through which railway department is informed on time about cracks and many lives can be saved. This is the application of IoT, due to this it is cost effective system. This effective methodology of continuous observation and assessment of rail tracks might facilitate to stop accidents. This methodology endlessly monitors the rail stress, evaluate the results and provide the rail break alerts such as potential buckling conditions, bending of rails and wheel impact load detection to the concerned authorities.
KEYWORDS: IOT, Raspberry, Smart railway, Fault detection, Ultrasonic sensor.

I. INTRODUCTION

Internet is basically system of interconnected computers through network. But now its use is changing with changing world and it is not just confined to emails or web browsing. Today's internet also deals with embedded sensors and has led to development of smart homes, smart rural area, e-health care's etc. and this introduced the concept of IoT [1].

Internet of Things refers to interconnection or communication between two or more devices without human-to-human and human-to-computer interaction. Connected devices are equipped with sensors or actuators perceive their surroundings. IOT has four major components which include sensing the device, accessing the device, processing the information of the device, and provides application and services. In addition to this it also provides security and privacy of data [2].

Automation has affected every aspect of our daily lives. More improvements are being introduced in almost all fields to reduce human effort and save time. Thinking of the same is trying to introduce automation in the field of track testing. Railroad track is an integral part of any company's asset base, since it provides them with the necessary business functionality. Problems that occur due to problems in railroads need to be overcome. The latest method used by the Indian railroad is the tracking of the train track which requires a lot of manpower and is time-consuming.

Existing System

Existing train tracks are manually researched. LED (Light Emitting Diode) and LDR (Light Dependent Resister) sensors cannot be implemented on the block of the tracks [3]. The input image processing is a clamorous system with high cost and does not give the exact result. The Automated Visual Test Method is a complicated method as the video color inspection is implemented to examine the cracks in rail track which does not give accurate result in bad weather. This traditional system delays transfer of information. Srivastava *et al.,* (2017) proposed a moving gadget to detect the cracks with the help of an array of IR sensors to identify the actual position of the cracks as well as notify to nearest railway station [4]. Mishra *et al.,* (2019) developed a system to track the cracks with the help of Arduino mega power using solar energy and laser. A GSM along with a GPS module was implemented to get the actual location of the faulty tracks to inform the authorities using SMS via a link to find actual location on Google Maps [5]. Rizvi Aliza Raza presented a prototype in that is capable of capturing photos of the track and compare it with the old database and sends a message to the authorities regarding the crack detected [6]. The detailed analysis of traditional railway track fault detection techniques is explained in table 1.

This paper proposes the construction of a rigid rail sensing system through the use of the Ultrasonic sensor assembly for the rail track detection system for detecting cracks in the train tracks. Most of the accidents of the train are caused by a train wreck, which can be easily detected. The hand-held inspection of the train track took more time and fatigue of the people. The proposed system introduces technology, to prevent railway accident.

Table 1: Literature survey of smart railway track fault detection system

Author	**Title**	**Source**	**Findings**
Naveen Bhargav *et al.* (2016)	Automatic Fault Detection of Railway Track System Based on PLC (ADOR TAST)	International Journal of Recent Research Aspects	The sensor is used to detect defect in the train track and the ultraviolet sensor is used to detect the obstruction in front of the train.
B. Siva Rama Krishna *et al.* (2017)	Railway track fault detection system using IR sensors and Bluetooth technology	Asian Journal of Applied Science and Technology (AJAST)	In the event of any defect on the track it will detect track defect using IR sensors and then it sends a message to the android phone using a Bluetooth module.
Parvathy A. *et al*. (2017)	Automatic Railway track fault detection for Indian railways	IEEE	The Automatic Railway Route automatically detects the fares of the Indian IEEE Rail Automatically and detects cracks very quickly without human intervention.
Swati D. Patil & Pallavi. M. Taralkar (2018)	Train track fault detection system	International Journal of Current Engineering and Scientific Research (IJCESR)	Rail crashes have been identified as a major cause of accidents in the past. So, the solution to this problem is using the robot to detect cracks in the train track and when the robot detects an error it sends a message to the base station.
Mansi R. Sarwan *et al.* (2018)	Automated Railway Track Fault Detection System Using Robot	International Conference on New Frontiers of Engineering, Management, Social Science & Humanities	An IR (Slot sensor) assembly that tracks the exact location of a faulty track was quickly repaired so that many lives could be saved.
M. Banupriya *et al*. (2019)	Self Powered For Railway Track Monitoring Using IoT	IOSR Journal of Engineering (IOSR JEN)	This has resulted in a rapid increase in surveillance of systems, buildings, vehicles, and machines using sensors.
S. Mishra, A. Shrivastava and B. Shrivastav (2019)	A Smart Fault Detection System For Indian Railways	International Journal of Scientific & Technology Research	The device built will be attached to a train engine and contains a sensor that can detect a few meters cracks and as soon as any cracks are found the train driver will receive a signal to install emergency brakes and the authorities will be notified of the correct location of the fault.

An Ultrasonic sensor is installed that monitors the track and provides status to the Raspberry pi controller. If any crack is detected it immediately sends the cloud crunch to the user's mobile phone. The paper uses a stepper motor assembly in which the ultrasonic sensor is attached and the ultrasonic sensor moves to the side of the track and in case of error anywhere the track receives and provides information to the railway department. To our best knowledge such IoT based automatic fault detection gadget has not been proposed in literature till date.

This project is very helpful in preventing accidents and provides information before the railway department about the cracks so they can get information about the cracks and can be fixed soon. Further sections of the paper deals with the block diagram with components description of the proposed work under section II followed by working of the device and its specifications in section III. At last, section IV concludes the paper and section V explains the future scope of the proposed work.

II. PROPOSED DESIGN

The block diagram of the proposed design is shown in figure 2. It consists of Power supply, Stepper Motor, Raspberry Pi, Ultrasonic Sensor, Buzzer and LCD display and the output is given to Cloud server. The components are explained in detail below.

Power supply: It is required for movement of stepper motor. The power supply given is 12V and 5A from power supply adapter.

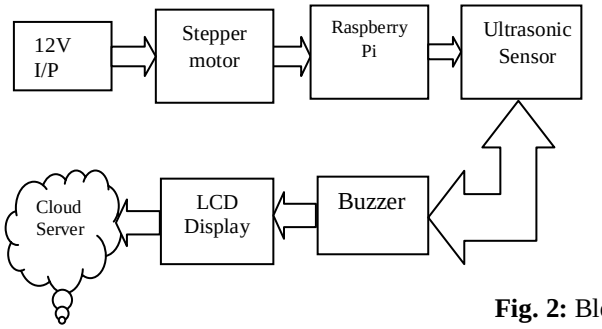

Fig. 2: Block diagram

Stepper Motor: Stepper motors are DC motors that travel at critical speeds. They have multiple coils arranged in groups called "phases. By enabling each phase in a row, the vehicle rotates one step at a time. Stepper motor, rotate the entire pulley system where the ultrasonic sensor is connected [14].

Raspberry Pi: Raspberry pi is a small computer and is the heart of this project. It will do all signal processing. Raspberry Pi is a small computer and is the heart of this project. It will do all signal processing. All the elements are interconnected and perform the necessary function as we provide command with raspberry pi pin [15].

Ultrasonic Sensor: The function of ultrasonic sensor here is to detect the fault and calculate the distance by sending ultrasonic waves to receiver where the fault is occurred.

Buzzer: It will produce beep sound when the crack in railway track is detected by ultrasonic sensor.

LCD Display: LCD is an electronic display module that uses liquid crystal to produce a virtual image. Here we used a 16 * 2 LCD display

Cloud Server: For information about a Rail track error from where the track actually broke, detailed error information is sent to the Cloud Control Room server.

Table 2: Device Specifications

Name of component	**Specifications**
Raspberry Pi	Processor Operating Voltage: 3.3v Raw input voltage: 5V, 2A power source. **Microprocessor:** Broadcom BCM283764bit Quad Core Processor
Ultrasonic Sensor	Operating Voltage:+5v Operating Current:<5Ma Operating frequency: 40Hz
Stepper Motor (Nema 17)	Operating Voltage: 12v DC Operating Current: 1.2A at 4v Step angle: 1.4 degree
LCD display	Operating Voltage: 4.7v to 5.3v Operating Current: 1mA

III. WORKING

As shown in block diagram, First of all we give power supply to stepper motor which is 12V and 5A from power adapter and 5V Supply to Raspberry Pi. Since ultrasonic sensor is connected through stepper motor with the help of pulley system, the ultrasonic sensor continuously moves back and forth across the railway track and checks for the fault. If any fault is found on railway track anywhere on the track, it immediately stops and send ultrasonic waves to find the fault (i.e. where the fault is) and measure the distance and again reflect back the signal and gives the detailed information of the fault to the cloud server from where the railway control room officer knows about fault in advance and accidents can be prevented.

In this circuit we have used stepper motor, ultrasonic sensor, motor driver IC (A4988), Raspberry pi and LCD display. The stepper motor will rotate back and forth across the whole railway track. If there is any fault detected on the track, the ultrasonic sensor attached to the system will send out ultrasonic waves and indicates the distance which is less than the preset distance and indicates a fault in track and the fault information to monitor screen of the railway department.

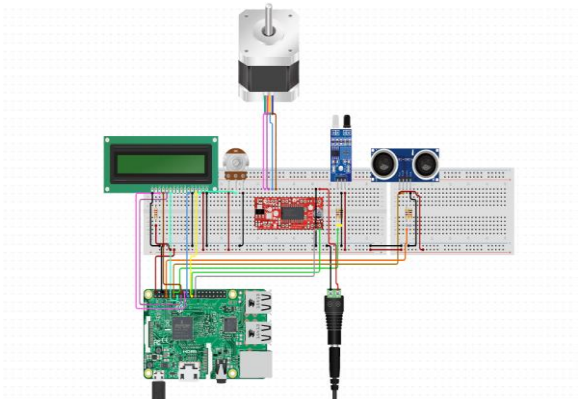

Fig. 3: Circuit description

The motor driving belt is tied to a pulley to which ultrasonic sensor is connected and moving back and forth with help of stepper motor and if fault is detected then it shows on LCD display and information is showed on cloud server. In this system the main use is of Ultrasonic Sensor which is a kind of active sensor i.e., it has component for both reception and transmission in it. So this sensor is mounted on a wooden plate which has given support by two smooth steel rods. The steel rods are there for the support of the wooden plate on which the infrared sensor in mounted. The wooden plate and the smooth rod are kept in contact to each other with the use of linear bearings, these bearings will let the rod to pass through them and simultaneously provide the support required for wooden plate. There are two smooth rods in this project which are fixed from both the ends and they are separated to each other by the breadth of the wooden plate. Now this wooden plate is fully supported and fully mobile. So this wooden plate is attached to a timing belt from beneath. And this timing belt is tied from a pulley from one end and from the another end it is wrapped around on a gear which is in the rod coming out of the Stepper Motor**,** this timing belt is tied in such a way so that when the gear on the stepper motor revolve then the timing belt also rotates and correspondingly the pulley will also rotate and accordingly the wooden plate on the smooth rod will also move in forward and backward direction. A wooden plank is used as a base for this whole project. On which these pulley, stepper motor and the other things will be screwed down to it to give it Support and make it Rigid. Now the stepper motor is controlled by the stepper motor module and the program fed in the raspberry pi so the speed and the steps of the stepper motor are controlled accordingly. The ultrasonic sensor which is mounted on the wooden plate is also connected to the raspberry pi. Now this sensor is used to sense the faults in the railway track. The ultrasonic sensor which sends emf waves to the railway track and the waves which are transmitted and reflected then the time in between this interval is calculated and accordingly the distance is calculated which is the main principle of this project. So to automate this project a IOT is used. So, a blynk app is used which is connected to the raspberry pi through internet so by which the whole project will be turned on and turned off.

IV. CONCLUSION

Accidents occurring in Railway transportation system cost a large number of lives. So this system helps us to prevent accidents and giving information about faults or cracks in advance to railway authorities. So that they can fix them and accidents cases becomes less.

This project is cost effective. By using more techniques they can be modified and developed according to their applications.

In this paper the system is presented to detect the cracks in the track effectively. We have implemented the Ultrasonic sensor based railway crack detection system using wireless technology. By this system many lives can be saved by avoiding accidents. The idea can be implemented in large scale in the long run to facilitate better safety standards for rail tracks and provide effective testing infrastructure for achieving better results in the future.

V. FUTURE SCOPE

In future CCTV systems with IP based camera can be used for monitoring the visual videos captured from the track. It will also increase security for both passengers and railways.

GPS can also be used to detect exact location of track fault area, IP cameras can also be used to show fault with the help of video. Locations on Google maps with the help of sensors can be used to detect in which area track is broken.

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