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Railway Track Crack Detection System Using Arduino Microcontroller and Gps Notification

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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 project work is aimed towards addressing the issue by developing an automatic railway track crack detection system. This work introduces a project that aims in designing robust railway crack detection scheme (RRCDS) using TSOP IR RECEIVER SENSOR assembly system which avoids the train accidents by detecting the cracks on railway tracks. And also capable of alerting the authorities in the form of SMS messages along with location by using GPS and GSM modules. The system also includes distance measuring sensor which displays the track deviation distance between the railway tracks.**

***Keywords*- ARDUINO MICROCONTROLLER, IR SENSOR, GSM, GPS.**

I. INTRODUCTION

Transport is a key necessity for specialization that allows production and consumption of products to occur at different locations. Economic prosperity has always been dependent on increasing the capacity and rationality of transport. But the infrastructure and operation of transport has a great impact on the land and is the largest drainer of energy, making transport sustainability and safety a major issue. In India, the rail transport occupies a prominent position in providing the necessary transport infrastructure to sustain and quench the ever-burgeoning needs of a rapidly growing economy.

However, in terms of the reliability and safety parameters, the global standards have yet not been reached. A survey on the internet states that about 60% of all the rail accidents are due to derailments, recent statistics reveal that about 90% are due to cracks on the rails. Hence, it is not safer for Human Life. This is needed to be at the utmost attention. These goes unnoticed and the properly maintenance of tracks is not done.

Cracks in rails have been identified to be the main cause of derailments in the past, yet there have been no cheap automated solutions available for testing purposes. Usually crack is measured manually by specialists. This is done via a track checker who is a small railway carriage used to audit the gauge and integrity of railway tracks. The first track checkers were simply people that walked on the tracks, making sure that the tracks were not damaged; these people were also called track walkers. A modern track checker, however is a small carriage on wheels and can be automated or driven by one engineer who is also known as a "Track Checker". This carriage drives along the tracks of a railway.

The Railway service uses machine-vision technology for the inspection, which consists of recording digital image of track elements analyzing those images using custom algorithms to identify defects or their symptoms. These machines are larger in size and are manually operated by a person. Proposed system is small and is efficient to use.

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 proximity sensoris 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.

1. Aim:

- To detect the cracks present on the railway tracks.
- To detect the obstacles entry on to the railway tracks.

2. Problem Identification:

The principal problem has been the lack of cheap and efficient technology to detect problems in the rail tracks and of course, the lack of proper maintenance of rails which have resulted in the formation of cracks in the rails and other similar problems caused by antisocial elements which jeopardize the security of operation of rail transport.

In the past, this problem has lead to a number of derailments resulting in a heavy loss of life and property. Cracks in rails have been identified to be the main cause of derailments in the past, yet there have been no cheap automated solutions available for testing purposes.

II. LITERATURE REVIEW

Indian railways is one of busiest network in the world covering track network of 1, 27,000 sq.km. Almost 60% of the accidents are occurring at railway track crossing and due to crack in railway tracks resulting in loss of precious life and loss of economy. So in current scenario this problem has immense potential in having an ideal solution to this problem.

So, basically the manual surveying and maintenance of tracks done by person and other is systems that they use like SPURT Car and USFD manual machine that are used in detecting and monitoring of cracks. The ideas inferred in designing railway crack detection system using Arduino Microcontroller and sensors in order to detect the cracks and location of cracks been given by GPS module and alert through messages through GSM module.

In building such system which will give an optimal solution to the crack detection problem and also reach in achieving higher accuracy and precision than existing systems.

Selvamraju Somalraju [1] proposed a RRCDS system which utilises a GPS module, GSM Modem and LED-LDR based crack detector assembly. The pro-posed broken rail detection system automatically detects the faulty rail track without any human intervention. By this proposed system the exact location of the faulty rail track can easily be located.

Qiao Jian-hua [2] proposed the system takes the linear charge coupled device (CCD) as image sensor, processes the image signal collected, judges out the crack signal, and displays the curve through the LCD, and gives off the alarm. The whole system is fixed on the vehicle-hold system, travelling along the railway, then conveniently examines the crack position, thus may promptly carry through track maintenance, avoiding the accident.

K. Vijayakumar [3] describes how a Microwave horn antenna can be used to detect the cracks in a rail track. Based on the simulation results obtained from the High Frequency Simulation Structure (HFSS), it has been shown that the design of the Microwave sensor has the potential for detecting defects in the rail surface including minor cracks as well as more serious ones.

Reenu George [4] has modified existing system by using smart phone which helps in detecting the exact location of the fault. This system consists of IR transmitter and receiver, crack detection, GPS, GSM, PIC microcontroller.

Prof. P. Navaraja [5] uses GPS Module, GSM modem, IR sensor, PIR sensor for application of communication purpose, crack detection and finding of human being present in the railway track. The GPS module and GSM modem help to find and send railway geometric parameter of crack detection to the nearest railway station. For measurement of track distance Ultrasonic sensor with high accuracy and less cost is used. System is applicable for both day and night time detection purpose.

Akhil n [6] uses the system that consists of GPS module, GSM module, Ultrasonic sensor, microcontroller LPC2148 and motor driver L293D. This system is applicable in detection during both day and night. The proposed system notices cracks in tracks and inform the railway authority and hence reduce railway accidents. It concludes that this system is more accurate and can be operated in tunnels without any interruption.

Kunduru Umamaheswari [7] has developed a prototype of testing for detecting obstacle and crack. The aurdino used for this system is Atmega 328 with flash memory and SPRM for storing data for future purpose. A testing train which uses ultrasonic sensor with range of 100 Cms and delay 30 cm and according to distance between the obstacles slows down speed of vehicle and finally stop.

Parag Nikhar [8] proposed a cost effective solution to the problem of crack detection utilizing IR sensors. Whenever the crack is detected a buzzer will be activated to alert the surroundings and message will be automatically sent to the controlling station of railway authority. It concludes that the GSM based crack detection system automatically detects the faulty rail track without any human interface.

Ebi Benny [9] has used optical sensor for detection of crack in the track. The FM receiver unit is fixed at the nearest railway station and transmitted signal is received by receiver unit and gives information to responsible authority. The IR sensor is used to detect the crack in the track.

Anand S. Muley [10] has implemented an efficient and cost effective solution suitable for large scale application by using the op-based crack detection in railway track

using GSM system. The sensitivity of this system is high hence no any problem comes in detection of crack.

After going through all these papers, we came to a conclusion to do a project which would provide better safety standards in a cost effective way for railway crack detection.

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. 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.

The LED (Light Emitting Diode), LDR (Light Dependent Resister) sensors cannot use on the slab of the tracks . Image processing input images are noisy system and it's not getting accurate output. This analysis is used to identify the crack in rail track under the bad whether condition which is not getting perfect output. The existing system is delay in passing the information. The existing system uses telephonic communication which is not that fast and accurate.

Disadvantages:

- Accurate results cannot be obtained.
- Slow and Time consuming.

IV. PROPOSED SYSTEM

The proposed system in the project involves the design of crack finding robot for finding cracks in railway tracks. The Arduino UNO board is used in this system. The controller is used 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, that is the Arduino controller 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.

The robotic model is interfaced with the microcontroller with the help of motor driver circuit. If any crack occurs in the rail, the robot will be stopped and then a SMS will be send. Using the GPS module, the exact latitude and longitudinal direction of the faulty track is obtained.

Advantages:

- Cost-effective and time saving.
- Good accuracy.

V. SYSTEM DESIGN

1. Aurdino Microcontroller:
Arduino UNO is one of the most popular development boards in robotics and electronics as well as. The board is very popular due to its flexibility, ability to connect different robotic parts including sensors, actuators, etc. UNO's features include a USB interface that doesn't require drivers to communicate with operating systems like Windows or Mac OS and can be programmed with the Arduino software. The ATmega328 on the Arduino Uno comes with a boot loader that allows user to upload new code to it without use of an external hardware programmer.

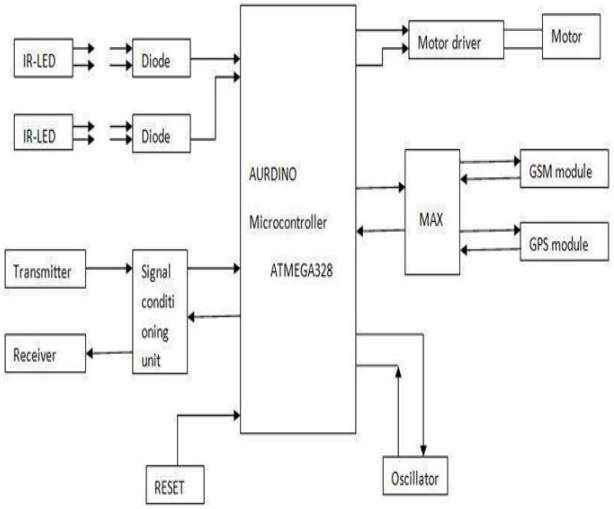


Fig 1. Block Diagram of Testing Vehicle.

2. Motor Driver:
Motor Driver ICs are primarily used in autonomous robotics only. Also most microprocessors operate at low voltages and require a small amount of current to operate while the motors require a relatively higher voltages and current. Thus current cannot be supplied to the motors from the microprocessor. When the motor is applied positive voltage on both sides then the voltage from both the sides brings the motor shaft to a halt. Depending upon the values of the Input and Enable the motors will rotate in either clockwise or anticlockwise direction with full speed or with less speed.

3. Brushless DC Motor:
A DC motor uses electrical energy to produce mechanical energy, very typically through the interaction of magnetic fields and current-carrying conductors. The input of a DC motor is current/voltage and its output is torque (speed). A brushless DC motor is similar to that brush DC motor in that it has an internal shaft position feedback which tells which windings to switch on at which an exact moment. The internal feedback is accomplished in a brush type DC motor with the mechanical commutator and the mechanical brushes through which the current is fed into

the commutator bars and switched sequentially into the appropriate winding in the armature.

4. IR Sensors:
An Infrared (IR) sensor is used to detect obstacles in front of the robot or to differentiate between colors depending on the configuration of the sensor. An IR sensor consists of an emitter, detector and associated circuitry. The circuit required to make an IR sensor consists of two parts; the emitter circuit and the receiver circuit. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, its resistance and correspondingly, its output voltage, change in proportion to the magnitude of the IR light received.

5. GSM Module:
This GSM Modem can accept any GSM network operator SIM card and act just like a mobile phone with its own unique phone number. Advantage of using this modem will be that its RS232 port can be used to communicate and develop embedded applications. The modem can either be connected to PC serial port directly or to any microcontroller. It can be used to send and receive SMS or make/receive voice calls.

This GSM modem is a highly flexible plug and play quad band GSM modem for direct and easy integration to RS232 applications.

6. GPS Module:
Global Positioning System (GPS) satellites broadcast signa ls from space that GPSreceivers, use to provide three-dimensional location (latitude, longitude, and altitude) plus precise time. GPS receivers provides reliable positioning, navigation, and timing services to worldwide users on a continuous basis in all weather, day and night, anywhere on or near the Earth.The Global Positioning System (GPS) is global navigation satellite system which uses a constellation of between 24 and 32 Medium Earth Orbit satellites that transmit precise microwave signals that enable GPS receivers to determine their location, speed, direction, and time.

7. The working principle of crack detection method can be classified based on the components as follows:

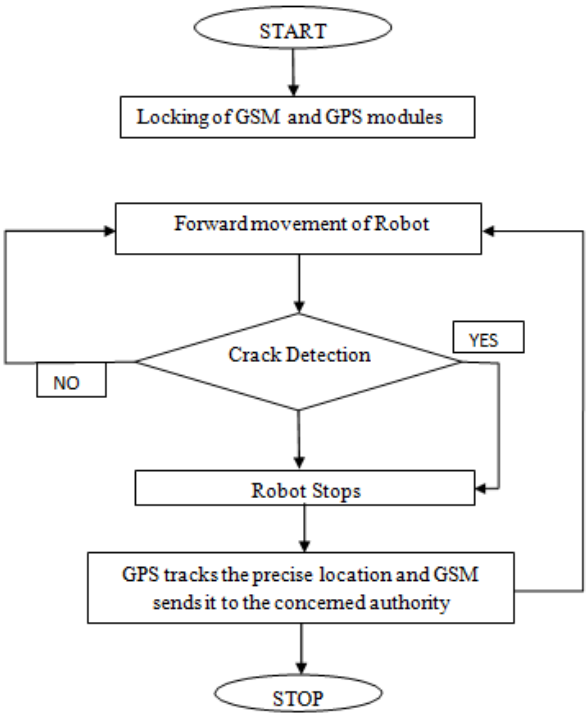
7.1 Hardware Interfacing and Component Placement:
Arduino UNO performs first level data pre processing which later gets stored in cloud. IR sensor is connected to the arduino which completes the circuit. IR Sensors are used to detect presence of obstacle in front of the robot and for detecting if the robot is on track or not.

A motor driver is connected to arduino, allows controlling speed and direction of motor. An ultrasonic sensor similar to IR sensor is used which provides distance between obstacle. It uses a trigger and echo pin to send and receive ultrasonic pulses. Based on the time taken to receive pulses and speed of sound in air, distance from the obstacle is calculated.

7.2 Sensor Calibration and Testing:
Each module has to be calibrated and tested based on the requirements. As IR sensor detects the presence of an object based on the reflected IR Light. A potentiometer is connected to sensor to calibrate the values. Since ultrasonic sensor provides distance between the obstacle and sensor, a hardware calibration is not needed.

7.3 Data Acquisition and Notification:
For communication purposes the GSM module and the GPS module are brought into use. The GSM module is used to send the current latitude and longitude data to the relevant authority as an SMS. A GPS receiver is used whose function is to receive the current latitude and longitude data. The afore mentioned functionalities has been achieved by interfacing the GSM and GPS modules with the Arduino microcontroller.

VI. FLOWCHART OF WORKING MODEL



VII. ADVANTAGES

- Low cost.
- Transmitting signals are immediately transferred.
- Low power consumption.
- Avoid accidents at a single track, accidents reduced.
- Very accurate detection.

- It also checks surface and near surface of cracking position.

VIII. APPLICATIONS

- Railway track damage detection applications.
- Wireless applications.
- Other remote control system.

IX. CONCLUSION

The main aim of this study is to replace the manual method of crack detection of railway which is very difficult and time consuming using robotic crack tracing system. Here we have designed a cost effective, low-power embedded system, which facilitate better safety standard for rail tracks for preventing railway accidents due to cracks and obstacles on railway tracks. The prototype of testing vechicle can efficiently detect cracks and obstacles and 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 applications, we can avoid accidents upto approximately 70%.

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