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AN ENHANCED RAILWAY TRACK SECURITY SYSTEM

Deepu Roy[1], Lois Mary Jose[2], Reena John[3], Prof. Kiran Boby[4]

[1,2,3,,4]Department of Electrical and Electronics Engineering Mar Athanasius College of Engineering Kothamangalam, Kerala, India

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Abstract - *In India, Railway is the backbone of transport system. Rail accidents occur commonly due to derailments due to cracked tracks than collision or fire in trains. Therefore, there is an immense need to improve crack detection and security system in the Indian Railway. This paper is a means to provide a solution for problem of crack detection in the rail tracks. This is to avoid rail accidents by using latest communication technologies. In this paper GSM communication protocols are used to convey the message of crack detection via SMS. Crack detection is achieved by using IR sensors attached to a vehicle that moves along the rails. With the detection of cracks, the system also alerts the railway authorities facilitating the security system.*

***Key words*:** PIC16F883 Microcontroller, GPS module, GSM module.

1. INTRODUCTION

India has fourth largest rail network in the world comprising 115,000 km of railway tracks. Approximately, 60 percent of rail accidents are due to derailments, of which, 90 percent are due to cracks problems. In December 2006, the Railway Safety Act Review was promoted by the government as an effort to further improve railway safety in India. This would help promote a safety culture within the railway industry and will at the same time manage to preserve and strengthen the vital role that railway industry plays in the Indian economy. In all transport systems, particularly in case of railways, safety and reliability are highly considered. There is a view that the current regulatory framework does not provide full set of tools to effectively deal with railway accidents and main-track derailments. It is imperative that the current framework be modernized and better aligned with safety legislation that applies to other modes of transport in India. In recent years, with the development of railways, capability of the trains is constantly improving. Train traffic is too high and manual labor is unreliable. This has initiated the cause for an automated system to monitor the presence of crack on the railway lines. The existing system includes the concept using LED (light emitting diode) and LDR (light dependent resistor) sensor assembly. The main drawback of the system is that LED and LDR should be exactly aligned opposite to each other to detect the crack; also the true values from LDR to be detected. This paper seeks to develop a device that will be an efficient and cost effective solution the problem of derailment of trains due to cracks by early detection of these cracks.

Long range ultrasonic techniques along with radiography technique are the methods used for crack detection. Wireless sensor network method and electromagnetic system are also used in detecting rail cracks. Transducers are arranged in a suitable array such that selected guided wave modes are generated in rails which allow a reliable long range inspection of the rail.

Digital X-ray radiography offers new possibilities and advantages in rail-wield evaluation over traditional film radiography based on gamma rays.

In wireless sensor networks the method of crack detection is such that cracks can be identified using infrared rays with the IR (infra-red) transmitter and receiver. An electromagnetic system for rail detection and traction enhancement comprises of an embodiment of wheel axles, wiring coils around the wheel axles, respectively. It also consists of a power source coupled to the wiring coils which is used for supplying power to produce electromagnetic flux. The wiring coils produce opposite magnetic north and south pole pairs on the axles.

They also proposed GSM (Global System for Mobile communications) communication protocols which can be used to convey the message of crack detection via SMS. Crack detection is achieved by using the concept of eddy current losses implemented in the terms of Darlington pair circuit. With the detection of cracks, the system also alerts the railway authorities facilitating the security system.

In a system that consists of IR sensor and fire sensor the IR sensor is used to detect the crack and as well as distances, fire sensors used to detect the fire accidents. To communicate the received information, we make use of a GSM modem. The GSM module is being used to send the current latitude and longitude data to the relevant authority as an SMS.

However, in this method the IR sensors were attached to the front of the moving train to detect the crack as the train moved along and brake the train upon crack detection. This method was not found effective as the range of IR sensors is quite small and it might not be possible to brake the train in time to avoid the crack, thus resulting in derailment.

2. DEVICE WORKING PRINCIPLE

The device proposed in this paper for crack detection consists of a vehicle carrying a pair of IR sensors and processor, which can be made to run on the tracks. One sensor is for one rail.

The Fig-1 shows the block diagram of the Enhanced Railway Track Security System.

The working principle of IR sensors is that they contain an IR LED that emits infrared radiation towards a target object. This radiation will either be reflected or absorbed by the object and the reflected light is detected by a photodiode in the sensor. If the object is white or light colored, it reflects back most of the light. However if it is black or dark shades, the radiation is absorbed mostly, very little light is reflected. Thus by sensing the intensity of the reflected light it is possible to detect cracks in the tracks. Moreover, using this method we can distinguish between small and deep cracks. Once a crack is sensed, the information about its depth is processed in microcontroller. Using GSM communication an SMS is sent indicating that a crack has occurred, while a GPS module is used to determine the location of the crack.

The Fig-2 shows the circuit diagram of the Enhanced Railway Track Security System. The power supply system consisting of battery and regulator powers all the components on the device. The IR pair sends signals continuously to the PIC microcontroller as the vehicle moves along the track and the motor (the vehicle wheels) keep moving.

When a crack is sensed, first it is detected as a small crack or deep crack. If the crack is small, the SMS message indicating crack and its location is sent using GSM. The vehicle continues to move on the track as the small crack is not dangerous to movement of train over it and can be fixed later. If however, the detected crack is too deep, and must be taken care of before any train can be allowed to pass over it, an SMS will be sent to the authorities notifying them of the crack location and the vehicle stops moving forward.

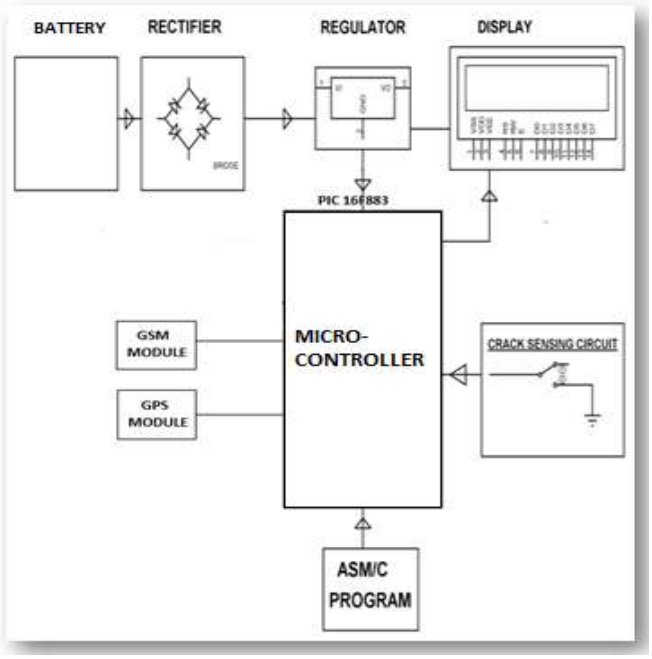

Fig -1: Block Diagram of Enhanced Railway Track Security System

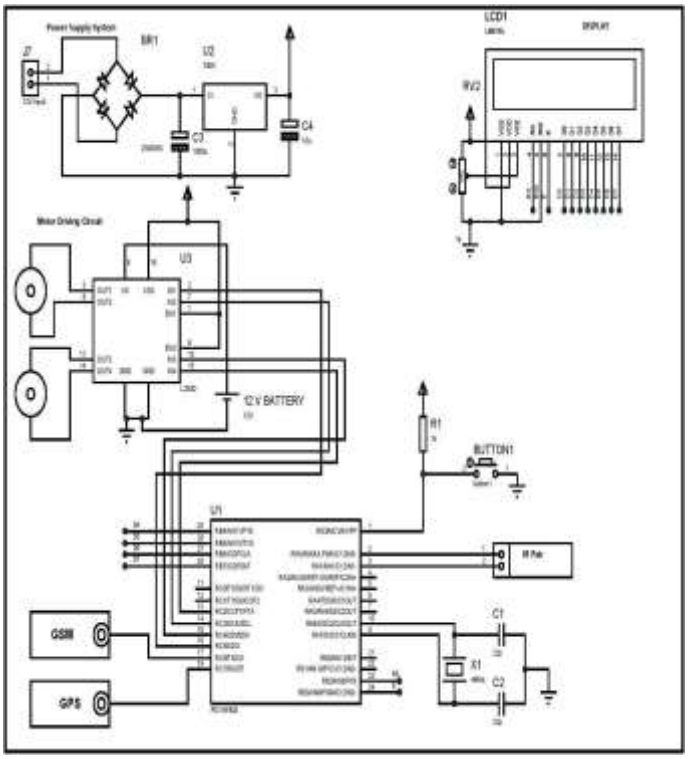

Fig -2: Circuit Diagram of Enhanced Railway Track Security System

3. DEVICE DESIGN

The microcontroller that is used is PIC16F883. It is preferred over 8051 because of its RISC (reduced instruction set computer) architecture which helps carry out several commands in short time. The IR pair gives input to the controller.

The pair of motors that is used is connected to PIC through a dual H-bridge motor driver IC. It is used to convert the small current that PIC provides to the range that the motor requires for its operation (about 350 mA). In motor drivers a low-current control signal is taken and converted into a higher-current signal. Thus they behave as current amplifiers. This higher current signal is used to drive the motors. L293D contains two inbuilt H-bridge driver circuits. When it is working in its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction.

A voltage regulator (LM7805) is used to convert the 12V DC voltage from battery to 5V, required to power the all the components.

GSM modem is a highly flexible plug and play GSM 300 modem for direct and easy integration RS232, voltage range for the power supply and audio interface make this device perfect solution for system integrators and single user. It also comes with license free integrated Python. Python is a powerful easy to learn programming language. This terminal is driven by Python and is 5 times better and faster and 5 times cheaper than standard PLC(programmable logic

device)/RTU(remote terminal unit). These, however, have communication interface and external GSM / GPRS modem.

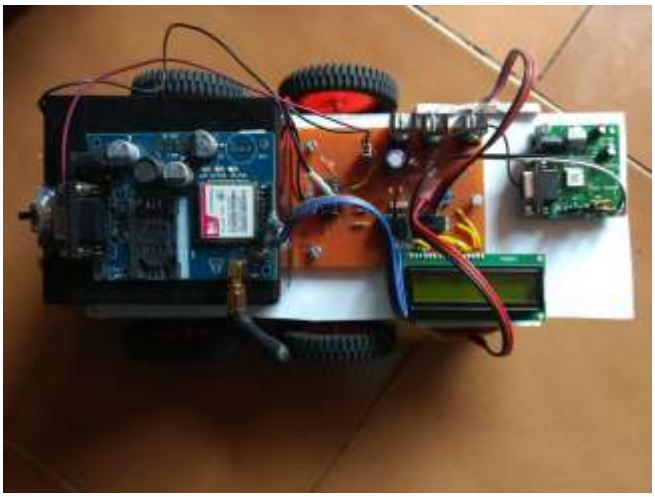

Fig-3: Experimental Setup of The Crack Sensing Device

The fact that GSM Modem supports popular AT command set allows users to develop applications quickly. The product has SIM Card holder to which activated SIM card is inserted for normal use. The power to this unit can be given from UPS to provide uninterrupted operation. This product can be used economically in remote location. This allows devices in such places to stay connected even though these are places where telephone lines do not exist.

A third generation POT (Patch Antenna On Top) GPS module is used. This POT GPS receiver provides a solution of high position and speed accuracy performances together with improved sensitivity and tracking capabilities in urban conditions. They also provide standard NMEA0183 strings in "raw" mode for any microcontroller. The module provides current time, date, latitude, longitude, speed, altitude and travel direction/heading and several other data. It can also be used in a host of applications, for example, navigation, tracking systems, fleet management, mapping and robotics. This is a stand alone GPS Module and is built with internal RTC Back up battery. It can be directly connected to Microcontroller's USART (universal synchronous/asynchronous receiver transmitter) and requires no external components except power supply decoupling capacitors. The module also has an option for connecting external active antenna if the need arises.

An LCD display is also used which will continuously show the values of the two IR sensors and show when the crack is detected.

Figure 5, shows the output of the experiment when it was performed. An SMS is sent to the phone number (that is already programmed into the device) as shown. The message reads 'Crack Detected' and also gives the co-ordinates of the location at which the crack has occurred. It is possible to obtain this location on a map using Google Map Apps. However, in order to do this the coordinates must first be converted to the degree-minute-second form.

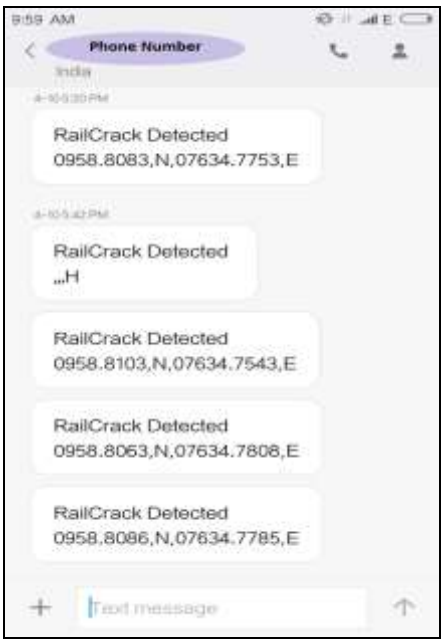

Fig -4: Output of the project.

4. CONCLUSION

The working model for efficient and cost effective crack detection on the rail tracks has been developed successfully. IR sensors have been used for sensing and detecting cracks and the information is processed using PIC microcontroller. The use of GSM and GPS module for conveying the information of the crack along with its location makes this method more useful. This helps lessen the dependence on manual detection and thereby reduces the chances of error and accidents. Although initial cost is high it will not require a lot of maintenance thereafter. It is possible to add other features to this device to make it more versatile. Equipments can be added to check for the quality of the rails.

5. FUTURE WORKS

Future work will aim to implement this method in all places where the track runs. But for this, range and wifi connections must be set up even in the remote places. Or else , newer methods can be developed which will ensure that this system of rail crack detection can be used even in the remote places. Also, if range of IR sensors can be improved, then the device can reach longer distances in shorter time. In the future we can use CCTV systems with IP based camera for monitoring visual videos captured from track. The power supply for motor operation and signal lights is a disadvantage. This can be avoided by using a battery charged with solar cell. The obstacle detection part can be implemented using Fuzzy logic. As it thinks in different angles and aspects, the system will work more efficiently.

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