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Smart Robot for Railway Track Crack Detection System Using LED-Photodiode Assembly

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Abstract—*The most of the commercial transport is being carried out by the railway network and therefore, any problems in the same has the capacity to induce major damage to the economy-notwithstanding the societal impact of loss of life or limb. This project presents a cost effective yet robust solution to the problem of railway crack detection utilizing a method that is unique in the sense that while it is simple, the idea is completely novel and hitherto untested. The project discusses the technical and design aspects in detail and also provides the proposed robust crack detection algorithm. The project also presents the details of the implementation results of the RRCDS utilizing simple components inclusive of IR LED-PHOTODIODE based crack detector assembly. The currently existing technical solutions in the detection of cracks in rails involve periodic maintenance coupled with occasional monitoring the inspection methods like are visual inspection, ultrasonic inspection, eddy current and laser methods.*

Keywords: *Infrared LED & Photodiode, RRCSC, Railway Cracks & gap, Robot.*

1. INTRODUCTION

In today's world, transport is a key necessity because in its absence it would be impossible for products to be consumed in areas which are not in the immediate vicinity of the production centers. In India, rail transport occupies a prominent position in quenching the ever-burgeoning needs of a rapidly growing economy. Hence these cracks in railway lines have been a perennial problem, which has to be addressed with utmost attention due to the frequency of rail usage in India. These cracks and other problems with the rails generally go unnoticed due to improper maintenance and the currently irregular and manual track line monitoring that is being carried out. The high frequency of trains and the unreliability of manual labor have put forth a need for an automated system to monitor the presence of crack on the railway lines. Owing to the crucial repercussions of this problem, this project presents an implementation of an efficient and cost effective solution suitable for large scale application. The project also presents the details of the implementation results of the RRCDS utilizing simple components inclusive of IR LED-PHOTODIODE based crack detector assembly [2]. The currently existing technical solutions in the detection of cracks in rails involve periodic maintenance coupled with occasional monitoring the inspection methods like are visual inspection, ultrasonic inspection, eddy current and laser methods [1].

2. AIMS AND OBJECTIVES OF THE PRESENT WORK

The main aim of project is to design and develop an automatic rail crack detection system based on infrared technology, where in on board robot circuitry can use obstacle detection principle using pair of infrared LED & Photodiode.

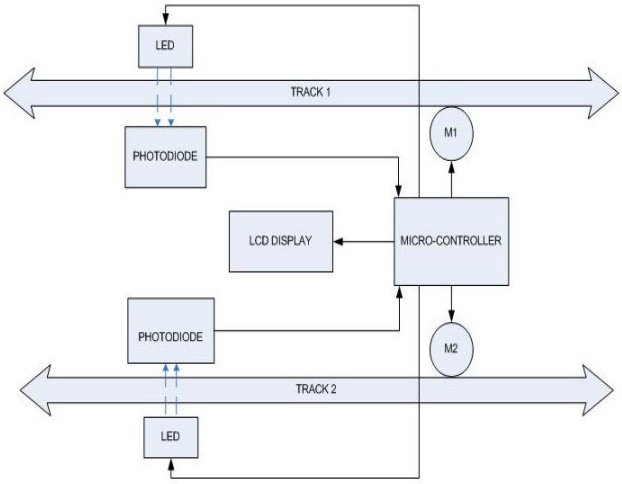

Fig. 1: Technical Conceptual Design

In this proposed project as shown in Fig. 1 system using the infrared technology, where the hardware & program developed can take the live data of number of crack & the instant at which the crack is detected. With help of infrared module which will capture the instantaneous detection time & number of that respective crack, which can send to seen on LCD display. This assembly consists of two DC motor for movement of robot over the railway track. This is cost effective and time efficient in its operation and can also increase efficiency of the whole system. The instantaneous crack information is shown on the display immediately [5].

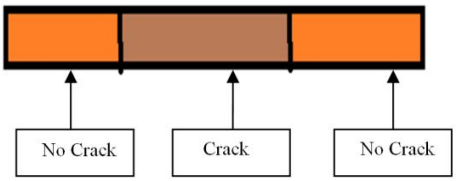

Fig. 2: Crack Region on Track

Fig. 2 shows details of location of crack on Track with various regions.

3. PROPOSED SYSTEM

Proposed system consists of photodiode, microcontroller and motor circuit. The main aim of the system is to sense the output of photodiode from onboard IR sensor as soon as the crack is detected on rail track [6]. So with help of infrared module, this will capture the instantaneous detection time & number of that respective crack, which can send to show on LCD display screen. The detection time is used to calculate the distance for particular crack by knowing the speed of moving robot.

The supply is given to crack detection block, microcontroller & motor driver IC L293D through power supply block. Microcontroller block is interfaced to motor driver & LCD display block, while it takes inputs from crack detection circuit. Crack detection circuit consists of LED-Photodiode Assembly. This LED- Photodiode assembly detects crack and send signal to ATmega32A Microcontroller.

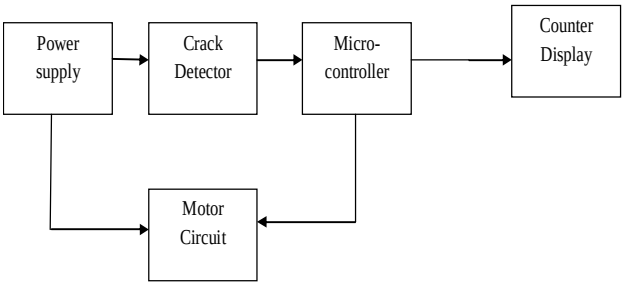

Fig. 3: Block Diagram of Proposed System

3.1 The IR Sensor-general purpose proximity sensor

We use it for collision detection. The module consists of an IR emitter and IR receiver pair. The high precision IR receiver always detects an IR signal. The module consists of 358 comparator IC. The output of sensor is high whenever it IR frequency and low otherwise. The on-board LED indicator helps user to check status of the sensor without using any additional hardware. The power consumption of this module is low. It gives a digital output.

The sensitivity of the IR Sensor is tuned using the potentiometer. The potentiometer is tuneable in both the directions. Initially tune the potentiometer in clockwise direction such that the Indicator LED starts glowing. Once that is achieved, turn the potentiometer just enough in anti-clockwise direction to turn off the Indicator LED [3].

3.2 ATmega32A Microcontroller

It is main component of system. It consumes less power and operated at 5V power supply. LCD and motor driver control circuit is interfaced with ATmega32A. The microcontroller is also interfaced with IR sensor which is connected at the center of the wheel. The signal is received at the controller when the crack is detected and the signal is send to the controller which sends the data to display it on the LCD.

3.3 L293DNE motor driver control

It is a high voltage, high current dual full-bridge driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors. ATmega32A microcontroller works on 5V DC power supply and the maximum current that can be drawn from its pins is just 40mA. To control large 12V DC motors need some kind of motor driver. The L293DNE Dual H-Bridge Motor Driver is a great value and can be used with a variety of robot controllers. It can drive up to 2 motors from 5-35V at 1A peak. The module can be used to control the speed of the robotics vehicle/motor using PWM and the direction of the motor to move the vehicle either left or right.

Table 1: State diagram

INPUT 1	INPUT 2	ENABLE 1, 2	RESULT
0	0	1	Stop
0	1	1	Anti- clockwise rotation
1	0	1	Clockwise rotation
1	1	1	stop

4. FLOW CHART

Flow chart shows sequence execution of Smart Robot for Railway Track Crack Detection System.

- Switch on the power supply
- Start the motor
- Check whether motor start button pressed or not.
- If button is pressed then motor start running and timer shows CT time, else it will wait for start button to be pressed.
- Check whether crack is detected or not if crack detected then shows crack No is incremented, CT time & DT time else motor running and Timer shows only CT time.
- If start motor button is on then motor keeps running on track & crack no is incremented, else stop the motor.
- If reset button is pressed at any instant of time then it will prompt for start motor button to be pressed.

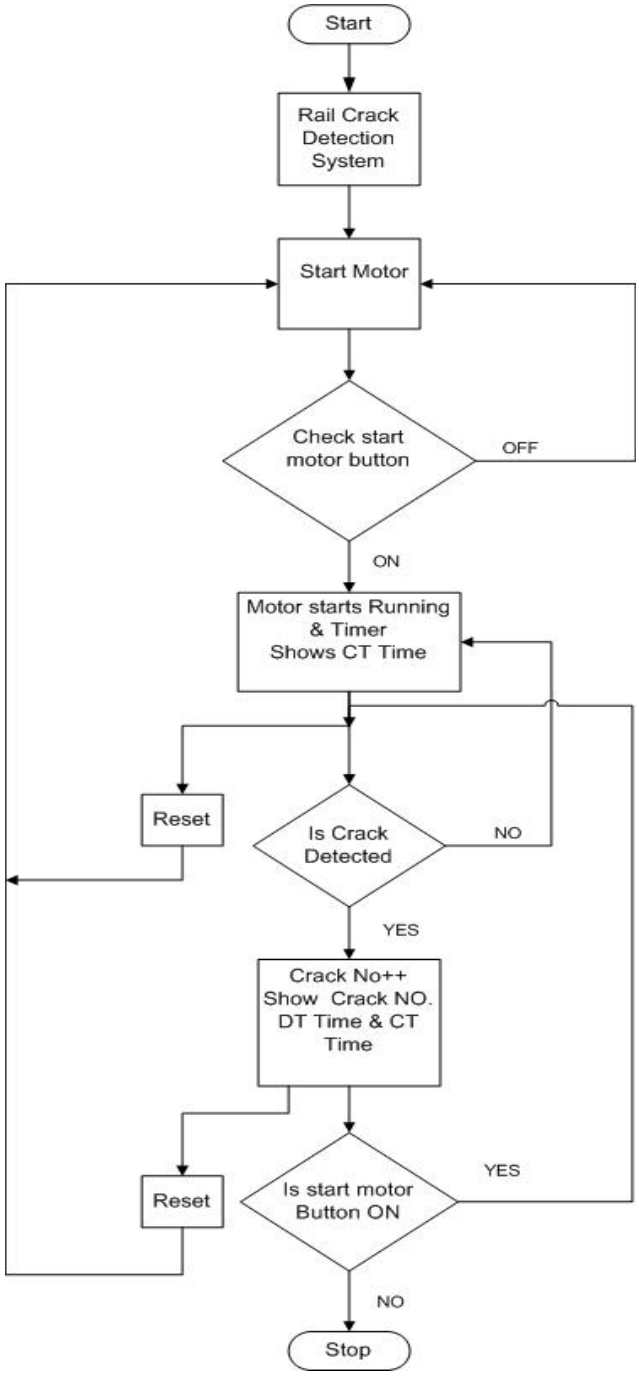

Fig. 4: Flow Chart of Crack detection System

5. CIRCUIT DIAGRAM

It consists of Atmega32 Microcontroller, LED-Photodiode module and DC motor. When crack on railway track is detected by photodiode, send signal to microcontroller and count of crack is increasing which display on LCD [4]. There is one push button to stop and start motor.

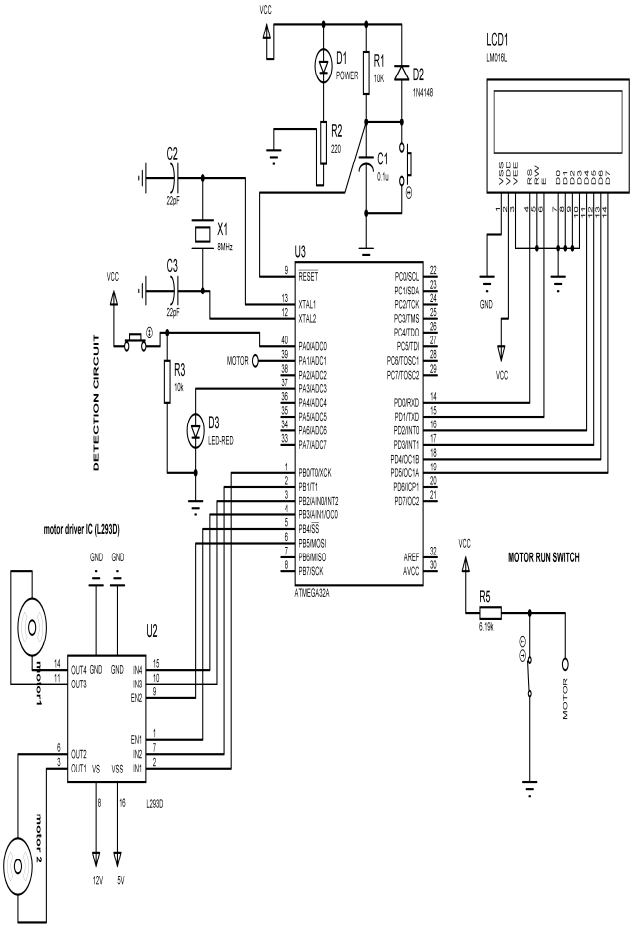

Fig. 5: Circuit diagram of system

6. APPLICATIONS/SCOPE OF THE SYSTEM

Project can be used for inspection at various places like

- Automatic detection of crack on railway tracks.
- Calculation of distance of the crack from the origin.
- Automatic crack detection in forged metal parts.
- Detection of cracks in concrete pipe.

7. RESULT

- Calculation of constant speed of the robot (cm/sec)

$$= \frac{perimeter\ of\ wheel\ in\ cm}{time\ required\ for\ one\ revolution\ in\ \text{sec}}$$

- Distance of detected crack from origin (cm)
  = (constant speed of robot) x (crack detection time)
- Calculated constant speed of robot for one revolution of wheel is 2.75 cm/sec.

Table 2: Result

Gap No	Actual Distance (cm)	Measured Time (sec)	Measured Distance (cm)	Difference in Actual & Measured Distance
1	30	9	24.75	5.25
2	50	16	44	6
3	80	26	71.5	8.5

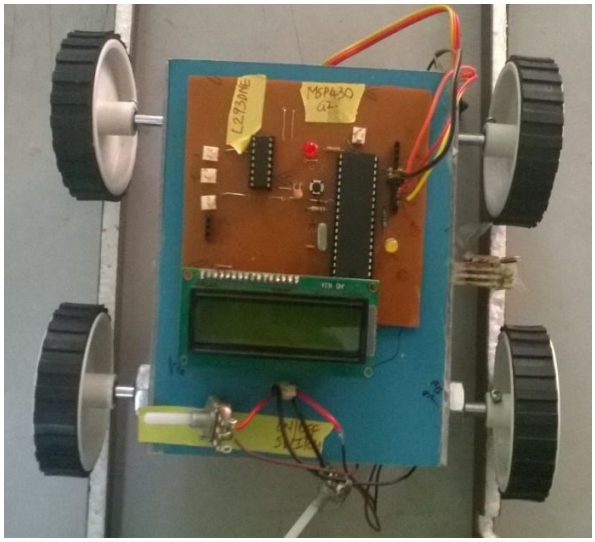

Fig. 6: Photograph of railway track crack detection system

8. CONCLUSION

Cracks in rails have been identified to be the main cause of derailments in the past. Hence, owing to the crucial solution of this problem, we have worked on implementing an efficient and cost effective solution suitable for this application. This system automatically detects the faulty rail track without any human intervention. There are many advantages with the proposed system when compared with the traditional detection techniques. The advantages include less cost, low power consumption and less analysis time. By this proposed system, the exact location of the faulty rail track can easily be located which will mended immediately so that many lives can be saved. By using LED-Photodiode assembly for railway track crack detection system we got accuracy up to 80%.

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