

Smart Machine for Crack Detection of Railway Track using Photodiode Assembly



Lalit Narayan ,Ankit Pandit ,Amrish Kumar Singh

Abstract: Most of the commercial goods are transported using railway trains and therefore, any problem in above network has the capacity to incur damage to the economy of that country. This model illustrates a cost effective yet robust solution to the issues related to railway crack detection. The project discusses the technical and design aspects in details alongside a better crack detection algorithm. The model also presents data related to all the components used in this system. The currently prevailing solution in the detection of cracks in rails involve periodic maintenance connected to occasional monitoring method like visual inspection, ultrasonic inspection, eddy current and laser methods.

Keywords: railway track, crack sensing, microcontroller, infrared sensor, trains, driver motor

I. INTRODUCTION

Nowadays, transport is a crucial necessity because in its absence it would not be possible for food stuffs to be consumed or used in areas which are not nearer to the production centers. In India, rail transport occupies a prominent position in satisfying the eternally growing requirements of a fast growing economy. However, cracks in the tracks of the railways have always been a tenacious issue, which has to address with utmost attention due to high frequency of rail usage in India. These types of issues associated with the railway tracks often go unobserved due to inappropriate maintenance and manual track line monitoring done by trackman or lineman. The high frequency of railway trains on the railway tracks and the undependability of manual labor have put forward a necessity for an automated monitoring system to identify any existence of cracks on the railway tracks[1].

Owing to the critical consequences of this problem, this model represents the implementation of more competent and cost effective solution suitable for large scale application. This model also provides the data related to implementation results of the RRCDS utilizing simple components inclusive of IR LED-PHOTODIODE based crack detector assembly. The currently prevailing technical solution for detecting cracks in tracks includes timely maintenance coupled with occasional monitoring tracks using visual inspection, ultrasonic inspection, eddy currents and laser method[2].

II. AIM AND OBJECTIVE OF CURRENT MODEL

The main aim of our model is to develop and design a smart machine for crack detection system based on infrared technology where a robot-based machine is employed for obstacle detection using pair of infrared LED and photodiode sensor.

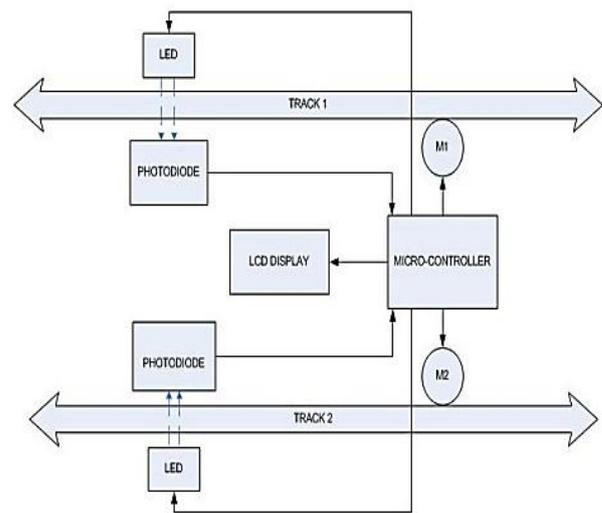


Fig. 1: Technical Conceptual Design

In the proposed model as displayed in above Fig.1 using infrared sensor, where the model can take the live data of number of crack and the instant at which the crack is detected. With the help of infrared sensor which capture instantaneous detection time and number of cracks. The number of cracks can be seen on the display unit. The proposed system assembly comprises of two DC motor for movement of robot over the tracks. The robot senses the defects in the railway tracks and notifies the microcontroller. The microcontroller takes input data and displays required information about the crack on the display unit.

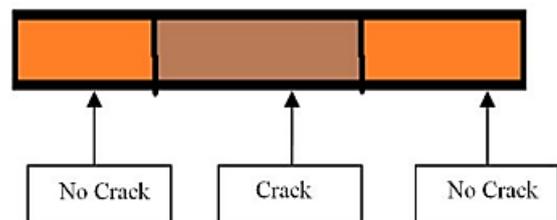


Fig. 2: Crack Region on Track

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III. PROPOSED MODEL

Proposed model comprises of components such as photodiode, microcontroller and motor circuit. The main aim of the model is to collect the output of the photodiode from the infrared sensor when a crack is detected on the railway track. The infrared module will capture instantaneous detection date and time of a particular crack on the track, which is further displayed on the LCD unit. The detection time is basically used to find out the distance of particular crack by analyzing the speed of the robot.

A power supply is provided to the crack detection block, microcontroller and motor driver IC L293D. Microcontroller is attached with the motor driver and LCD display block, while taking input from crack detection circuit. Crack detection circuit primarily comprises of LED photodiode assembly. This assembly detects cracks and transfer signal o ATmega32A microcontroller[3].

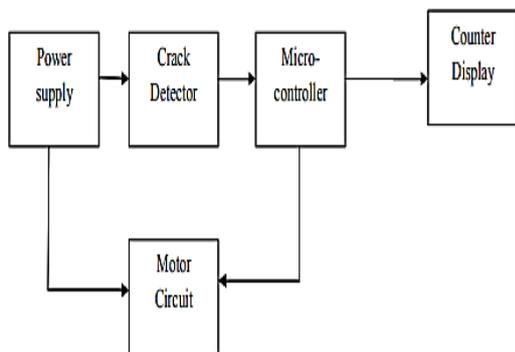


Fig. 3: Block Diagram of Proposed System

A. Why Infrared Sensor?

The infrared sensor is basically used for collision detection. The sensor mainly comprises of IR emitter and IR receiver pair. The high precision IR transmitter projects an infrared wave towards the track and IR receiver receives that wave. The module comprises of 358 comparator IC. The output of sensor is high whenever its infrared wave frequency is lower. Also, efficiency of this module is great. It provides output in the form of digital signal.

The sensitivity of the infrared sensor is modified using a potentiometer. The potentiometer is adjustable in both directions. Initially potentiometer is rotated in clockwise direction such that the indicator LED starts glowing. After that, the potentiometer is turned in the anticlockwise direction just enough to tun off the indicator LED[4].

B. AT mega 32A Microcontroller

It is the main component of our model. It is operated by consuming 5V DC power. The control of LCD and motor driver lies in the hands of the microcontroller. It is also interfaced with infrared sensor. The signal is received by the microcontroller when the sensor detects the crack, which is then analyzed by the microcontroller and displayed on the LCD unit.

C. L293DNE Motor Driver

The motor is high voltage and current, dual full bridge driver intended to receivetypical TTL logic levels and run inductive loads for e.g. relays, solenoids, DC and stepping motors. Atmega32A microcontroller works on 5V DC power source and the maximum current that can be drawn from its pins are just 40mA. The module is basically

employed to control speed of robotic vehicle using PWM and the direction of the motor to move vehicle 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

IV. FLOWCHART

The flow diagram of our model is as follows for railway track crack detection:

1. Switch on the power supply
2. Start the motor
3. Check whether the motor is started or not
4. If start button is pressed then motor starts running and timer shows crack detection time, else it will wait for start button to be pressed.
5. Check whether crack is detected or not if crack detected then shows crack number is incremented, collision time and detection time else motor running and timer shows only collision time.
6. If start motor button is ON, then motor keeps running on track and crack number is increments, else stop the motor.
7. If reset button is pressed at any instant of time then it will prompt for start button to be pressed.

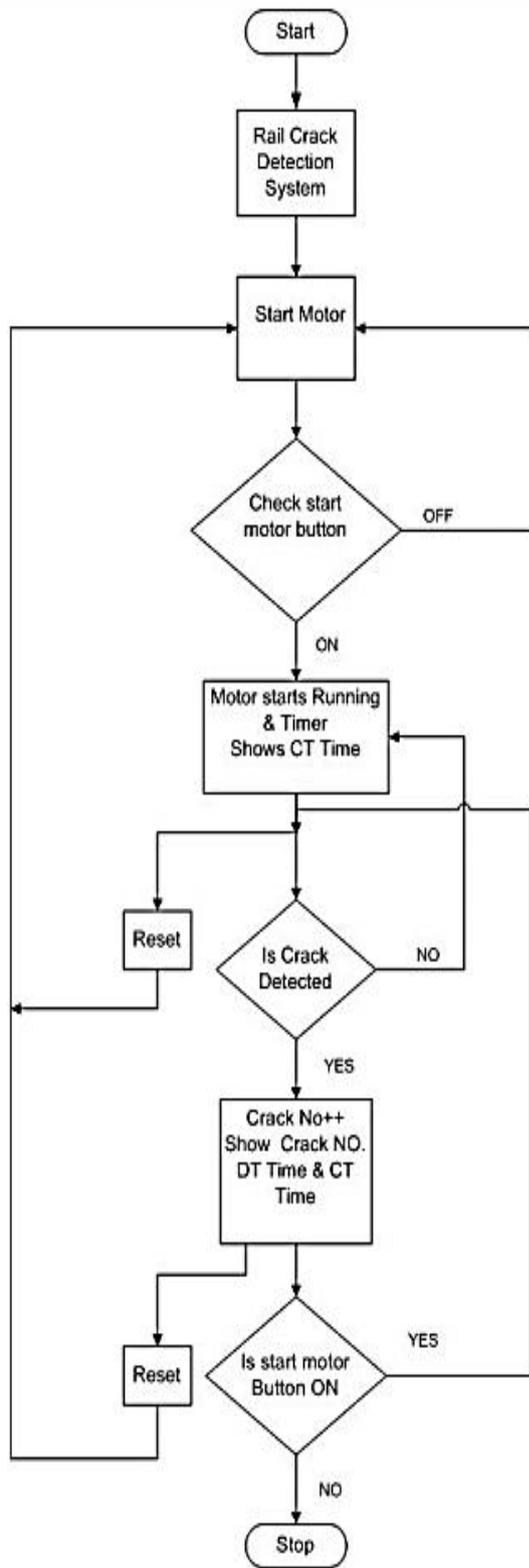


Fig. 4: Flow Chart of Crack detection System

V. APPLICATION/SCOPE OF THE SYSTEM

Our proposed model can be used at variable places like:

- 1. Automatic detection of crack on railway tracks
- 2. Calculation of distance of the crack from the origin.
- 3. Crack detection in forged metal parts
- 4. Crack detection in concrete pipe

VI. RESULT

- The speed of the robot is calculated by using formula

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

The unit is cm/sec.

- For calculating distance of crack from origin we use formula(constant speed of robot) * (crack detection time)

GA P NO	ACTUAL DISTANCE (cm)	MEASURE D TIME (sec)	MEASURE D DISTANCE (cm)	DIFFERENC E IN ACTUAL AND MEASURED DISTANCE
1	30	9	24.75	5
2	50	16	44	6
3	80	26	71.25	8.5

Table 2: Result

VII. CONCLUSION

The main cause of derailment of trains was identified as cracks in the tracks. Henceforth, our model will provide an efficient and cost effective solution to above problem. This model automatically detects any level of crack in the railway track without the need of any human intervention. Our model has several advantages as compared to with traditional detection technique. Major points are less power and less analyzation time. Our model will help in pinpointing exact location of the faulty track which will be recovered immediately resulting in saving thousands of lives. By using above mentioned component, we get accuracy up to 80% [5].

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