Detection of Crack in Railway Track using Ultrasonic Sensors

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***Abstract*—In country like India, where majority of people depend on railways for transportation, if a crack in railway track is not detected during the early stages they may lead to derailment causing heavy loss to human life and property. In this paper a crack detection system is proposed which detects the crack without human intervention and sends the location of fault to the authorized personnel using GSM. Crack detection by this method can be done during both day and night time and exact location of fault can be obtained.**

***Index Terms*—crack detection, railway, ultrasonic sensor**

I. INTRODUCTION

India has the fourth largest railway networking in the world after the United States, Russia and China. Indian rail network is still following the increasing trajectory to fulfill the commutation requirement of large population economically. The rail network traverses every length and breadth of the country and is known to carry over 30 million passengers and 2.8 million tons of freight daily. In spite of that in terms of the reliability and safety parameters, we are yet a bit away from true global standards. Though rail transportation in India growing fast but due to inadequate safety measures, there have been frequent derailments that have resulted in severe loss of valuables and human lives. One of the major causes of such rail accidents according to the statistics is crack developed in railway track shown in Figure 1, which may occur either due to improper maintenance or antisocial activities. Manual inspection of track is a tedious job.

Fig 1

To overcome this issue multiple techniques have been proposed which involve graphical inspections, Non-destructive testing (NDT) technologies such as acoustic emissions, magnetic field methods, radiography, thermal field methods, fiber optic sensors of various kinds, use of LDR[1] etc. Another composite detection system is proposed which consists of laser source, a digital processing CCD camera and a supervision system. These existing systems for detection of crack are either not very accurate or a bit of cumbersome process.

The basic objective of the proposed work is to develop a low cost breakage detection system of railway tracks using ultrasonic sensors and send the location information to the authorized personnel for further action.

II. BLOCK DIAGRAM OF PROPOSED SYSTEM

Figure 2 shows the block diagram of the proposed system. A prototype is developed for the crack detection of railway track. In this project, a prototype vehicle is built which is designed to move in between the railway tracks. The prototype vehicle uses Arduino micro-controller and the driver circuit (L293D) and GSM module are interfaced with the Arduino microcontroller. Here, we have used Bluetooth device for the movement of the vehicle. While moving in between the track as a crack is detected in either side of the railway track a message is sent to the authorized person with the information of location.

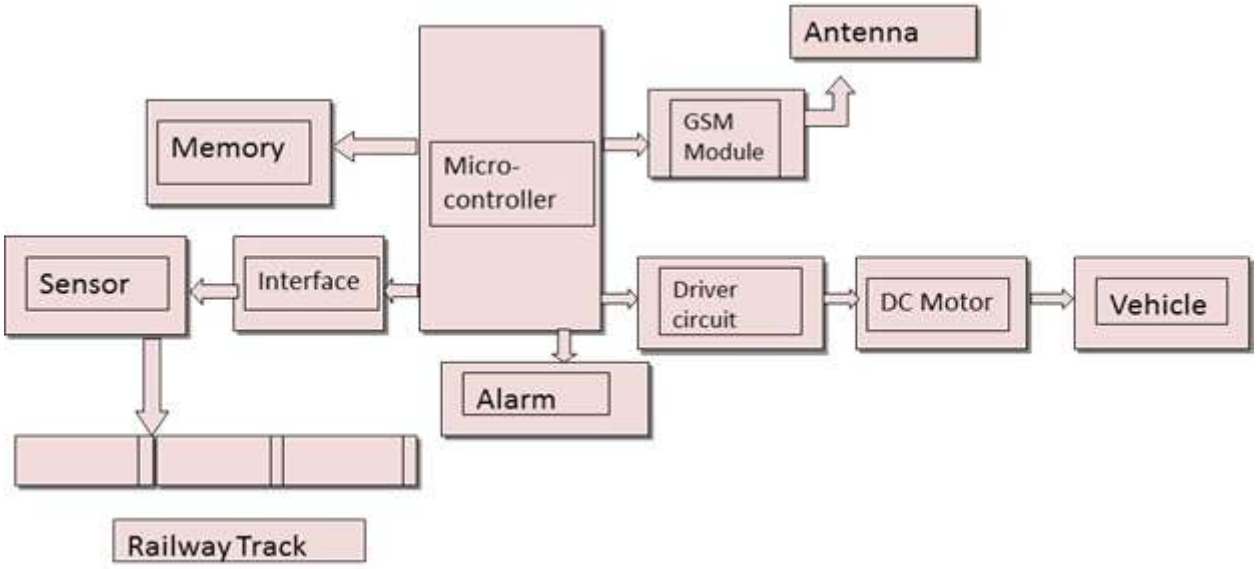

Fig 2

III. SYSTEM COMPONENTS

Ultrasonic Sensor

The ultrasonic sensors are placed between the vehicles on both right and left hand side of the prototype vehicle. The ultrasonic sensor detects the crack and the vehicle is stopped. Once the vehicle is stopped, the GSM module will send a message to the nearest station alarming them about the crack and exact location of the crack. A GPS module can be used to feed start and destination latitude and longitude and the vehicle moves from start point to destination point following the track to maintain equal distance from both the sides of the track. Distance between the tracks is measured and in case of change in distance system identifies it as fault and an alert message would be sent. Among the different types of NDT techniques, the Ultrasonic Detection system is the first detection system developed. By using ultrasonic Detector system railway operators will have the benefit of monitoring rails continuously for broken rails without human intervention which is more advantages and cost effective.

Fig 3: Ultrasonic Sensor

The ultrasonic sensors which basically work on the distance measurement are used for crack detection. These devices typically transmit a short burst of ultrasonic sound toward a target, which reflects the sound back to the sensor. The system then measures the time for the echo to return to the sensor and computes the distance to the target using the speed of sound in the medium. The prototype vehicle is made to move in-between the tracks. From the center of the vehicle to the tracks, the distance is maintained. Whenever this distance increases, it is determined that the crack is located in that particular place.

DC Series motor

In this proposed system, the small prototype vehicle is developed as a detection system. The vehicle is given a potential from 100 rpm, 10kg torque dc series motor connected to the back wheels of the vehicle. The front two wheels are free wheels. The wheels sizes are big according to the design of the real time application. Wheels are thick enough and robust giving plenty of room for wear. The vehicle contains ultrasonic sensors fixed at the sides and other components rested on the top of vehicle.

Arduino UNO

Arduino Uno kit is used as the main component which is being interfaced with others as dc driver, sensors and more. In this proposed system, two Arduino Uno kits are used as it has only one serial communication slot. One kit is interfaced with GSM Module and sensors. The other kit is interfaced with Bluetooth device and the dc driver circuit. The crack that has been detected by sensors sends a signal to AT Mega (Arduino Uno Kit).

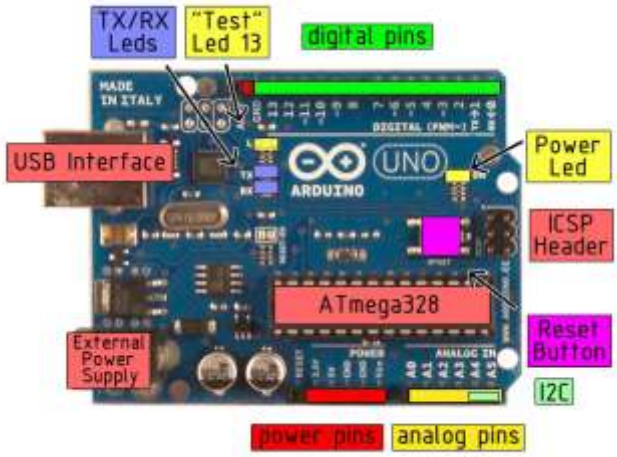

Fig 4: Arduino UNO

GSM Module

The GSM Module connected through the serial communication is used for sending message. GSM Module used is of sim900A. The signal and the GSM modem communicate with an AT Commands. The two main commands that are used here CMGF and CMGS, message format and send message respectively. The message is sent to the nearby station with the information of crack detection either on right or left of the track and the location. The communication within the modem and the message sending has a delay of one second. The message is sent in order to attain the main objective of the proposed system.

Bluetooth Device

In the proposed system, the prototype vehicle is accelerated by using Bluetooth Module. This Bluetooth Module is interfaced with the other Arduino Kit through serial communication. The vehicle here is accelerated through Bluetooth mobile application. This Bluetooth mobile application helps in moving the vehicle right, left, forward or backward according to the need. Bluetooth is used here for testing purpose; it can be designed to follow the track as per pre-defined path.

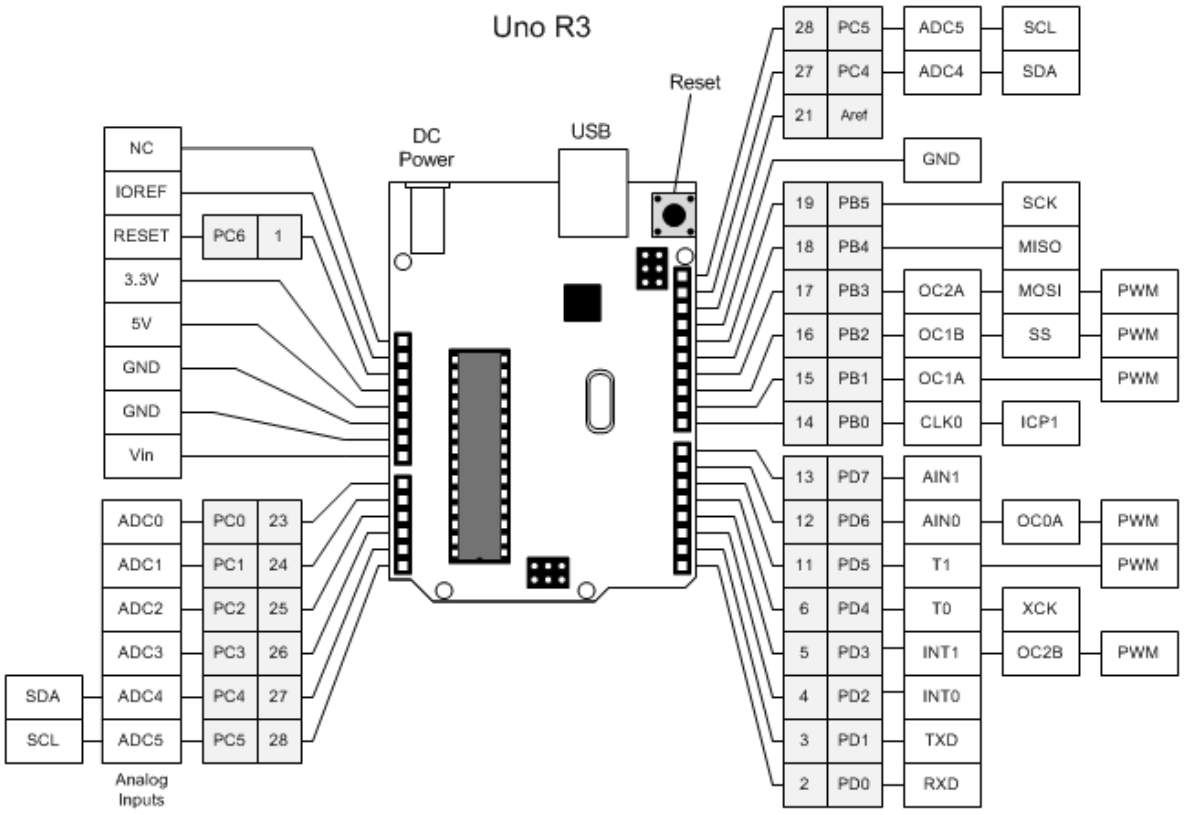

FIG 5. : OVERALL SYSTEM

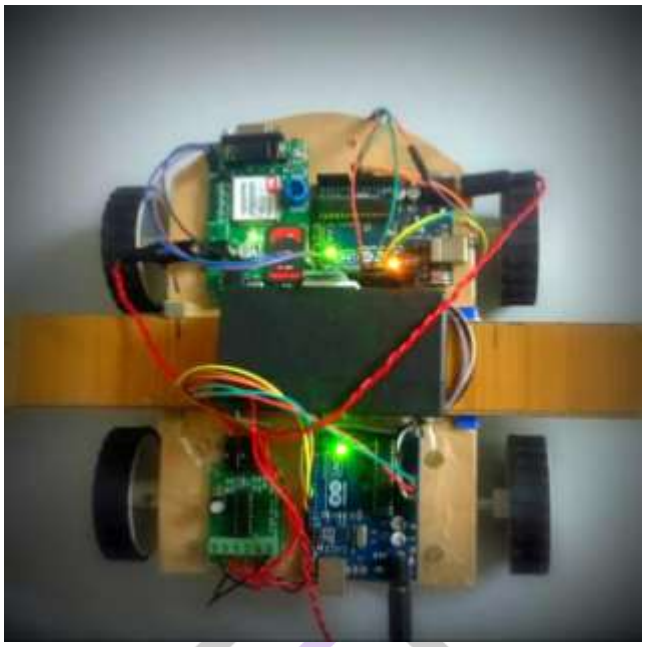

Fig 6: Experimental setup

IV. CONCLUSION AND FUTURE WORK

The proposed system can be used to detect the crack effectively and send the location of fault accurately in minimum time to the predefined mobile numbers. The advantages of the proposed system are that it has no noise, output is very much accurate and the cost is comparatively lesser than the composite system. This system can be used both during daytime and nighttime. Solar panel can be connected to power the system in place of rechargeable battery used for the purpose which would make use of renewable energy sources.

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