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IOT: Automatic Flaw Detection in Railway Lines

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Abstract: The seventh largest railway system in the world is our Indian railways which is the major source of our increasing economy. The maintenance of the railway system is quiet tedious and human error may cause disasters. Until today, there are problems arising due to rail derailment caused from track fracture. It is because it is practically impossible to inspect thousand miles of rail lines by a trained human inspector. To avoid such crisis and improve the accuracy, our proposed system will automatically inspect the railway track by sensor based method. In this project, we have intoduced the integration of infrared and total station for railway track geometry surveying system. The sensors are used for crack detection as well as motion detection. A GSM module is fixed and it sends messages to notify the authorities on crack detection. The Internet of Things (IoT) helps us to find and send the railway geometric parameter of crack detection to nearest railway station. The real-live video streaming is captured to view the defects on railroads from the base stations.
Keywords:

I. INTRODUCTION

Transportation is very important to carry the passengers and goods from one place to another across the globe. The better transpot leads to more trade. Economic level is mainly dependent on increasing capacity and the level of transport. Such a major mode of transportation is the Railway Sysem. Railway is one of the most conventional methods of travelling. India has the world's seventh largest railway system. The detection of cracks on such an extensive system of 115,000 km of track around the country manually increases the probability of error rate. Many derailment cases due to cracks found on track have been cited even today. Over 16 cases have been filed in 2017 itself. A few cases are listed below:

A. On January 2017, the Hirakh and express wrecked close kuneru in Andhra Pradesh slaughtering 41 individuals and perpetrating wounds on 68 individuals in a mischance whose reason is suspected to be due to railfracture.
B. On 30th March 2017, derailment of eight coaches of Mahakaushal Express near Mahoba station in Uttar Pradesh has injured 50 passengers severely.
C. Jagdalpur-Bhubaneswar Express derailed on its way to Bhubaneswar killing nearly 27 passengers and 36 passengers were wounded badly.

The above mentioned scenarios are devastating events due to rail fracture. The railways extend all throughout the country and accidents have been recorded since 1890. Enormous lives were lost due to improper detection of cracks in railway lines. There are many reasons for the rupture of railway tracks. It may be due to drastic change in temperature, aging of the rail lines or by using faulty rails at the time of construction. The disastrous derailment and the loss of lives can be prevented if the crack is detected at an early stage.

The Sensors(Infrared Sensor and Passive Infrared Sensor), GSM (Global System for Mobile Communications) and microcontroller based broken railway rail detection when implemented is a productive method of detection of cracks and thus avoiding derailment of the trains. The implementation of Internet of Things (IoT), which is a fast growing technology in the present times, is used for smart surveillance system.

This system is used in-between two stations which will detect the cracks present on the track using infrared sensors. If a crack is detected the infrared sensor will send a signal to the Arduino IDE board which will activate the GPS receiver which in turn send the exact location to the higher authorities through the messages.

This system also consist of PIR sensor which detects the motion of human beings or animals on the track and sends message. On receiving the crack detection message, the camera of the mobile is turned on using Arduino microcontroller. It will provide the live feed of the track.

The track can be clearly viewed from the base station in 360 degree and it can also be zoomed in and out from the application. This smart invention is cost effective and saves millions of lives from dying.
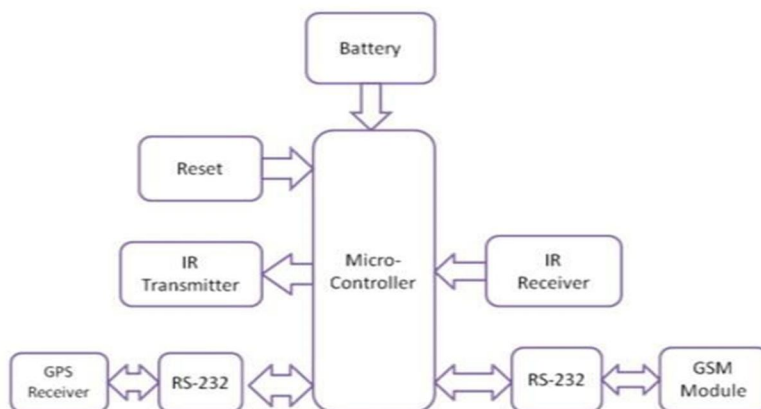
II. EXISTING SYSTEM

Fig.1Crack detection using IR.

The existing system portrayed in Fig.1 uses a microcontroller for the manipulation of the other peripherals attached to the system. The sensing system used in this technique is an IR transmitter and receiver. If light is incident on the IR transmitter, the intensity of light is directly proportional to the intensity of the crack present in the tracks. The IR receiver will then give a signal to the GPS receiver which will pin point the latitude and the longitude coordinates and sends them to the GSM module which will send a message to authorities.
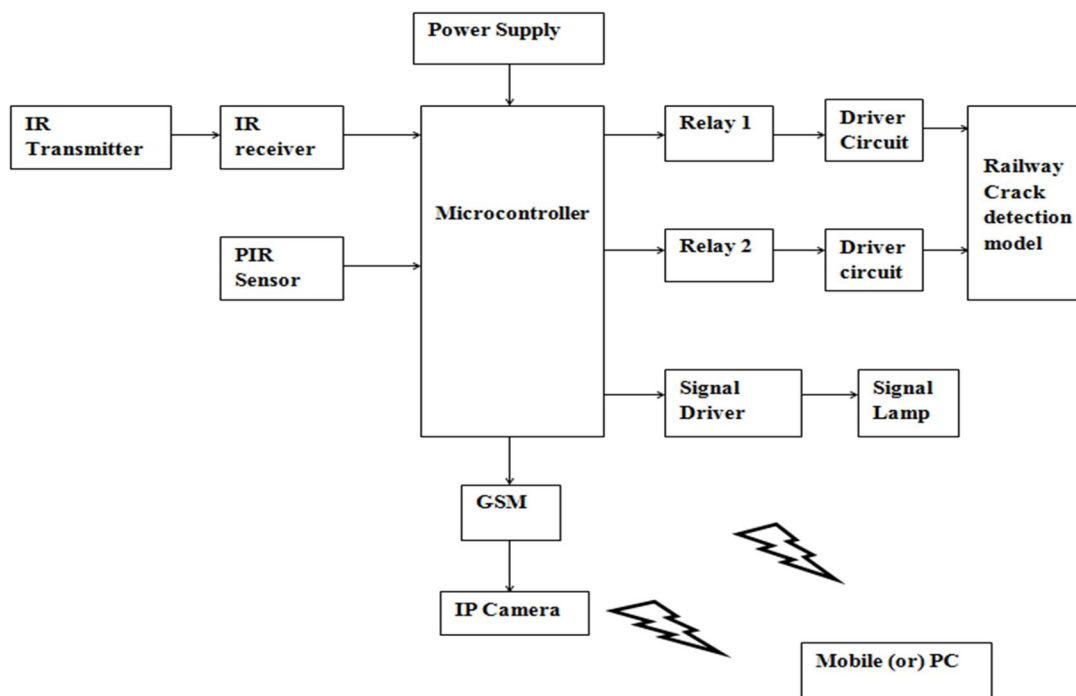
III. PROPOSED SYSTEM

Fig.2 IoT interfaced flaw detection technology

The embedded system depicted in Fig.2 utilizes Arduino IDE microcontrollers that acts as a processing unit for the other peripherals which has been interfaced. An arduino board is incorporated in the model which acts as an interface between the infrared sensors, passive infrared sensors and the GSM and the mobile camera to capture the live streaming. The complete system is embedded on a four wheeler bot which travels between the railway tracks. The Bot is programmed to move forward with an IR sensor fixed at the front which detects the track fracture.

IV. HARDWARE DESCRIPTION

Arduino is a solitary board microcontroller intended to make the application more accesible which are intelligent articles and its environment. The hardware features with an open-source hardware board designed around an 8-bit Atmel AVR microcontroller or a 32-bit Atmel ARM. Current models comprises a USB interface, 6 simple information pins and 24 computerized I/O sticks that enables the client to join different expansion sheets.

Arduino is programmed with Arduino IDE and it connected to several devices such as motor driver which is essential for moving our bot in both forward and reverse direction, GSM module to send messages to the higher authorities, Infrared sensor to detect the cracks, PIR sensor to detect the motion of the living things based on temperature changes and a mobile camera to capture the live-streaming video of the detected crack.
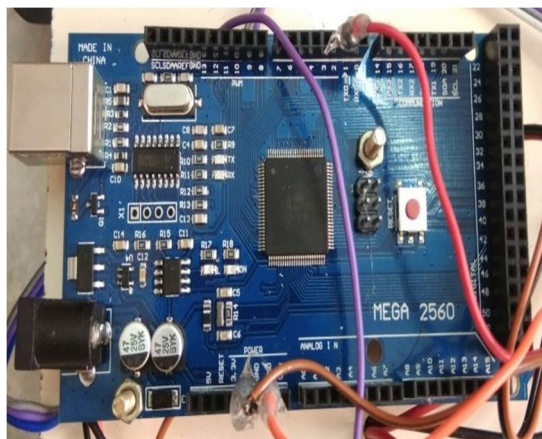
A. Arduino MEGA 2560

Fig.3 Arduino MEGA 2560

An Arduino MEGA 2560 board as depicted in Fig.3 is a microcontroller based on the Atmega328.It has 14 digital input/output pins in which 6 pins can be used as PWM outputs, a 16 MHz ceramic resonator, an ICSP header, a USB connection, 6 analog inputs, a power jack and a reset button. This contains all the required support needed for microcontoller. In order to get started, they are simply connected to a computer with a USB cable or with a AC to DC adapter or a battery.
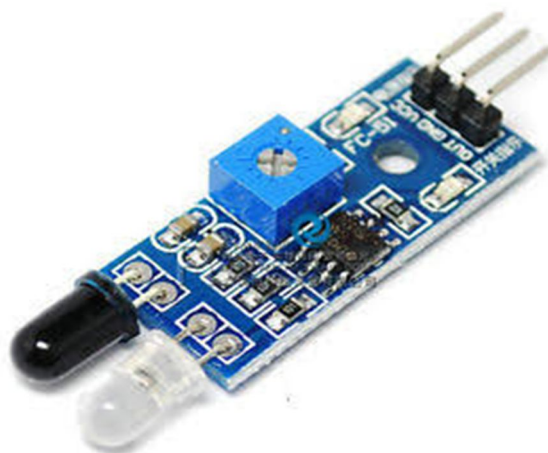
B. Infrared Sensor

Fig.4 Infrared Sensor

Infrared sensor represented in Figure 4, analyze the target by determing the reflected signals from the crack. IR transmitter and receiver are used to control any device wirelessly, means remotely. Here in our circuit, IR LED acts as a transmitter and TSOP1738 as a receiver. The modulated IR of 38 kHZ is generated using 555 timer in Astable mode and the flaw is detected.

C. Passive Infrared Sensor

Fig.5 Passive Infared Sensor

The Passive Infrared (PIR) Sensor as in Fig.5 provides thermal indoor/outdoor motion of intruders within the detection area. It consists of a sensor unit, stand holder and batteries. It detects a human being moving around within approximately 10m from the sensor according to the temperature changes.

D. GSM Module

Fig.6 GSM Module

The GSM module illustrated in Figure 6 is a circuit or chip is a digital system using time division multiple access (TDMA) technique for communication purpose. It digitizes and reduces the data, then send it down through a channel with two different streans of client data, each in its own particular time slot. The computerized framework has a capacity to convey 64kbps to 120Mbps of information rates.

E. Video Streaming

The mobile IP camera is used for video streaming. Using the port number of the other mobiles IP camera that is incorporated in the system, we can view the clear live-stream video of the detected crack in railway lines. We can also zoom in and out and 360 degree rotation is enabled.
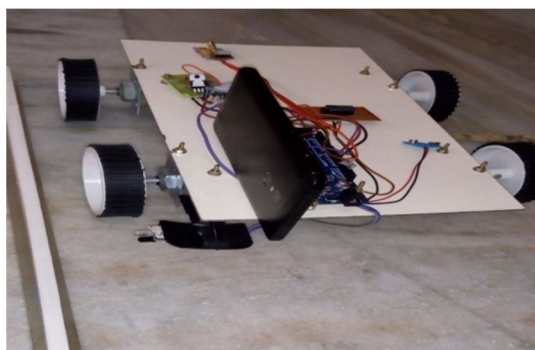
V. RESULT

Fig.7 Total Model

The above Fig.7 shows the total model. The function of the model starts from the Motor Driver circuit. Driver circuit helps in moving the bot in both reverse and forward direction. The bot os moved between the tracks and the Infrared Sensor fixed at the side is used to detect the track fracture. Sensor transmits a wave of frequency 38KHz to the controller for an ideal track.When a rupture is detected a disrupted signal is sent to controller which in turn signals the GSM module. The GSM Module sends message of crack detected to the authorized person. On detection of crack, the controller sends signal to the mobile and the IP camera is switched on. Through the other phone, we can view the crack in a deliberate manner. Whereas Passive Infrared Sensor detects the motion of human being and sends signal to the GSM module. This is inturn sends alert to the higher authorities.

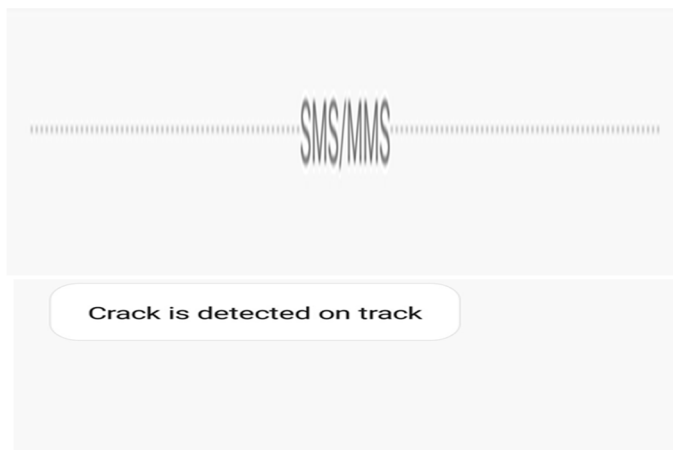The output of this paradigm is listed below:

Fig.8 Message from GSM Module on detection of crack

The message from GSM Module on detection of crack as shown in Fig.8 is one of the output of this model. When an IR sensor detects the track fracture, it sends signal to the GSM Module via controller which sends messages to the higher officials.

Fig.7 Screenshot of live-video streaming of the crack

The above Fig.9 shows the live-video streaming of the crack is the major output of this model. On detection of the crack, the IP camera is activated via controller which in turn captures the video of the crack. The clear view can be portrayed on rotating the camera on 360 degrees and the zooming options are also available.
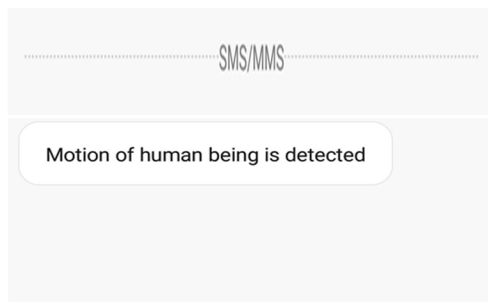

Fig.10 Message from GSM module on detection of the motion

The message from the GSM Module on detecting the motion of human being as shown in Fig.10 is the third output of the paradigm. The Passive Infrared Sensor plays a vital role on detecting the human beings. In our model, the message is sent on detection of human beings moving at least thrice by the side of PIR as it is too sensitive. We have programmed to check whether it is a person or animal and the constrained message is sent to the official.

VI. CONCLUSION

The railway is the most commonly used mode of transportation by the people and for goods. The transport system must always be secure. Utilising the benefit of embedded system we can build a system which helps the cause of safe travel. The proposed system is an amalgamation of the conventional method of crack detection and the innovative method of live video streaming and IoT. The entire system is placed on a four wheeler bot which travels along the rails. When compared to existing system which uses IR transmitter and receiver, the proposed system is an innovative technique which lowers the burden of the authorities and increases the accuracy of the crack detection. The process is done at a periodic rate to check for cracks so that causalities can be avoided entirely. The entirety of the model is to ensure that defective rails can be found in time to stop derailment of trains, to save the loss of lives and property.

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