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Railway Track Crack Detection System

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Abstract: Indian Railways has one of the largest railway networks in the world, criss-crossing over 1,15,000 kilometers in distance, all over India. However, with regard to reliability and passenger safety Indian Railways is not up to global standards. Among other factors, cracks developed on the rails due to absence of timely detection and the associated maintenance pose serious questions on the security of operation of rail transport. A recent study revealed that over 25% of the track length is in need of replacement due to the development of cracks on it. Manual detection of tracks is cumbersome and not fully effective owing to much time consumption and requirement of skilled technicians. This project work is aimed towards addressing the issue by developing an automatic railway track crack detection system. This proposed system identifies the cracks and obstacles on the track using sensors and is also capable of alerting the authorities in the form of SMS messages along with location by using GPS and GSM modules.

Keywords: Railway track, arduino microcontroller, GSM module, GPS module, IR sensor.

I. INTRODUCTION

Transport is a key necessity for specialization that allows production and consumption of products to occur at different locations. Transport has throughout history been a spur to expansion as better transport leads to more trade. Economic prosperity has always been dependent on increasing the capacity and rationality of transport. But the infrastructure and operation of transport has a great impact on the land and is the largest drainer of energy. In today's world, transport being one of the biggest drainers of energy, its sustainability and safety are issues of paramount importance. In India, rail transport occupies a prominent position in quenching the ever growing needs of a rapidly growing economy. However, if we consider the reliability and safety parameters, India has not reached the global standards yet. The major problem is that there is no efficient and cost effective technology to detect problems in the rail tracks and the lack of proper maintenance. However, the proper operation and maintenance of transport infrastructure has a large impact on the economy. This model says about a proposed prototype of testing train for detecting obstacles and cracks, which is similar to that of line following testing train. The proposed testing train is cost effective and analysis time is less. With this proposed system the exact location of the faulty rail track can be easily located, so that many lives can be saved.

II. PROPOSED METHODOLOGY

The proposed Railway Track Crack Detection System has following features:

1. Checking the railway track for cracks or objects.
2. If a crack or object is detected, collect the data from GPS.
3. Transmit the exact location of the crack or object via an SMS with the help of the GSM module.

When a crack is detected by the IR sensor the vehicle stops at once, and the GPS receiver triangulates the position of the vehicle to receive the Latitude and Longitude coordinates of the vehicle position, from satellites. The Latitude and Longitude coordinates received by GPS are converted into a text message which is done by microcontroller. The GSM module sends the text message to the predefined number with the help of SIM card that is inserted into the module.

AT NORMAL CONDITION: The IR transmitter sensor is transmitting the infrared rays. These infrared rays are received bythe IR receiver sensor. The Transistors are used as an amplifier section. At normal condition Transistor is in OFF condition. At that time relay is OFF, so that the vehicle keeps running continuously.

AT CRACK CONDITION: When the track is without any cracks then output of IR LED and photodiode will be high. As soon asthe crack is detected by the system the sensor reflection will be equal to zero and the robot will be stopped automatically. Another sensor is used to monitor the pit on the way of the railway track. When this output is high then it is concluded that there is no pit in the track. But if any pit is detected by the sensor the output of the sensor given to the microcontroller will be zero and again the microcontroller will stop the robot. When a crack is detected by the IR sensor the vehicle stops at once, and the GPS receiver triangulates the position of the vehicle to receive the Latitude and Longitude coordinates of the vehicle position, from satellites. The Latitude and Longitude coordinates received by

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GPS are converted into a text message which is done by microcontroller. The GSM module sends the text message to the predefined number with the help of SIM card that is inserted into the module to send the SMS.
Fig 1 shows block diagram of "Railway track crack detection system", there are two set of IR sensor units fixed to the front side of the vehicle with the microcontroller to check the railway track. When the vehicle is switched on, it moves forward along the track. The IR sensors check the condition of the tracks. In normal condition the motor, LDR, Serial transmission is in initial stage. When the power is supplied to the microcontroller, it starts the motor in forward direction and sends the messages to the microcontroller using serial transmission. The Arduino controller is used to control the sensor outputs and transmit the information through a GSM module, whose function is to send the signal whenever it detects a crack or an obstacle to the base station through an SMS. The GPS module is used to get the exact latitudinal and longitudinal position of the crack on the track.

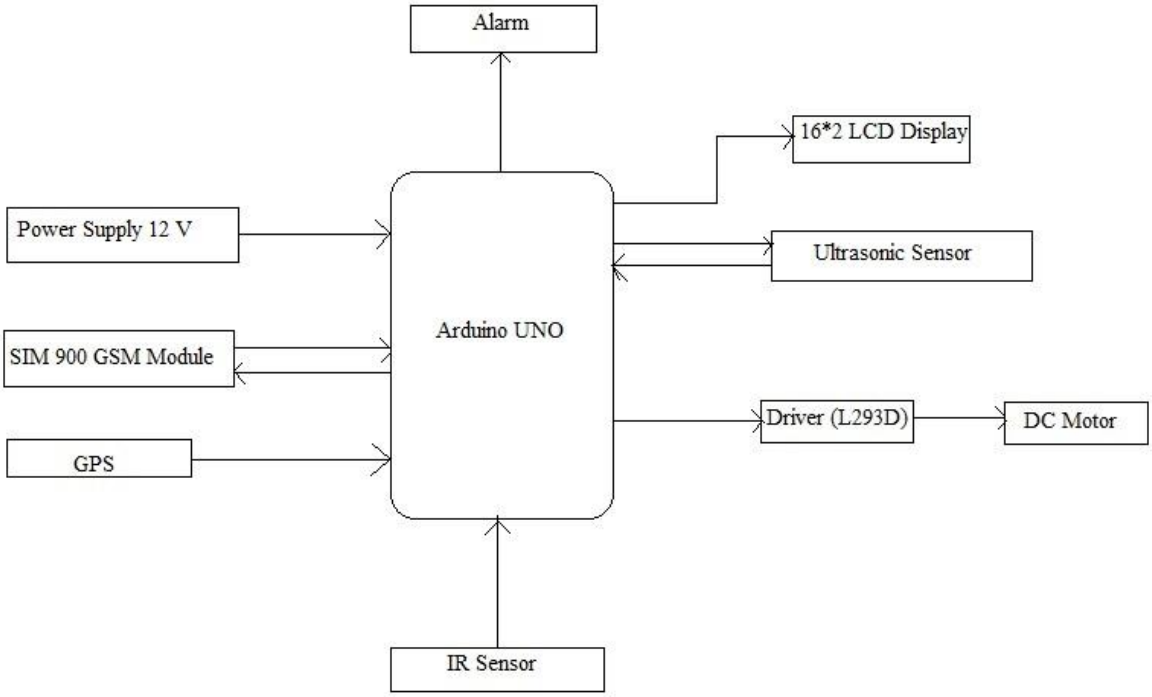

Figure 1: Block Diagram

III. COMPONENTS USED

1. ARDUINO UNO (ATMEGA328P): Arduino is an open source programmable circuit board based on easy to use hardware and software. It is very robust in nature and can support the peripherals efficiently. It is centred on ATmega328. It has 14 digital I/O pins 6 analog inputs, 16MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. The power required to run the board can be supplied through connecting it to the laptop using a USB cable or plugging an ACDC power supply. The maximum length and width of the UNO PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. It consists of a flash Memory of 32 KB of which 0.5 KB is used by the bootloader, SRAM of 2 KB and an EEPROM of 1 KB. Flash memory is used for storing code. Arduino has a crystal oscillator of 16 MHz.

2. GPS MODULE: Global Positioning System (GPS) is a satellite navigation system used to locate the ground position of an object. A GPS receiver calculates its position precisely by timing the signals sent by the GPS satellites high above the earth. The position is then displayed with a moving map display or latitude and longitude. The GPS Receiver consist of two units, first is active antenna which receives RF signals and amplifies it. The antenna is active in the sense it takes power from the module and amplifies the signal for high sensitivity. The RF signal is filtered and processed to generate NMEA format serial data output.

3. GSM MODULE (SIM 900): SIM 900 is a Quad-band GSM/GPRS engine, it works on a wide range of frequencies, such as 850 MHz, 900 MHz, 1800 MHz and 1900 MHz. It is very compact in size and easy to use as a plug in GSM Modem. The Modem is designed with RS232 Level converter circuitry, which allows you to directly interface PC Serial port. The baud rate can be configured from 9600-115200 through AT command. The modem needs only 3 wires

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(Tx,Rx,GND) except Power supply to interface with microcontroller/Host PC. The built in Low Dropout Linear voltage regulator allows you to connect wide range of unregulated power supply (4.2V -13V). Using this modem, you will be able to send and read SMS and connect to internet via GPRS through simple AT commands.

4. MAX 232: Max232 is used to convert a RS232 logic level to TTL logic level and vice-versa, during serial communication of microcontroller and GSM modem because GSM modem work at RS232 voltage levels logic 1 varies from -3 to -15 volts and logic 0 varies from +3 to +15 volts where the controller which works on TTL logic levels logic 1 is +5 volts and logic 0 is 0 volts.

5. INFRARED SENSORS: An Infrared (IR) sensor is used to detect obstacles in front of the robot. The sensor emits IR light and gives a signal when it detects the reflected light. An IR sensor consists of an emitter, detector and associated circuitry. The circuit required to make an IR sensor consists of two parts; the emitter circuit and the receiver circuit. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, its resistance and correspondingly, its output voltage, changes in proportion to the magnitude of the IR light received. This is the underlying principle of working of the IR sensor.

6. BRUSHLESS DC MOTOR: Brushless DC motor is a relatively new class of motors whose application have been increasing at a rapid rate each year, due to both declining costs as well as increasing functionality. A brushless DC motor is similar to a brush DC motor in that it has an internal shaft position feedback which tells which windings to switch on at which moment. This internal feedback gives both the brush DC motor and brushless DC motor their unique characteristics. Linear speed-torque curves which are well suited for speed and position control and high starting torque. The internal feedback is accomplished in a brush type DC motor with the mechanical commutator (a series of copper bar which are insulated from each other) and the mechanical brushes through which the current is fed into the commutator bars and switched sequentially into the appropriate winding in the armature.

7. LCD DISPLAY: LCD (Liquid Crystal Display) screen is an electronic display module and has a wide range of applications. A 16x2 LCD display is used in our projrct. A 16x2 LCD display is a very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. 16 Characters x 2 Lines Built-in HD44780 Equivalent LCD Controller Works directly with ATMEGA, ARDUINO, PIC and many other microcontroller kits.

IV. RESULTS

STEP 1: When all the components are activated, the robot runs continuously on the track, until a crack is detected, as shown in fig. 2.

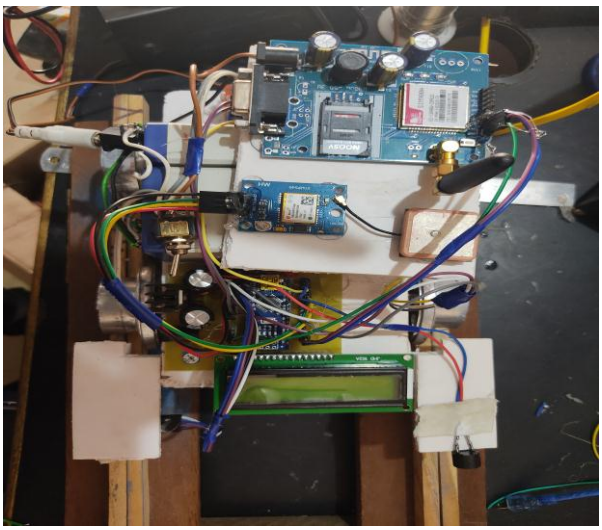

Figure 2: Robot on track in ON condition

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STEP 2: When crack is detected by the Ultrasonic sensor on the track then robot stops. GPS locates the crack and 'CRACK FIND' message is displayed and the same is sent to control station through GSM as shown in the fig.3.

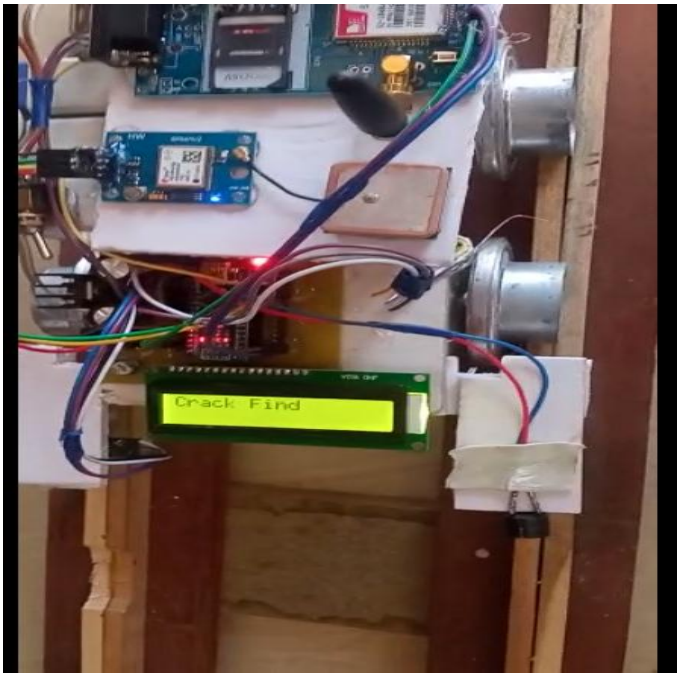

Figure 1: Detecting a crack on the track

STEP 3: An alerting message is sent to the registered number along with the link of the location where crack or obstacle has been detected as shown in fig. 4.

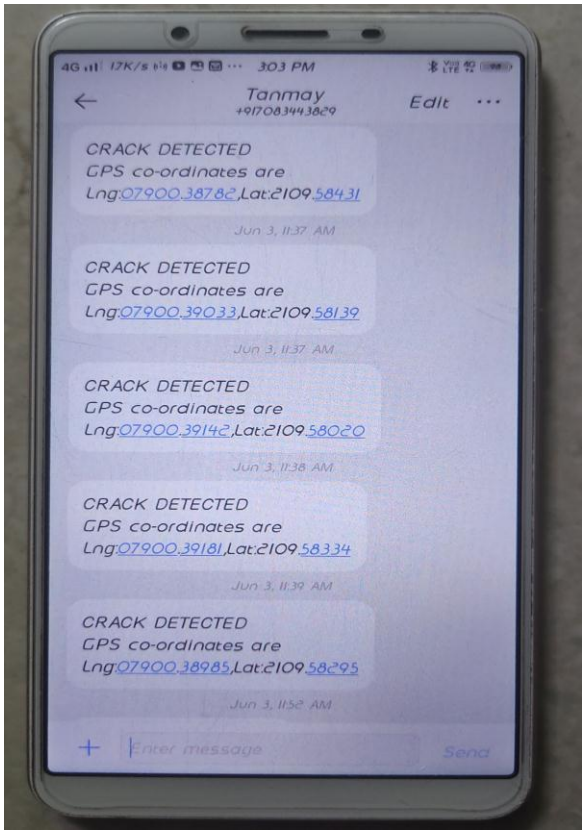

Figure 4: SMS received on the registered number

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V. APPLICATIONS

- This system is useful in finding cracks or objects on a railway track with the help of sensors, without the need of human intervention and less analysis time.
- This system is also capable of finding hairline cracks that are invisible to the naked eyes, ensuring safety and avoiding derailment of trains, saving many human lives.

VI. CONCLUSION

In this paper we have designed a cost effective, low-power embedded system, which facilitate better safety standards for rail tracks for preventing railway accidents due to cracks and obstacles on railway tracks. The Prototype of testing vehicle can efficiently detect cracks and obstacles on railway tracks. The result shows that this new innovative technology will increase the reliability of safety systems in railway transport. By implementing these features in real time application, we can avoid accidents up to approximately 70%.

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