MINI-PROJECT REPORT

ON

RAILWAY TRACK CRACK DETECTION SYSTEM

SUBMITTED BY

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UNDER THE GUIDANCE OF

PROF. V. SISALE

DEPARTMENT OF

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

MKSSS's

Cummins College of Engineering for Women, Pune

(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

(2019-2020)

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CERTIFICATE

This is to certify that the Mini Project work entitled

'RAILWAY TRACK CRACK DETECTION SYSTEM'

is a bonafide record of project work carried out in this institute

by

Tanmayee chandrakant Talekar(ROLL No.-3268)

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in partial completion of the term work for the Third Year B.Tech.

in

Electronics and Telecommunication Engineering

in the academic year **2019-2020.**

This Mini-Project Report is a record of their own work carried out under our supervision and guidance.

Prof. V.Sisale	**Dr. Prachi Mukherji**	**Dr. M. B. Khambete**
Internal Guide	**Head of Department (E&Tc)**	**Director,**
		CCOEW,Pune-52.

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RAILWAY TRACK CRACK DETECTION SYSTEM

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Abstract

In this project we have integrated a railway track geometry surveying system. This project consists of GPS module, GSM modem, IR sensor for application of communication purpose, crack detection. The GPS module and GSM modem help us to find the location of the crack and send it to a central location via SMS. The importance of this project is applicable both day and night time detection purposes.

Introduction

The recent Indian railway network has a track length of 113,617 kilometers (70,598 mi) over a route of 63,974 kilometers (39,752 mi) and 7,083 railway stations. It is the fourth largest railway network in the world. Indian rail network is still associated with lack of safety infrastructure. Our facilities are inadequate compared to the international standards and as a result, there have been frequent derailments that have resulted in severe loss of valuable human resources. About 60% of all the rail accidents are due to derailments, recent statistics reveal that about 90% are due to cracks on the rails. Hence these cracks in railway lines have to be addressed with utmost attention due to the frequency of rail usage. These cracks generally go unnoticed due to improper maintenance.The high frequency of trains and the unreliability of manual labor have initiated the cause for an automated system to monitor the presence of cracks on the railway lines.

The existing system includes the concept using Composite Detection System- consisting of a laser source, whose beam is collimated by a suited optic lens into a light plane, two 512X512 -pixel CCD cameras for complete optimum observation of the track, a digital processing system per camera, and a supervision system. The laser beam focused by the cylindrical lens as a thin plane enlightens the upper part of the railway track orthogonally to the track surface. The intersection of the plane is therefore the track profile (in the laser beam plane it is a two-dimensional line) which is observed by the CCD cameras. Each digital processing system performs real-time profile filtering and extraction (in the CCD camera geometrical coordinates) by using a composite approach from images of the corresponding CCD camera. Besides, the profile is approximately lying in a linear direction, i.e.,

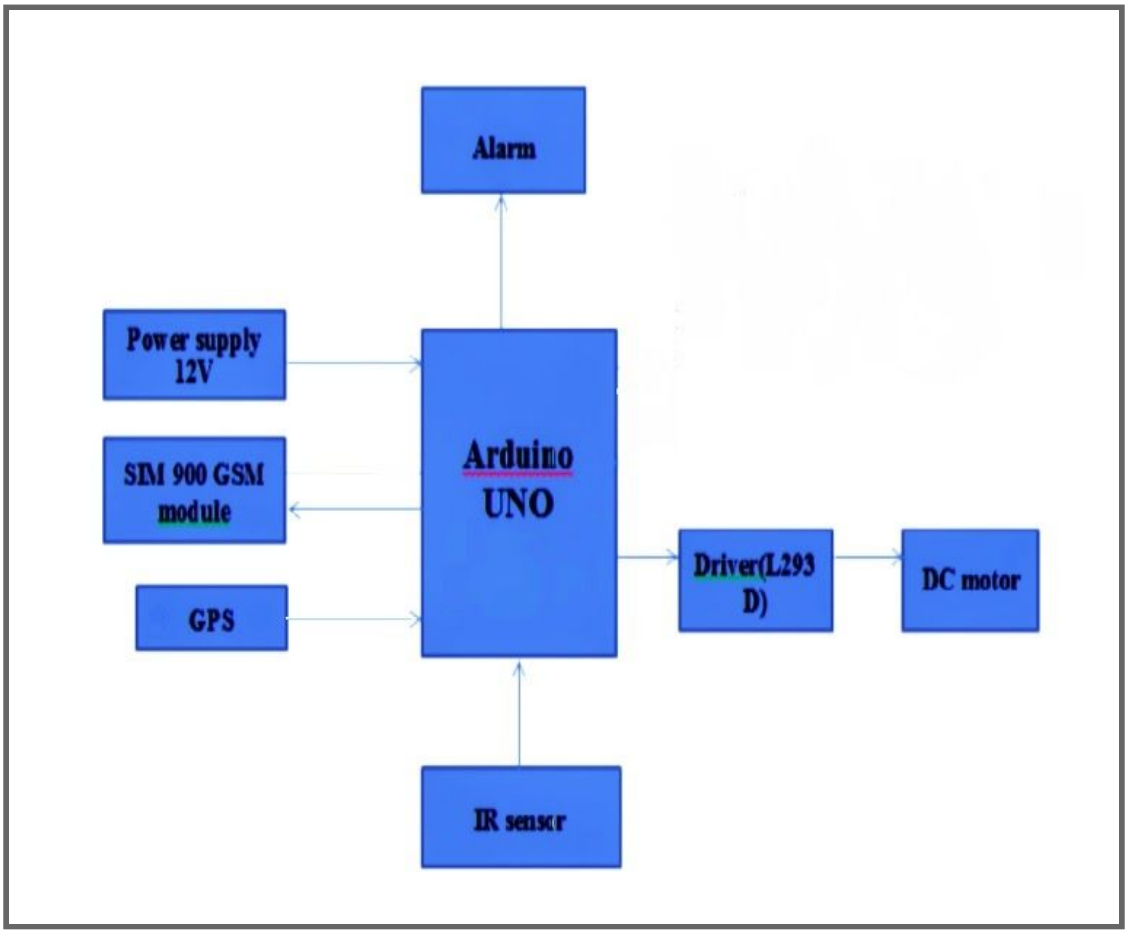
cutting the image in stripes. Only one point of the profile belongs to each stripe. This characteristic allows for parallel processing since each stripe can be analyzed independently to reach 10 ms image processing time without affecting the profile accuracy. ,but the disadvantage which can not be overlooked here is noise in input images, cost is high, and output is not accurate.

Another method is Crack Detection using Rayleigh wave-In this method we use EMATs on rail for longitudinal and transverse crack defect detection and depth gauging. Ultrasonic surface waves that are similar in behaviour to Rayleigh waves are an obvious candidate for surface breaking crack detection. If a defect lies between the Rayleigh wave generator and detector then it will to some degree block the Rayleigh wave. The amplitude of a Rayleigh wave displacement decays with depth into the sample and most of the energy associated with a particular frequency lies within a depth equal to one wavelength at that frequency. Almost all of the energy lies within a depth corresponding to two wavelengths.But wideband guided Ultrasonic waves where Closed or partially closed cracks complicates the analysis and increases the amount of Rayleigh wave energy transmitted through the crack compared to an open crack.

Proposed System

In the proposed system our project detects the railroad crack. when IR sensors are used to detect the crack in the track. If any cracks are occurred in the track means longitude and latitude of the place are messaged to the nearest station using GPS and GSM modem. The proposed work consists of an 8-bit AVR ATmega 1280 microcontroller, sensor unit and a control unit.Atmega 1280 has an inbuilt UART setup and 86bit I/O ports.A GSM and GPS Module is used to message the location of the crack through GSM.

Block Diagram



BLOCK DIAGRAM DESCRIPTION:

Above diagram shows the block diagram of the proposed work “railway track crack identification system”.

In this system we are using an Arduino Uno microcontroller, which acts as a brain of the system. This microcontroller controls the circuit function. Various components are interfaced with this microcontroller to perform desired operation of the system.

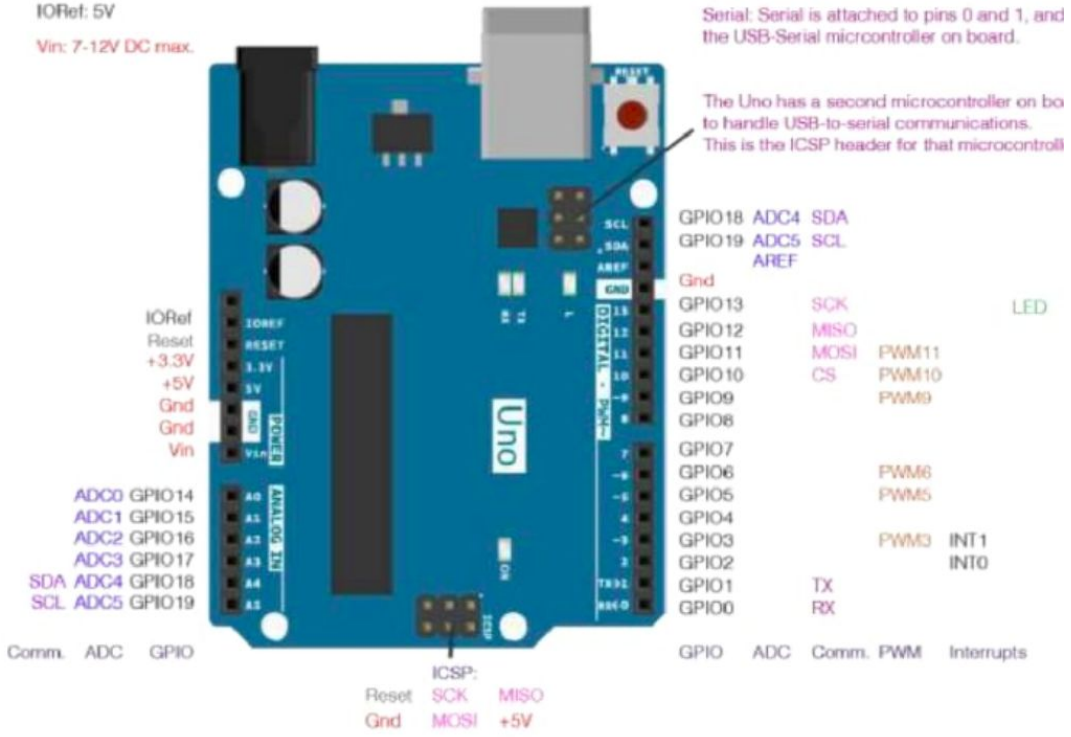
The hardware components used in this system require regulated power supply for the operation. This power is provided by the rechargeable battery connected in the system. In this system we have interfaced an IR sensor with the microcontroller for the distance and detection of the crack present in the track of the railway line.

To communicate the received information, we make use of a GSM modem. The GSM module is being used to send the current latitude and longitude data to the relevant authority as an SMS. This GSM module is interfaced with the microcontroller through a matching circuit MAX232.

A GPS receiver is also interfaced with the microcontroller to determine the exact location of the crack on the railway track. This GPS receiver will provide the longitude and latitude parameter values to the controller.

Two DC motors are used to move the robot in forward direction. These motors are interfaced and controlled through the microcontroller. To operate these motors through a microcontroller a driver circuit is required for interfacing between microcontroller and motors.

Pin Diagram of The Arduino:



Design Details

ATmega 328p:
The high-performance Microchip picoPower 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts.

By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed.

GPS:
The GPS (Global Positioning System) module and is used for navigation. The module simply checks its location on earth and provides output data which is longitude and latitude of its position.It is from a family of stand-alone GPS receivers. These flexible and cost effective receivers offer numerous connectivity options in a miniature package. The compact architecture, power and memory options make modules ideal for battery operated mobile devices with very strict cost and space constraints. Its Innovative design gives excellent navigation performance even in the most challenging environments.The GPS is used to receive the position data from the vehicles and send the location to the nearest centre. It too will have the interface to the communication link. Enhanced features include video features, trace mode, history track, vehicle database, network support.

GSM Module:
GSM is an international standard for mobile telephones. It is an acronym that stands for Global System for Mobile Communications. It is also sometimes referred to as 2G, as it is a second-generation cellular network.

The GSM net used by cell phones provides a low cost, long range, wireless communication channel for applications that need connectivity rather than high data rates. It is used to send the SMS to mobile phones.

IR Sensor:

Infrared transmitter is one type of LED which emits infrared rays generally called as IR Transmitter. Similarly IR Receiver is used to receive the IR rays transmitted by the IR transmitter. One important point is both the IR transmitter and receiver should be placed straight line to each other.

DC Motor:
To traverse a distance of 22 Km in 4 hrs, an average speed of 1.5 meters/sec is needed. The proposed design uses 2 DC motors.

Algorithm

1. Start
2. include required header files.
3. set tx=7 and rx=8 by using SIM900().
4. Create an instance of TinyGPS.
5. set pin for 2 IR sensor and a LED i.e. pin5 pin7 and pin6 respectively.
6. The L239D motor driver IC is used to control two DC motors.Driver's pin IN1,IN2,IN3,IN4,ENA and EN2 are connected to Arduino UNO's pin no. 10,11,12,13, 3 and 4 respectively.
7. buttonState is used to define the current state of the button.
8. In setup() method, By using pinMode() method we have set buttonPin and buttonPin1 as input and driver' pin and led pin as output.By using begin() method we have set the baud rate.
9. In loop() method,By using digitalRead() logic state of buttonPin is stored in buttonState.
10. by using if statement compare buttonState and buttonState1 to its previous state.if buttonState or buttonState1 is LOW then by using digitalWrite() method which is used to write high or low in respective pin,make ledPin high.
11. To control speed of motor analogWrite() is used where 255 value implies ENA,ENB is on.
12. To control direction of motor digitalWrite() is used which writes high and low in digital pins.it is used to make IN1,IN2IN3andIN4 Low.
13. delay() is used to provide delay in a given amount of milliseconds.
14. for loop is used to parse Gps date and report some key value.
15. Serial.available() returns the number of characters (i.e. bytes of data) which have arrived in the serial buffer and that are ready to be read. this method returns the first (oldest) character in the buffer and removes that byte of data from the buffer. until there is

character in the buffer,Serial.read() will store it in variable c.

16. gps.encode(c) will check if any location has come or not.if yes then newData will be true.
17. if newData is true, gps.f_get_position() gets position i.e. location.
18. set GSM module in text mode using AT+CMGF command and send message to corresponding number with country code by using AT+CMGS command,set chars 1.
19. Print Latitude, Longitude.
20. End AT Command by passing ASCII code 26
21. if chars is 0 then print message to check wiring.else to control speed of motor analogWrite() is used where 255 value implies ENA,ENB is on.
22. To control the direction of the motor digitalWrite() is used.it is used to make IN1=HIGH,IN2=LOW,IN3=HIGH, IN4=LOW and ledPin=LOW.
23. Stop.

Simulation Code

```
#include <TinyGPS.h>
#include <SoftwareSerial.h>
SoftwareSerial SIM900(7, 8);     //SIM900 Tx & Rx is connected to Arduino

TinyGPS gps;                     //Creates a new instance of the TinyGPS object
const int  buttonPin = 5;        // the pin that the ir sensor 1 is attached
const int  buttonPin1 = 7;         // the pin that the ir sensor 2 is attached
const int ledPin = 6;            // the pin that the LED is attached
const int IN1 = 10;
const int IN2 = 11;
const int IN3 = 12;
const int IN4 = 13;
const int ENA = 3;
const int ENB = 4;

int buttonState = 0;             // current state of the button
int buttonState1 = 0;              // current state of the button1


void setup()
{
 pinMode(buttonPin, INPUT);              // initialize the button pin as a input
 pinMode(buttonPin1, INPUT);               // initialize the button1 pin as a input
 pinMode(ledPin, OUTPUT);              // initialize the LED as an output:
 pinMode (IN1, OUTPUT);
 pinMode (IN2, OUTPUT);
 pinMode (IN3, OUTPUT);
 pinMode (IN4, OUTPUT);
 pinMode (ENA, OUTPUT);
```

```
 pinMode (ENB, OUTPUT);
 Serial.begin(9600);              //initializes the serial connection at 9600 bits/sec
 SIM900.begin(9600);             // start communication with the SIM900A in 9600
                                                  bits/sec

}

void loop()
{
  bool newData = false;
  unsigned long chars;
  unsigned short sentences, failed;

 buttonState = digitalRead(buttonPin);              // read the pushbutton input pin:
 buttonState1 = digitalRead(buttonPin1);              // read the pushbutton1 input pin:

   // compare the buttonState to its previous state
   if (buttonState == LOW || buttonState1 == LOW)
   {
    // if the current state is HIGH then the button went from off to on:
    digitalWrite(ledPin, HIGH);

    //control speed
    analogWrite(ENA, 255);
    analogWrite(ENB, 255);

     //control direction
    digitalWrite(IN1, LOW);
    digitalWrite(IN2, LOW);
    digitalWrite(IN3, LOW);
    digitalWrite(IN4, LOW);
     delay(5);

 // For one second we parse GPS data and report some key values
 for (unsigned long start = millis(); millis() - start < 1000;)
 {
      while (Serial.available())
     {
      char c = Serial.read();
      Serial.print(c);
      if (gps.encode(c))                        //check if any location is came or not.
      {
         newData = true;
    }
    }
 }

 if (newData)                                  //if newData is true
 {
  float flat, flon;
  unsigned long age;
```

```
  gps.f_get_position(&flat, &flon, &age);
  SIM900.print("AT+CMGF=1\r");      //Sets the GSM Module in Text Mode
  delay(40);
  SIM900.println("AT + CMGS = \"+91xxxxxxxxxx\"");    //Send a message to
                                                      number with country code
  chars=1;
  delay(30);

  SIM900.print("Crack is detected in location ");

  SIM900.print("Latitude = ");
  SIM900.print(flat == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flat, 6);

  SIM900.print(" Longitude = ");
  SIM900.print(flon == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flon, 6);

  delay(20);
  SIM900.println((char)26);               //End AT command with a ^Z, ASCII code 26
  delay(20);
  SIM900.println();
}
//if any error occurs due to connection.
Serial.println(failed);
 if (chars == 0)
{
 Serial.println("** No characters received from GPS: check wiring **");
 }
 else
{

    //control speed
    analogWrite(ENA, 255);
    analogWrite(ENB, 255);

    //control direction
    digitalWrite(IN1, HIGH);
    digitalWrite(IN2, LOW);
    digitalWrite(IN3, HIGH);
    digitalWrite(IN4, LOW);
    digitalWrite(ledPin, LOW);

  }


}
```

WORKING

In our project, there are IR sensor units fitted to the side of the vehicle. These units are used to activate/deactivate GSM transmitter unit when there are any cracks in the track. The IR transmitter and IR receiver circuit is used to sense the cracks. They are fixed to the front sides of the vehicle with a suitable arrangement. When the vehicle is Powered On, it moves along the model track. The IR sensors monitor the condition of the tracks. In normal condition the motor, LDR, Serial transmission is in the initial stage. When the battery power supply supplies the microcontroller then its starting the motor in forward direction and serial transmission is used to send the messages to the microcontroller. 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 a 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 by the IR receiver sensor. The Transistors are used as an amplifier section. At normal condition Transistor is OFF. At that time the relay is OFF, so that the vehicle runs continuously.

At Crack Detection: At crack detection conditions the IR transmitter and IR receiver, the resistance across the Transmitter and receiver is high due to the non-conductivity of the IR waves. When the track is continuous without any cracks then output of the IR LED will be high. As soon as the crack is detected by the system the system will be stopped automatically. 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 a SIM card that is inserted into the module to send the SMS.

APPLICATIONS/SCOPE OF THE SYSTEM

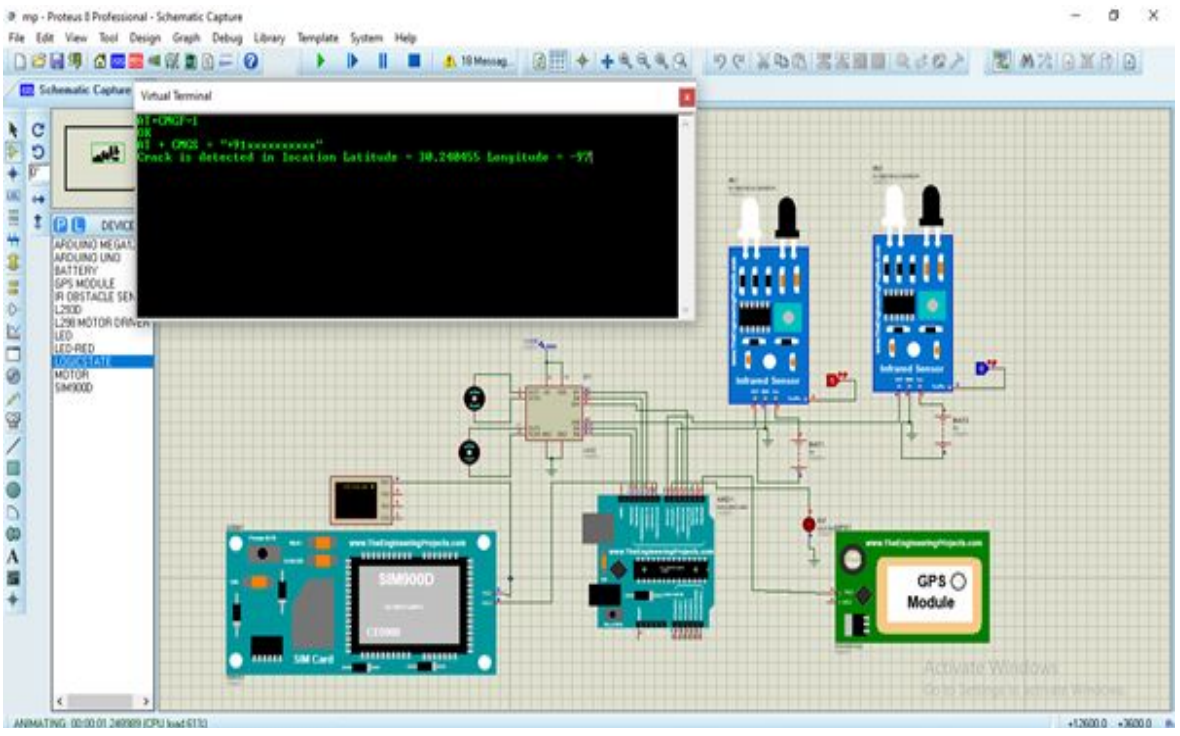
Project can be used for inspection at various places like,

- 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.

RESULTS

At Normal Condition: The IR transmitter sensor is transmitting the infrared rays. These infrared rays are received by the IR receiver sensor so IR sensor output is high. and vehicles running continuously.

At Crack Condition: As soon as the crack detected by the system the IR sensor output is equal to zero and the vehicle will be stopped automatically.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 a SIM card that is inserted into the module to send the SMS.



CONCLUSION

In this project, we have designed the IR sensor based crack detection of railway system with GSM & GPS technology.The crack on the track is sensed automatically and accidents are prevented.The method replaces manual inspection of the track section, by automatic inspection. This will help to detect cracks immediately and reduce the possibilities of any mishappening. Since the system would be automatic and will require less manual intervention, the utmost efficiency of the system can be ensured. simulation has been done by proteus.

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