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AUTOMATIC RAILWAY TRACK CRACK DETECTING VEHICLE

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Abstract

The Indian railway has one of the largest railway network in the world, crisscrossing over 1,15,000 km 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 the absence of a 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 crack length is in need of replacement due to the development of the cracks on it.

Manual detection of cracks is cumbersome and not fully effective owing to much time consumption and requirement of skilled techniques. This project works is aimed at addressing the issue by developing an automatic railway tracking detection system.

This work introduces a project that aims in designing robust crack detecting scheme a system which avoids the train accidents by detecting the cracks on railway tracks. And also capable of alerting the authorities in the form of SMS messages along with location by using GPS and GSM modules. The system also includes a distance measuring sensors which displays the crack deviation distance between the railway tracks.

Keywords: IR Transmitter, IR Receiver, crack detection, sensor unit

1. INTRODUCTION

This is an era of automation where it is broadly defined as replacement of manual effort by Electronics in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased.
Degrees of automation are of two types:

Full automation.

Semi automation.

In semi automation a combination of manual effort and mechanical power is required whereas in full automation human participation is very negligible. In our project is fully automation one.

NEED FOR AUTOMATION

Automation can be achieved through computers, hydraulics, pneumatics, robotics, etc., of these sources, form an attractive medium for low cost automation. The main advantages of all automation systems are economy, accuracy and simplicity. Automation plays an important role in all industries.

1.1 AIM AND OBJECTIVE OT THE PROJECT

The vehicle draws power from the battery. The optical sensor is used to detect the crack in the railway track. Suppose any crack in the track, the vehicle automatically stops and activates the FM transmitter circuit.

Cordless identification to the station master: -

This unit can also be used to intimate the nearest railway station. The FM receiver circuit is fixed in the room of the station master.

Automation can be achieved through computers, hydraulics, pneumatics, robotics, etc., of these sources, form an attractive medium for low cost automation. The main advantages of all automation systems are economy, accuracy and simplicity. Automation plays an important role in all industries.

1.2 NEED OF THE PROJECT

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reliability and passenger safety Indian railways is not up to global standards. Among other factors cracks developed on the rails rails due to the absence of a 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 crack length is in need of replacement due to the development of the cracks on it.

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1.3 PROBLEM IDENTIFICATION

According to the survey conducted through the years 2010-2017 there had been 895 people killed and 2123 people injured in a train derailment accident in India. The main cause of the accidents of a railway track and an unstable rock level.

FIG 1.1: RAILWAY CRACK AND ACCIDENT IDENTIFICATION

The principle problem has been the lack of the cheap and efficient technology to detect problems in the railway track and of course , the lack of proper maintenance of rails which have resulted in the formation of cracks in the rail and other similar problems caused by antisocial elements which expose the security of operations of rail transport. In the past the problem has led to a number of derailments resulting in a heavy loss of life and property.

Cracks in rails have been identified to the main cause of derailments in the past yet there have been no cheap automated solutions available for testing purposes.

2. LITERATURE REVIEW

2.1 RAILWAY TRACK

Track-caused derailments are often caused by wide gauge. Proper gauge, the distance between rails, is 56.5 inches (four feet, eight-and-a-half inches) on standard gauge track. As tracks wear from train traffic, the rails can develop a wear pattern that is somewhat uneven. Uneven wear in the tracks can result in periodic oscillations in the truck, called 'truck hunting.' Truck hunting can be a contributing cause of derailments. A rail breaks cleanly, it is relatively easy to detect. A track occupancy light will light up in the signal tower indicating that a track circuit has been interrupted. If there is no train in the section, the signaller must investigate. One possible reason is a clean rail break. For detecting the rail break this way, one has to use signal bonds that are welded or pin brazed on the head of the rail.

2.2 CRACK DETECTION USING ULTRASONIC AND PIR SENSOR

In this detection of the rail road crack, measuring distance for two rail road and also measure the pursuing human in the railway track. When IR sensor are used for detect the crack in the track and ultrasound sensor measure the distance between the two track and also PIR sensor are used to detect human being pursuing in the track. If any crack are occurred in the track means longitude and latitude of the place are messaged to the nearest station and ultrasonic sensor are measure the distance between the two track if any small variance means they detect and message to the nearest station using GPS and

GSM modem. When PIR sensor are detect the human being and animals on the railway track, if any one pursuing on the track means they stop the surveying work after crossing rail road they are detect the track

2.3 CRACK DETECTION USING LED-LDR

The principle involved in crack detection is the concept of LDR. In the proposed design, the LED will be attached to one side of the rails and the LDR to the opposite side. During normal operation, when there are no cracks, the LED light does not fall on the LDR and hence the LDR resistance is high. Subsequently, when the LED light falls on the LDR, the resistance of the LDR gets reduced and the amount of reduction will be approximately proportional to the intensity of the incident light. As a consequence, when light from the LED deviates from its path due to the presence of a crack or a break, a sudden decrease in the resistance value of the LDR ensues. This change in resistance indicates the presence of a crack or some other similar structural defect in the rails. In order to detect the current location of the device in case of detection of a crack, a GPS receiver whose function is to receive the current latitude and longitude data is used. To communicate the received information, a GSM modem has been utilized. The GSM modem transfers the received Information to the GPRS which then shows the exact location of the faulty rail track in the mobile. The proposed rail track detection system architecture consists of ARM7 controller, GPS, GSM, LED-LDR Assembly, and GPRS, DC Motor.

2.4 INTELLIGENT RAILWAY CRACK DEFECT INSPECTION

The proposed system consists of mainly three components that are Micro-controller, IR module and Zigbee module. IR sensor is used to detect the crack in railway track. Infrared (IR) transmitter is one type of LED which emits infrared rays generally called as IR Transmitter. The transmitted light rays are received by IR receiver on adjacent side. IR transmitter and receiver should be kept parallel and adjacent to each other so that transmitted light can fall on receiver straight. Then the LCD display is used to view the result.

3. METHODOLOGY

3.1 PROBLEM IDENTIFICATION

Railway Accidents are occurred the following reasons:-

The unmanned level crossing

- Signal Failure
- Human error
- Railway gate opening at the time of train comes.
- Crack in the railway track
- Any big object in the track

Automatic crack checking: -

The vehicle draws power from the battery. The optical sensor is used to detect the crack in the railway track. Suppose any crack in the track, the vehicle automatically stops and activates the FM transmitter circuit.

Cordless identification to the station master: -

This unit can also be used to intimate the nearest railway station. The FM receiver circuit is fixed in the room of the station master.

Automation can be achieved through computers, hydraulics, pneumatics, robotics, etc., of these sources, form an attractive medium for low cost automation. The main advantages of all automation systems are economy, accuracy and simplicity. Automation plays an important role in all industries.

3.2 MATERIAL SELECTION

SL. NO	COMPONENTS	MATERIAL
1	FM transmitter and Receiver unit	Electronic
2	DC Motor	Aluminium
3	Bearing with bearing gap	Steel
4	Spur gear	C.I
5	Battery	Lead acid
6	Track	M.S
7	Connecting	Cu

	Wire	
8	Bolt& nut	M.S
9	Shaft	M.S
10	Engine	M.S
11	Sensor	IR Sensor

Table 3.1 : List of materials

4. PROPOSED SYSTEM

In order to solve this problem, an autonomous mobile robotic vehicle has been created. This robotic vehicle continuously runs on the railway track for railway safety monitoring and save the priceless human lives in case of an accident.

IR sensor is used to detect the crack in railway track. Infrared (IR) transmitter is one type of LED which emits infrared rays generally called as IR Transmitter. The transmitted light rays are received by IR receiver on adjacent side. IR transmitter and receiver should be kept parallel and adjacent to each other so that transmitted light can fall on receiver straight

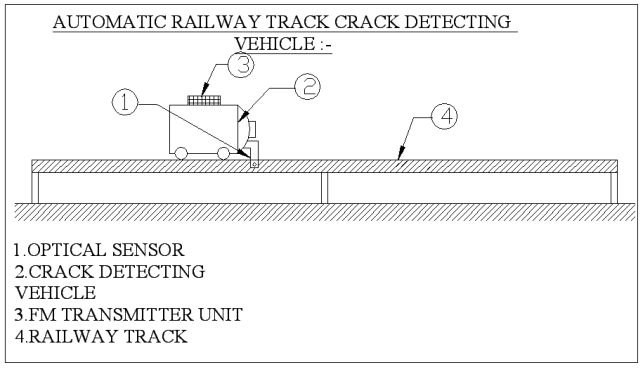

FIG 4.1: AUTOMATIC RAILWAY TRACK CRACK DETECTING VEHICLE

In our project is being with an introduction to railway track inspection to railway track inspection and various applications. The sensors are used to detect the crack in the railway track automatically and this signal is given to FM transmitter unit. The transmitted signal is received by the unit , and gives the information to the station master by alarm by indication. The era of automation where it is broadly defined as manual replacement effort by mechanical power in all degrees of automation.

5. COMPONENTS AND DESCRIPTION

Components of the automatic railway track crack detecting vehicle

- IR Sensor
- FM transmitter and Receiver Unit
- D.C. Motor
- Engine (Spur Gear Mechanism)
- Railway Track
- Battery
-

SENSORS

A sensor is a transducer used to make a measurement of a physical variable. Any sensor requires calibration in order to be useful as a measuring device. Calibration is the procedure by which the relationship between the measured variable and the converted output signal is established.

Care should be taken in the choice of sensory devices for particular tasks. The operating characteristics of each device should be closely matched to the task for which it is being utilized. Different sensors can be used in different ways to sense same conditions and the same sensors can be used in different ways to sense different conditions.

5.1 IR SENSORS

Proximity sensors:

Proximity sensors generally have a binary output, which indicates the presence of an object within a specified distance interval. The proximity sensors are divided into five types.

1. Inductive sensor.

2. Hall-effect sensor.

3. Capacitate sensor.

4. Ultrasonic sensor.

5. Optical proximity sensor.

1. Inductive sensor:

Inductive sensors are based on a change of inductance due to the presence if a metallic object is among the most widely used industrial proximity sensors. The principle of operation of these sensors can be explains as a inductive sensor which basically consist of a wound coil located next to a permanent magnet packaged in a simple, rugged housing.

2**. Hall-effect sensor:**

Hall Effect related the voltage between two points in a conducting or semi conducting material to a magnetic field across the material. The all-effect sensors can only detect magnetized objects.

3. Capacitive sensor:

Unlike inductive and Hall-effect sensors which detect only Ferromagnetic materials, capacitive sensors are potentially capable (with various degrees of sensitivity) of detecting all solid and liquid materials. As this name implies, these sensors are based on detecting a change in capacitance induced by a surface that is brought near the sensing elements.

4. Ultrasonic sensors:

In our project we are using **ULTRASONIC SENSOR**. Now, we will see about it in detail. The response of all the proximity sensors discussed thus far depends strangely on the material being sensed. This dependence can be reduced considerably by using ultrasonic sensors. The following figure shows the structure of a typical ultrasonic transducer used for proximity sensing.

The basic element is an Electro-acoustic transducer, often of the piezoelectric ceramic type. The resin layer protects the transducer against humidity, dust, and other environmental factors; it also acts as an acoustical impedance receiving, fast damping of the acoustic energy is necessary to detect objects at close range.

The operation of an ultrasonic proximity sensor is best understood by analyzing the waveforms used for both transmission and detection of the acoustic energy signals.

5. Optical proximity sensors:

These are similar to ultrasonic sensor in the sense that they detect proximity of an object by its influence on a propagating wave as it travels from a transmitter to a receiver. This sensor consist of a solid state light emitting diode (LED), which acts as a transmitter of infrared light, and a solid state photo diode which acts as a receiver.

The cones of light formed by focusing the source and detector on the same plane intersect in a long, pencil-like volume. This volume defines field of operation of the sensor since a reflective surface. Which intersects the volume is illuminated by the source and simultaneously seen by the receiver.

5.2 BATTERY

In isolated systems away from the grid, batteries are used for storage of excess solar energy converted into electrical energy. The only exceptions are isolated sunshine load such as irrigation pumps or drinking water supplies for storage.

In fact for small units with output less than one kilowatt. Batteries seem to be the only technically and economically available storage means. Since both the photo-voltaic system and batteries are high in capital costs. It is necessary that the overall system be optimized with respect to available energy and local demand pattern. To be economically attractive the storage of solar electricity requires a battery with a particular combination of properties:

(1) Low cost

(2) Long life

(3) High reliability

(4) High overall efficiency

(5) Low discharge

LEAD-ACID WET CELL:

Where high values of load current are necessary, the lead-acid cell is the type most commonly used. The electrolyte is a dilute solution of sulfuric acid (H_2SO_4). In the application of battery power to start the engine in an auto mobile, for example, the load current to the starter motor is typically 200 to 400A. One cell has a nominal output of 2.1V, but lead-acid cells are often used in a series combination of three for a 6-V battery and six for a 12-V battery. The lead acid cell type is a secondary cell or storage cell, which can be recharged. The charge and discharge cycle can be repeated many times to restore the output voltage, as long as the cell is in good physical condition. However, heat with excessive charge and discharge currents short ends the useful life to about 3 to 5 years for an automobile battery. Of the different types of secondary cells, the lead-acid type has the highest output voltage, which allows fewer cells for a specified battery voltage.

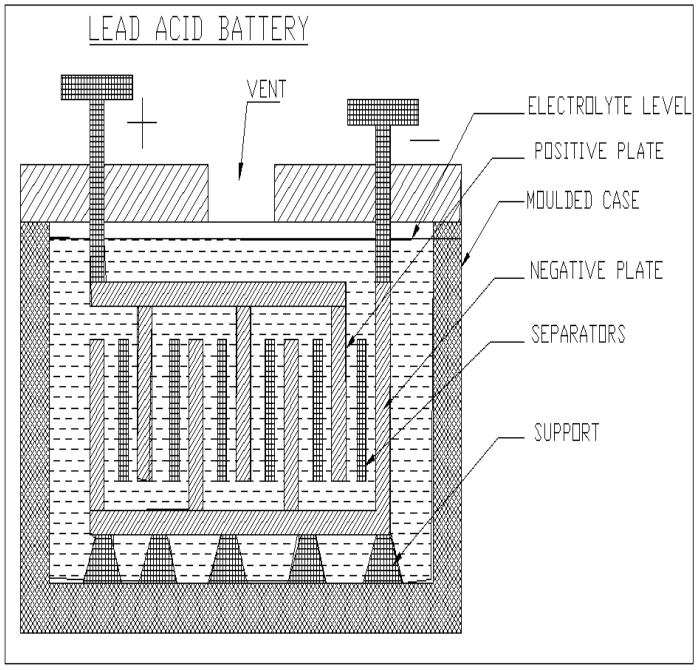

FIG 5.1: LEAD ACID BATTERY

Inside a lead-acid battery, the positive and negative electrodes consist of a group of plates welded to a connecting strap. The plates are immersed in the electrolyte, consisting of 8 parts of water to 3 parts of concentrated sulphuric acid. Each plate is a grid or framework, made of a lead-antimony alloy. This construction enables the active material, which is lead oxide, to be pasted into the grid. In manufacture of the cell, a forming charge produces the positive and negative electrodes. In the forming process, the active material in the positive plate is changed to lead peroxide (pbo_2). The negative electrode is spongy lead (pb).

Automobile batteries are usually shipped dry from the manufacturer. The electrolyte is put in at the time of installation, and then the battery is charged to from the plates. With maintenance-free batteries, little or no water need be added in normal service. Some types are sealed, except for a pressure vent, without provision for adding water.

5.3 DC MOTOR

An electric motor is a machine which converts electrical energy to mechanical energy. Its action is based on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a magnetic force whose direction is given by Fleming□s left hand rule.

When a motor is in operation, it develops torque. This torque can produce mechanical rotation. DC motors are also like generators classified into shunt wound or series wound or compound wound motors.

FLEMING□S LEFT HAND RULE:

Keep the force finger, middle finger and thumb of the left hand mutually perpendicular to one another. If the fore finger indicates the direction of magnetic field and middle finger indicates direction of current in the conductor, then the thumb indicates the direction of the motion of conductor.

PRINCIPLE OF OPERATION OF DC MOTOR:

The conductor is perpendicular to the direction of the magnetic field. The conductor is as carrying a current away from the viewer, but the field due to the N and S poles has been removed. There is no movement of the conductor during the above two conditions. The current carrying conductor is placed in the magnetic field. The field due to the current in the conductor supports the main field above the conductor, but opposes the main field below the conductor

The result is to increase the flux density in to the region directly above the conductor and to reduce the flux density in the region directly below the conductor. It is found that a force acts on the conductor, trying to push the conductor downwards as shown by the arrow. If the current in the conductor is reversed, the strengthening of flux lines occurs below the conductor, and the conductor will be pushed upwards.

Now consider a single turn coil carrying a current as shown in the above figure. in view of the reasons given above, the coil side A will be forced to move downwards, whereas the coil side B will be forced to move upwards. The forces acting on the coil sides A and B will be of same magnitude. But their direction is opposite to one another. As the coil is wound on the armature core which is supported by the bearings, the armature will now rotate. The commentator periodically reverses the direction of current flow through the armature. Therefore the armature will have a continuous rotation.

The conductors are wound over a soft iron core. DC supply is given to the field poles for producing flux. The conductors are connected to the DC supply through brushes

Let's start by looking at the overall plan of a simple 2-pole DC electric motor. A simple motor has 6 parts, as shown in the diagram below.

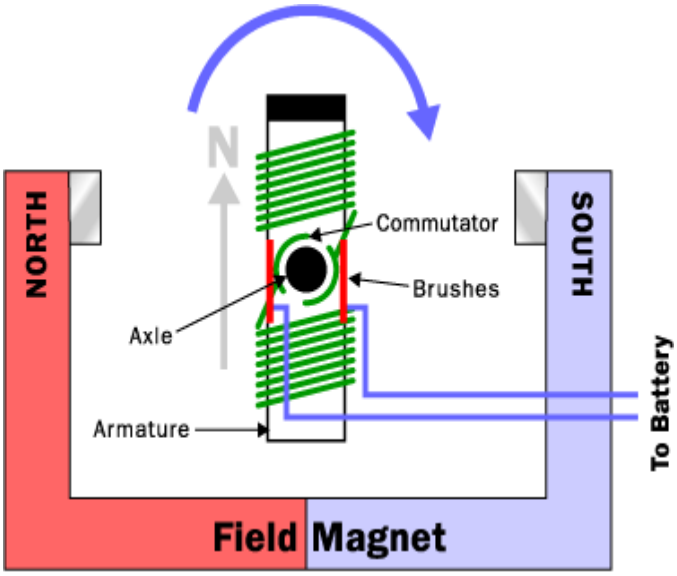

FIG 6.2:DC MOTOR

5.4 RELAY

The traditional method of switching current through a load, which requires isolation from the controlling circuit, involves the use of an electromechanical relay. Such devices offer a simple low cost solution to the problem of maintaining adequate isolation between the controlling circuit and the potentially lethal voltage associated with an a.c. main.

Relays offer many of the desirable characteristics of an ?ideal? switching device (notable a very low ? on? resistance and virtually infinite ?off? resistance coupled with a coil to contact break down voltage which is usually in excess of several KV). Unfortunately, relays also have several short comings.

Electromechanical relays have inherently low switching speed coupled with the contact bounce which occurs during the transitory state which occurs during the transitory state which, exists between the ?on? and ?off? conditions.

Further more electromechanical relays are, by virtue of their moving parts and open sets, are some what prone to failure when compared with their modern solid state counterparts.

6. WORKING PRINCIPLE

In our project, there are two set of IR sensor units are used to fit the two sides of the vehicle. This unit is used to activate/deactivate FM transmitter unit when there is any cracks in there path.
The IR transmitter and IR receiver circuit is used to sense the cracks. It is fixed to the front sides of the vehicle with a suitable arrangement.

AT NORMAL CONDITION:

The IR transmitter sensor is transmitting the infrared rays with the help of 555 IC timer circuit. These infrared rays are received by the IR receiver sensor. The Transistor T1, T2 and T3 are used as an amplifier section. At normal condition Transistor T5 is OFF condition. At that time relay is OFF, so that the vehicle running continuously.

AT CRACK CONDITION:

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. So the output of transistor T5 goes from OFF condition to ON stage. In that time the relay is ON position. In that time, the motor power supply is disconnected and switch on to the FM transmitter unit. The Fm receiver is fixed to the nearest station master, so that the alarm signal is given to the station master.

7. DESIGN

The main design considerations are,

- SPUR GEAR
- BEARINGS

1. SPUR GEAR:

Diameter of the motor gear wheel (D1) = 36 mm
Diameter of the Shaft Gear Wheel (D2) = 78 mm
Speed of the Motor (N1) = 30 RPM
Speed of the shaft wheel (N2) = (D1 / D2) x N1
= (36 / 78) x 30
= 14 RPM

2. BEARING:-

Bearing No. 6205
Outer Diameter of Bearing (D) = 35 mm

Thickness of Bearing (B) = 10 mm
Inner Diameter of the Bearing (d) = 15 mm

r_1 = Corner radii on shaft and housing
r_1 = 1 (From design data book)
Maximum Speed = 14,000 rpm (From design data book)
Mean Diameter (dm) = (D + d) / 2
= (35 + 15) / 2
dm = 25 mm
Spring index (C) = (D /d)
= 35 / 15
C = 2.33

WHAL STRESS FACTOR

Ks = 4C 1 + 0.65
4C 4 C
= (4 X 2.3) -1 + 0.65
(4 X 2.3)-4 2.3
Ks = 1.85

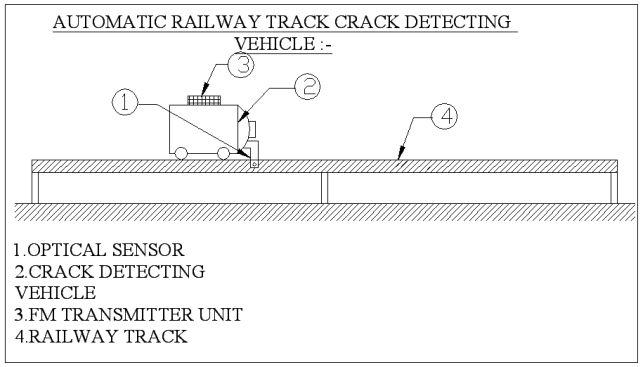

FIG 7.1 DESIGN

SPUR GEARS:

Spur gears are used to transmit power between parallel shafts. They impose only radial loads on their bearings. The tooth profiles are ordinarily curved in the shape of an involutes. Variations in centre distance do not affect the trueness of the gear in action unless the change is so great as to other jam the teeth into the root of the mating member or with draw the almost out of action. Spur-gear teeth may be hobbled, shaped, milled, drawn, sintered, cast, and shear-cut. They may be given a finishing operation such as grinding, shaving, lapping, rolling, and burnishing. Generally, there are more kinds of machine tools and processes available to make spur gears than to make any other gear type.

The spur gears, which are designed to transmit motion and power between parallel shafts, are the most economical gears in the power transmission industry.

8. ADVANTAGES

- The auto crack detection method is more efficient in the technical field
- Quick response is achieved
- Simple in construction
- Easy to maintain and repair
- Cost of the unit is less when compared to other
- No fire hazard problem due to over loading
- Comparatively the operation cost is less
- Continuous operation is possible without stopping
- Automatic alert system to the station master
- The signal transmission is wireless transmission.

9. APPLICATIONS

Automatic crack checking:-

The vehicle draws power from the battery. The optical sensor is used to detect the crack in the railway track. Suppose any crack in the track, the vehicle automatically stop and activates the FM transmitter circuit.

Cordless identification to the station master:-

This unit can also be used to intimate the nearest railway station. The FM receiver circuit is fixed in the room of the station master.

10. RESULT

The sensors sense the crack and send the information to the microcontroller, where it responds and gives the command to the particular component with predefined algorithm, the time parameters are crucial which can be easily changed and modified using microcontrollers. Thus,

this device would help to reduce the train collisions. The arrangement utilized aluminum frame kept in the form of tracks and the model was made to traverse it. We included a break manually and found that the device successfully detected that user-created crack and the current latitude and longitude values were received by the GPS receiver, converted into a suitable text format and then finally transmitted to a mobile phone by means of the GSM module. However, as the rail tracks did not contain any cracks, we were not able to test the GSM and GPS modules on field. But the previously mentioned simulated trial validates the project. Thus, the field trials indicate a fairly good degree of accuracy and also the GSM and GPS modules worked properly by transmitting the current latitude and longitude data to a mobile phone on detecting our simulated crack.

11. CONCLUSION

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between institution and industries.

We are proud that we have completed the work with the limited time successfully. The **AUTOMATIC RAILWAY TRACK CRACK DETECTING VEHICLE** is working with satisfactory conditions. We are able to understand the difficulties in maintaining the tolerances and also quality. We have done to our ability and skill making maximum use of available facilities.

In conclusion remarks of our project work, let us add a few more lines about our impression project work. Thus, we have developed an ***"AUTOMATIC RAILWAY TRACK CRACK DETECTING VEHICLE"*** which helps to know how to achieve low cost automation. The application of sensor produces accurate operation. By using more techniques, they can be modified and developed according to the applications.

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