Railway Track Crack and Break Detection System with Onboard Signalling

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ABSTRACT

A derailment occurs when a vehicle such as a train runs off its rails. This does not necessarily mean that it leaves its track. Although many derailments are minor, all result in temporary disruption of the proper operation of the railway system, and they are potentially seriously hazardous to human health and safety. Usually, the derailment of a train can be caused by a collision with another object, an operational error, the mechanical failure of tracks, such as broken rails, or the mechanical failure of the wheels. In emergency situations, deliberate derailment with derails or catch points is sometimes used to prevent a more serious accident. This paper proposes an advanced approach for the detection of cracks in the railway tracks. The principal problem with the present day system has been the lack of cheap and efficient technology to detect cracks on the railway tracks. If these deficiencies are not controlled at early stages they might lead to a number of derailments resulting in a heavy loss of life and property. The proposed rail crack detection system automatically detects the faulty rail track without any human intervention. This system comprises of GPS module, Signalling system, GSM module, IR sensors, Ultrasonic sensor to bring into operation the crack and object detection. There are many advantages with the proposed system when compared with the traditional detection techniques. The advantages include less cost, low power consumption and less analysis time. By this proposed system the exact location of the faulty rail track can easily be located which will be mended immediately so that many lives can be saved. We hope that our idea can be implemented in the long run to facilitate better safety standards and provide effective testing infrastructure for achieving better results in near future.

Keywords: *Derailment, GPS module, GSM module, IR sensors, Signalling System*

I.INTRODUCTION

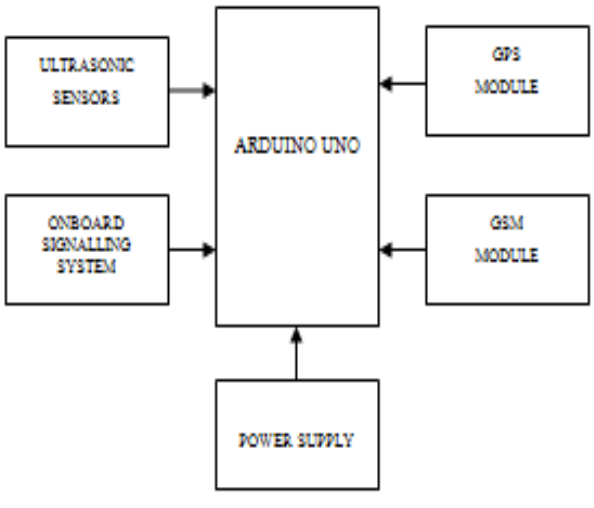
Transport is a key necessity for specialization that allows production and consumption of products to occur at different locations. Economic prosperity has always been dependent on increasing the capacity and rationality of transport. But the infrastructure and operation of transport has a great impact on the land and is the

largest drainer of energy, making Transport sustainability and safety a major issue. In India, it is found that rail transport occupies a prominent position in providing the necessary transport infrastructure to sustain and quench the ever-burgeoning needs of a rapidly growing economy.

Today, India possesses the fourth largest railway network in the world. However, in terms of the reliability and safety parameters, they have not yet reached truly global standards. The principal problem has been the lack of cheap and efficient technology to detect problems in the rail tracks and of course, the lack of proper maintenance of rails which have resulted in the formation of cracks in the rails and other similar problems caused by antisocial elements which jeopardize the security of operation of rail transport. This problem has led to a number of derailments resulting in a heavy loss

of life and property. Cracks in rails have been identified the main cause of derailments, yet there have been no cheap automated solutions available for testing purposes. Hence, owing to the crucial repercussions of this problem, the proposed system is on implementing an efficient and cost effective solution suitable for large scale application. This idea can be implemented in the long run to facilitate better safety standards and provide effective testing infrastructure for achieving better results in the future. Statistics to justify the problem: The Indian Railways today has 114,617 kilometers (70,598 mi).of total track over a route of 64,974 kilometers (49,752 mi) and 7,084 stations. The Indian railway network is the fourth largest railway network in the world. Our facilities are inadequate compared to the international standards. Approximately 60% of all the rail accidents have derailments as their cause. These cracks are unnoticed due to improper maintenance and irregular Manual track line monitoring that is being carried out. *A* derailment occurs when a vehicle such as a train runs off its rails. This does not necessarily mean that it leaves its track. Although many derailments are minor, all result in temporary disruption of the proper operation of the railway system, and they are potentially seriously hazardous to human health and safety. Usually, the derailment of a train can be caused by a collision with another object, an operational error, the mechanical failure of tracks, such as broken rails, or the mechanical failure of the wheels. In emergency situations, deliberate derailment with derails or catch points is sometimes used to prevent a more serious accident. This paper proposes an advanced approach for the detection of cracks in the railway tracks. The principal problem with the present day system has been the lack of cheap and efficient technology to detect cracks on the railway tracks.

If these deficiencies are not controlled at early stages they might lead to a number of derailments resulting in a heavy loss of life and property. The proposed rail crack detection system automatically detects the faulty rail track without any human intervention. This system comprises of GPS module, Signaling system, GSM module, IR sensors, Ultrasonic sensor to bring into operation the crack and object detection. There are many advantages with the proposed system when compared with the traditional detection techniques. The advantages include less cost, low power consumption and less analysis time. By this proposed system the exact location of the faulty rail track can easily be located which will be mended immediately so that many lives can be saved. We hope that our idea can be implemented in the long run to facilitate better safety standards and provide effective testing infrastructure for achieving better results in near future.



II.METHODOLOGY

Proposed approach is useful for railway department to reduce the effort for taking care of track and also the railway crossing management. Basically it consists of modules which are respect to the crack detection, obstacle detection, and railway crossing management.

Arduino Uno is the heart of the system which is based on the Microchip ATmega328P microcontroller architecture. It will interface with all other modules. Microcontroller receives the information from all the modules and processes the data for further uses. Whenever any problem occurs it will give the alerts to the railway department control station.LED and the seven segment display is used to display the robot status.

1] When the vehicle is Powered On, it moves along the model track. With the signaling system onboard. The ultrasonic sensors monitor the condition of the tracks.

2] When a crack is detected by the sensor the vehicle stops at once, the signal turns to red and the GPS receiver triangulates the position of the vehicle to receive the Latitude and Longitude coordinates from satellites.
3] The Latitude and Longitude coordinates received by GPS are converted into a text message.
4] The text message is further reported to the track maintenance department

1. Crack Detection IR sensor is used to detect the crack and send the information to the microcontroller. It analyses the input and makes robot to stop automatically my providing 0 volts to DC motor. The signal message is displayed on LED block of robot section. The position of robot is detected by GPS and information of latitude and longitude is sent to subscribe mobile station through GSM module.

2. Obstacle Detection ultrasonic sensor is used to detect the obstacle and sends the information to the microcontroller. It analyses the input, makes robot to stop automatically by providing 0 vo lt to DC motor. The signal message is displayed on LED signal block of robot sect ion. The posit io n o f robot is detected by GPS and information o f latitude and longitude is sent to subscribe mo bile station through GSM module.

3. Position Detection When the robot section detect any crack or obstacle GPS module get activated, then it find the latitude and longitude o f the posit ion where the crack or obstacle are found. Then through GSM module the location is sent to respected subscriber.

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Whenever any problem occurs it will give the alerts to the railway department control station.LED is used to display the robot status.

III.COMPONENTS USED

1. ARDUINO UNO

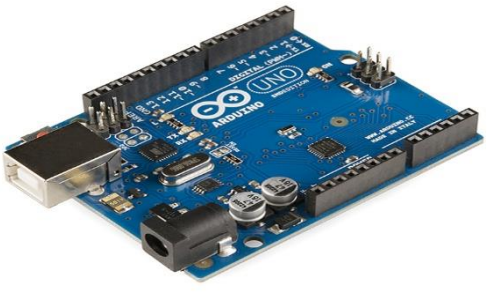

Fig: Arduino Uno microcontroller

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped wit h sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. The hardware reference design is distributed under a Creative Commons Attribution Share- Alike 2.5 license and is available on the Arduino website. Layout and

production files for some versions o f the hardware are also available. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0.The Uno board and version 1 .0 o f Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases.

2. ULTRASONIC SENSOR

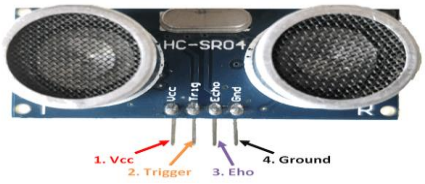

Fig : Ultrasonic sensor

The HC-SR04 Ultrasonic (US) sensor is a 4-pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively. This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is observed by the Ultrasonic receiver module.

Ultrasonic sensors are a type of acoustic sensor divided into three broad categories: transmitters, receivers and transceivers. Transmitters convert electrical signals into ultrasound, receivers convert ultrasound into electrical signals, and transceivers can both transmit and receive ultrasound. In a similar way to radar and sonar, ultrasonic transducers are used in systems which evaluate targets by interpreting the reflected signals. For example, by measuring the time between sending a signal and receiving an echo the distance of an object can be calculated. Passive ultrasonic sensors are basically microphones that detect ultrasonic noise that is present under certain conditions. Ultrasonic probes and ultrasonic baths apply ultrasonic energy to agitate particles in a wide range of materials.

3. GSM Module

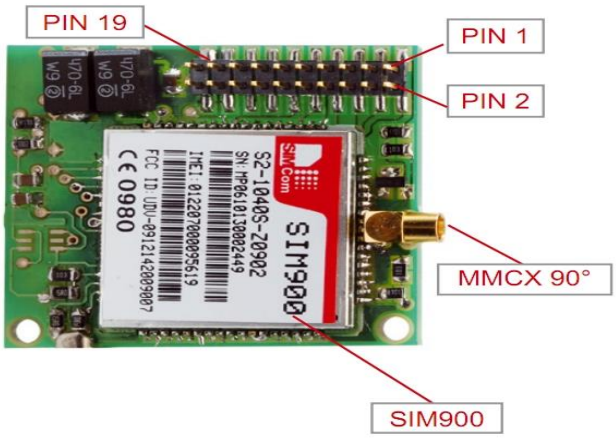

Fig : GSM Module

GSM is a mobile communication modem; it is stands for global system for mobile communication (GSM). The idea of GSM was developed at Bell Laboratories in 1970.

It is widely used mobile communication system in the world. GSM is an open and digital cellular technology used for transmitting mobile voice and data services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands. GSM system was developed as a digital system using time division multiple access (TDMA) technique for communication purpose. A GSM digitizes and reduces the data, then sends it down through a channel with two different streams of client data, each in its own particular time slot. The digital system has an ability to carry 64 kbps to 120 Mbps of data rates. There are various cell sizes in a GSM system such as macro, micro, Pico and umbrella cells. Each cell varies as per the implementation domain. There are five different cell sizes in a GSM network macro, micro, pico and umbrella cells. The coverage area of each cell varies according to the implementation environment.

4. GPS Module

Fig: GPS Module

GPS stands for Global Positioning System by which anyone can always obtain the position information anywhere in the world. Firstly, the signal of time is sent from a GPS satellite at a given point. Subsequently, the time difference between GPS time and the point of time clock which GPS receiver receives the time signal will be calculated to generate the distance from the receiver to the satellite. The same process will be done with three other available satellites. It is possible to calculate the position of the GPS receiver from distance from the GPS receiver to three satellites. However, the position generated by means of this method is not accurate, for there is an error in calculated distance between satellites and a GPS receiver, which arises from a time error on the clock incorporated into a GPS receiver. For a satellite, an atomic clock is incorporated to generate on-the-spot time information, but the time generated by clocks incorporated into GPS receivers is not as precise as the time generated by atomic clocks on satellites. Here, the fourth satellite comes to play its role: the distance from the fourth satellite to the receiver can be used to compute the position in relations to the position data generated by distance between three satellites and the receiver, hence reducing the margin of error imposition accuracy.

5. Seven Segment Display

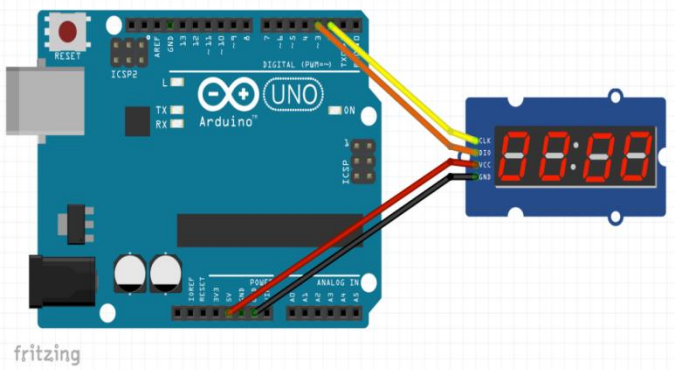

Fig: Seven Segment Display Module

A seven-segment display (SSD), or seven-segment indicator, is a form of electronic display device for displaying decimal numerals that is an alternative to the more complex dot matrix displays. Seven-segment displays are widely used in digital clocks, electronic meters, basic calculators, and other electronic devices that display numerical information.

6. LED for Signaling

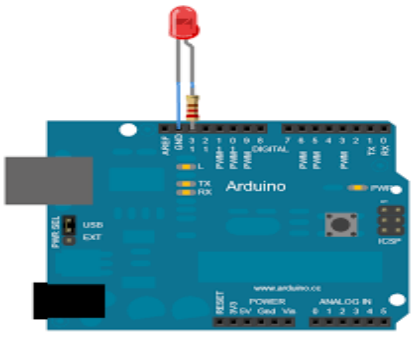

Fig: LED Module

A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. When a current flows through the diode, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence. The color of the light (corresponding to the energy of the photons) is determined by the energy band gap of the semiconductor. White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device. Early LEDs were often used as indicator lamps, replacing small incandescent bulbs, and in seven-segment displays. Recent developments have produced white-light LEDs suitable for room lighting. LEDs have led to new displays and sensors, while their high switching rates are useful in advanced communications technology. LEDs have many advantages over incandescent light sources, including lower energy consumption, longer lifetime, improved physical robustness, smaller size, and faster switching.

7. DC Motors

Fig: DC Motors

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields.

14. IR Sensor

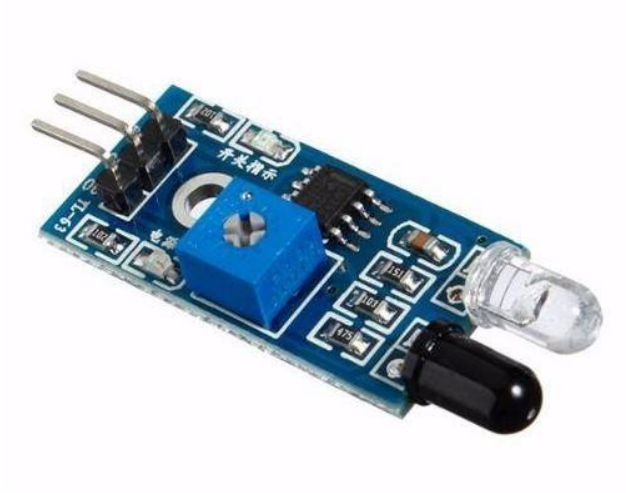

Fig: IR Sensor

An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor.

IV.CONCLUSION

By utilizing this autonomous vehicle will help in preventing train accidents.
The areas where manual examination in thick forest areas can be effortlessly done utilizing this vehicle. This will help in maintaining and observing the state of railroad tracks with no mistakes and thereby keeping up the tracks in good condition. The solar panel is an additional preferred standpoint, which helps rationing the power asset. The cost of the proposed system is very less. It also checks surface and near surface of the cracking position. Transmitting signals are immediately transferred and accidents are reduced. It can work in any terrain 24*7 and detects cracks accurately. The system is robust and rugged to environmental changes. As more relevant data is acquired it is expected that the present system may assist loco pilot in averting accidents effectively. Since robot is made up of sensor unit it may get damaged anywhere while detecting and power consumption is more. The project is developed and designed to improve rail track management. The main aim of project is to reduce man power. By using this project we can detect crack in railway track and obstacle on the track. In the proposed method IR sensor is used to detect the crack and UV sensor is used to detect object on the track.

The robotic section continuously checks the crack and obstacle. Location of crack and obstacle is detected by GPS and then send to authority by GSM. The system can be operated in tunnel without any interruptions. By utilizing this autonomous vehicle will help in preventing train accidents. The areas where manual examination in thick forest areas can be effortlessly done utilizing this vehicle. This will help in maintaining and observing the state of railroad tracks with no mistakes and thereby keeping up the tracks in good condition. The solar panel is an additional preferred standpoint, which helps rationing the power asset. The cost of the proposed system is very less. It also checks surface and near surface of the cracking position. Transmitting signals are immediately transferred and accidents are reduced. It can work in any terrain 24*7 and detects cracks accurately. The system is robust and rugged to environmental changes. As more relevant data is acquired it is expected that the present system may assist loco pilot in averting accidents effectively. Since robot is made up of sensor unit it may get damaged anywhere while detecting and power consumption is more. The project is developed and designed to improve rail track management. The main aim of project is to reduce man power. By using this project we can detect crack in railway track and obstacle on the track. In the proposed method IR sensor is used to detect the crack and UV sensor is used to detect object on the track. The robotic section continuously checks the crack and obstacle. Location of crack and obstacle is detected by GPS and then send to authority by GSM. The system can be operated in tunnel without any interruptions.

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