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Robust Railway Crack Detection Scheme Using Led-Ldr Assembly

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ABSTRACT:

The Transportation of train always depends on railway tracks (rails) only. If there is a crack in these rails, it creates a major problem. Most of the accidents in the train are caused due to cracks in the railway tracks, which cannot be easily identified. Also it takes more time to rectify this problem. In order to avoid this problem, we are using the crack detector robot, which detects the crack in the rails and gives an alarm.

A robot is an apparently human automation, intelligent and obedient but impersonal machine. It is relatively, that robots have started to employ a degree of Artificial Intelligence (AI) in their work and many robots required human operators, or precise guidance throughout their missions. Slowly, robots are becoming more and more autonomous.

This system involves the design of crack finding robot for finding cracks in railway tracks. This system uses controller for interfacing the robotic vehicle and crack detection sensor. The sensing device senses the voltage variations from the crack sensor and then it gives the signal to the microcontroller.

The microcontroller checks the voltage variations between measured value and threshold value and controls the robot according to it. The robotic model is interfaced with the microcontroller with the help of SPDT relays and driver IC. If any crack occurs in the rail, the robot will be stopped and then an alarm will be raised.

Keywords:

Railway track, crack detection, ARM, GSM, GPS, Automatic Rail crack detection, GPRS.

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, making transport sustainability and safety a major issue.

In India, we find 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.The Indian railway network today has a track length of 113,617 kilometers (70,598 mi).over a route of 63,974 kilometers (39,752 mi) and 7,083 stations. It is the fourth largest railway network in the world exceeded only by those of the United States, Russia and China.

The rail network traverses every length and breadth of India and is known carry over 30 million passengers and 2.8 million tons of freight daily. Despite boasting of such impressive statistics, the Indian rail network is still on the growth trajectory trying to fuel the economic needs of our nation. In terms of the reliability and safety parameters, we have not yet reached truly global standards.

Though rail transport in India growing at a rapid pace, the associated safety infrastructure facilities have not kept up with the aforementioned proliferation. 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 lives and property as well. 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 anti-social elements which jeopardize the security of operation of rail transport.

II.RELATED WORK:

In general, there exist three main categories of techniques currently used for damage identification and condition monitoring of Railway tracks. These include:

• Visual inspections

• Non-destructive testing (NDT) technologies such as acoustic emissions or ultrasonic methods, magnetic field methods, radiography, eddy current techniques, thermal field methods, dye penetrate, fiber optic sensors of various kinds

• Vibration-based global methods. Visual inspection is the primary technique used for defect identification in tracks, and is effectively used in specialized disciplines. The successful implementation of this method generally requires the regions of the suspected damage to be known as a first step, and be readily accessible for physical inspection. As a result, this method can be costly, time consuming and ineffective for large and complex structural systems such as the rail track. An NDT technique has resulted in a number of tools for us to choose from. Among the inspection methods used to ensure rail integrity, the common ones are ultrasonic inspection and eddy current inspection. Ultrasonic Inspections are common place in the rail industry in many foreign countries. It is a relatively well understood technique and was thought to be the best solution to crack detection. The Ultrasonic Broken Rail Detector system is the first and only alternative broken rail detection system developed, produced and implemented on a large scale. By using ultrasonic Broken Rail Detector system railway operators will have the benefit of monitoring rails continuously for broken rails without human intervention. This will contribute to ensure that the people do not suffer losses as a result of train derailments. Ultrasonic's can only inspect the core of materials; that is, the method cannot check for surface and near-surface cracking where many of the faults are located.

Fig. Ultrasonic Broken Rail Detector

Another method for detection of cracks on tracks is by using wireless sensor networks. In this method the detection of Cracks can be identified using IR rays with the IR transmitter & receiver.IR receiver is connected to the Signal Lamp or Electrified lamp with the IR sensor.

CAN controller is connected to the main node and it send the information via GSM and transmit the message to engine and to the nearest station. The detection of Cracks can be identified using IR rays and IR sensor.IR receiver is connected to the signal lamp and to the CAN controller.

The electrified lamp is nothing but it sides of the tracks the electric lamp which is current flowing for the engines transportation. But this type of system doesn't locate small cracks and the system is also costly.

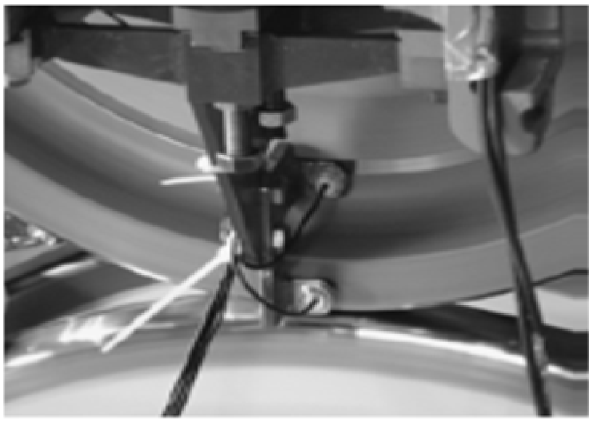

Fig. Model Figure to Fix the IR Sensor on the Wheel

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III. DESIGN ISSUES INHERENT TO INDIAN SCENARIO:

A literature survey on the existing techniques for crack detection revealed a number of sophisticated and accurate crack detection technologies. Whilst techniques based on ultrasonic imaging, IR method and electromagnetic detection offer several advantages, when their applicability for large scale implementation in the current Indian scenario was considered, they were found to lack robustness and practicality in a number of aspects.

a) First, in the Indian rails, typically there are small gaps in the rail tracks to provide for thermal expansion during the summer. This design is provided so as to ensure that the track does not twist or crack due to the heat. When the existing technique of crack detection was implemented, it was found that the system was giving false positive signals; that is, it was counting the thermal gaps as cracks. b) Another issue faced during practical implementation is the presence of railway bifurcations. If the mechanical design of the robot is unsuitable, then it will have a tendency to either get stuck in these bifurcations or in worst case even fall out of the tracks.

c) During the designing of prototype for actual on-field implementation, the problem of presence of debris on the outsides of the tracks was encountered. Though this problem seemed trivial, the effects of dirt on our robot wheels could have been substantial. In addition, as the proposed design utilized a LED-LDR based design, the ambient light intensity variations imposed extreme challenges to our design concept.

IV. PROPOSED RRCD SCHEME:

In the process of designing the prototype, Hyderabad's Central Railway System, South Line, which runs between Kachiguda to Medchal spanning a total of 29 Kms, was considered as the testing and usage area. This railway line doesn't operate between 1:00 am to 3:00 am. This gives us a two hour window during which the robot has to traverse the railway line looking for cracks. Figure illustrates the overall conceptual design of the proposed scheme. To ensure robustness, repeatability and easy implementation, the principle idea has been kept very simple.

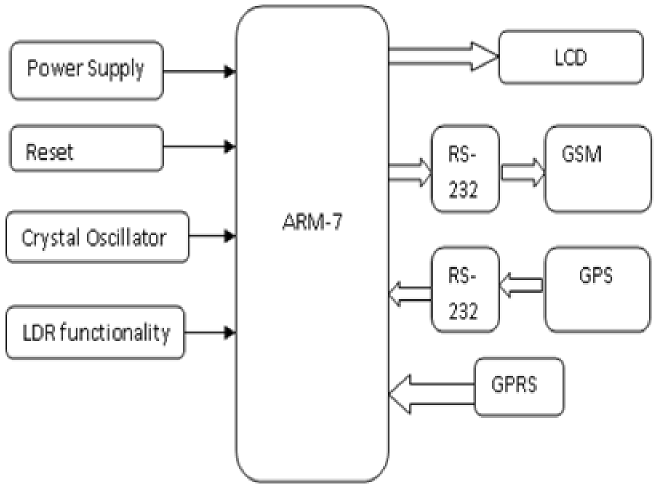

Fig: Block Diagram of Proposed System

The core of the proposed crack detection scheme consists of a Light Emitting Diode (LED)-Light Dependent Resistor (LDR) assembly that functions as the rail crack detector. 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 function of the GSM module being used is to send the current latitude and longitude data to the relevant authority as an SMS. The aforementioned functionality has been achieved by interfacing the GSM module, GPS module and LED-LDR arrangement with a microcontroller. The robot is driven by four DC motors.

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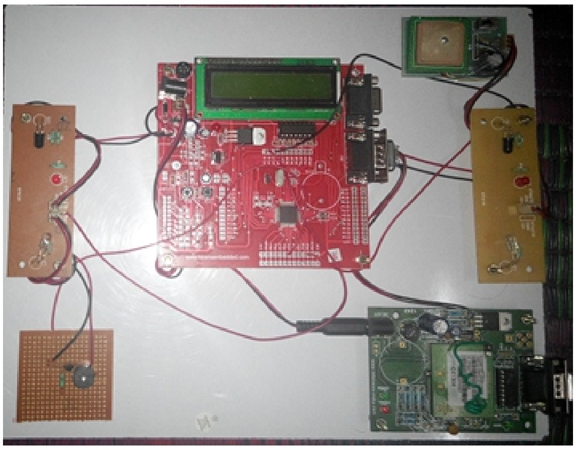

Fig: Proposed system Design

Before the start of the railway line scan the robot has been programmed to self-calibrate the LED-LDR arrangement. It is necessary because the LDR has a natural tendency to show a drifting effect because of which, its resistance under the same lighting condition may vary with time. After calibration, the robot waits for a predetermined period of time so that the onboard GPS module starts reading the correct geographic coordinate. This is necessary because any GPS module will take some time to synchronize with the satellites.

V. ELECTRICAL DESIGN:

A. Microcontroller:

An ARM-7 microcontroller forms the brain of the scheme. This board has been chosen for two important reasons other than the fact that it is cost effective. First, the ARM-7 32-bit ARM7TDMI-S microcontroller with In-System Programming/In-Application Programming (ISP/IAP) via on-chip boot loader software. Single flash sector or full chip erases in 400 ms and programming of 256 bytes in 1 ms. Secondly it has more number of pins when compared to other controllers to interface the required peripherals. The detailed description about how various components have been interfaced with ARM-7 is also discussed hereafter.

B. GPS module:

EM-406 GPS receiver has been used as the GPS module. It follows NMEA convention. With a baud rate of 9600 bps, 1Hz update rate and 1 sec hot start time, the properties of the said module was found to ideally match the requirements. It is interfaced with ARM-7 using the UART0.

C. GSM module:

The SIM 900 GSM module has been chosen to achieve the SMS functionality. Since the ARM-7 has two UART ports, it was easy to connect the two modules to the two ports of the ARM-7 ports. Here the GSM module is connected to the UART1 port. The overall electrical design of the RRCDS has been shown in Figure 2.

D. DC Motors:

To traverse a distance of 22 Km in 4 hrs, an average speed of 1.5 meters/sec is needed. The proposed design uses 4 DC motors (Torque Rating: 10Kg and Speed Rating: 500 rpm) interfaced with the ARM-7 using H-Bridges. With a wheel diameter of 5.2 cm and the total mass of around 5 Kg the approximate speed of the robot is around 0.5 metres/sec.

E. LED-LDR Assembly:

The common 5V LED and cadmium sulphide LDR was found to be sufficient. The LED is powered using one of the digital pin of the ARM-7. The LDR and a 45kΩ resistor form a potential divider arrangement. The output of the potential divider is given to one of the analog input channel of the ARM-7. The LDR is calibrated every time the robot is used. To compensate for the ambient light we use the concept of dead band.

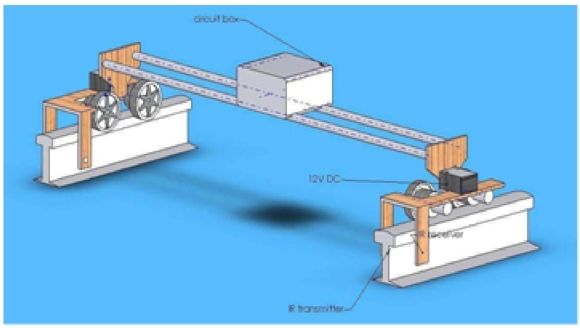

Fig: Proposed system overview

VII. PROPOSED SYSTEM RESULTS

The crack was detected exactly at a distance of 200 meters. This is exactly the distance at which the crack was created. The system exact location of the faulty rail track can easily be located. We will get the exact crack location located by GPS as Longitude & Latitude and then GSM will send the SMS to target number.

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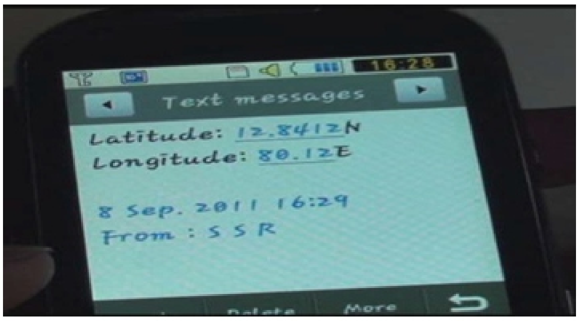

Fig: Message received from GSM module

VIII. CONCLUSION :

It is used for damage identification and condition monitoring of Railway tracks.That their idea can be implemented in large scale in the long run to facilitate better safety standards for rail tracks we have presented the rationale, design of our robust LED-LDR based railway crack. The authors hope that their idea can be implemented in large scale in the long run.

The project has been successfully designed and tested. Integrating features of all the hardware components used have developed it. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly, using highly advanced IC's and with the help of growing technology the project has been successfully implemented.

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