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Railway Track Crack Detection Using LED-LDR Assembly

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Abstract—In India rail transport occupies a prominent position in providing the necessary transport infrastructure to sustain 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, we have not yet reached truly global standards. The main problem about a railway analysis is detection of cracks in the structure. 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. This paper proposes a cost effective solution to the problem of railway track crack detection utilizing LED-LDR assembly which tracks the exact location of faulty track which then mended immediately so that many lives will be saved.
Keywords: Railway track, crack detection, ARM, GSM, GPS, Auto matic 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. Today, India possesses the fourth largest railway network in the world. However, in terms of the reliability and safety parameters, we 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 anti-social elements which jeopardize the security of operation of rail transport. In the past, this problem has lead to a number of derailments resulting in a heavy loss of life and property. Cracks in rails have been identified to be the main cause of derailments in the past, yet there have been no cheap automated solutions available for testing purposes. Hence, owing to the crucial repercussions of this problem, we have worked on implementing an efficient and cost effective solution suitable for large scale application. 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 the future.

Statistics to justify the problem:

The Indian Railways today has 113,617 kilometers (70,598 mi).of total track over a route of 63,974 kilometers (39,752 mi) and 7,083 stations. It has the world's fourth largest railway network after those of the United States, Russia and China. The railways traverse the length and breadth of the country and carry over 30 million passengers and 2.8 million tons of freight daily. It is the world's second largest commercial or utility employer, with more than 1.36 million employees. Despite boasting such impressive figures, we find that Indian rail network is still on the growth trajectory trying to fuel the economic needs of our nation. Though we find 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 poor when compared to the international standards and as a result, we have been having frequent derailments that have resulted in severe

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loss of valuable human lives and also property. To demonstrate the gravity of the problem, statistics say that there have been 11 accidents in 2011 till the month of july alone, which leaves much to be desired regarding rail safety. On further analysis of the factors that cause these rail accidents, recent statistics reveal that approximately 60% of all the rail accidents have derailments as their cause, of which about 90% is due to cracks on the rails either due to natural causes (like excessive expansion due to heat) or due to anti- social elements. These cracks and other problems with the rails generally go unnoticed due to improper maintenance and the currently irregular and manual track line monitoring that is being carried out in the current situation.

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 penetrant, fibre 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 [3]. NDT techniques have 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 [6].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 does not suffer losses as a result of train derailments [10].Ultrasonic scan 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[6].

Fig.1 Ultrasonic Broken Rail Detector

Survey of contemporary solutions:

The prompt detection of the conditions in rails that may lead to a crack or rather a break now plays a critical role in the maintenance of rails worldwide. The understanding of these mechanisms is constantly improving and the evolution of a range of complementary (Non Destructive Testing) NDT techniques has resulted in a number of tools for us to choose from.. However, 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. Eddy currents are used to tide over this limitation associated with ultrasonic's. They are effectively used to check for cracks located at the surface of metals such as rails. Further, (Magnetic Particle Inspection) MPI is also used in the rail industry but there are a number of problems inherent with this technique, some of which are mentioned below:

• Surface of the rail or component must first be cleaned of all coatings, rust and so on.

• To get a sensitive reading, contrast paint must first be applied to the rail, followed by the magnetic particle coating.

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• The same inspection must then be carried out in two different directions at a very slow overall speed. However, in the Indian scenario, we find that the visual form of inspection is widely used, though it produces the poorest results of all the methods. It is now becoming widely accepted that even surface cracking often cannot be seen by the naked eye.

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 [2],[9].But this type of system doesn't locate small cracks and the system is also costly.

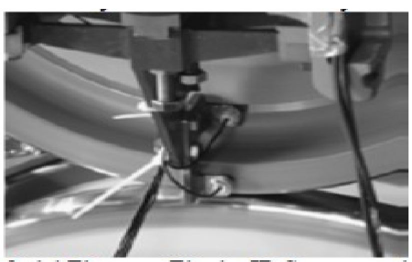

Fig.2 Model Figure to Fix the IR Sensor on the Wheel

Fig.3 Signal Lamp Example

III. CURRENT SYSTEM

In the Current System the principle involved in crack detection is the concept of LDR (Light dependent Resistor). 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 robot is driven by four DC motors. With this current system only latitudes and longitudes of the broken track will only be received so that the exact location cannot be known [6].

IV .PROPOSED MODEL

The proposed system will overcome the limitations of both the traditional and the current system that are using for detection of faulty tracks. In the current system we don't get the exact location of the faulty track. We only receive latitudes and longitudes of the location. In the proposed system we are using Gprs module so that we can get the exact location of the broken rail track. In this proposed system we are also using ARM7 controller which consumes low power and also less cost. By using the ARM controller the analysis time of the proposed will be reduced drastically. 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

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coordinate. This is necessary because any GPS module will take some time to synchronize with the satellites.

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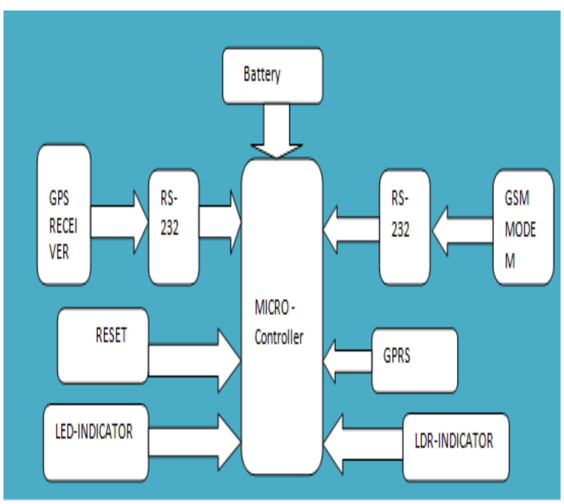

Fig.4 Automatic Broken Rail Detection Scheme using LED-LDR Assembly

A. System Architecture

The proposed rail track detection system architecture consists of ARM7 controller, GPS, GSM, LED-LDR Assembly, and GPRS, DC Motor.

B. Operation

This section explains the operation of modules present in the faulty rail track detection system architecture

1) MicroController: The microcontroller used in this system is LPC2148 microcontroller that is based on a 32/16 bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combines the microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB.Due to their tiny size and low power consumption, LPC21418 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. A blend of serial communications interfaces ranging from a USB 2.0 Full Speed device, multiple UARTs, SPI, SSP to I2Cs, and on chip SRAM of 8 kB up to 40 kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power [14].

2) GPS Module: SR-92 GPS receiver has been used as the GPS module. SR-92 is a low-power, ultra-high performance, easy to use GPS smart antenna module based on SiRF's third generation single chip. The 5-pin I/O interface is then connected to the main board with either connector or wire soldering. The main features of GPS module includes

- High tracking sensitivity of -159dBm
- Low power consumption of 40mA at full tracking
- Built-in backup battery allowing hot/warm starts and better performance
- Hardware power saving control pin allowing power off GPS via GPIO [8].

3) GSM Module: The SIM 300 GSM module has been chosen to achieve the SMS functionality. Featuring an industry-standard interface, the SIM300 deliversGSM/GPRS900/1800/1900Mhz performance for voice, SMS, data and Fax in a small form factor and with low power consumption. The leading features of SIM300 make it deal fir virtually unlimited application, such as WLL applications, M2M application, handheld

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devices and much more[13]. The GSM Playground can be used for:

• Security devices - listening of protected area, scanning of sensors, controlling of door lock or klaxon, measurement of ambient temperature, remote controlling of other devices using SMS or DTMF signal, remote shouting at a burglar using embedded amplifier.

• Domestic automation - remote opening of doors or gates using DTMF or just a call, switching of lights or sauna, controlling of heating, hands free voice communication with somebody at home, emergency

***4) 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 controller. 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. The LDR is calibrated every time the robot is used. The light dependent resistor or cadmium sulfide (CdS) cell is a resistor whose resistance decreases with increasing incident light intensity.

***5) GPRS Module*:** In this system the Gprs module is used to know the exact location of the broken rail track. The GSM modem sends the coordinates of the faulty rail track to the GPRS which then sends the exact location to the mobile

***6) DC Motor*:** The proposed design uses 4 DC motors (Torque Rating: 10Kg and Speed Rating: 500 rpm) interfaced with the ARM With a wheel diameter of 5.2 cm and the total mass of around 5 Kg[6]. The approximate speed of the robot is around 0.5 metres/sec.

Advantages of the Proposed System:

The currently existing technical solutions offered by many companies in the detection of cracks in rails involve periodic maintenance coupled with occasional monitoring usually once a month or in a similar timeframe. Our paper however possesses the inherent advantage of facilitating monitoring of rail tracks on a daily basis during nights when the usual train traffic is suspended. Further, we believe that the simplicity of our idea and the easy-availability of the components make our project ideal for implementation on a large scale with very little initial investment. The simplicity of our project ensures robustness of operation and also the design has been carefully modified to permit rugged operation. Another disadvantage that can be attributed to the conventional commercially available testing equipments is that they are heavy which poses a practical limitation. However, this important disadvantage has been rectified in our project as the design is simple and sensible enabling the device to be easily portable. While designing the mechanical parts of the robot, due consideration has been given to the variable nature of the tracks and the unique challenges posed by the deviations in the Indian scenario. For example, in areas near road-crossings the outer part of the track is usually covered with cement. Also, there is always the problem of rocks obstructing the path on the inside parts of the rails. The specialized wheels that have been provided in our robot have taken this into account and are specifically designed to overcome the aforementioned problem.

V.CONCLUSION

The proposed broken rail detection system automatically detects the faulty rail track without any human intervention. 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 mended immediately so that many lives can be saved.

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