A MICROCONTROLLER BASED STOUT ROBOT WITH AUTOMATIC CRACK DETECTION IN RAILWAY TRACKS USING LED-LDR ASSEMBLY

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Abstract— **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.**

In this paper 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.

Index Terms— **Railway Cracks, Microcontroller,GSM, Robot, LED-LDR.**

I. INTRODUCTION[1]

In general 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 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. 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.

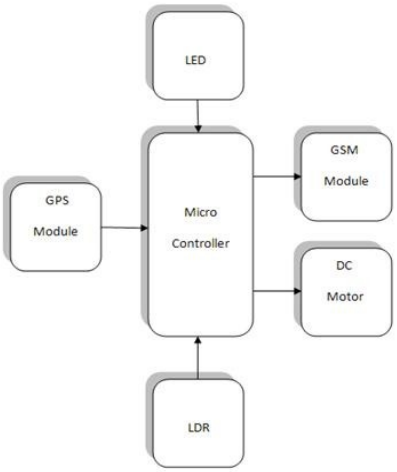

Figure 1. Block Diagram of Crack Detection System

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.

II. LITERATURE SURVEY

With the advent of powerful digital signal processors, Image Processing techniques [2] have been explored to formulate solutions to the problem of railway crack detection. Though it provides good accuracy, this method uses techniques like image segmentation, morphology and edge detection all of which take a lot of processing power and an extreme amount of time rendering the robot slow and thereby unsuitable. Recent research has investigated the use of microwave horn antennas for crack detection [3]. This technique was found to produce very accurate results in lab based testing. But, unfortunately it requires spectrum analyzers which are both costly and also can't be placed onboard a moving robot because of their delicacy. Eddy current based methods ([4], [5] and [6]) are used to tide over limitations associated with ultrasonics and microwave techniques. However they have the problem of very slow overall speed which reduces the usability of the same. A vast majority of the work done in the field of crack detection uses the infrared sensing technique ([7], [8] and [9]). It is a well understood technique so much so that it was

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initially thought to be the best solution to the problem of crack detection, but later it was found to be prone to external disturbances and hence came to be considered inaccurate. Techniques that employ ultrasonics ([10], [11] and [12]) tide over some of the problems mentioned earlier, but they can only inspect the core of the track; that is, it cannot check for surface and near surface cracking where most faults are usually located. Several other miscellaneous techniques like observation and analysis of wave propagation via model impacts and piezo actuation [13] have also been developed.

III. Proposed 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.

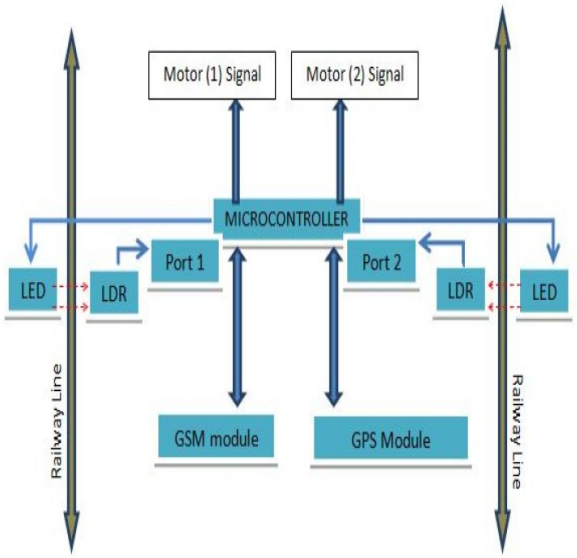

Figure 2. Technical block diagram of railway crack detection [1]

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. Microcontroller Unit

Microprocessors and microcontrollers are widely used in embedded systems products. Microcontroller is a programmable device

The microcontroller used in this project is AT89C51. Atmel Corporation introduced this 89C51 microcontroller. This microcontroller belongs to 8051 family. This microcontroller had 128 bytes of RAM, 4K bytes of on-chip ROM, two timers, one serial port and four ports (each 8-bits wide) all on a single chip. AT89C51 is Flash type 8051.

The present project is implemented on Keil Uvision. In order to program the device, Proload tool has been used to burn the program onto the microcontroller.The features, pin description of the microcontroller and the software tools used are discussed in the following sections.

FEATURES OF AT89C51:

- 4K Bytes of Re-programmable Flash Memory.
- RAM is 128 bytes.
- 2.7V to 6V Operating Range.
- Fully Static Operation: 0 Hz to 24 MHz.
- Two-level Program Memory Lock.
- 128 x 8-bit Internal RAM.
- 32 Programmable I/O Lines.
- Two 16-bit Timer/Counters.
- Six Interrupt Sources.
- Programmable Serial UART Channel.
- Low-power Idle and Power-down Modes.

Description:

The AT89C51 is a low-voltage, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash programmable memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer, which provides a highly flexible and cost-effective solution to many embedded control applications.

In addition, the AT89C51 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning. The power-down mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset.

V. GSM & LED-LDR Assembly

GSM (Global System for Mobile communication) is a digital mobile telephone system that is widely used in Europe and other parts of the world. GSM uses a variation of Time Division Multiple Access (TDMA) and is the most widely used of the three digital wireless telephone technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1,800 MHz frequency band.GSM was first introduced in 1991. As of the end of

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1997, GSM service was available in more than 100 countries and has become the *de facto* standard in Europe and Asia.

SMS CENTER

An SMS center (SMSC) is responsible for handling the SMS operations of a wireless network. When an SMS message is sent from a mobile phone, it will reach an SMS center first. The SMS center then forwards the SMS message towards the destination. An SMS message may need to pass through more than one network entity (e.g. SMSC and SMS gateway) before reaching the destination. The main duty of an SMSC is to route SMS messages and regulate the process. If the recipient is unavailable (for example, when the mobile phone is switched off), the SMSC will store the SMS message. It will forward the SMS message when the recipient is available.

Very often an SMSC is dedicated to handle the SMS traffic of one wireless network. A network operator usually manages its own SMSC(s) and locates them inside its wireless network system. However, it is possible for a network operator to use a third-party SMSC that is located outside the wireless network system. You must know the address of the wireless network operator's SMSC in order to use SMS messaging with your mobile phone. Typically an SMSC address is an ordinary phone number in the international format. A mobile phone should have a menu option that can be used to configure the SMSC address. Normally, the SMSC address is pre-set in the SIM card by the wireless network operator, which means you do not need to make any changes to it.

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].

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 devices and much more[13].

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.

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 meters/sec.

VI. RESULTS & CONCLUSIONS

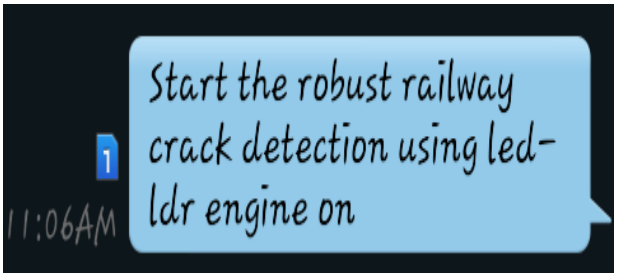

Figure 3. Message showing START of the Automatic Robot crack detection system

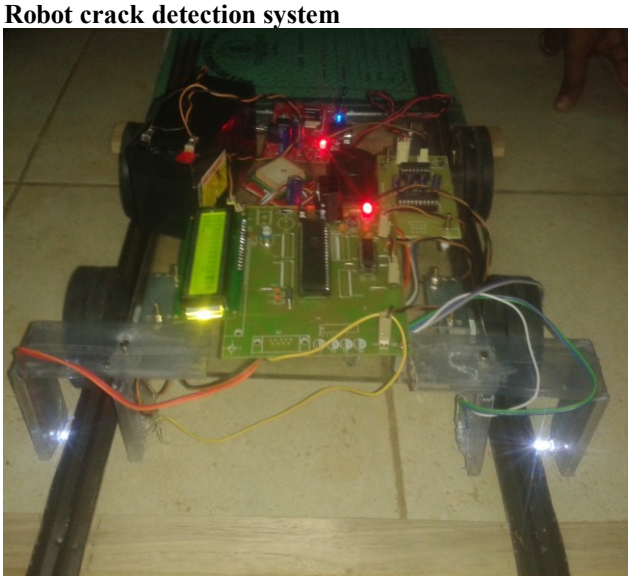

Figure 4.After receiving the message Robot start to move on the track

Figure 5. Showing the Crack in the Railway Track

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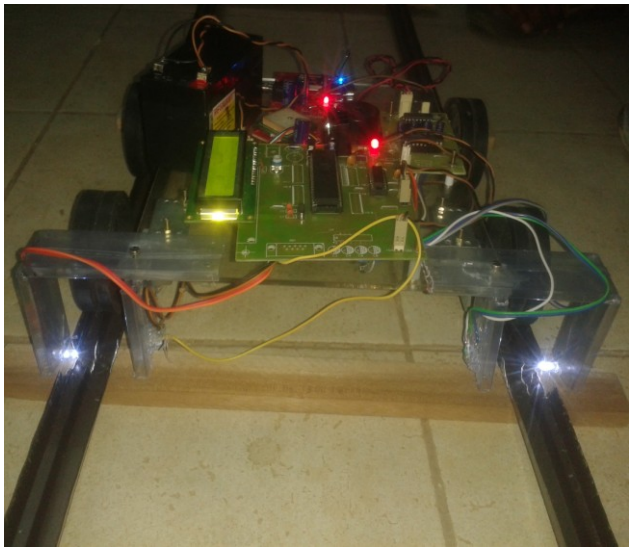

Figure 6. Showing that crack detected and LED rays are fallen on LDR sensing that crack is detected

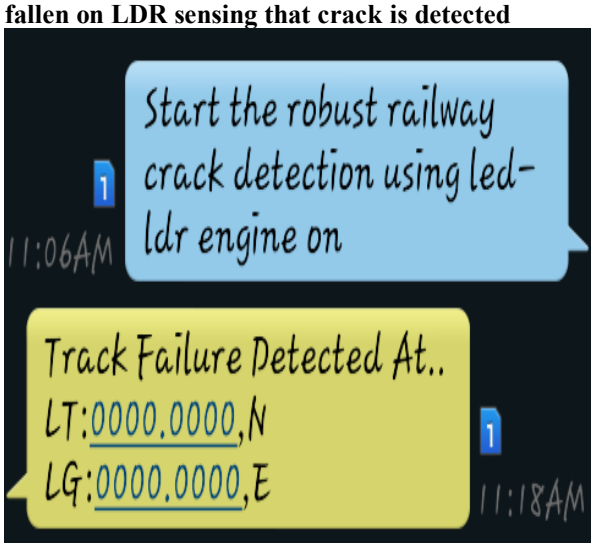

Figure 7.Message showing that track was failed and it is detected and message is received to the control room

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BIOGRAPHIES

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He has many accepted International Journals & Conferences in that one of the Research Paper entitled **"Design of Optimal Digital FIR Filter using Particle Swarm Optimization Algorithm"** with **DOI 10.1007/978-3-319-00951-3_31** was published in **The Fifth International Conference** on **Wireless & Mobile Networks(WIMO-2013),Turkey** which is in conjunction with Computational Science, Engineering and Information Technology **(CCSEIT-2013)** in a book title **Advances in Computational Science, Engineering and Information Technology** by **Springer International Publishing Switzerland June 2013**.

Many of his paper are indexed in **Academic Journal Database, Google Scholar, & DOAJ(Directory of Open Access Journals).** Recently he reviewed some research papers of International Journals like **IJCNC**, **(International Journal of Computer networks and Communication** & also he invited to review a paper from **International Journal of Research in Environmental Science and Toxicology(JREST).**

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He was **cordially invited** to be an **Editorial Board Member** of International Journal on Information Theory**(IJIT)ISSN : 2319 - 7609 (Online) ; 2320 – 8465 (Print)**Journal. and **PCM(Program Committee Member)** for the related conferences of **AIRCC**. A research paper entitled **"Implementation of Multi Swarm PSO Algorithm for Ripples Reduction in Digital FIR Low Pass Filter"** has **Accepted** for presentation in **ICCCCM 2013**(International Conference on Control Computing Communication & Materials).

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