

# Design and Implementation of Wireless Security System for Railway Tracks

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**Abstract---** This paper describes a system, basically an electronic system that can help us to detect the exact location of the crack which has been formed accidentally or due to the terrorist activities. In India railway transportation occupies a very important role for connecting the entire country via different routes in the hilly regions, deserts, plateaus and all other extreme climatic conditions found all across the country to meet the ever-burgeoning needs of the growing economy. India has the fourth rank in terms of railway network in the world but in terms of safety and other technical advancements we have not yet achieved the specific position in the world. In this paper we are implementing a system that can locate the exact location of the crack on the track which will help to reduce the rail accidents which often leads to heavy loss of life and property. Advanced Niyantaran is a cost effective solution to the problem of railway track crack detection utilizing IR sensor which tracks the exact location of faulty track and ultrasonic sensor which detects the obstacles in track which then quickly notified to the control room. So that many lives will be saved and the railways will not face any loss due to accidents hence creating a safer mode of transportation

**Keywords---** Railway Cracks, PIC microcontroller (16f886), GSM-A6, GPS, Mechanical model, IR and ultrasonic sensor.

## I.INTRODUCTION

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,<sup>1</sup> 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 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. The principal problem has been the lack of cheap and efficient technology to detect which jeopardize the security of operation of rail transport. In the past, this problem has led 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.

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The other main reasons for the accidents of Train are: 1. Train Derailment in curves and bends, 2. Running Train collisions with the Standing Train, 3. Train Accidents in Slopes, 4. Mis-signaling due to fog or Mist. There is no fruitful steps have been taken so far in these areas. This paper deals about one of the efficient methods to avoid train derailment. Also by using simple electronic components we tried to automate the control of railway in an embedded platform. The system has been implemented and demonstrated by using IR sensor and ultrasonic sensor with the help of microcontroller.

## 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. Non-destructive testing method provides different ways for detecting rail defects. From definition non-destructive testing is the testing of materials, without interfering in any way with the integrity of the material or its suitability for service. NDT techniques give number of tools or ways for people to choose. So various method of NDT are ultrasonic crack detection methods, magnetic particle inspection methods, radiography methods, eddy current techniques, thermal field methods, dye penetrant or liquid penetrant methods, fiber optic sensors of various kinds. Among all the available detection methods used to make sure rail integrity, the common ones are visual inspection, ultrasonic inspection and eddy current inspection. Among all the available methods Visual Inspection is the oldest and cheapest method. However, in case of Indian scenario, the visual form of inspection method is mostly used, though it produces the poorest results of all the available 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 ultrasonic 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]). It is a well understood technique so much so that it was 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 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.

## III. PROPOSED SYSTEM

In the Current System the principle involved in crack detection is the concept of IR (infra-red sensor). In the proposed design, the IR transmitter will be attached to one side of the rails and IR receiver to the opposite side. During normal operation, when there are no cracks, the transmitter light does not fall on the receiver. Subsequently, when the transmitter light falls on the receiver that means crack is detected.

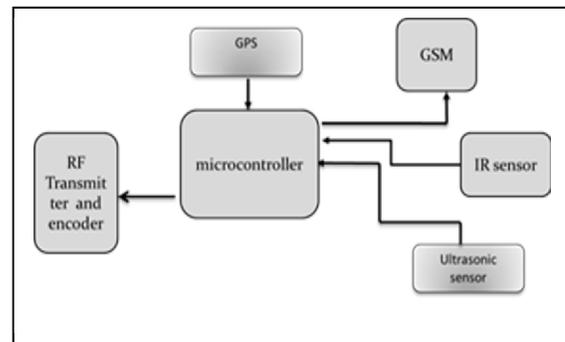


Figure 1. Block Diagram of Crack Detection System

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 can be known.



Figure 2. Technical railway crack detection system

(Advanced Niyrantran)

#### IV. MICROCONTROLLER UNIT

Microcontroller is a programmable device. The microcontroller used in this project is PIC microcontroller (16f886). This microcontroller has 368 bytes of RAM, 8192 flash(words), two timers, one serial port and four ports (each 8-bits wide) all on a single chip. The present project is implemented on Kiel Uvision. In order to program the device, Preload tool has been used to burn the program onto the microcontroller. High-Performance RISC CPU:

- Only 35 instructions to learn- All single-cycle instructions except branches
- Operating speed:- DC – 20 MHz oscillator/clock input- DC – 200 ns instruction cycle
- Interrupt capability
- 8-level deep hardware stack
- Direct, Indirect and Relative Addressing modes
- Special Microcontroller Features
- Precision Internal Oscillator:- Factory calibrated to  $\pm 1\%$  - Software selectable frequency range of 8 MHz to 31 kHz- Software tunable- Two-Speed Start-up mode- Crystal fail detect for critical applications- Clock mode switching during operation for power savings
- Power-Saving Sleep mode
- Wide operating voltage range (2.0V-5.5V)

#### V. COMPONENT SPECIFICATION

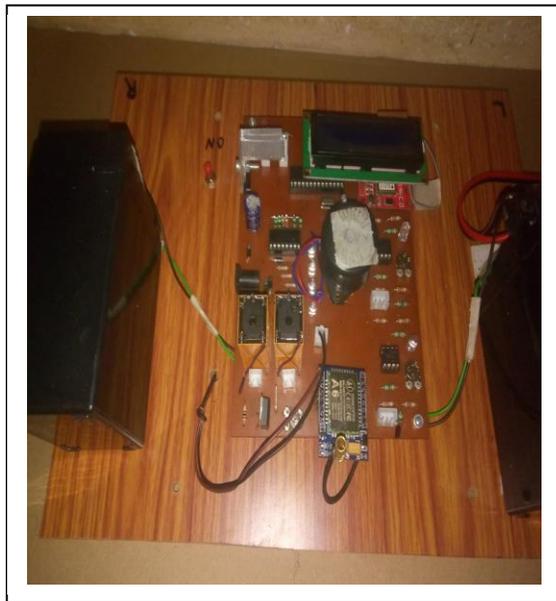


Figure 3. The heart of railway crack detection system

(Advanced Niyantran)

##### 1. 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



Figure 4. GPS Module

- 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]

##### 2. GSM MODULE:

The GSM –A6 module has been chosen to achieve the SMS functionality. Supports GPRS data services, the maximum data rate, download 85.6Kbps,upload 42.8Kbps Support standard GSM07.07,07.05 AT command and Ai Thinker extended commands.



Figure 5. GSM –A6 module

Supports 2 serial ports :download a serial port and AT command port .The leading features of GSM A6 make it deal fir virtually unlimited application, such as WLL applications, M2M application, handheld devices and much more.

##### 3 DC MOTOR:

The proposed design uses 4 DC motors (Torque Rating: 2Kg and Speed Rating: 100 rpm) interfaced with the PIC microcontroller with a wheel diameter of 5.2 cm and the total mass of around 5 Kg. The approximate speed of the robot is around 1 meter/minute

##### 4. RELAY DRIVER:

As during working process of the robot it does not require change of speed and for driving DC motors it requires 12V supply hence ULN2003 relay driver will convert the 5V supply of pic microcontroller into 12V power circuit. In proposed

system 12V relay driver is used to drive 12V DC motors. The relay driver is more reliable than the H-Bridge MOSFET circuit as some times due to high current surge the H- Bridge motor driver burns out resulting into the failure of budget. The ULN2003 converts the 5 volt supply of the microcontroller into 12V.

**5. OPERATIONAL AMPLIFIER**

The operational amplifier (op-amp) is a voltage controlled voltage source with very high gain. It is a five terminal four port active element. The power supply voltages  $V_{CC}$  and  $V_{EE}$  power the operational amplifier and in general define the output voltage range of the amplifier. The terminals labeled with the “+” and the “-” signs are called non-inverting and inverting respectively. The input voltage  $V_p$  and  $V_n$  and the output voltage  $V_o$  are referenced to ground.

**6. VOLTAGE REGULATOR**

Input sources 12 v battery, which is required for motors and relays .while the rest of the circuit need 5 v power supply, therefore LM7805 5v regulator is used to provide constant 5v to circuit

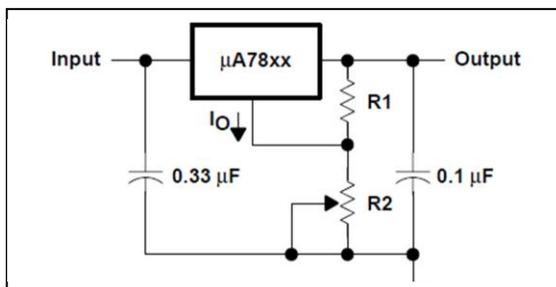


Figure 6. Voltage regulator circuit

The voltage regulator has 3-Terminal Regulators, Output Current up to 1.5 A, Internal Thermal-Overload Protection High Power-Dissipation Capability, Internal Short-Circuit Current Limiting, Output Transistor Safe-Area Compensation

**VI. RESULTS**

Sr.No.	Measured distance	Displayed distance through sms	Error
1	0.085m	0.09m	0.005
2	0.14m	0.15m	0.01
3	0.165m	0.17m	0.005

Table1: observations of crack distance detected

When the crack is detected on the track the text message is send to the preferred number by using the GSM and GPS service. The text message contains the latitude and longitude value of the place where the crack is detected. The infra-red sensor will verify the distance between two tracks. When the human or animal is on the track the ultrasonic sensor will detect the presence and stop the checking process till they move on. After they moved on the track it will continue the process.

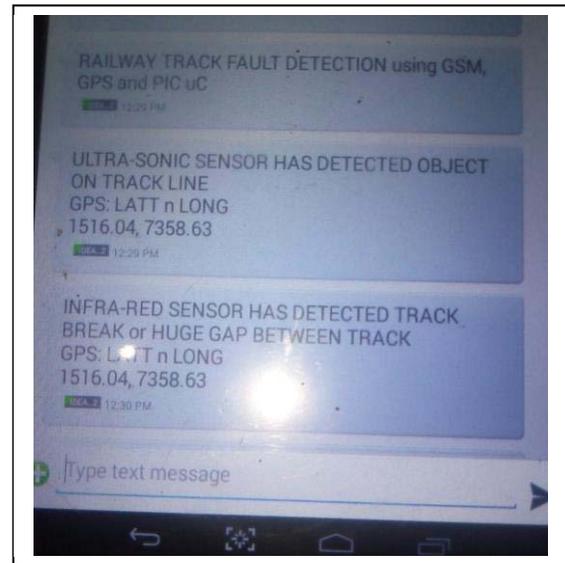


Figure 7. (1)Message showing the name of the system once the system starts, (2) detection of object on the track, (3) detection of crack on the track

**VIII. CONCLUSION**

Cracks in rails have been identified to be the main cause of derailments in the past. Hence, owing to the crucial solution of this problem, we have worked on implementing an efficient and cost effective solution suitable for this application. This 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

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### REFERENCES

1. Robust Railway Crack Detection Scheme (RRCDS) Using LED-LDR Assembly Selvamraju Somalraju, Vigneshwar Murali published in ICRTIT-2012.
2. Qiao Jian-hua; Li Lin-sheng; Zhang Jing-gang; "Design of Rail Surface Crack-detecting System Based on Linear CCD Sensor", IEEE Int. Conf. on Networking, Sensing and Control, 2008.
3. K. Vijayakumar, S.R. Wylie, J. D. Cullen, C.C. Wright, A.I. AISHamma'a, "Noninvasive rail track detection system using Microwave sensor", Journal of App. Phy., 2009.
4. Transverse crack detection in rail head using low frequency eddy currents, Patent US6768298, [www.google.com/patents/US6768298](http://www.google.com/patents/US6768298).
5. M. Cacciola, G. Megali, D. Pellicano, S. Calcagno, M. Versaci, and F. C. Morabito, "Rotating Electromagnetic Field for Crack Detection in Railway Tracks", PIERS ONLINE, Vol. 6, NO. 3, 2010.
6. Wojnarowski, Robert John Welles, II, Kenneth Brakeley Kornrumpf, William Paul, "Electromagnetic system for railroad track crack detection and traction enhancement", Patent US6262573, [www.patentstorm.us/patents/6262573/description.html](http://www.patentstorm.us/patents/6262573/description.html)
7. Richard J. Greene, John R. Yates and Eann A. Patterson, "Crack detection in rail using infrared methods", Opt. Eng. 46, 051013, May 2007
8. R.J. Greene, J.R. Yates, E.A. Patterson, "Rail Crack Detection: An Infrared Approach to In-service Track Monitoring", SEM Annual Conference 2006

### BIOGRAPHIES



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