# Broken Rail Detection System using RF Technology

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## Abstract

The system designed here performs the function of identifying the broken rails through wireless network. Broken rail/ track represents that either the glued joint (Fish plate) is removed or track is broken in any section. Detecting broken tracks through RF modules is the trend in such field and therefore these kinds of systems can be installed either in engine or in nearest railway station. If the system installed in running train, the engine driver can notice the fault in advance by which accidents can be avoided. The concept is to circulate some potential through a particular zone of railway track, as this zone contains many sections and all the sections tracks are joined with glued joints. If any section joint is removed, signal will not travel further, by which that particular section will be identified through processing unit and information will be transmitted through RF transmitter.

**Keywords** – Railway tracks, RF Communication, Microcontroller, 2x16 LCD

## I. INTRODUCTION

In India most of the commercial transport is being carried out by the railway network and therefore as any problem occurred during transportation the major damage is getting occurred to the economy non-withstanding a social life. This paper presents an implementation of an efficient and cost effective solution suitable for railway application. The Indian railway network today has a track length of 113,617 kilo-meters (70,598mi) over a route of 63,974 kilo-meters (39,752mi) and 7, 083 stations. It is the fourth largest railway networking 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 rail sand other similar problems caused by anti-social elements which jeopardize the security of operation of rail transport.

## A. What is meant by Rail Inspection?

Rail Inspection is the practice of examining rail tracks for flaws that could lead to catastrophic failures. According to the United States Federal Railroad Administration Office of Safety Analysis, track defects are the second leading cause of accidents in railways.

## B. How it Works?

This invention relates to a system and method of detecting a broken rail in a railway system. The track sensing circuitry of the present invention applies a voltage across the rails and then sensing that voltage at the far end of the block. A Broken rail will open the path and prevent voltage from reaching the far end of the block.

## II. LITERATURE SURVEY

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

- > Graphical inspections.
- Non-destructive testing technologies such as acoustic emissions or ultrasonic methods, magnetic field methods, radio graphic, eddy Existing techniques, thermal field methods, dye penetrate, fibre optic sensors of various kinds.
- Shuddering-based global methods.

## A. Existing Method

## 1) Composite Detection System

The composite detection System The composite detection system consists of a laser source, whose beam is collimated by a suited optic lens into a light plane, two 512X512 -pixel CCD cameras for complete optimum observation of the track, a digital processing system per camera, and a supervision system. The laser beam focused by the cylindrical lens as a thin plane enlightens the upper part of the railway track orthogonally to the track surface. The intersection of the plane is therefore the track profile (in the laser beam plane it is a two-dimensional line) which is observed by the CCD cameras. Each digital

processing system performs real-time profile filtering and extraction (in the CCD camera geometrical coordinates) by using a composite approach from images of the corresponding CCD camera. Besides, the profile is approximately lying in a linear direction, i.e., cutting the image in stripes. Only one point of the profile belongs to each stripe. This characteristic allows for parallel processing since each stripe can be analyzed independently to reach 10 ms image processing time without affecting the profile accuracy. In each column of the image localizing the position of the track profile means to find the position of the maximum laser reflection intensity. In the ideal case the intensity distribution along the column is Gaussian. Localizing the maximum implies therefore detecting the position of the expected Gaussian profile with the maximum likelihood.

To tackle this application, we tested both traditional filtering techniques with minimum-square approximation and neural network techniques. In the first case, results were quite poor due to the inability of capturing all nonlinearities and distortions. In the second case, the number of pixels to be processed in each column and the variety of the possible maximum light profile positions led to large inaccurate networks that are also difficult to train. It is worth noting that highly approximate localization of the area of interest in each image is quite trivial for the human observer, even without experience. Track profile localization does not need to take into account all details in the whole column, but only the area around the maximum lighting. Experiments have shown that no information out of a 40-pixel strip centred approximately on the maximum lighting is necessary for accurate reconstruction of the track profile. Besides, this area of interest corresponds approximately to the zone around the highestintensity Gaussian profile in the column. Such area can be easily found by identifying the maximum correlation of the light profile with the Gaussian reference: correlation can be effectively used. Finer localization of the maximum must deal with all non linearity's presented above, which are difficult to be captured algorithmically while they are easily described by examples. In the literature, neural networks were proved effective for this kind of task.



2) Crack Detection using Rayleigh wave-like Wideband Guided Ultrasonic Waves:

Ultrasonic inspection of rails is usually restricted to low speeds of around 20-30mph, which limits the viability of testing many tracks regularly. Furthermore many of the most serious defects that can develop in the rail head can be very difficult to detect using the currently available inspection equipment. One of the reasons for slow inspection speeds using conventional NDT is the need for coupling between the transducer and the track using either liquid or dry coupling materials. EMATs have been used 2,3 or suggested 4 to measure both rail tracks and wheels by other workers and the use of non-contact ultrasonic measurements are still being investigated by a number of international research groups. In this method we discuss the use of EMATs on rail for longitudinal and transverse crack defect detection and depth gauging. Ultrasonic surface waves that are similar in behaviour to Rayleigh waves are an obvious candidate for surface breaking crack detection. If a defect lies between the Rayleigh wave generator and detector then it will to some degree block the Rayleigh wave. The amplitude of a Rayleigh wave displacement decays with depth into the sample and most of the energy associated with a particular frequency lies within a depth equal to one wavelength at that frequency. Almost all of the energy lies within a depth corresponding to two wavelengths. The different frequency components will effectively probe to different depths below the sample surface. In a measurement where we attempt to propagate a Rayleigh wave through a region containing a surface breaking crack, the crack depth can be estimated by the amount of Rayleigh wave energy or amplitude that is transmitted through or underneath that region. Closed or partially closed cracks can obviously complicate the analysis and increase the amount of Rayleigh wave energy transmitted through the crack compared to an open crack.



Fig 2: Rayleigh Waves Around the Rail head to measure and Detect the Longitudinal tracks

#### III. PROPOSED METHOD

In the proposed system, the design is used to detect the broken rail and gives the exact information about the tracks. To prove the concept practically metal track is simulated over the wooden plank and it is divided into few sections, all the sections are numbered for identity and all the tracks are joined with small metal plates. If any section is isolated by removing the joint, immediately this information will

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be passed to the remote unit. Initially alarm will be raised in the receiver to alert the staff, and then broken track number will be displayed through an LCD interfaced with microcontroller. This system does not require the human intervention for the inspection of rails. In this design, the broken rails are detected by applying a voltage across the rails and sensing that voltage at the far end of the block. When the tracks are at good condition then the voltage reaches to the appropriate port of the microcontroller, these information is transmitted by RF transmitter (STT-433MHz) in digital form by Amplitude Shift Keying (ASK). The RF receiver (STR-433Mhz) is used in the receiver section in order to receive the transmitted data and the information regarding the track is displayed on the LCD. In case there is any fault in the tracks, the voltage does not pass through the tracks and the relevant information about the tracks is transmitted. In the receiver section, the LCD shows the track number which is removed or broken. The receiver is placed at the nearest station in order to alert the station staff with a buzzer which makes the trains not to pass by the route where the fault in the track is detected and this process is controlled by the railway signalling system. Here we can see the separate blocks of transmitter and receiver where different elements are interfaced by the microcontroller.



Fig. 3: Block Diagram of Transmitter Section



Fig. 4: Block Diagram of Receiver Section

#### IV. BLOCK DIAGRAM DESCRIPTION

The proposed broken rail detection system consists of 89C2051 controller, RF modules, regulated power supply, 2x16 LCD, buzzer and railway tracks.

#### A. Microcontroller

The AT89C2051 provides for 2k EPROM/ ROM, 128 byte RAM and 15 I/O lines. It also includes a universal asynchronous receive-transmit (UART) device, two 16-bit timer/ counters and elaborate interrupt logic. Lack of multiply and divide instructions which had been always felt in 8-bit microprocessors/micro controllers, has also been taken care of in the 89C51. The AT89C2051 is a lowvoltage, high-performance CMOS 8-hit microcomputer with 2K bytes of Flash programmable and erasable read-only memory (EPROM). The device is manufactured using ATMEL high-density non-volatile memory technology and is compatible with the industry-standard 83 MCS-51 instruction set. ATMEL AT89C2051 is a powerful micro-computer which provides a highly-flexible and cost-effective solution to many embedded control applications.

# B. RF Communication

## 1) What is RF?

Radio frequency (RF) is a frequency or rate of oscillation within the range of about 3 Hz to 300 GHz. This range corresponds to frequency of alternating current electrical signals used to produce and detect radio waves. Since most of this range is beyond the vibration rate that most mechanical systems can respond to, RF usually refers to oscillations in electrical circuits or electromagnetic radiation.

#### 2) Why RF?

RF is widely used because it does not require any line of sight, less distortions and no interference.

#### 3) **RF** transmitter:

OOK (On-Off Keying) modulation is a binary form of amplitude modulation. When a logical 0 (data line low) is being sent, the transmitter is off, fully suppressing the carrier. In this state, the transmitter current is very low, less than 1mA. When a logical 1 is being sent, the carrier is fully on. In this state, the module current consumption is at its highest, about 11mA with a 3V power supply. OOK is the modulation method of choice for remote control applications where power consumption and cost are the primary factors.

#### 4) **RF Receiver:**

The STR-433 uses a super-regenerative AM detector to demodulate the incoming AM carrier. A super regenerative detector is a gain stage with positive feedback greater than unity so that it oscillates. An RC-time constant is included in the gain stage so that when the gain stage oscillates, the gain will be lowered over time proportional to the RC time constant until the oscillation eventually dies.

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Detection is accomplished by measuring the emitter current of the gain stage. Any RF input signal at the frequency of the main oscillation will aid the main oscillation in restarting. If the amplitude of the RF input increases, the main oscillation will stay on for a longer period of time, and the emitter current will be higher. Therefore, we can detect the original baseband signal by simply low-pass filtering the emitter current.

## C. LCD (2x16):

A liquid crystal display (LCD) is a thin, flat display device made up of any number of colour or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular to each other. Many microcontroller devices use 'smart LCD' displays to output visual information. LCD displays designed around LCD NT-C1611 module, are inexpensive, easy to use, and it is even possible to produce a readout using the 5X7 dots plus cursor of the display. They have a standard ASCII set of characters and mathematical symbols. For an 8-bit data bus, the display requires a +5V supply plus 10 I/O lines (RS RW D7 D6 D5 D4 D3 D2 D1 D0). For a 4-bit data bus it only requires the supply lines plus 6 extra lines (RS RW D7 D6 D5 D4). When the LCD display is not enabled, data lines are tri-state and they do not interfere with the operation of the microcontroller.

#### V. CONCLUSION

The proposed method for broken rail detects automatically detects the fault track without any human intervention. There are many advantages with the proposed system when compared to traditional system. The advantages include low cost, low power consumption and less time analysis. By this method we can easily identify the exact location of fault track which helps in saving lives.

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## **Examples follow:**

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