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EFFECTS OF RADIO FREQUENCY WAVES FOR ANALYSING RAILWAY TRACK

Prof. S. Khandekar[1], Dr. Dewyani Patil[2], Mrs. Anuradha Lohar[3]

[1]Assistant Professor, [3]Project Scientist,[2]Student,

[1,3] Department of Electronics Engineering, MIT AOE, Pune, ,Savitribai Phule Pune University, Pune.

ABSTRACT

In rapidly growing countries like India train transportation is majorly used due to the cost effective solution of transportation. The train transportation depends on the rails or tracks. If there is break or crack or any other fault present over the track it creates a serious problem.. Railways track failure is big issue and to recognize the failure before the train travels on the same track is under development using Voltage Standing Wave Ratio technique. Project laid on development system for processing VSWR (Voltage standing wave ratio) signals received from VSWR meter. In the wireless transmission system the reflected power and voltage standing wave ratio figures are having importance related to its best performance.. These waves can be captured using VSWR meter/through line power meters and makes its online analysis. The electronic system is used to capture and further processing of signals.

The proposed system in this paper is used to rectify all these problems. Typically this paper gives the brief description of effect of RF waves on railway track. An electronic circuit is built to analyze the RF signal. Further the output of this electronic circuit is connected to Raspberry pi for further processing

Keywords: Rail Track, RF wave, VSWR

I. INTRODUCTION

Transportation is very essential aspect this days as in its absence people cannot reach from one place to another. There are many transportation means are available like road transportation, air transportation, water transportation, railway transportation. But the people gives the choice priory to the trains because they are cheap as compared with others and having comfort for long distance & long time journey . If we talk about the Indian Railway then it ia larger rail traveller transport. In India maximum commercial transport is transported through the railway. In India there is huge increase in requirement for the transportation as it is having very vastly developing economy which is appeared as a extensive increase in amount of transportation on the Indian Railway network. When production and consumptions of goods is at different location then transportation becomes essential [1].

Economic growth has always been dependent on developing the quantity and coherence of transportation. But the framework and working of transportation has a huge force on the land and is the biggest source of power, building transport sustainability & security is a considerable concern. [1].

Indian Railways is an Indian state-owned enterprise, owned and operated by the Government of India through the Ministry of Railways. It is one of the world's largest railway networks comprising 115,000 km of track over a route of 65,808 km and 7,112 stations [2].

Today, after United states, Russia & China, India acquire fourth biggest railway structure. The railway cross over the length & width of the country and move up 30 million passengers and 2.8 million tons of carriage every day [1] .

Instead of making glad of such a tremendous facts, the Indian rail network is whist on the age of growing path attempting to fuel the economic need of Indian nation. Yet in terms of the accuracy & security parameters, India has still not attain actual worldwide specifications. However rail transport in India increasing at a rapid proportion, the linked railway security infrastructure facilities have not kept with foregoing procreation

When anybody goes through the daily news of the newspaper they come to know that there are many accidents in railroad railing. Railroad related accidents are occurred mostly due to the major cracks in rails and due to any obstacle present on railroad. Therefore railroad related accidents are quite dangerous than other transportation accidents in terms of severity and death etc. Facilities are not sufficient 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 [3].

The principal problem has been the lack of cheap and efficient technology to detect problems in the rail tracks and definitely, the lack of regular maintenance of rails which have resulted in the formation of cracks in the rail track and other similar problems caused by anti-social elements which jeopardize the security of operation of rail transport [1]. Recent statistics shows that approximately 60% of all the rail accidents have their reason as derailments, out of which about 90% are due to cracks or breaks in rails either due to natural causes (like excessive expansion due to heat) or due to anti- social elements(like due to bomb blast). Out of 100 accidents seven takes place due to the features tracks. According to railway own estimate remaining takes place by combination of problems such as human error, engineering defects, natural climates and storage.

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. The high frequency of trains and the unreliability of manual labor have put forth a need for an automated system to monitor the presence of crack on & obstacle the railway lines [3].

Therefore more efforts are necessary for improving the railway safety of the world. Railway safety is difficult aspect of rail operation the world over. Faulty performance resulting into railroad railing accidents usually get wide media coverage even when the railway is not at fault for railroad railing accidents, among uniformed public, an unsuitable image of inefficiency often fuelling calls for immediate reforms..

II. LITERATURE REVIEW

Most of the research is going on this field. Some techniques are proactive and some are active. Means some detect the fault before it occurs and some detects the fault after it is happened.

I. P. Topalov & M. S. Georgieval introduces a fiber optic technique which is used to detect the damaged rail, weight of passing train, strain created by cracked rail. fiber optic technology may be best suited to control the track especially laid over concrete slippers and complex track sections that are difficult to insulate and contains multiple ground return path. The main advantage of this technology is being very sensitive to crack detection. It detects the crack that has not completely fractured the rail. It gives early detection of cracks and cautioning of forthcoming failures. But the application of fiber optic technology is still in progress for long distance rail tack. The fiber optic fiber is attached to rail head using epoxy or glue over the entire length of track. A light source is applied at the one end of fiber and received at the other end. If any crack or break in the rail occurs, it breaks the fiber, which stops the receiving light and convenient warning will alert the signal system.

Advantage of fiber optic technology:

- Detection of buckled track, without extra sensors
- Detection of weld cracks before a full break occurs
- Application is promising over the tracks that are difficult to insulate [4].

Prof. P. Navaraja introduced the combination of ultrasonic and total station for railway track geometry estimating system. Different types of modules like GPS module, GSM module, IR sensors, PIR sensors are used for the communication purpose, crack detection and finding out the presence of human being over the railway track. The GPS & GSM modules are used to find and send the railway geometric parameter of crack detection to nearest railway station.IR sensors are used to detect the crack, ultrasonic sensors are used to detect distances between track and PIR sensors are used to find out the presence of human being. IR transmitter and receiver are used to transmit and receive are used to transmit and receive the IR rays. These transmitter and receiver are placed straight line to each other. PIR sensors calculate the infrared light radiating from objects in the railway track [5].

Vishnu Kiran B & S.Sandeep proposes a cost effective solution to the problem of railway track crack detection by making the use of zigbee control assembly which tracks the exact location of track damage. They use the zigbee communication, Arm control, track damage detection robot, GPS & GSM assembly. The different types of sensors which are wirelessly connected with each other are used to measure air pressure, Temperature, Acceleration etc. Sensors can transmit the signals via radio signals [6].

Sireesha R designed a system for identifying the broken rails through wireless network. Here broken rail refers either the fish plate is removed or track is broken in any section. The system is installed either in engine or in nearest railway station. If it is installed in railway engine driver will know in advance about the crack and accidents are avoided. The concept is to circulate some potential through a particular 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. The advantage of this system is having low cost, low power consumption & less timing analysis [7].

Ken Schwartz investigated the use of ultrasonic acoustic propagation for detecting broken rail over long distances. Different roadside nodes are used to transmit and receive the acoustic signal. When the reflected acoustic signal is not received it indicates the track or rail is broken anywhere on the track. An acoustic propagation is used as the digital communication network .There is no need of installing an extra wayside communication system. Echo location of nearest node is used to compute a range to the break where it is occurred .3 and 80 KHz acoustic frequencies are used. This is a reactive concept. Mechanical Joints creates a Problem [8].

III. RF WAVES

Radio waves are a type of electromagnetic (EM) radiation with wavelengths in the electromagnetic spectrum longer than infrared light. They have frequencies from 300 GHz to as low as 3 kHz, and corresponding wavelengths from 1 millimeter to 100 kilometers [9].

Among the kind of Electromagnetic waves Radio waves have a longer wavelength than Infrared rays and are defined as electromagnetic waves with a frequency of less than 3000 GHz. In free space their propagation velocity is same as that of light at approximately 300,000 Km in 1 second.

As the wavelength of the radio waves becomes short they get the qualities of light and their straightness become greater. RF wave gets strong directivity due to the concentration of energy in one direction.AS going towards higher frequencies of RF waves the attenuation of the wave energy becomes sharp. Generally radio waves are considered to be proposed in straight line, but if any physical obstacle comes in their path like mountains, buildings, walls or peoples and so on, then what happen. Consider an example of civil area, which is having many buildings. There are different types of waves present over there like direct wave that arrive directly, reflected wave that arrive after hitting building and like diffracted waves that skirt the shadows of building ,transmitted waves that arrive by passing through the glass or walls of buildings and so on. The type of obstacle differ the type of wave. Radio waves can pass through glass and ceramics, but they are reflected by metal and ceramics. Waves with frequencies higher than several GHz are scattered and absorbed by rain, snow, fog and like ,and their power tends to attenuate [10].

Radio propagation is the behavior of radio waves when they are transmitted, or propagated from one point on the Earth to another, or into various parts of the atmosphere. As a form of electromagnetic radiation, like light waves, radio waves are affected by the phenomena of reflection, refraction, diffraction, absorption, polarization, and scattering. Radio waves at different frequencies propagate in different ways. At extremely low frequencies (ELF) and very low frequencies the wavelength is much larger than the separation between the earth's surface and the D layer of the ionosphere, so electromagnetic waves may propagate in this region as a waveguide. Indeed, for frequencies below 20 kHz, the wave propagates as a single waveguide mode with a horizontal magnetic field and vertical electric field [11].

IV. VSWR (VOLTAGE STANDING WAVE RATIO)

For a radio (transmitter or receiver) to deliver power to an antenna, the impedance of the radio and transmission line must be well matched to the antenna's impedance. The parameter VSWR is a measure that numerically describes how well the antenna is impedance matched to the radio or transmission line it is connected to. VSWR stands for **Voltage Standing Wave Ratio**, and is also referred to as Standing Wave Ratio (SWR). VSWR is a function of the reflection coefficient, which describes the power reflected from the antenna. If the reflection coefficient is given by Γ, then the VSWR is defined by the following formula:

$$VSWR = \frac{1+\Gamma}{1-\Gamma} \quad (1)$$

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The reflection coefficient is also known as s11 or return loss. See the VSWR table below to see a numerical mapping between reflected power, s11 and VSWR [12].

Table I. VSWR, Reflected Power, and Γ (s11) [12]

VSWR	**Γ (s11)**	**Reflected Power (%)**	**Reflected Power (dB)**
1.0	0.000	0.00	-Infinity
1.5	0.200	4.0	-14.0
2.0	0.333	11.1	-9.55
2.5	0.429	18.4	-7.36
3.0	0.500	25.0	-6.00
3.5	0.556	30.9	-5.10
4.0	0.600	36.0	-4.44
5.0	0.667	44.0	-3.52
6.0	0.714	51.0	-2.92
7.0	0.750	56.3	-2.50
8.0	0.778	60.5	-2.18
9.0	0.800	64.0	-1.94
10.0	0.818	66.9	-1.74
15.0	0.875	76.6	-1.16
20.0	0.905	81.9	-0.87
50.0	0.961	92.3	-0.35

The VSWR is always a real and positive number for antennas. The smaller the VSWR is, the better the antenna is matched to the transmission line and the more power is delivered to the antenna. The minimum VSWR is 1.0. In this case, no power is reflected from the antenna, which is ideal [12].

4.1 Physical Meaning of VSWR

VSWR is determined from the voltage measured along a transmission line leading to an antenna. VSWR is the ratio of the peak amplitude of a standing wave to the minimum amplitude of a standing wave, as seen in the following Fig 1.

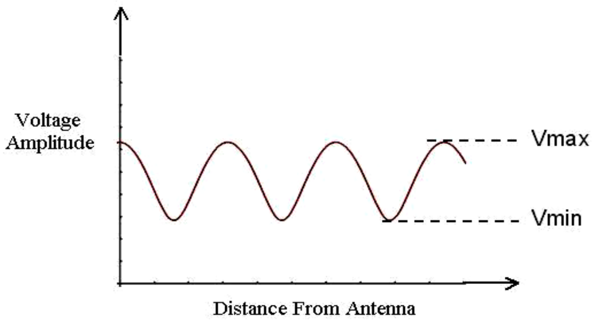

Figure 1:Voltage Measured Along a Transmission Line.

When an antenna is not matched to the receiver, power is reflected (so that the reflection coefficient, Γ, is not zero). This causes a "reflected voltage wave", which creates standing waves along the transmission line. The result is the peaks and valleys as seen in Figure 1. If the VSWR = 1.0, there would be no reflected power and the voltage would have a constant magnitude along the transmission line [12].

V. EFFECTS OF RF WAVES ON RAILWAY TRACK

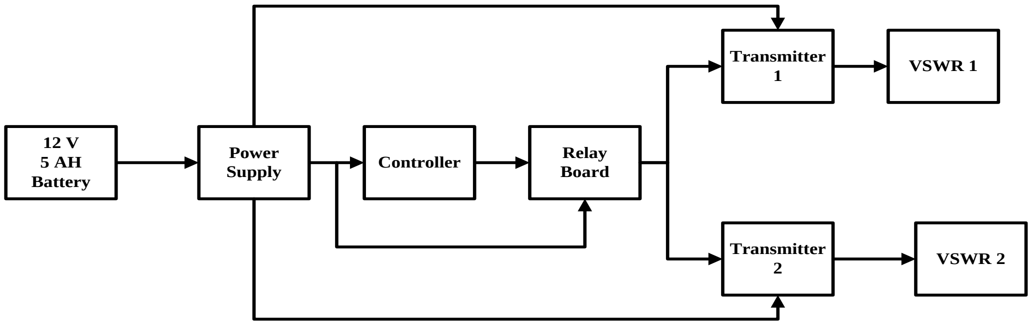

Figure 2: Block Diagram of RF Wave Sending Mechanism

The above circuit is designed to observe the effects of RF waves on Rail track. Effect is measured in terms of VSWR. Two transmitters of 29 MHz and 380 MHz are used to transmit the RF waves through track. Artificial rail track is formed for experimental setup. Relay board is used for switching between two transmitters. Controller is used for controlling the operation of relay board. Arduino UNO controller board is used as a controller. 12 V Power supply is converted into 5V supply using power regulator circuit and connected to the controller board, relay board, and two transmitters. Digital SWR meters are connected to respective transmitters for displaying VSWR. After each 30 sec transmitter 1 and transmitter 2 are made on. At the end of VSWR meter two points are taken out which gives forward power and reflected power in terms of voltage.

VI. RESULT

First we find out the forward and reflected power when it is not connected to rails. Then after rail track is connected for finding the changes in VSWR.

When no track is connected

Forward Power	Reflected Power	VSWR
+0.12	-0.16	13.4
+0.15	-0.23	19.8
+0.13	-0.18	12.2
+0.16	-0.23	11.9

Forward Power(Digital SWR meter)	Multimeter Readings	Reflected Power(Digital SWR meter)	Multimeter Readings
+0.20	0.06 mv	-0.12	0.04
+0.17	0.05 mv	-0.18	0.05
+0.18	0.05 mv	-0.23	0.06
+0.19	0.05mv	-0.13	0.04

When track is connected

Forward Power	Reflected Power	VSWR
+0.87	**-0.23**	**3.1**
+1.00	**-0.29**	**3.3**
+0.88	**-0.23**	**3.2**
+0.87	**-0.23**	**3.1**

Forward Power(Digital SWR meter)	Multimeter Readings	Reflected Power(Digital SWR meter)	Multimeter Readings
+0.88	0.15 mv	-0.24	0.06 mv
+0.97	0.17 mv	-0.26	0.07 mv
+0.87	0.15 mv	-0.23	0.05 mv
+0.83	0.14 mv	-0.22	0.05 mv

As shown in above results tables, there is drastic change in VSWR before and after connecting to the Rail track.

VII. FUTURE SCOPE

Thus any changes in the track circuit occurs it changes the VSWR .This change in the VSWR is used to find out the crack or break in the rail track. Further for the crack detection this system is connected to the Raspberry pi to find out the rail crack

VIII. ACKNOWLEDGMENT

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