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Automatic Rail Fault Track Detection for Indian Railways

Parvathy A
Electronics and Instrumentation
College of engineering Kidangoor
Kottayam , India
parvathya142@gmail.com

Mebin George Mathew
Electronics and Instrumentation
College of engineering Kidangoor
Kottayam , India
mailmemebin@gmail.com

Saji Justus
Asst.Professor
Electronics and Instrumentation
College of engineering Kidangoor
Kottayam , India
sajijustus@gmail.com

Ajan.A
Asst.Professor
Electrical and Electronics Engineering
College of engineering Aranmula
Pathanamthitta
ajansree@gmail.com

***Abstract*—Indian railway is the largest railway network in Asia and additionally world's second largest network operated underneath a single management. The railways became the prime suggests that of transportation because of their capability, speed and responsibleness. Even a small improvement in this sector will aid the overall development of a nation. Due to the gigantic size, it's a tedious task to monitor and maintain the rails in a timely manner. The poor maintenance of the railway tracks will result in accidents. Occurrence of cracks in tracks became a serious concern for the railway. The rail cracks should be identified and corrected as early as possible as it poses a serious threat to the safe operation of the carriages. This proposal aims at elimination of the long prevailing issues in this sector. This effective methodology of continuous observation and assessment of rail tracks might facilitate to stop accidents. This methodology endlessly monitors the rail stress, evaluate the results and provide the rail break alerts such as potential buckling conditions, bending of rails and wheel impact load detection to the concerned authorities.**

Index Terms—Rail line, fault, crack detection, stress.

I. INTRODUCTION

In most of the countries, rail transportation is the backbone of trade and economy. Railways give energy economical means to transport material over land. The railway tracks are an outsized part of the system give sleek and arduous surfaces on that the wheels of the train roll with a trifle friction. Conjointly the track spreads the load acting over it as uniformly distributed loads. Nowadays, rail networks across the planet are becoming busier with trains that travel at higher speeds and carrying a lot of passengers and heavier shaft loads than ever before. The mix of those factors has place extended pressure on the present infrastructure, resulting in enlarged demand in examination and maintenance of rail assets. The expenditure for examination and maintenance has so adult steady over the previous couple of years while not but being followed by a major improvement of the industry's safety records. The fault detection and maintenance in Indian railway is being carried out manually now a days, which is a tedious task. A real time fault observation system based on microcontroller is proposed in this paper which is capable of tackling the demerits of manual monitoring and maintenance process. The proposed system is cost effective and sturdy. The sensing modules are placed on the outer surfaces of the tracks alternatively and equidistantly. The outputs from independent modules feeded to the microcontroller based control module which will further process the signals and evaluates whether any rail fault existing. .The effective methodology of continuous observation and assessment of track conditions might facilitate to eliminate accidents and to save lots of life and assets of the people.

II. LITERATURE SURVEY

A. Existing monitoring system

Every portion of the track is being inspected daily on foot. The categories of patrolling are Gang patrol throughout abnormal rain, night patrolling throughout monsoon, weather patrolling for welded track, security patrolling, watchmen at vulnerable locations and weather condition patrolling. Gang patrolling is the patrolling which carried out on foot along the railway tracks during rainy seasons. Security patrolling is finished to safeguard train against change of state with track and obstruction on the road. Weather patrolling is meant to be done once rail temperature reaches td + twenty or higher than in Welded Rail Sections. The use of powerful digital signal processors, Image process techniques [1] are being explored to formulate solutions to the matter of rail crack detection. Although it provides smart accuracy, this system uses techniques like image segmentation, morphology associated edge detection all of that take plenty of process power and an extreme quantity of your time rendering the mechanism slow and thereby unsuitable. Recent analysis has investigated the utilization of microwave antennas, such as horn antennas for crack detection [2]. This method was found to provide terribly correct ends up in science lab primarily based testing. But, sadly it needs spectrum analyzers that are each pricey and conjointly can't be placed on board a moving mechanism as a

result of their delicacy. Eddy current based ways [3]- [4] and [5] are used to serve limitations related to ultrasonic's and microwave techniques. But they have the defect of terribly low overall speed that reduces the usability of same. A colossal majority of the work exhausted the field of crack detection uses the infrared sensing technique [6]-[8].It's a well understood technique such a lot so it absolutely was thought to be the most effective answer to the matter of crack detection, however later it absolutely was found to be at risk of external disturbances and thus came to be thought-about inaccurate. Techniques that use ultrasonic's [9]-[11] serve a number of the issues mentioned earlier, however they will solely examine the core of the track; as, it cannot check for surface and near surface cracking wherever most faults are seemed to be situated. Many different miscellaneous techniques like observation and analysis of wave propagation via model impacts and piezo actuation [12] have conjointly been developed. The matter inherent in all these techniques is that the price incurred is high. So this work proposes an inexpensive, novel nonetheless easy theme with ample strength appropriate to the Indian state of affairs that uses a microcontroller primarily based sensing element arrangement to observe the crack in railway lines, that proves to be cost effective compared to the present techniques being used.

B. Proposed system

The proposed system consists of a gauge which finds the amount of stress that is being applied over the rail lines during the train passes through it. The stress on the wheels and rails are the primary indicators. Strainguages are employed for measuring the above said factors. Knowing the dynamic parameters of the rail (Young's modulus E, Poisson's ratio ν) and its geometrical characteristics (web thickness t, geometrical moment of inertia I, first moment of space H) the theoretical value of the strain can be calculated for a particular stress. By comparing the experimental values and the theoretically calculated values the possibilities of a rail fault can be easily find out. The amount of strain developed on a traditional track and a broken track will be completely different. The use of accelerometer device on the track might facilitate to seek out if there's any abnormal bending is caused once a train passes over through the track. Also ultrasonic sensors are used along with this module, which are placed on both sides of the tracks. If any changes in the width or length of the tracks ,these sensors detects it and alert the operator. The temperature sensors are used sense the track temperatures. The sharp changes in temperature are a reason for buckling. The outputs of those sensors are coordinated and transmitted to the closest station. When a higher degree deviation from the conventional value occurs the alerting system within the station master's space might get activated and corrective measures can be taken in a timely manner. The power requirement for the proposed system is very less and it can be even powered with the assistance of solar cells or by the employment of piezoelectric energy generation methodology.

III. MATH

A. Equations

There is a linear relationship between output of the strain gage and also the amendment in its resistance.The subsequent formula is valid:

$\Delta R / R = K * \varepsilon$

R : Initial resistance of the strain gage (Ω)

ΔR : Resistance amendment caused by elongation or contraction (Ω)

K : Proportional constant (called the "gauge factor")

ε : Strain

The gauge factor K varies according to the bimetal foil used.

Temprature in milli volts= (value/1024.0)*5000

Temprature in celecius= Milli volts/10

Temprature in faranheat= (celecius*9)/5+32

IV. BLOCK DIAGRAM

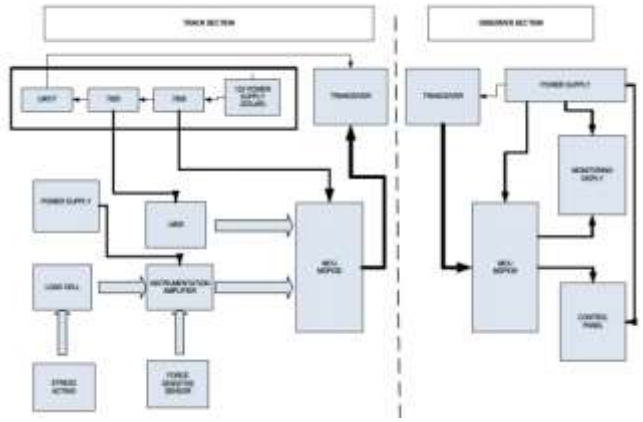

Fig 1: Block diagram of automatic rail fault track detection system

V. ELECTRICAL DESIGN

A. Microcontroller

An Arduino Uno board that has ATMega328 microcontroller forms the brain of the theme. This board has been chosen for 2 necessary reasons aside from the very fact that it's value effective. First, the Arduino integrated development setting (IDE) is Associate in Nursing ASCII text file project that extremely simplifies the writing and debugging method. Second, it's all the specified pins to interface the specified peripherals. It has six analog input pins, fourteen digital I/O pins (of that six provides PWM output) and one UART. The careful description regarding however numerous elements are interfaced with arduino is additionally mentioned hereafter.

B. Temperature detector

The temperature detector LM35 is simply and accurately interfaced with the microcontroller unit. LM35 may be a preciseness IC temperature detector with its output

proportional to the temperature (in ^{o}C). The detector's electronic equipment is sealed and thus it's not subjected to reaction and any other processes. With LM35, temperature is measured accurately than with a thermal resistor. It conjointly possess low self heating and doesn't cause quite zero. The operative temperature vary is from -55°C to 150°C.

C.Load Cell

A load cell may be a detector or a transducer that converts a load or force functioning on it into electronic signal. This signal can be a voltage, current or frequency modification depending on the type of load cell and circuit used. There are various forms of load cells.Resistive load cells work on the principle of piezo-resistivity. once a load/force/stress is applied to the detector, it changes its resistance.This modification in resistance leads to alteration in output voltage when an input voltage is applied.

D. Ultrasonic sensor

The HC-SR04 is a sensor that works extraordinarily with Arduino. The time difference between a transmitted wave and a reflected wave (which is a reflected wave from the target) is calculated and this value is then multiplied by the speed of sound (343m/sec = zero.0343cm/µs = [1/29.1] cm/µs approx.)

Distance = (Time for wave to return * Speed of sound) / 2.

E. Accelerometer

Accelerometers are devices that measure acceleration, that is the rate of change of velocity. It's unit is m/s2 or in G-forces (g). 1 G-force=9.8 m/s2, however this will vary slightly with elevation.Accelerometers area unit helpful for sensing vibrations in systems or for orientation applications.

VI .NECESSARY GRAPHS AND DIAGRAMS

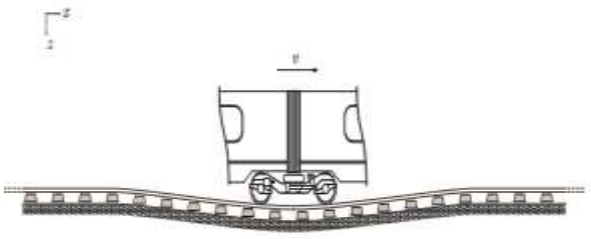

Fig 2: Deflection of track when train passes through it

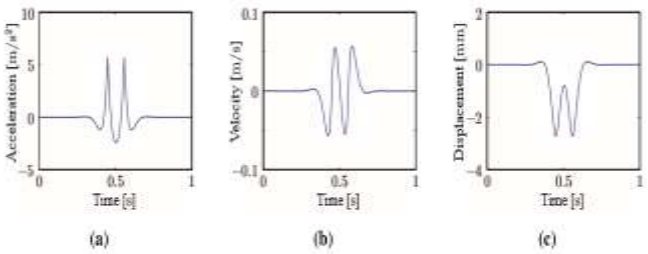

Fig 3: Deflection of track caused by passing a single bogie

(a).Acceleration,(b).Velocity,(c).Displacement

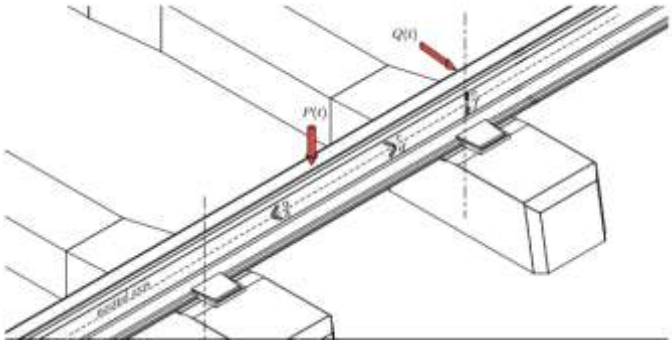

Fig 4: Vertical and lateral forces acting on a strain gauge

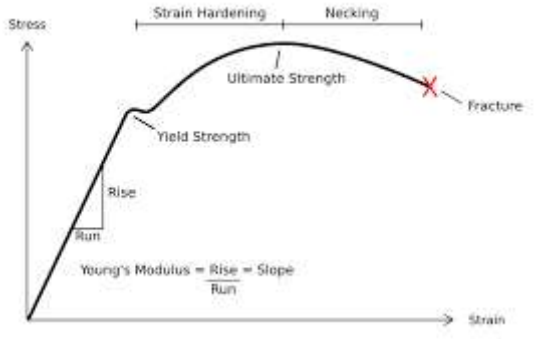

Fig 5: Stress Vs Strain graph

Fig 6: Implementation of the proposed system on PCB

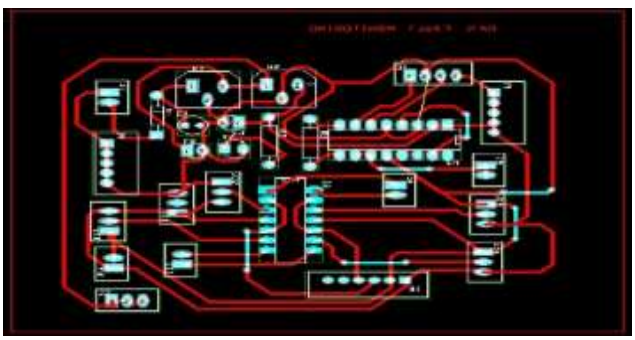

Fig 7: PCB layout

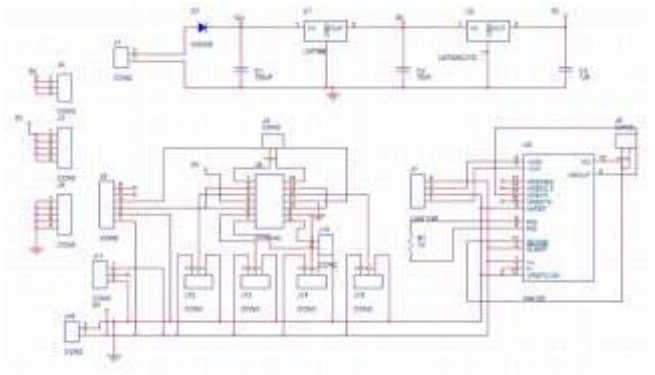

Fig 8: Circuit diagram

VII.CONCLUSION

The idea can be enforced in large scale to facilitate higher safety standards for railway tracks in future. The proposed system can have an excellent impact on the security and maintenance of tracks. To make sure the method is simple and efficient the principle plan has been made terribly easy. Accidents occurring in railway transportation systems price an outsized range of lives. Many people die and several others get physically and mentally wounded. Accidents are the key causes for traumatic injuries. There's a need of advanced and sturdy techniques which will solely stop these accidents along with eradicate all potentialities of their incidence. Wireless device network that continuously monitors the railway track through the sensors and observe any abnormality within the track. The device nodes are equipped with sensors which will sense the vibration within the railway track when the train passes. Improved communication protocols and real time operation with minimum delay will undoubtfully enhance the present monitoring and maintenance scenarios.

References

[1] 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

[2] K. Vijayakumar, S.R. Wylie, J. D. Cullen, C.C. Wright, A.I. AIShamma’a, “Non invasive rail track detection system using Microwave sensor”, Journal of App. Phy., 2009

[3] Tranverse crack detection in rail head using low frequency eddy currents, Patent US6768298,

[4] M. Cacciola, G. Megali, D. Pellicanμo, S. Calcagno, M. Versaci, and F. C. Morabito, "Rotating Electromagnetic Field for Crack Detection in Railway Tracks", PIERS ONLINE, Vol. 6, NO. 3, 2010

[5] Wojnarowski, Robert John Welles, II, Kenneth Brakeley Kornrumpf, William Paul, "Electromagnetic system for railroad track crack detection and traction enhancement", Patent US6262573,

[6] Richard J. Greene, John R. Yates and Eann A. Patterson, "Crack detection in rail using infrared methods", Opt. Eng. 46, 051013, May 2007

[7] R.J. Greene, J.R. Yates,E.A. Patterson, "Rail Crack Detection: An Infrared Approach to In-service Track Monitoring", SEM Annual Conference & Exposition on Experimental and Applied Mechanics, 2006

[8] Hartman, G.A., Infrared Damage Detection System (IDDS) for realtime, small-scale damage monitoring, Proc. SEM Ann. Conf. on Exptl Mech., Charlotte, North Carolina (2003)

[9] Stuart B Palmer, Steve Dixon, Rachel S Edwards and Xiaoming Jian, "Transverse and longitudinal crack detection in the head of rail tracks using Rayleigh wave-like wideband guided ultrasonic wave", Centre for Materials Science and Engineering The University of Edinburgh,

[10] Thomas Heckel, Hans-Martin Thomas, Marc Kreutzbruck and Sven Ruhe, "High Speed Non-destructive Rail Testing with Advanced Ultrasound and Eddy-Current Testing Techniques", NDTIP Proceedings, Prague, 2009

[11] Lanza di Scalea, F., Rizzo, P., Coccia, S., Bartoli, I., Fateh, M., Viola, E. and Pascale, G., “Non-contact ultrasonic inspection of rails and signal processing for automatic defect detection and classification, Insight – NDT and condition monitoring”, Special Issue on NDT of Rails 47(6) 346-353 (2005)

[12] Spencer Ackers, Ronald Evans, Timothy Johnson, Harold Kess, Jonathan White, Douglas E Adams, Pam Brown, "Crack detection in a wheel end spindle using wave propagation via modal impacts and piezo actuation", Health Monitoring and Smart Nondestructive Evaluation of Structural and Biologicalsystems V, SPIE (2006).