

# SMART ENERGY HARVESTING FOR INTELLIGENT RAILWAY CONDITION MONITORING SYSTEM

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## ABSTRACT

*Remote sensor systems are utilized for observing the railway structures like spans, rail tracks, track beds and track hardware. The requirement for railway monitoring system is vital. This paper describes about cyber physical system which is controlled by the computer based algorithms for remote transmission of information. The arrangements of remote sensor modules like accelerometer, temperature sensor, humidity sensor and IR detector for monitoring the distinctive specifications of railways are also explained. The vibration from the rail track produces energy to power up the remote sensor modules. The end device is controlled by a magnetic levitation energy harvester. The energy harvester is chosen because of its wide band reaction qualities. The transmission of data is done wirelessly by wireless RF device. The rail tracks are monitored by the railway system and the monitored information are stored in the work stations hard drive and the movement of train is controlled by the provided information.*

**Keywords:** Energy harvester, Railway condition monitoring, Wireless Sensor Networks (WSN), Sensors.

## I. INTRODUCTION

Railways include a vast foundation and are vital method of transportation in numerous

nations. Railways are the life savers of a nation and have turned into another method for transportation attributable to their ability, speed, and dependability, being nearly connected with traveler and products transportation. They have high hazard related with them as far as human lives and cost of advantages. The poor upkeep of the railways can prompt mishaps at certain time even after the new advancement and well-being of railway systems.

In this way, a legitimate methodology is required for support and examination of tracks. Detection and upkeep of rail abandons are significant issues for the rail group all around the globe. The deformities mostly incorporate inward imperfections such as exhausted rails, head checks, squats, shelling, layering and moving contact weariness which started issuing as surface splits. If these imperfections are not taken care they can prompt to rail breaks and these issues are investigated and managed honestly. The support choices can decrease potential danger of rail breaks.

Fundamental difficulties looked by railroad engineers for rail route track checking are:

- Power supply issue of rail-side devices.
- Wired monitoring gadgets rely upon the lattice framework, which needs high

investment; though the remote one requires batteries which can work for a specific time.

- The railroad track is long, in which rendering the substitution of batteries is unthinkable.
- Traditionally monitoring equipments are at high cost.

In remote region it is difficult to guarantee power supply of rail-side monitoring gear. But the wire connected power supply is not accessible for railroads passed in these remote area zones [1]. On the other way, utilization of remote power supply, such as batteries, is a major problem and substitution of batteries in remote areas is also difficult. It is important along these lines to build up another vitality procedure. As a matter of fact, Germany has effectively occupied with covering area more than 33% of its yearly twelve billion kilowatt-hour vitality necessity for the railroad coordinate with inexhaustible sources by 2020 [2],[3]. The spared vitality is fit for fueling WSNs, which can be utilized for checking the railroad framework such as, spans, turnout, rail tracks, cuttings and passages, and track beds [4]-[8].

The remaining part of this paper is organized as follows: Part II describes about the existing methods used in monitoring the railways. In part III block description of transmitter and receiver section of the proposed work is explained. Part IV analyzes about the result and discussion of the work. Finally part V concludes the work.

## II. EXISTING METHODS

Compared with other wireless personal area networks (Bluetooth and Wi-Fi) Zig-Bee specification is expected to be less complex, more affordable and expends less power [9]. The transmission separations are constrained to 10-100 meters of areas. The Zig-Bee gadgets can

transmit information over long areas by building up a work system of halfway gadgets [10]. Since Zig-Bee has a defined transmission rate of 250 Kbps, rendering it appropriates irregular information transmissions from sensors or information gadgets. Browne et al., proposed a novel versatile receiving wired structure associated with a Zig-Bee remote handset. The structure was utilized to transfer anxiety information on railroad tracks. The power utilization was 1mW for handset and the correspondence separate came to 91m [11].

Railways are expensive foundations and are the prime method of transportation in numerous nations. Indeed, even a little change in execution of railways has critical monetary advantages to rail industry. Therefore, a legitimate support technique is required to administer streamlining of examination recurrence, and additionally for a change in expertise and proficiency [12].

## III. PROPOSED WORK

The proposed model comprises of a RF device at street side and progression of sensors (Accelerometer, temperature sensor, humidity sensor, infrared identifier) is associated with an end gadget at rail-side. The end gadget is fueled by the magnetic levitation energy harvester and the RF device is communicated wirelessly. The below figure 1 and 2 shows the transmitter and receiver section of the proposed work respectively.

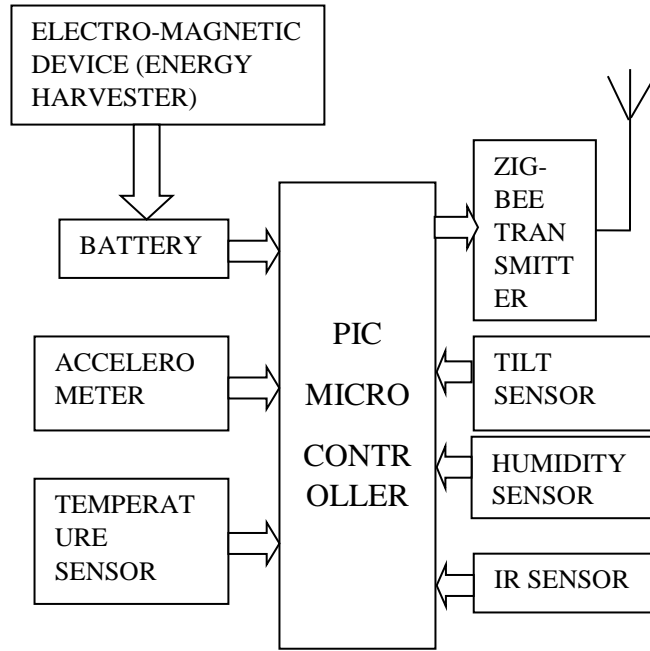


Fig.I. Transmitter Section

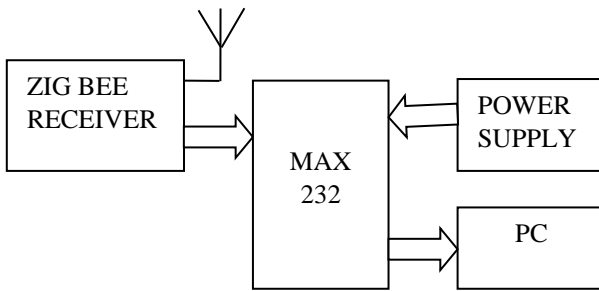


Fig.II. Receiver Section

The wireless RF device is a full function device which takes administrator to organize the development of the system. The equipment model incorporates a System-On-Chip (SOC) Chipset CC2530F256, Chipset PL2303, SMA radio wire connector, 32 MHz crystal, USB port, Inter-integrated circuit and a Serial peripheral interface, few LEDs, Control on/off switch, program connector and different peripherals. CC2530F256 is associated with the fringe interfaces and to a standard SMA connector with an outside RF radio wire. The advancement of the equipment is alluded to the schematics in

advancement units of Texas Instruments [13]. The WSN incorporates three hubs: Sensor hub, Switch hub and Root hub. The sensor hub gathers the information; the root hub's information sink is connected to the base station, and the switch hub is in the middle of the road hub to hand-off the information. The correspondence connection between the WSN is built-up by Zig-Bee which works as a multi-bounce organizer. The sensor-net protocol characterizes the steering tree [14]. Its versatility allows the picking of the most reliable point for transmission by irregularly evaluating the interfacing quality to the neighboring ones.

The block description of the transmitter section and receiver section is described below.

#### *BATTERY*

The hub is fueled by the lithium batteries. The energy harvester controls the lithium batteries and accordingly expands the working time of general framework.

#### *POWER SUPPLY*

Most of the power supplies are expected to change over from high voltage supply to a sensible low voltage supply for different circuits and devices. The power supply gives the steady voltages of 5V, 9V, 12V. IC78XX is the settled positive voltage controller and IC79XX is the settled negative voltage controller.

#### *PIC MICROCONTROLLER*

The PIC used is PIC16F877A. It is a modified Harvard architecture microcontroller. It typically does a limited number of tasks, but they do them well. They are best suited for embedded applications.

#### *ZIG-BEE (CC2500)*

The Zig-Bee organizer is a Full Function Device (FFD) which takes administrator to organize the development of the framework. Zig-Bee framework structure comprises of three

unique kinds of gadgets. Each Zig-Bee systems must comprise of less than one or no organizer which acts as a root for extension of the system.

#### *ACCELEROMETER*

An accelerometer is a device that measures the vibration, or expanding pace of development of a structure. The power caused by a vibration or an alteration in development makes the mass smash of the piezoelectric material, which produce an electrical charge that is related to the power connected upon it.

#### *TEMPERATURE SENSOR*

A temperature sensor measures the measure of warmth vitality or even coldness that is created by a material or framework. This enables us to sense or identify any physical change to that temperature, delivering either a simple or computerized yield of measurement.

#### *HUMIDITY SENSOR*

A humidity sensor (hygrometer) detects, measures and reports the relative humidity in the air. In this manner, it measures both dampness and air temperature. Relative humidity is the proportion of real dampness noticeable all around to the most astounding measure of dampness that can be held at that air temperature.

#### *INFRARED SENSOR*

An infrared sensor is an electronic gadget that transmits with a specific end goal to detect a few parts of the environment. An IR sensor can measure the warmth of a material and additionally distinguishes the movement.

### **1. ENERGY HARVESTER**

Magnetic levitation energy harvester is utilized to energize the modules. The levitation oscillator is utilized because of its broadband reaction characteristics. It is a dynamic framework with nonlinear re-establishing force.

The vitality collector utilizes attractive power to suspend a wavering focus magnet. The gadget utilizes two external magnets that are mechanically supported. The middle magnet is placed between the two external magnets and the attractive poles are put in such an approach to repulse the N and S pole. The energy harvester is shown in figure 3.

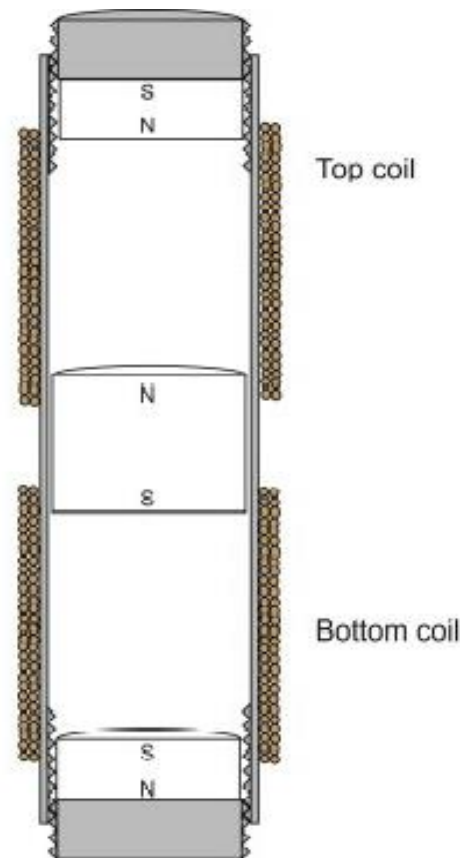


Fig.III. Energy Harvester

The energy harvester can deliver a relative voltage from track vibrations. That is, nonlinear re-establishing power at the point when there is going off preparation through the railroad, and the rails are subjected to its vibrations. This vibration will be passed on to the energy harvesters that are mounted serially or in parallel with the rails. In this manner because of

these vibrations the suspending magnet will waver about its harmony position, consequently creating a fluctuating attractive field. This shifting attractive field will cut the copper loops twisted around the framework, delivering an actuated electro-magnetic force. It is to be noticed that an energy harvester can't control the modules straight forwardly. This will charge the Lithium ion particle batteries which thus self disciplines the modules.

The energy harvester can be associated with the rail in two ways, specifically serial association and parallel association. We characterize the parallel associated electromagnetic harvester as far as voice loop, spring resounding, attractive levitation. The collector gadgets were mounted to the rail foot and are subjected to the vibration produced by the track framework. For the serial design, the harvester is ordinarily situated between the rail and sleeper, or between the sleeper and counter-weight bed. Accordingly, the presence of the serial-associated gadget will change the track solidness. For the parallel design, the energy harvester is inflexibly associated with the rail web or rail base; it is neither associated with the wheel-set nor to the rail sleeper, so we regard the parallel setup as an additional mass to the rail, and compute the resultant differences in the rail mass and rail moment of inertia.

#### IV. RESULT AND DISCUSSION

The experimental setup of railway condition monitoring system is shown in figure 4. A hardware platform was developed and tested. The RF device gathered the temperature, the mugginess, and the increasing speed of railroad track. The Zig-Bee facilitator exchanges the information to the work station phone, which can show the sign's profile and store the information to a log record.

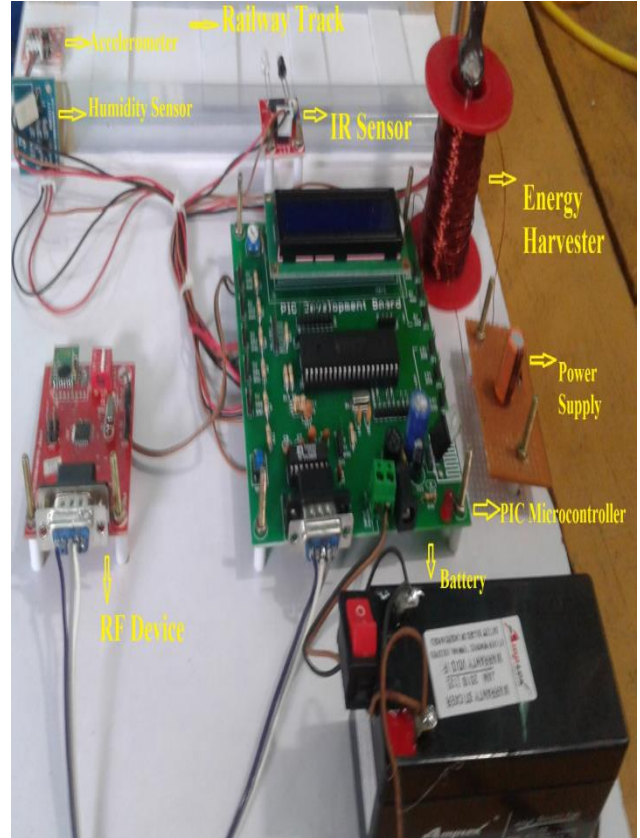


Fig.IV. Experimental Setup

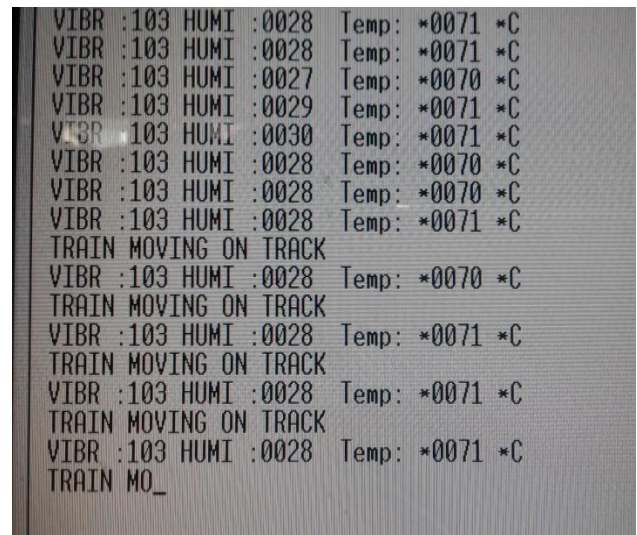


Fig.V. Investigation about the vibration, humidity, and temperature on rail track



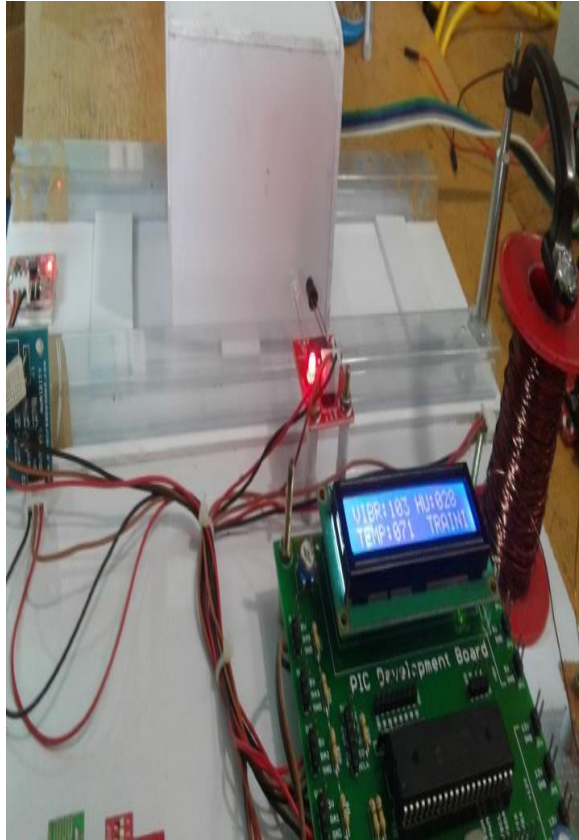


Fig.VI. Train moving on the track

The examining information from the oscilloscope were recorded and exchanged to a nearby PC for ensuing investigation which is shown in figure 5. The oscilloscope was filled in as an information examining gadget and was associated with the PC with lab view signal express programming. Along with these lines, we can enact the auto trigger/record mode and acknowledge the examination of persistent information. The information was put away on the workstation's hard drive. Frequency sweeping vibration tests were conducted to characterize the performance of the energy harvester. The operation value of the harvester rises with the change of acceleration amplitude. Figure 6 shows the train moving on the track provided by the recorded information. The movement of the railway on the rail track was controlled by the railway system based on the monitored information.

## V. CONCLUSION

This paper researched the likelihood of building up a self-powered remote sensor arranged by incorporating the procedures of wireless RF device and energy harvester. The objective was gone through the railroad condition monitoring. Electromagnetic harvester by magnetic levitation is reasonable for controlling the RF device because of its wide recurrence reaction. The rail tracks are monitored by the railway system and the monitored information are stored in the work stations hard drive and the movement of train is controlled by the provided information. An equipment stage was created and tried, demonstrating the proposed approach.

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