ENERGY HARVESTING TECHNIQUE FOR RAIL BY USING ZIGBEE COMMUNICATION

Vasuki S [1]

Assistant Professor, Dept. of CSE,
SNS College of Technology, Coimbatore, Tamil Nadu, India

Deepika S [2], Dhanya M.R [3], Gopika G.S [4], Harini M [5]

Student , Dept. of CSE,
SNS College of Technology, Coimbatore, Tamil Nadu, India

Abstract:

This is an energy harvesting technology for railway tracks that uses Zig-bee connectivity to gather data about energy use. With the aid of the Internet of Things, we can access and monitor the harvesting process. We installed a few sensors for the railway track monitoring in this broken section of the track. With this type of sensor, we can produce electricity by harvesting and send the power information from one node to another via Zig-bee. The primary limitation of the current system in a rural location is that we fix the sensor from the rail track, but we are unable to provide this sensor's operational supply through WPT (Wireless Power Transmission). To address this issue, we can utilise a wireless sensor to create energy using a track-borne energy harvesting approach. This integration promotes energy efficiency and enables seamless data exchange among railway components, contributing to a more sustainable and interconnected rail infrastructure. In order to provide broadband communication between Zigbee nodes, magnetic levitation will be used. The primary use of this idea is to monitor the state of the railway network using a wireless sensor network. To achieve this monitoring, we will use a variety of sensors to obtain precise information on the state of the railway.

Keywords: Zigbee , Track-borne , Image processing , Energy Harvester , Rural location tracker

I.INTRODUCTION

Rail systems can harvest energy from several sources, including vibrations, and regenerative braking, by utilizing Zigbee communication. A more connected and environmentally friendly railway network is facilitated by this sustainable energy method, which also increases the effectiveness of rail infrastructure Using Zigbee communication and rail energy harvesting, devices that use Zigbee technology for communication are powered by different energy sources located along railway systems. While Zigbee enables effective wireless communication between devices on the rail network, this sustainable solution seeks to harness energy from sources such as vibrations, or regenerative braking. Vibrations, solar power, and regenerative braking are all used in rail energy harvesting, which transforms the railroad landscape with the help of Zigbee connection. This creative collaboration sets up a strong wireless network and increases sustainability while facilitating effective data interchange across rail components. The end product is a more intelligent, connected, and environmentally friendly train infrastructure that meets. A cutting-edge tactic to improve the sustainability and effectiveness of railway systems is rail energy harvesting with Zigbee communication. With this method, energy is gathered from several sources, such as solar panels for renewable energy, train vibrations, and regenerative brakes for kinetic energy storage and collection. Because it allows wireless communication between different equipment on the rail network, Zigbee technology is essential. This promotes optimal energy use and operational efficiency by facilitating real-time data transmission and control. An intelligent and networked infrastructure may be built thanks to the incorporation of Zigbee in train systems. Vibration energy harvesting is the process of producing electrical energy from the mechanical vibrations produced by moving trains. This captured energy can help charge onboard systems or power sensors and monitoring equipment. Along with monitoring the health of vehicles, including chassis, bogies, wheels, and wagons, it can be used to monitor the railway infrastructure, including bridges, rail tracks, track beds, and track equipment. The need for human inspection is decreased by condition monitoring lowers maintenance by identifying issues before they worsen through automated monitoring, and enhances dependability and safety. The growth, improvement, and expansion depend on throughout railroad networks. In India, the main factors contributing to train accidents are now human mistake and negligence. The larger Growth has been facilitated by developments in the railroad sector everywhere in the train activity thickness. This has resulted in regarding the increase in the number of accidents, which includes train accidents A natural disaster can potentially result in a train mishap. Apply Zigbee communication to a rail industry energy harvesting technique. To power sensors and communication devices, energy harvesting is the process of obtaining and storing energy from a variety of sources, such as solar power or vibrations. Wireless communication protocols like Zigbee are frequently utilized for remote control and monitoring.The idea is to create a system that can wirelessly transmit data using Zigbee technology and harvest energy from the rail environment, possibly from vibrations brought on by moving trains. Applications like track maintenance, train tracking, and rail condition monitoring may benefit from this. The goal of the project is to improve productivity, lessen the need for battery replacements, and allow real-time data exchange among rail industry participants.

II.LITERATURE REVIEW

Using the Zigbee communication for global rail system condition monitoring is a crucial component of our solution. Minimize the expense of power system and sensor node maintenance. We can access and monitor the energy harvesting process by using Zig-bee connectivity and the Internet of Things to power railway track energy harvesting equipment.

“Self-Powered ZigBee Wireless Sensor Nodes for Railway Condition Monitoring." research published in 2021, by adding a self-powered ZigBee wireless sensor node, the authors expand the use of this application. The suggested hardware prototype is made up of a ZigBee coordinator at the roadside and several sensors (such as an infrared detector, temperature, humidity, and accelerometer) connected to a ZigBee end device at the rail side. The magnetic levitation energy harvester powers the ZigBee end device, which communicates wirelessly with the ZigBee coordinator.

A study published in 2020 with the title “Maximizing the energy harvested from piezo-electric materials for clean energy generation " This paper examines cutting-edge methods and technologies for piezoelectric material energy harvesting, with a particular emphasis on large-scale power harvesting and generation. The main performance and cost estimations of energy harvesting systems for roads and railroads, a comparison of costs with other renewable energy harvesting systems, and advancements in mechanical and electrical configurations to take into account for designing and implementing high-performance energy harvesting systems are all included in this study.

“Thermoelectric power generation: Peltier element versus thermoelectric generator” research published in 2020 This study provides a thorough comparison of thermoelectric generators (TEGs) and Peltier elements, commonly known as thermoelectric coolers (TEC), for use as thermoelectric power generators. Though its typical uses involve cooling or heat pumping, the former can also function as a generator. The use of thermoelectric energy harvesting systems is growing in the modern world; examples include wireless sensors and exhaust pipes.

The authors of a 2019 study titled " High-altitude wind energy for sustainable marine transportation," The total aerodynamic properties of the kite wing were calculated and contrasted with those of the flat, rectangular, non-twisted wing with the same aspect ratio and section (Clark Y profile). Throughout, it was thought that the boundary layer of the flat and curved wings was turbulent. It was found that the aerodynamic properties are only slightly deteriorated by the curvature.

III.PROPOSED SYSTEM

In order to generate power from the sensor nodes, we employed a track-borne method, System's key feature is that it uses the Internet of Things to monitor railway conditions worldwide lower the sensor node and power systems' maintenance costs by designing energy beams optimally and jointly allocating time and power under time constraints and data delivery constraints for all SNs in the system, we formulate an optimization problem to minimize the total required energy for information transmission.

We use the semi-definite relaxation (SDR) method to convert the non-convex problem into a convex optimization problem, which we can then solve efficiently to reduce the need for external power

IV.FLOW DIAGRAM

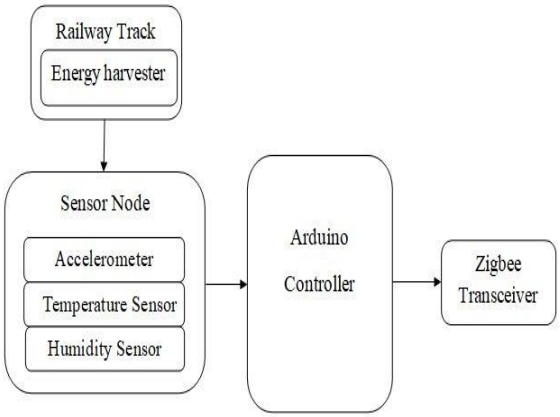

Figure 1

This is a railway track energy harvesting technique that uses Zigbee communication to gather energy usage data. With the aid of IOT, we can access and monitor the harvesting method. We fixed some sensors for the railway track monitoring in this broken section of the track. With this type of sensor operating power, we can generate it using this harvesting method and send the power details from one node to another via Zigbee.The primary flaw in the current system is that, although we can fix the sensor from the rail track in a rural area, we are unable to provide the sensor's operating supply through WPT (Wireless Power Transmission). To address this issue, we can use Wireless Sensor Networks to generate energy using a track-borne energy harvesting method. We will use magnetic levitation to enable broadband communication between Zigbee nodes. In order to monitor the railway network, the primary application of this concept is to use a wireless sensor network. To achieve this, we will assign a number to each sensor in order to obtain precise information about the state of the railway A smart city can guarantee its residents' quality of life and health by functionally and structurally enhancing the sustainability and efficiency of the city. Widespread deployment of wireless sensor networks (WSNs) is necessary to achieve smart city realization. Examples of these environments include water distribution, building structural integrity, and urban road traffic. The most crucial duties of the sensor nodes are to monitor ambient environments and deliver that information to the sink node. Additionally, densely positioned small-battery sensor nodes in WSNs can be used to monitor temperature, sound, localization.

V.METHODOLOGY

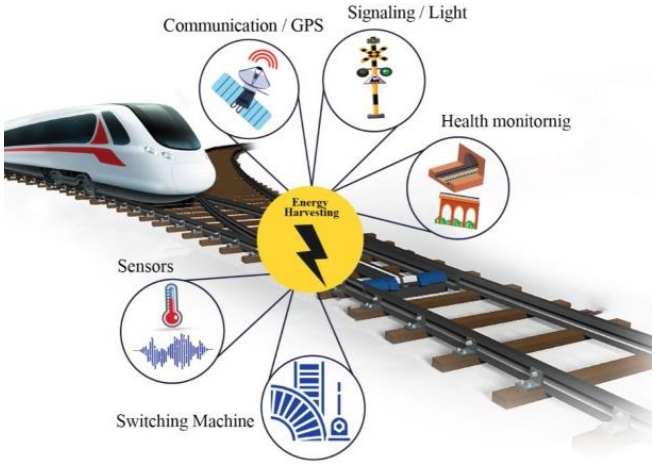

Figure 2

Online To verify the operation of the system and the input and output of different components, simulate the circuit using software tools like MPLAB IDE. Next, the necessary parts are assembled and put through real-time testing. Utilize renewable energy sources to increase rail systems' energy efficiency to power different parts and sensors within the rail infrastructure, it uses solar panels or the kinetic energy from moving trains by putting energy harvesting techniques into practice, rail systems can lessen their environmental impact and carbon footprint. That lessen the dependency on fossil fuels. Reduce the running costs of rail systems by utilizing energy harvesting possibly resulting in long-term savings, to augment or replace conventional power sources Utilizing Zigbee communication protocols, enable remote monitoring and control of rail infrastructure, enabling for gathering and analysing data in real time about vital systems. Increase safety by implementing energy-efficient sensors and systems that can track temperature, rail conditions, and potential problems like obstructions on the track or malfunctioning equipment

VI.CONCLUSION

Cooperation between railroad operators, technology developers, and regulatory agencies is essential to maximizing the potential of this energy harvesting and Zigbee system for railroads. Optimizing energy harvesting methods, improving Zigbee communication protocols, and guaranteeing the system's dependability and safety should be the main goals of ongoing research and development.

VII.REFERENCES:

1. Mingyuan Gao, Ping Wang, Yifeng Wang, Lingkan Yao. Self-Powered ZigBee Wireless Sensor Nodes for Railway Condition Monitoring. IEEE Transactions on Intelligent Transportation Systems, June 2017
2. Yasna Schifferli. Maximizing the energy harvested from piezo-electric materials for clean energy generation. Humanitarian Technology Conference (IHTC), 2017 IEEE Canada International, 21-22 July 2017
3. Marco Nesarajah , Georg Frey. Thermoelectric power generation: Peltier element versus thermoelectric generator. Industrial Electronics Society, IECON 2016, 42nd Annual Conference of the IEEE 23-26 Oct 2016.
4. Manoj Tolani, Sunny, Rajat Kumar Singh, Kumar Shubham, Rajesh Kumar. Two-Layer Optimized Railway Monitoring System Using Wi-Fi and ZigBee Interfaced Wireless Sensor Network. IEEE Sensors Journal, 7 April 2017
5. P.R. Goundan, A. Jhunjhunwala. Evaluation of relative merits/demerits of different signaling schemes used at a railway station for an approaching train in Indian Railways today. IEEE Transactions on Vehicular Technology, 3 May 2019
6. Sanjay Singh Negi, Nand Kishor, Kjetil Uhlen, Richa Negi. Event Detection and Its Signal Characterization in PMU Data Stream. IEEE Transactions on Industrial Informatics , 2017