Wireless Communication in Smart Rail Transportation System: A Survey

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ABSTRACT. The beginning of Wireless networking in public transit has ushered in a slew of innovative advances in railways, including better signal and consumer data transfers. Wireless technologies have advanced significantly in recent years, and they are now able to satisfy the growing need for connectivity networks for smart transportation system power, operation, and maintenance. Available radio technology involve Cellular Reliability (IEEE 802.11xx), Worldwide Interoperability for Broadband Applications (IEEE 802.11xx), Long term Evolution (LTE), wireless sensors, wireless ad hoc channels, or, in general, potential fifth- generation (5G) technology which does place a strong emphasis on the advancement of intelligent mobility systems for both ground and aerial devices. The spectrum of wearable sensors has instantly increased in recent years, while sensor devices have become more affordable. This has resulted in a dramatic increase in the use of detectors to track the state of devices, buildings, equipment, and railways. Technological breakthroughs in connectivity systems like wireless connectivity and handheld ad hoc connectivity, as well as the infrastructure to integrate them, are critical aspects. WSNs would be used to inspect train facilities such as bridges, rail lines, bridge platforms, and train machinery, as well as vehicle damage control such as engines, bogies, tires, and locomotives. Status tracking decreases manual intervention needs by automating detection, lowers repair costs by finding faults until they become severe, and increases scalability. This seems to be critical to railroad system growth, upgrade, or extension. This paper focuses at how emerging wireless network technologies could be used to track networks, buildings, automobiles, and equipment throughout the rail industry. Internally and externally interactions of classification process and transmission of the train system are the subject of this article. In a qualitative analysis, it describes its distinct reasons and evaluates their benefits and drawbacks.

Key words: Wireless Communication, Wi-Fi, WiMAX, LTE, 5G, High speed train.

1. Introduction

Modern trains are made up of integrated technological solutions and parts, and also traditional transit networks such as electronic routing protocols, digital signage, and smart meters. To address an ever requirement of energy-efficient and safe networks, these systems will need robust elevated cellular networking and optimized technological aspects to maximize the use of infrastructure, from tracks to railways, according to Olliaey et al., would be critical to this growth, updating, and extension, especially if it is combined with such a transition to improve performance. Lopheiz Heiguera et al. devised a structured public health stairwell, with each step increasing in difficulty and usefulness. The most basic Level 1 methods detect destruction through finding it, while Level 2 structures have position data. A Level 3 model may assess the severity of the injury, while a Level 4 model can predict the damage's effects and potential life span. Eventually, a Level 5 device would provide sophisticated hardware, unique protocols, and technology to allow diagnostic, condition, and sometimes even approach recommendations.

2. Problem Identity

The most difficult task for WSNs of railway applications is deciding which calculation technology to employ. To allow effective state tracking in rugged but inconvenient conditions, the WSN should be both accurate and consistent, as well as cost efficient. There is a shortage of an automated structure that can analyses data and include options for the transfer of any information that isn't part of it, as well as a classifiers which can be conveniently and rapidly adapted for some sort of stuff rail network or creative process requirements. Absence of the contact tool that takes advantage of train-station activity periods, such as loading time. Keeping unlabeled information and transmits it to data centers for delivery consumes a lot of resources, such as bandwidth utilization, time, storage, and money, so data division is needed. Long-term storing of big data on- board, from the other hand, would be expensive and limited by processing power with existing storing technologies. There is no expense transmission network to handle the situation.

3. Related Works

3.1 Improving rail network velocity: A machine learning approach to predictivemaintenance

Fumieo et al. (2015) suggested a new CBM (Condition Base Maintenance) methodology predicated upon SDA (Streaming Data Analysis) which uses Online Support Vector Regression (OL-SVR) which forecast the RUL (Remaining Useful Life). However, since the SVR isn't really ideal for massive data sets, lossless compression has been implemented, resulting in additional problems and failure transmitting efforts.

3.2 Condition based maintenance in railway transportation systems based on bigstreaming analysis

Liv et al. (2016) used a mixture of computational methods to meet improved system requirement or workload across rail networks, since rail acceleration must be improved despite losing protection. As a consequence, if we were using a static framework for various contexts, the system could produce inaccurate data. As a result, we must develop a dynamic prototype that can be combined with various rail network in order to prevent flight delays and boost channel agility. Misinterpretation of information could result in erroneous service requirements.

3.3 Time synchronized wireless sensor network for structural healthmonitoring applications in railway environments

Valk et al. (2017) created better frameworks for condition monitoring that only transmit quick information among sensor network in normal cabins and a data channelin the operator cab. For channels calculation, the TDMA MAC framework has been used, as well as a synchronizations method is employed to save space. Because of another stage malfunction of both the synchronizations protocol, the TDMA Mac protocol is only optimal for heavily congested loads, resulting in misleading sustainability for low / mid loading conditions.

3.4 Energy efficient wireless mac protocols for railway monitoring applications

In engine performance control for low / mid traffic loads, G.M. Shafiullaih et al.(2018) suggested the very same definition as Valk et al. The advancement of vehicle health monitoring (VHM) structures is shown in Fig.1 has been sparked by recent developments in wireless sensor networking (WSN) technologies. They used the EA-TDMA and E-BMA protocols and save resources through piggybacking, however the protocols have such a greater transmission delay than most other protocols, making them unsuitable for increased traffic rates.

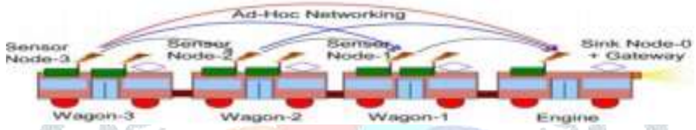

Figure1. Wagon tracking system

3.5 Two layer optimized railway monitoring system using Wi-Fi and zigbeeinterfaced wireless sensor network

For inner information sharing, Mano Tolanei et al. (2019) were using a bi-layered Zigbee-Wi-Fi connectivity system. As shown in Fig.2 a bi- layer system of wireless sensor network (WSN), namely wireless local area network (WLAN) as well as wireless personal area network (WPAN), are applied, evaluated inneural framework. The data loss is also reduced, and itis only 7percent of total (2/15 times less) than the Wi-Fi based WSN In comparison to a completely Wi-Fi-based framework, the number of retransmit requests is decreased by 50 per cent.

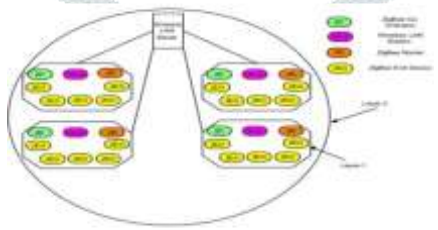

Figure 2. Bi-layer system of wireless network

3.6 Fully autonomous wireless sensor network for freight wagon monitoring

By developing a bi-periodic scheduling algorithm for regional data networks, a flexible maintenance of the GPS module, and an utilization design of the GPRS transmitter, Alesandreo Loie et al. (2019) has presented a design as shown in Fig.3 employing Zigbee on platform transmitting status between every coach and cab drivers through sensor systems for remote data transfer. The suggested strategies are related to the existing models in order to mitigate energy demand to levels that heat engines can maintain despite sacrificing operational efficiency and observations on a device sample but in various operating conditions that does not confirm the underlying concepts.

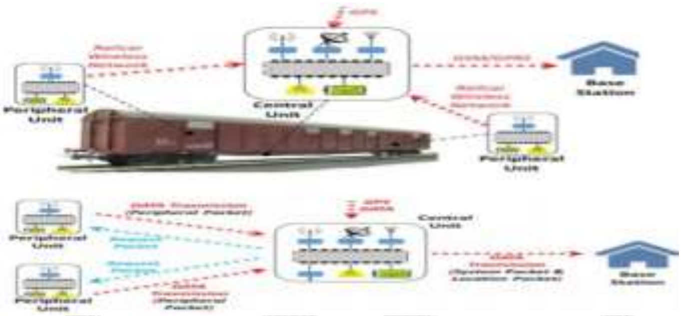

Figure 3. A structure of on-scale tracking system

3.7 A cloud-based heterogeneous wireless platform for monitoring and management of freight trains.

By expanding the technology from Mathias Grudey et al., Machucci et al. with Chidchio et al. (2019) created a data extraction and transmitting strong emphasis in Cognitive radio routers as shown in Fig.4 for inner (on-board) and wireless networks for outer (long-range) connectivity. This paper describes the design and implementation of interconnected and diverse platform that provides an 868 MHz WSN (Wireless Sensor Net) for on-board connectivity and data sharing. M2M (Machine-to-Machine) SIMs are used to send data over a cell network, and data is collected on the Cloud for analysis and anomaly detection but issues on bandwidth and lack of redundancy on protocol rises.

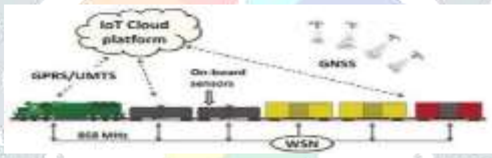

Figure 4. GE910-GNSS Module System

4. Conclusion

The selection of WSNs used for performance control in the rail industry was discussed in this article. Until recently, train inspection was conducted physically, but this really looked at items conceptually and infrequently, and the results had to be understood by an objective specialist. To allow effective quality tracking in rugged and unavailable conditions, the WSN must be both reliable and precise, as well as cost effective. To allow predictive analytics in the railroad transportation infrastructure product life cycle, it has to be necessary formodify WSN through detector report as meaningful but also knowledge.

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