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Study Of An Adaptive Model For Railway Monitoring System Using Ieee Standards

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Abstract-An adaptive railway monitoring system using IEEE802.11 and IEEE802.15 (Wireless Sensor Networks) has been proposed for low power consumption and bandwidth optimization. These two wireless standards are implemented to reduce the data traffic and to achieve high data rate. IEEE802.15 (Wireless Personal Area Network) is used to reduce the power consumption and IEEEE802.11(Wireless Local Area Network) is used for achieving high data rate. In the proposed system, better throughput can be achieved and the data dropping rate can be reduced.
Keywords – Wireless Sensor Networks , railway monitoring system , IEEE802.11 , IEEE802.15, data rate ,throughput.

I. INTRODUCTION

In the recent works, wireless sensor network plays a vital role in many areas especially in the field of railways. Even now railway monitoring system involves some manual work. In such areas, wireless sensor networks helps in reducing the manual task. Various research works are being undertaken to reduce the manual intervention in railway monitoring and controlling systems with Ad Hoc and wireless sensor network.

Power consumption has become the major problem in railway applications. Some other challenges in railway monitoring system are to make the system durable and more reliable. These challenges can be overcome by using WSN technologies. While designing the sensor boards, each sensor board requires its own battery that has limited lifetime. So the sensor power consumption has become a serious issue. In wireless networks, the use of IEEE 802.15(Zigbee) standards will reduce the power consumption and also increases the battery life. Bandwidth limitation is one of the major disadvantages in Zigbee. Though Zigbee has bandwidth constraint, it can be used for long range communications. Sometimes failure occurs due to unbalanced load conditions.

In order to overcome the disadvantages, an efficient system using WLAN and WPAN has been proposed. A WLAN station and Zigbee coordinator are interfaced together. For all Zigbee end devices Zigbee coordinator acts as a destination device. Zigbee devices are suitable for low bandwidth communication whereas Wi-Fi devices are suitable for high bandwidth communication. But Wi-Fi devices consumes comparatively more power than Zigbee devices. In order to design a reliable network, Wi-Fi devices has to be placed at locations where frequent charging and replacing of batteries is easier.

A single sensor node has a cluster of different sensors. These sensors share single controller and memory along with ADC with transceiver as shown in Fig.1. The output measured from different sensors are further converted into digital form by analog to digital converter. The digital values obtained from ADC are processed by microcontroller connected to memory and transceiver device. In the proposed system the transceiver is the Zigbee module. The Zigbee module along with controller, memory and sensors together forms a single Zigbee node. Collection of these Zigbee nodes are commonly referred as wireless sensor network. In order to increase the packet generation rate the number of sensor nodes has to be increased. In Zigbee devices due to bandwidth constraint data rate is limited. This causes data traffic in the central gateway, which limits data rate to 250kbps.

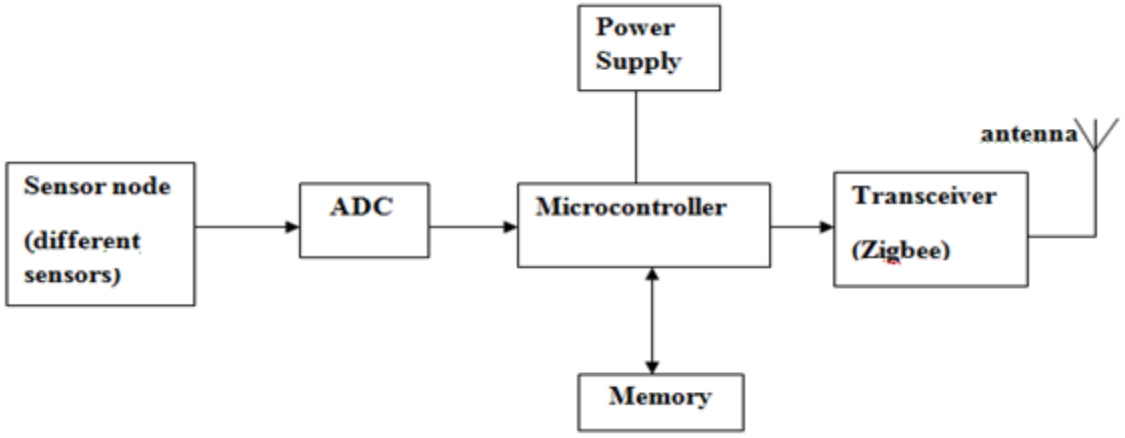

Figure.1.Sensor nodes interfaced with ADC , Microcontroller and transceiver

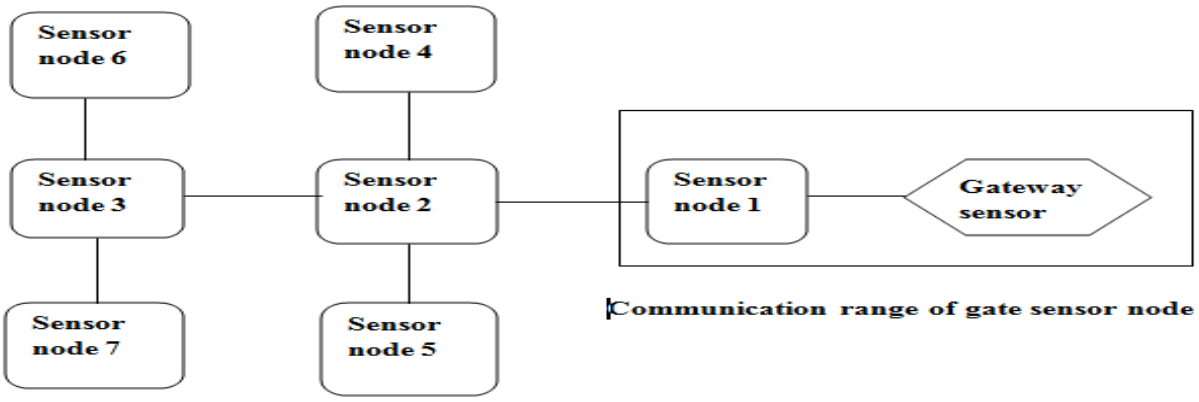

Figure.2.Zigbee based WSN

The bandwidth of Wi-Fi is higher the Zigbee that is upto several Mbps. But, Zigbee has an advantage of low power consumption when compared to Wi-Fi. So, for power optimisation, maximum number of Wi-Fi nodes are replaced by Zigbee nodes. The Wi-Fi nodes are used only for bandwidth improvement at places where the data rate of Zigbee is lower than Wi-Fi.

In Wireless Sensor Networks, the failure of the nodes that are nearer to the gateway node occurs because these nodes are heavily loaded compared to other nodes. this condition is known as unbalanced node condition as shown in Fig 2. In order to handle this problem Ad Hoc transmission is avoided in Zigbee nodes . In the proposed system, the first layer end devices will send the data to the central node which acts as gateway sensor node and as a coordinator for the Zigbee network. The gateway sensors are interfaced with WLAN stations. The second communication layer is formed by the WLAN stations from the first layer for the transmission of data to the server node.The aim of this project is to create a reliable railway monitoring system using WSN technique by introducing two layer architecture where the first layer consist of WPAN for power optimisation and the second layer has WLAN for bandwidth efficiency.

The rest of the paper is organized as follows. Proposed embedding and extraction algorithms are explained in section II. Experimental results are presented in section III. Concluding remarks are given in section IV.

II. PROPOSED SYSTEM

For long-range communication, ZigBee network can be used. with the help of intermediate nodes we can transmit data from one node to another node. we use Ad Hoc network where far apart nodes can communicate with each other using intermediate node. Sometimes unbalanced load problem occurs as shown in the Fig.2. In this figure, if the sensor node 3,6 and 7 need to transfer their data to gateway node, they transmit data with the help of

intermediate node via nodes 2 and 1.It is not possible to transfer the data directly, because they are not in communication range of gateway sensor node (GSN).

One of the major drawback of pure zigbee network is the low bandwidth constraint. In the proposed railway monitoring system, the various type of sensors like vibration sensor ,humidity sensor, temperature sensor, and some special type of sensor for monitoring railway track and train, break test, window monitoring, track monitor, navigation, axle spring motion, wheel bearing monitor, driving comfort monitoring, that may generate traffic about 12 packets/s. Each node will generate the traffic of about 10 KBps or 80 kbps. At these scenario only limited nodes can send data, at this time bandwidth of Zigbee is limited to 250 kbps.

The Ad Hoc nature of the network is the main reason for unbalanced load problem this can be resolved by using two layer structure of WI-Fi and Zigbee devices.Due to the bandwidth limitation of Zigbee devices it is used in first layer(L1). In this layer group of 3 nodes communicate directly with the gateway node. Each L1 layer has Wi-Fi node and gateway node interfaced together. The WI-Fi node communicates with server node in L2 layer. The gateway Wi-Fi node in L1 layer is a relay node. This node generally has higher bandwidth and is powerful in nature. In L2 layer all relay nodes communicate with each other and to the server node. WPAN is formed using Zigbee as the first layer.WLAN is formed using Wi-Fi as the second layer.

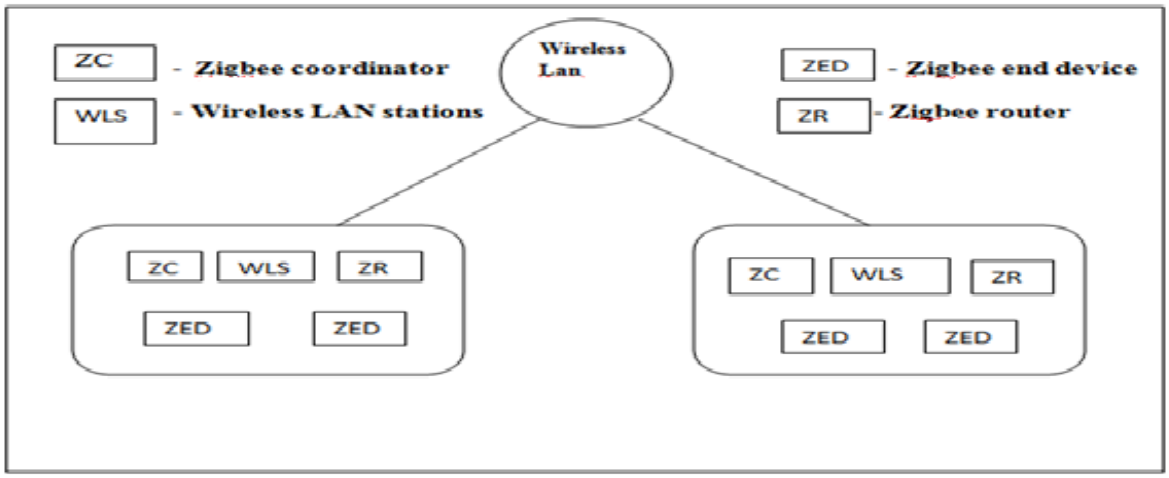

Figure.3.Dual layered Wi-Fi and Zigbee

In railway monitoring system, there are various tasks such as wheel checking and track checking etc are performed manually. Sometimes failure may occur due to manual checking, because the information cannot be provided priorly which may lead to accidents.

In order to obtain accurate information of railway track various sensors like water level sensor, vibration sensor ,pressure sensor etc. are used in the field.

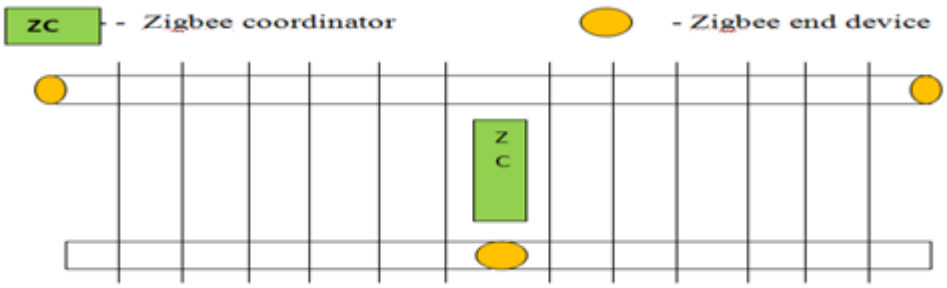

Figure.4.single Railway pannel with zigbee coordinator and zigbee end device

The information collected from the sensor will be in the analog form which is needed to be converted in the digital form for the purpose of storing in microcontroller. This digital data is collected by Zigbee end device and is transmitted. Likewise data from different Zigbee end devices are transmitted to WLAN server via Zigbee

coordinator which acts as a gateway.Zigbee coordinator and Zigbee end devices are connected as shown in Fig.4. Transmission and reception of data is done with the help of Wi-Fi for the purpose of achieving high data rate.

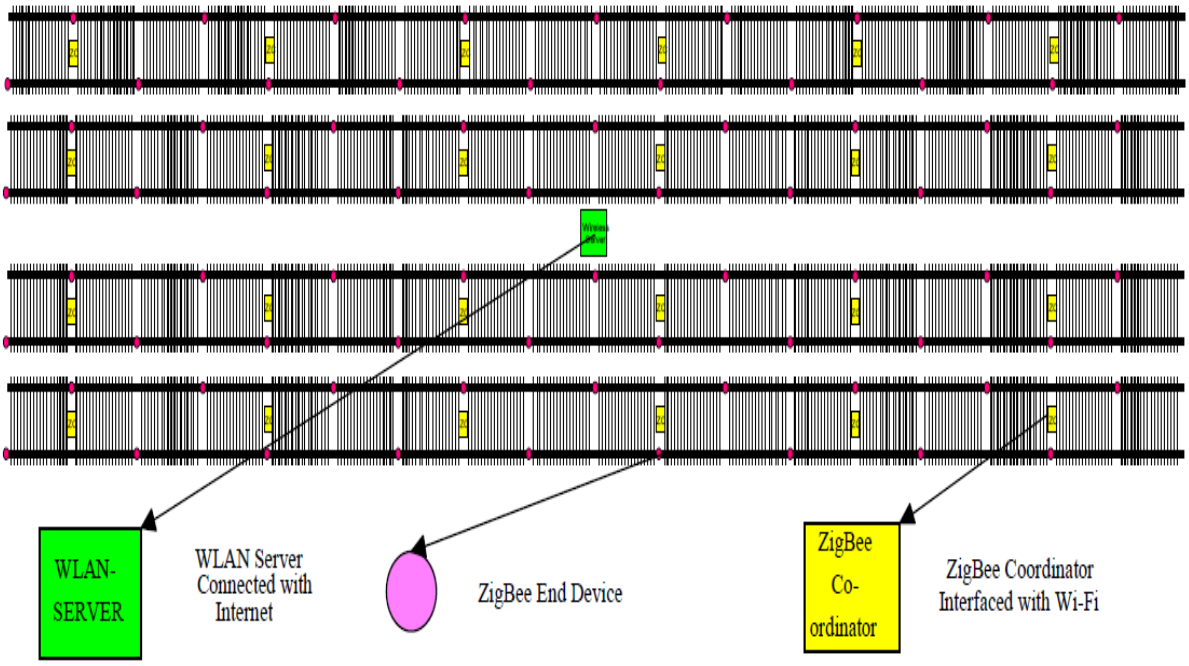

Fig.5 Railway tracks with zigbee coordinator and WLAN server
(ref: Manoj Tolani, Sunny, Rajat Kumar Singh, Kumar Shubham, Rajesh Kumar , "Two-Layer Optimized Railway Monitoring System using Wi-Fi and ZigBee Interfaced Wireless Sensor Network, 1530-437X (c) 2016 IEEE.)

IV.EXPERIMENT AND RESULT

The term simulation which is used in the Embedded real-time software construction has usually posed interesting challenges due to the complexity of the tasks executed. It is the operation of a real-world process or system. For executing the simulation we have using the Proteus software which is used to execute the codings and simulated output. The simulation which helps to test our coding in the case basis and analysis before interface with the hardware system.

By the help of the simulation method, we can obtain the particular result in real-time systems. It will be in the easy to obtain the results which are related to the programmatic oriented case basis, and it will be very useful for the software testing and as well as for the software debugging.

Table -1 Experiment Result

	Existing System	Proposed System
Power consumption in standby mode	1.5Amp.	0.7 Amp.
Power consumption in transmission mode	50.08 Amp.	20.9 Amp.
Efficiency(in %)	70	85

V. CONCLUSION

In the proposed railway monitoring system load is distributed uniformly. Dual layered structure of IEEE802.11 and IEEE802.15 has been proposed for bandwidth utilization and power optimization. This design is used in railway track. From the result we have found that data rate has improved and power consumption has reduced upto 60 percent. By using this structure we can achieve low power consumption and high data rate when compared to purely wifi based networks. This system can handle packet generation rate upto 25-35 packets per second by each node. By using this system we can reduce data drop and delay.

VI. REFERENCES

[1] 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, 1530-437X (c) 2016 IEEE.

[2] Victoria J. Hodge, S. O'Keefe, M. Weeks, and A. Moulds, "Wireless Sensor Networks for Condition Monitoring in the Railway Industry: A Survey", IEEE Transactions On Intelligent Transportation Systems, vol.16, No. 3, pp.1088-1106, June.2015.

[3] Nuffer and T. Bein, "Application of piezoelectric materials in transportation industry," in Proc. Global Symp. Innovative Solutions Advancement Transp. Ind., San Sebastian, Spain, pp. 1–11, 2006.

[4] A. Pourghodrat, "Energy harvesting systems design for railroad safety,"M.S thesis, Mechanical (and Materials) Engineering, Univ. Nebraska- Lincoln, Lincoln, NE, USA, 2011.

[5] J. Lynch and K. Loh, "A summary review of wireless sensors and sensornetworks for structural health monitoring," Shock Vibration Dig., vol.38, no. 2, pp. 91–130, Mar. 2006.

[6] R. Piyare, Seong-ro Lee, "Performance Analysis of XBee ZB Module Based Wireless Sensor Networks," International Journal of Scientific & Engineering Research, vol. 4, April 2013.

[7] L. U. KeZhong, C. GuoLiang, L. Gang and M. Rui, "Approximation algorithm for minimizing relay node placement in wireless sensor networks," SCIENCE CHINA Information Sciences, vol. 53, no.11, pp.2322-2342, Nov. 2010.

[8] C. Ma, W. Liang, Zheng, and H. Sharif, "A Novel Local Search Approximation Algorithm for Relay Node placement in Wireless Sensor Network" Proc. IEEE WCNC'15, pp. 1536-1541, 2015.

[9] J. Lee, Y. Su, and C. Shen, "A Comparative Study of Wireless Protocols: Bluetooth, UWB, ZigBee, and Wi-Fi," The 33rd Annual Conference of the IEEE Industrial Electronics Society (IECON), Taipei, Taiwan, pp.5-8, Nov. 2007

[10] Y. Zhang and Q. Li, "Exploiting ZigBee in Reducing Wi-Fi Power Consumption for Mobile Devices," IEEE Transactions on Mobile Computing, vol. 13, No. 12, pp. 2806-2819, Dec. 2014.

[11] Firdaus, E. Nugroho, A. Sahroni, "ZigBee and Wi-Fi Network Interface on Wireless Sensor Networks," Makassar International Conference on Electrical Engineering and Infonnatics (MICEEI) Makassar Golden Hotel, Makassar, South Sulawesi, Indonesia, pp. 26-30, Nov. 2014

[12] OPNET Technologies. Available: http://www.riverbed.com

[13] Stuart Hince.Great Western Railway—44' 6" Rail Panels. [online]