Wireless Sensor Networks with Alert System in the Railway Industry

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Abstract— Now a day, the sensing technologies has grown rapidly, whereas sensor devices have nominal price also. Wireless sensor networks (WSNs) gaining importance for monitoring in the railway industry for analyzing systems, structures, vehicles, and machinery. It also provides up-to-date information and alerts. These techniques will combine data from different sensor systems using sophisticated modeling techniques.

Key words: Condition Monitoring, Event Detection, Wireless Sensor Networks (WSNS)

I. INTRODUCTION

Wireless Sensor Networks are consisting of minute devices which are self-powered and consist of different sensors. These sensors can access information from the environment. They can also wirelessly transmit and recessive data with each other. Each sensor can to coordinate themselves and sent the information to a base station. Monitoring applications can get advantage from this technology since a large number of nodes can be arranged in the manner without the need for wiring. By means of routing and synchronization protocols, sensor nodes can communicate with each other to sense the environment. Now a days, for e.g., the future prospects for WSNs as assuring for the Critical Infrastructure Protection (CIP) field have been recognized. Based on that, WSNs have more chances to become an essential part of the protection of CIs. Their distributed nature makes them particularly suitable opposite failures and attacks as they are much more less affected in their entirety, unlike wired systems. One of the main problem, researchers and industry wanted to tackle in order for WSNs to become pervasive in this application domain is the lack of QoS support, mainly due to their wireless nature.

For the development of railway industry there is great effort is needed. The main thing is the condition monitoring. Condition monitoring identifies and detects failures in the industry before anything happens. The sensors will collect the data and the data reach a threshold value, then an alarm is activated. This is a simplistic approach that may lead to false alarms and missed failures [4]. So there is integrated data processing is needed and the sensors are networked [7], [2].

II. SENSOR DESIGN

There are a multi number of sensors types available in railway condition monitoring for analyzing different aspects of structures, infrastructure, and machinery. The sensors converts a measured mechanical signal into an electrical signal. Most railway sensors are under the the micro electro mechanical systems (MEMS). MEMS combine electrical and mechanical components. They are small, integrated devices, cheap and efficient because they can be produced to consume low power [5], [3]. Sensor design must requires more functionality and low power. Condition monitoring systems for railways are in remote or inaccessible areas, so there is no wired power supply available. Hence, the sensors need power from either batteries or local energy generation.

Sensor design consists of Measurement Sensors, Sensor Nodes and Sensor Power. Sensor devices are used to measure temperature and humidity, and they can combine measurements from other systems. Sensors are placed on a board that consists of mobile computing and wireless communication. A sensor node moves around for data processing to identify problems. Mostly sensors use batteries for energy. They can also use solar power. And for the power consumption they can move to sleep mode and wake up only when an event detects.

III. NETWORK DESIGN

WSNs capture continuous real-time data. However, WSNs enable long term condition monitoring in less amount of energy usage. They typically use low-power sensors by batteries and local energy generation. Hence, the network carefully captures the data and also designed to overcome transmission errors, latency, network outages, missing data, or corrupted data. The network design consist of Base Station, Relay Nodes [8], Network Model, Sensor Network Topology (Data Linkage), Communications Medium, Transmission and Routing.

Consider the Fig. 1, it shows a typical WSN setup for railway condition monitoring. The base station controls all the sensors and that are attached to the railway system like rail tracks. And also acts a gateway between sensor node and server. The sensor node collects the data from the rail tracks and transmits to base station using

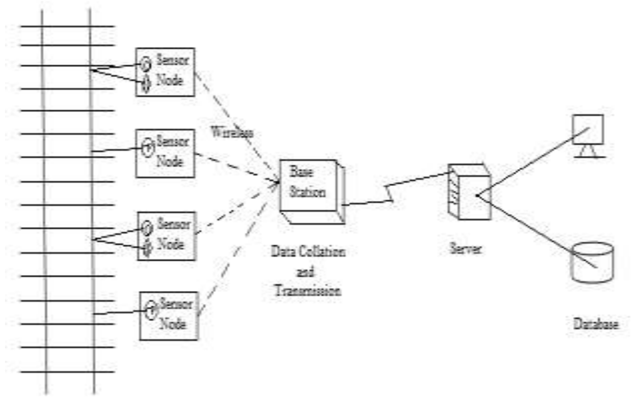

Fig. 1: Diagram shows a typical WSN setup for railway condition monitoring.

short range of communication like Wi-Fi or Bluetooth. But there is a chance of losting data due to communication errors. So relay nodes are used to avoid these types of errors. The relay nodes are placed in between the sensor node and base station. Hence, the data transmit from sensor node to relay node and it reach the base station. From the base station data send to the remote server through long range of communication such as GPRS or satellite. After reaching data from base station to remote server, it transmits to database and an engineer which in charge a administrator. The corresponding person always checking the information.

The network model of WSNs consists of five layers such as physical layer, data link layer, network layer, transport layer and application layer. In which the physical layer defines how the sensors transmit their data to the network. The data link layer defines the network topology and connects nodes to each other. The network layer routes the data through the network as packets. The transport layer controls the sending and receiving of data. And finally, the application layer allows application software to access the data. There is three types of management planes [1], [2] are available such as power management plane for power consumption of sensor nodes, the mobility management plane for identification and records the movement of sensor nodes and the task management plane for balances and coordinates network regions.

IV. Monitoring System

The data generated from railway system and transfers to sensors is treated as either a time series or a sequence of readings. In the case of time series data can be produced as continuously or periodically. And in the case of sequence reading where the data generated ad hoc, for e.g., data generated every time a train passes. The data searching is to find a threshold value. Condition monitoring can be performed in two ways such as continuously or periodically. Continuous monitoring detect a problem straight away but it is expensive and requires more energy, which is a problem for WSNs where the network components need high power; and the sensor data are very noisy means it may contains errors, which requires careful data handling to ensure accurate diagnostics. Periodic monitoring has less price, they uses less energy, and allows time for data cleaning and filtering but a problem will only be diagnosed at the next processing run. Periodic monitoring may be acceptable for the situations that change slowly like cracks developing in bridges but for time critical scenarios, then continuous monitoring is necessary.

Due to the mobility of the sensor nodes the topology of WSNs often varies over time. The communications network for WSN can be subdivided into two: the fixed network and movable network [6]. The fixed network relates to sensor nodes in fixed locations such as bridges, tunnels, and special points, and the movable network relates to sensor nodes attached to locomotives or rail wagons.

V. Conclusion

A reliable railway network monitoring system is proposed and by effectively implementing the system and training the users in the system to efficiently use the system for the best results would make the system more and more reliable. In the future, condition monitoring will be able to exploit cheaper, more robust and more pervasive hardware. New data processing techniques will generate more accurate, robust, and reliable models from existing and new sensor data. Data and processing will be standardized. Systems will be secure and provide clear and detailed decisions and recommendations.

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