Avoidance of Fire Accident on Running Train Using ZigBee Wireless Sensor Network

R. Pitchai Ramasamy[1], M. Praveen Kumar[1],
S. Sarath Kumar[2] and R. Raghu Raman[3]

[1,1]*Information Technology, Adhiparasakthi Engineering College*
Melmaruvathur-603319, Tamil Nadu, India.
[2,3]*Information Technology, Adhiparasakthi Engineering College*
Melmaruvathur-603319, Tamil Nadu, India.

Abstract

The main objective of our proposed system is to safe guard people's life and government property. This paper will focus on the system that will detect and control the fire accidents on running train. In-house parameters such as temperature and humidity in the each coach can be monitored in real time. From the information collected by the sensor system, decisions for firefighting, alarming, and automatic water sprinkler system can be made more quickly by the relevant system or engine driver. After receiving the signal, the engine driver will stop the train and take necessary action.

Key Terms: Fire alarm system, Fire protection systems, Wireless sensor network, Automatic sprinklers, Signal transmission.

1. Introduction

The trains are moderate vehicles used for transporting people and goods. Mostly, the people prefer the train journey for longer distance as it is cheaper. Since induction of train for public transportation, the fire accidents are not catered seriously by the Indian Railways. The notices showing "Do not smoke", "Do not carry inflammable material" are the only precautionary warnings about the fire in each compartment. However, because of failure in routine maintenance system or by the activities of illegal social elements, the fire accidents in train occur frequently. These fire accidents are among the most serious disasters to human lives and the property of government. In recent

days, the train fire accident occurred and made several human loss. The prevention of train fire has become a serious concern in our country. Currently, Our Indian Railways doesn't use any sophisticated fire prevention methods. But it is realized to have an automatic system to monitor the fire in the coach giving alarm to the people, sending signal to the engine driver to stop the train and the fire is extinguished with the help of automatic sprinkler system. To have these all above in a single package a wireless sensor network based on ZigBee technique is proposed. This system is used for monitoring, automatic fire sprinkling, cautioning and preventing of fire in running trains.

The fire may occur in Anyform of activities such as short circuit in the electrical wires, prohibited activities of carrying diesel, petrol, gas stoves and smoking nearby them will cause fire accidents. To control these we do not have an intensive work force. To overcome this, a system of having automatic sensor monitoring, fire alarm warning and fire extinguishing are based on ZigBee wireless sensor network technology. This system can monitor real-time related parameters such as temperature and humidity in each coach. From the information collected by the system, decisions for firefighting, alarming, and automatic operation of the train braking system can be made more quickly by the system or engine driver. The engine driver will get the warning light and he stops the engine. Further he informs to the immediate concern authority for help.

2. Main Parameters of Coach Fire Monitor

There are three factors comprising of fire. The factors are oxygen, material and heat or ignition. A train fire usually occurs as the result of these three elements. Here, we are going to see elaborately the heat or ignitions being produced by the following,

- A deteriorated insulation on electrical wire causing short circuit
- Carelessness of smoker's activities
- Illegal usage of stoves used by the tea or coffee vendors
- And the anti-social activities

To control these we must have a system of work force which is not deployed by the Indian Railways. To enable these we propose to have a temperature monitoring system in each coach. The device categorically of thermocouple used for monitoring the coach temperature and also provides both external and internal alarms. The devices are fixed on each coach at the appropriate distance covering full coach. ie., the total length of the coach is divided into four segments and the sensor is centrally placed in each segment.

3. Structure and Function of the sensor node

The sensor is a basic unit and platform of the wireless sensor network. A sensor is commonly composed of a sensor module, a processing module, a ZigBee wireless module and a driver display module. The sensor module is responsible for wave-

electrical conversion and collecting parameters such as relative humidity and atmospheric temperature. This module processingis used to calculate the temperature, sensing alarm node and sending the signal to engine driver. The ZigBee wireless module is responsible for receiving a reliable signal and it illuminates the warning light indicating to stop the train by engine driver. The driver display module monitors the three modules and control the fire by using fire sprinkler system. In this Sensor, is principle calculates the increased temperature over the atmospheric temperature and then it transmits the signal to the engine driver through ZigBee wireless technology. Simultaneously alert the passenger by alarm also initiate the emergency fire sprinkler for operation.
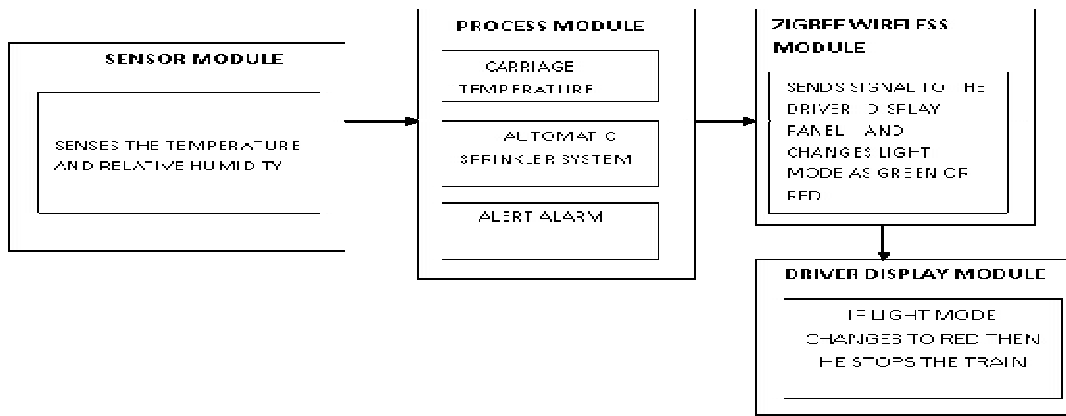

Fig. 1: Different types of module.

4. ZigBee Technology

ZigBee is a considered as a path for a suite of high level communication protocols. Zigbee is generally called as wireless communication technology. ZigBeealso support low rate and low-power digital radios based on an IEEE 802 standard for personal area networks [PAN]. The purpose of the technology defined by the ZigBee specification is to be simpler and less expensive than other WPANs (Wireless personal area network), such as Bluetooth. ZigBee is aimed for radio-frequency (RF) applications because they require a less data rate, high battery life, and forsecure network. ZigBee has a defined rate of 250 kbps best suited for periodic or intermittent data or a single signal transmission from a sensor or input device.

There are a multitude of proprietary wireless systems manufactured today to solve a multitude of problems that also don't require high data rates but do require low cost and very low current drain. These proprietary systems were designed because there were no standards that met their requirements. Hence the legacy systems were creating significant interoperability problems with one another and with upcoming technologies. It is Open standard protocol with no or negligible licensing fees, chipsets

available from multiple sources, remotely upgraded firmware, fully wireless and low power, mesh networking to operate on batteries, low maintenance and larger network size with standard based high security.

The ZigBee specification identifies three kinds of devices that incorporate ZigBee radios, with all three found in a typical ZigBeenetwork.Coordinator (ZC): organizes the network and maintains routing tables. Routers (ZR): can talk to the coordinator, to other routers and to reduced-function end devices End devices (ZED): can talk to routers and the coordinator, but not to each other.

The ZigBee Alliance is not pushing a technology; rather it is providing a standardized base set of solutions for sensor and control systems. ZigBee is poised to become the global control/sensor network standard. It has been designed to provide the following features:
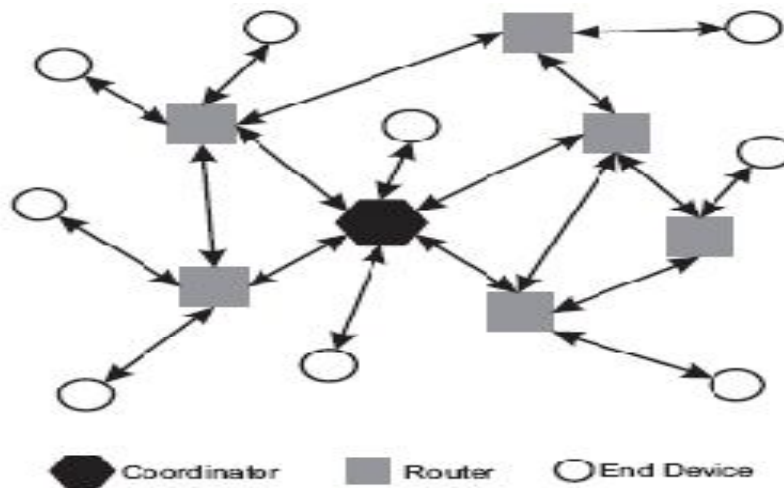

Fig. 2: ZigBee network.

- Less power consumption, easy to implement
- Users expect batteries for long periods (last many months to years)! Consider that a typical single family house has about 10 smoke/CO detectors. supopose the batteries for each one only lasted ten months, the home owner might be replacing batteries every month!
- Based on your latency and power requirements the bluetooth have many different modes and states such as sniffle, park, hold, active, etc.; ZigBee/IEEE 802.15.4 has active (transmit/receive) or sleep. Application software needs to focus on the application, not on which power mode is optimum for each aspect of operation.
- Even mains powered equipment needs to be conscious of energy. Consider a future home with 100 wireless control/sensor devices,

- ZigBee devices will be a more ecological friendly than its predecessors saving megawatts at it full deployment.
- Cost will be low (device, installation, maintenance)
- Less cost to the users, which means cost of the device is low,installation cost is low and the low maintenance. ZigBee devices allow batteries to last up to years using primary cells (low cost) without any chargers (low cost and easy installation). ZigBee'stechinques simply allows to inherent the configuration and redundancy of network devices provides low maintenance.
- Density of nodes could be high per network
- ZigBee'sdevice used as the IEEE 802.15.4 PHY and MAC,which allow the networks to handle any number of devices. This type of attribute is critical for massive sensor arrays and control networks.
- Used as simple protocol, globaly implementation.
- ZigBee's protocols code stack is to be estimated about $1/4^{th}$ of either the Bluetooth's or 802.11's. Simplicity cost is more essential, interoperability, and maintenance. The IEEE 802.15.4 PHY is to be adopted in ZigBeetechinques has been designed for thesome of the contries,in Europe 868 MHz band, the 915 MHz band in America, Australia, etc; and the 2.4 GHz band is now recognized to be a global band accepted in almost all countries.

5. Application of ZigBee wireless sensor network in Fire Detection system

A wireless sensor network which combines driver's display unit and signal transmitter is considered to be one of the reliable applications. This network is composed of micro sensor nodes which have the ability to calculate. These nodes can monitor sense and collect information of different locations in the coach.

ZigBee is a low-rate, low-cost and low-power kind of short range wireless network communication protocol. Compared with other wireless technologies, ZigBeetechinques has provide important of unique advantages are safe and reliable in data transmission, an easy and more flexible network configuration, low cost for equipments and Long- lasting batteries. The ZigBee Alliance is not pushing a technology; rather it is providing a standardized base set of solutions for sensor and control systems and The ZigBee Network Node is designed for battery powered or high energy savings.

Thus, it has great development potential and a promising market application in the field of industrial control. By applying a wireless sensor network based on ZigBee to a train fire monitoring system, information such as temperature and relative humidity at any part of the train covered by the network could easily be collected, dealt with and analyzed at any time. In addition, the system can be extended significantly, the cost of equipment maintenance could be reduced and the whole system could be optimized.

6. Fire Alarming System

The thermocouple temperature sensor is to monitor for fire conditions within rail coach and provides external and internal alarms, together with automatic operation of the train braking system. When the temperature senses it triggers the alarm in the coaches to make the people alert and wake up who are sleeping. The carriage Controllers have associated with the LED batteries such that fire protection is maintained by indicating the color lights in the driver's display unit. As a backup, the alarm also installed in the engine driver. This provision is created to ensure that the engine driver does not oversight the illuminator light.
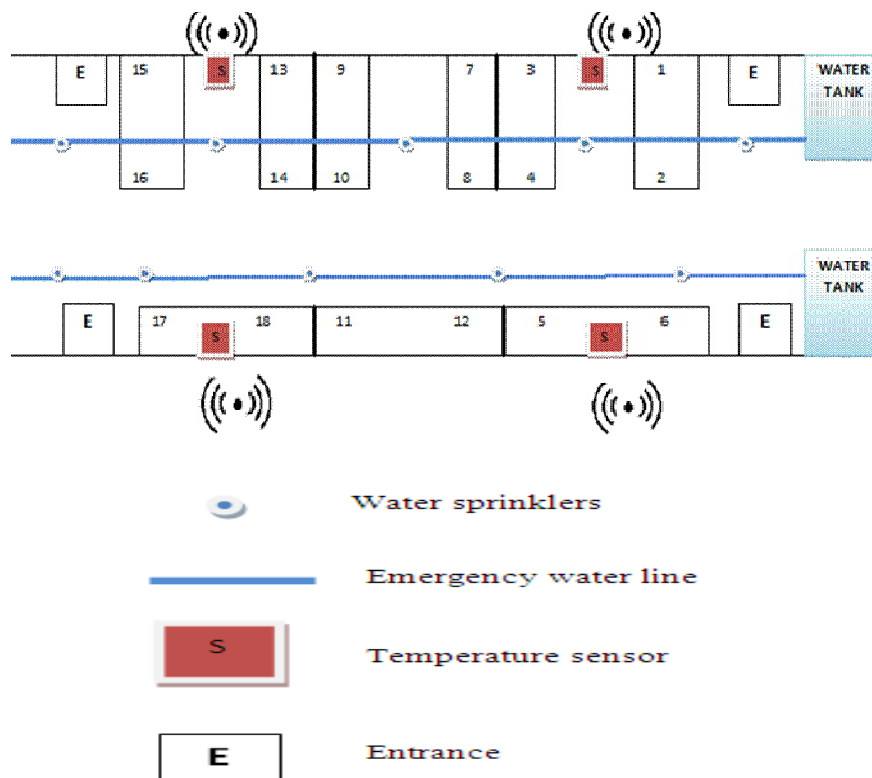

Fig. 3: Layout of a train.

7. Control of Fire Accidents

After the signal send by the ZigBee wireless monitoring system, it also ensures the fire sprinkler system gets operated and the fire extinguished or the temperature is brought down substantially. To facilitate this, a pipeline all along the compartment is connected with the water tank. The value is intermittently fitted in the pipeline. When the sensor is detecting the increased temperature, this enables the valve to get open and automatic sprinkler sprays the water in the compartment. Resulting the fire is extinguished or temperature is brought down.
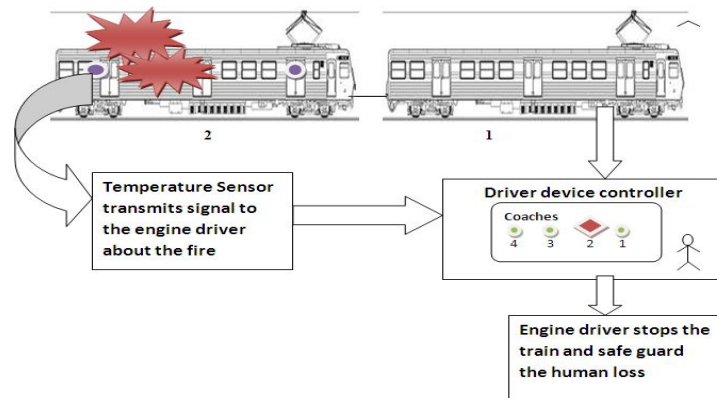
Fig. 4: Overall view process.

8. Process Overview

When fire is noticed in any one of the compartment, temperature sensor senses the fire by the way of difference between the coach temperature and the critical temperature. It collects the signal of increased temperature and it responses to the driver display unit when it reaches above the critical fire point. Then it invokes three major processes to control the fire explosion. They are,

- AUTOMATIC ALARM SYSTEM
- ZIGBEE WIRELESS SENSOR NETWORK
- AUTOMATIC WATER SPRINKLER SYSTEM
- **Automatic alarm system** which alerts all the passengers at sleep during night Thereby the people can put maximum effort to safe guard themselves as well to control the fire.
- **ZigBee wireless sensor network** which transmits signal to the engine driver panel enabling the warning light and alarm to function. The Engine driver stops the train. The main reason for stopping the engine is to avoid spreading of fire to other compartments when train is moving into the wind. Simultaneously the driver informs to the concern authority for help.
- **Automatic water sprinkler system** which is energized and shut-off valve opens. It allows water to enter into the sprinklers and get sprayed. Now the temperature and the heat intensity are reduced. These three processes are mainly used for controlling the fire accidents on running train.
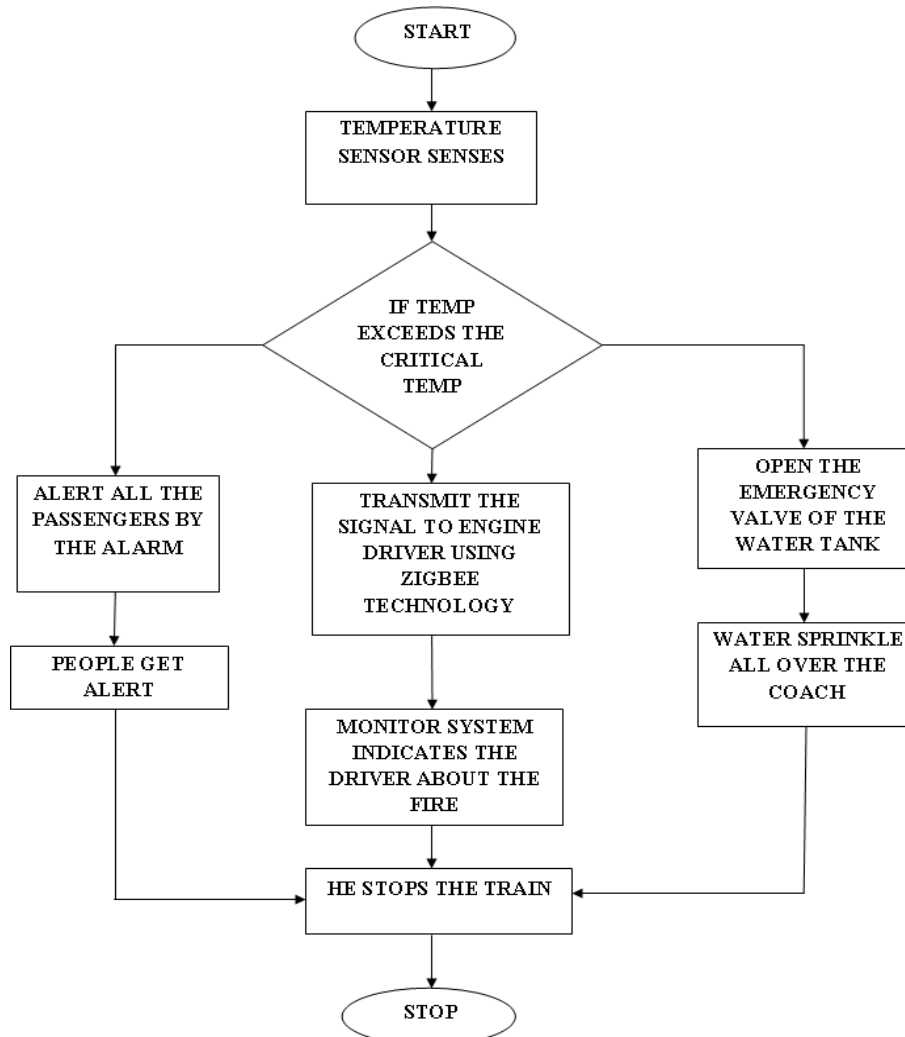
Fig. 5: Flow chart for controlling fire accidents.

Conclusion

Wireless sensor network are increasingly applied in the field of fire safety and monitoring. Especially in difficult and harsh workstations such as mines, ships, submarines. In addition, wireless sensor technology has a broad application background in the field of real time forest fire monitoring. This system has not been applied in practical train fire monitoring. To monitor temperature and humidity in the coach in a more timely and precise way, we pointed out unique advantage of safety in signal transmission, flexibility in network set up and low cost. We propose this system as a first attempt and compliment to Indian railways fire monitoring system. To extend the potential of the system and improve the Indian railways to implement on priority basis in order to avoid train fire accidents in future.

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