Prevention Of Fire Accidents In Villages Using Wireless Sensor Networks

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Abstract—**Fire is crucial for the development of human society, and it has become an important part of human civilization. Among different types of disasters, fire constitutes a significant threat to life and property in urban and rural areas. We have seen several fire accidents such as forest fires, coal fires, gas fires, oil fires and so on and some measurements are taken to prevent these fire accidents. Fire accidents in rural areas are currently viewed as one of the greatest threats to human life, that results in loss of property and lives. The fire spreads very quickly through out the village and causes great damage before the firefighters arrive to the fire affected area. Hence, this paper proposes a new fire safety system to prevent the fire accidents in rural areas in the initial stage only using wireless sensor networks.**

Keywords—*Fire accident, Fire fighters, Fire safety system, Wireless sensor networks.*

I. INTRODUCTION

Fire is one of the five basic elements that is composing the universe and is necessary to human life and the continuity of human existence. Fire is a very good servant as long as it is under our control i.e. it serves a lot of useful purposes for us but, it is a very bad master once it goes out of our control i.e. it can create a lot of destruction. However, despite the presence of fire safety measures, the occurrence of accidents is oftentimes inevitable.

Because of the useful purposes that it serves, people keep sources of fire in and around their houses or workplaces. These fire sources could sometimes result in "undesired" fire. If fire is something which has no useful purpose then, the number of incidents of fire would have been very less as people won't keep sources of fire around them.

We have seen several fire accidents such as forest fires, coal fires, gas fires, oil fires, building fires, industrial fires, chemical fires, electrical short circuit fires and there are different fire safety measures that are in existence to protect people from these fire accidents. The UK fire and rescue services uses a number of risk identification methodologies. The Fire Service Emergency Cover (FSEC) Toolkit is the nationally available methodology, which is an IT based tool which can be used to assess the risk from fire and other incidents, allowing the fire and rescue service to allocate resources proportionate to the risk [1]. A mathematical model is used by the FSEC toolkit to predict the number of lives lost in dwellings fires, special services incidents and other building fires, the amount of property lost and the total cost of the resources allocated [2]. In addition, all fire and rescue services are required to create an Integrated Risk Management Plan under the guidance of the Fire and

Rescue Service National Framework [3]. Part of this planning exercise involves the creation of a risk map, which indicates the level of fire risk present to small geographical areas based on historic fire incidents. However, these methodologies are modeled to lower output area geography making it difficult to target fire prevention resources towards the individual.

Village fires are currently viewed as one of the greatest threats to human life because village density increases the likelihood of tragedy. Modeling techniques that use mathematical analyses for the design of fire safety systems have been widely studied [4,5]. However, these studies have limited practical use because village houses are designed according to individual construction plans, rather than a single, efficient design. These limitations have led to extremely complex fire safety systems, elevated operational training and additional administrative personal requirements. It becomes necessary for qualified operators to remain continuously on standby in security firms, civil defense organizations and municipalities because of the system monitoring requirements [6,7]. Additionally, a high number of intercom calls makes it difficult for operators to focus on their work, which increases the likelihood of mistakes [8]. At the subway control center in Daegu, Korea, an urgent intercom call regarding a fire was overlooked because of an overworked operator. Sadly, this oversight led to the deaths of 196 people and the wounding of another 116. This accident demonstrated that the use of an intercom can be fatal when immediate action is required because even a small fire has the capacity for great tragedy [9,10]. However, despite the presence of fire safety measures, the occurrence of accidents is oftentimes inevitable.

This paper proposes a new fire safety system to prevent the fire accidents in villages using wireless sensor networks. By implementing this fire safety system in villages, we can detect the fire and can bring the fire under control in the initial stage only. This paper is organized as follows. Section 2 provides a brief description of the causes and effects of fire accidents in villages. Section 3 describes the existed system and the proposed system to control the fire accident. The experimental work of the proposed fire safety system is shown in section 4. Finally, the paper is concluded in section 5.

II. CAUSES AND EFFECTS

A. Causes

Carelessness of the occupants of a house, factory, office or a shop is the main cause of fire accidents. The major cause of fire accidents in rural areas is negligence and

ignorance of the people while handling fire. As there are large number of thatched houses in rural areas, fire accidents in villages lead to much loss during summer months. If people become more conscious while handling fire, most of these fire accidents can be avoided in rural areas.

Fire accidents are also caused in rural areas when children play with fire. In summer months, rural areas have large stock of dried hay and children play near them. During their play under the shade of these hay stacks, they involve in cooking food, thus literally playing with fire. The wind carries this fire to the dried hay stack which leads to fire accidents.

In rural areas, the compost pits near houses are also major cause of several fire accidents. Organic wastes and excreta of domestic animals like cows are put in these compost pits. It should be noted that dried cow dung is combustible. Women throw hot ash from their firewood stoves into these pits due to ignorance and negligence. This ash contains residue of fire which slowly ignites the dried cow dung in the pit. It will take hours and so it is not noticeable in the initial stages. Fire from these pits spreads out to nearby haystacks or thatched houses. This is a major cause behind fire accidents in rural areas.

Careless use of electric heaters and gas stoves during cooking also leads to fire accidents in rural areas. Fire officials are also worried about rise in fire accidents due to short circuit in rural areas. They blame it on faulty wiring of houses by inexperienced electricians and overload. There have been cases where fire accidents occurred due to overload because of use of heaters by using illegally obtained electricity. Although naked power supply cables are being replaced by insulated power supply cables, there are areas where naked power supply cables hang dangerously over thatched houses. Sparks from these cables also lead to fire accidents.

B. Effects

Fire accidents can result in terrible personal injury and shocking damage. Every year, billions of dollars of property damage occurs all over the world due to fire accidents. Victims of fire accidents suffer from serious harm, including burn injury to their entire body. Most fire fatalities [11] are due to the inhalation of smoke and toxic combustion gases [12].

The other effects of fire accidents are as follows :

- Loss of the ability to react and unconsciousness.

- Slower walking speed and modified behavior.

- There will be some psychological effects on victims.

- Long-term effects, such as cancer and lung damage.

- Large number of flora and fauna will be destroyed.

- Fire eats up all the articles in the accident premises.

III. FIRE SAFETY SYSTEM

Fire safety is very important in rural as well as urban areas. The purpose of fire safety is to prevent loss of property and life during fire accidents. There are different fire safety methods that are existed in the society. Fire safety programs are also conducted in rural and urban areas in order to create awareness among the people about the cause of fire accidents and the safety measurements that are to be taken during fire accidents. The main topics of the fire safety program are how to prevent damage or loss of property, and how to prevent human suffering, casualties, injuries, and exposures to hazardous atmospheres and transmittable diseases. Everyone has to follow the fire safety methods or else something will go wrong.

A. Existed System

In the existed system, fire accidents in villages are controlled by the firefighters. When a fire accident occurs in a village, the people will inform to the nearby fire station. Then the firefighters from the fire station arrives to the fire affected area along with the fire control equipment to control the fire. Firefighters have many health considerations. For instance, they must stay informed about job-related health issues. They must also use precautions to avoid exposure to AIDS. Other considerations even consist of properly cleaning and storing tools and equipment. Firefighters also have to keep up with physical fitness. All of these things help to maintain a good safety record. The different types of safety consists of being on the apparatus, safety in the fire station, personal safety, tool and equipment safety, safety in training, and emergency scene safety.

Firefighters face serious risks in the job. They face heat, flames, physical and mental stress, and high levels of carbon monoxide (CO) and other toxic risks in the areas around fires. Firefighters face a high risk for many diseases. Firefighters who smoke are at greater risk. Smoking increases the risk of getting heart disease, cancer, respiratory illnesses, stress, and poorer treatment outcomes for certain diseases, such as hepatitis.

The assistance of the professional emergency services, for example in the form of rescue operations by firefighters and emergency treatment by paramedics, can only be provided after the first and most important stage of a fire. So, the fire spreads very quickly through out the village and causes great damage before the firefighters arrive to the fire affected area.

The special dress and equipment used by the firefighters to keep them safe from flames and smoke is of more cost and have to carry them every time during the fire accidents and in the absence of these may lead to serious problems such as death to the firefighters.

In order to overcome the problems in the existed system, a new fire safety system is proposed to prevent fire accidents in villages using wireless sensor networks. By implementing this fire safety system in villages, we can detect the fire accident and can bring the fire under control in the initial stage only without the involvement of the firefighters which reduces the cost of rescue operations.

Fig. 1. The dress and the fire control equipment of the firefighter.

Fig. 2. The block diagram of the fire safety system for two houses.

B. Proposed System

In the proposed system, a fire safety system is implemented in rural areas using wireless sensor networks. The apparatus that are required for implementing the fire safety system in villages are as follows.

1) Sensor Node: A sensor node is a node in a wireless sensor network that is capable of performing some processing, gathering sensory information and communicating with other connected nodes in the network.

2) Gateway: A Gateway is a node that is responsible for forwarding the information gathered from the sensor patch to a remote base station through a local transit network.

3) Base Station: A base station is a radio receiver and transmitter that serves as the hub of the local wireless network, and may also be the gateway between a wired network and the wireless network.

4) Fire Control Server: The fire control server receives the data from the base station and processes the data and performs necessary operations.

5) Fire Alarm Panel: The fire alarm panel is a flat, often vertical, area where monitoring instruments are displayed. The fire alarm panel consists of two devices.

a) Alarm: An alarm is a device designed to alert people from audio alarms when fire is present. These alarms are activated by the fire control server during fire accident.

b) Bulb: A bulb is a device that produces light from electricity. Bulb is activated by the fire control server when there is a fire accident.

6) Water Pump: A water pump is a device that operates by rotary mechanism and consume energy to perform mechanical work by moving the water.
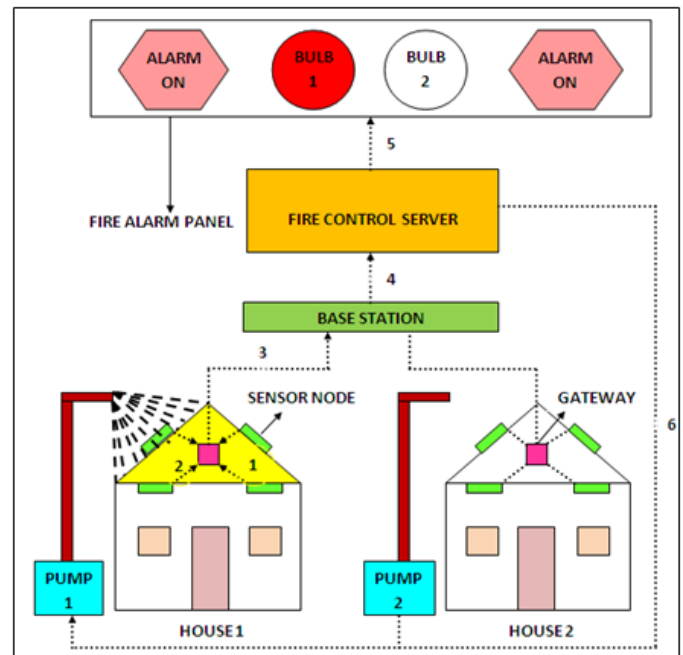
1. Occurrence of a fire accident in a house.

2. Sensor nodes sends information to the gateway.

3. Gateway sends the information to the base station.

4. Base station sends the information to the fire control server.

5. Fire control server activates the alarm and the bulb.

6. Fire control server activates the water pump at the fire house.

A network of sensor nodes is established at each house in a village to detect a fire accident. The nodes contains sensors to sense temperature, humidity and gases which are produced by fire during a fire accident. When a fire accident occurs at a house in a village, the sensor patch attached to that house detects it and sends the information to the gateway. The gateway gathers the information from the sensor patch and forwards it to the remote base station through a local transit network. The base station transmits this information to the fire control server. The fire control server processes the information and performs necessary operations i.e. activates the fire alarm, and the corresponding indicator bulb in the fire alarm panel and also activates the water pump at the fire affected house.

The advantage of implementing this fire safety system in villages is as follows:

- We can detect and bring the fire under control in the initial stage only.

- We will be able to know when a fire is started and how it is spreading at a particular place.

- A large number of flora and fauna can be saved from destruction at the fire affected area.

- Protects the rural areas from loss of property and lives of the people.

IV.   EXPERIMENTAL WORK

The experimental work is implemented in java and carried out on the windows operating system.

The following figure shows the implementation of the fire safety system for four houses which consists of sensor nodes, water pumps, indicator bulbs and fire alarms.
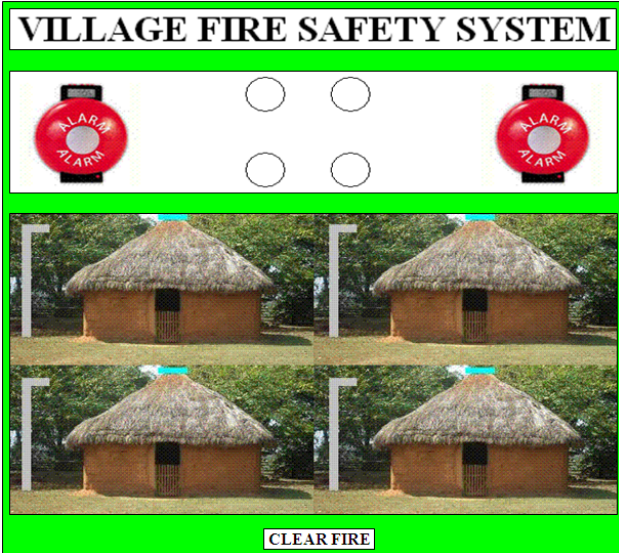

Fig. 3.   Screenshot of implementation of fire safety system for four houses.

The following figure shows the activation of water pumps at the two houses, and the fire alarms and indicator bulbs in the fire alarm panel during a fire accident.
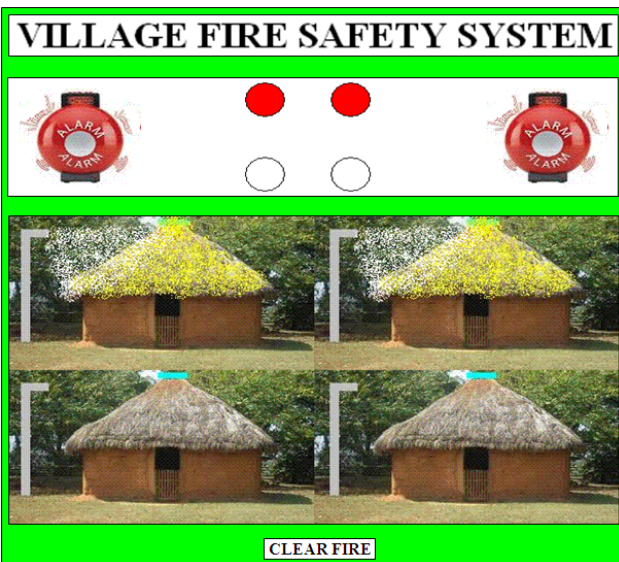

Fig. 4.   Screenshot of functioning of fire safety system during fire accident.

V.   CONCLUSION

Fire accidents are increasing day to day in rural areas which results in loss of property and lives of the people. The fire spreads very quickly through out the village and causes great damage before the firefighters arrive to the fire affected area. Hence, a new fire safety system is proposed to prevent fire accidents in villages using wireless sensor networks. By implementing this fire safety system in villages, we can detect the fire accidents and can bring the fire under control in the initial stage only without the involvement of the firefighters which reduces the cost of rescue operations. By using the Wireless Sensor Networks, we will be able to know when a fire is started and how it is spreading. This fire safety system can be used not only in rural areas but also in various places such as buses, trains, forests, and tribal areas with small modifications in the system.

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