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Intelligent Modeling of Smart House Environment for Fire Prevention and Safety

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Annotation: *Fires usually occur in homes because of carelessness and changes in environmental conditions. They cause threats to the residential community and may result in human death and property damage. Consequently, house fires must detected early to prevent these types of threats. The immediate notification of a fire is the most critical issue in domestic fire detection systems. Fire detection systems using wireless sensor networks sometimes do not detect a fire as consequence of sensor failure. Wireless sensor networks (WSN) consist of tiny, cheap, and low-power sensor devices that have the ability to sense the environment and can provide real-time fire detection with high accuracy. In this paper, we designed and evaluated a wireless sensor network using multiple sensors for early detection of house fires. In addition, we used the Global System for Mobile Communications (GSM) to avoid false alarms. To test the results of our fire detection system, we simulated a fire in a smart house using the Fire Dynamics Simulator and a language program. The simulation results showed that our system is able to detect early fire, even when a sensor is not working, while keeping the energy consumption of the sensors at an acceptable level.*

Keywords: *WSN (Wireless Sensor Network); smart houses; fire; multi-Sensor; GSM communication; Safety;*

In recent years, fire detection has become a very big issue, as it has caused severe damages including the loss of human lives. Sometimes, these incidents are more destructive when the fire spreads to the surrounding area. Early detection of a fire event is an effective way to save lives and reduce property damage. To escape a fiery place and to douse the fire source, the fire must detected at its initial stage. The installation of a fire alarm system is the most convenient way to detect a fire early and avoid losses. Fire alarms consist of different devices working together that have the ability to detect fire and alert people through visual and audio appliances. The detection devices (i.e., heat, smoke, and gas detectors) detect events and activate the alarm automatically, and sometimes they activate manually. The alarm may consist of bells, mountable sounders, or horns.

Most of the fire alarm systems use the technology of a wireless sensor network (WSN). WSNs have gained popularity because they have a variety of uses in different applications, such as target tracking localization healthcare Smart Transpiration environmental monitoring, and industrial automation. People can also use WSN in collecting data and monitoring, both autonomouslyand with the help of users. WSN applications also help human and animals andwecan usethem for industrial purposes, for example, underground pipeline monitoring.

In a WSN sensor devices are often very tiny, battery-powered, and densely populated with the functionality of monitoring several parameters of the environment. Users may send the sensed data to the main collecting unit (i.e., the sink, cluster head etc.) for processing. WSNs used for fire detection systems also have the same functional properties. Each sensor detects rising heat, smoke, or gas in some spots in a home and generate san alert in its head node in a network. The head node collects reports from various sensors and identifies the presence of a fire. Next, different heads coordinate the received inputs and consult with a remote command center to plan a response that may consist in a simple fire alarm generation or in complicated evacuation methods. Numerous technologies based on WSN have already been proposed to detect fire. Some of them are stand-alone with WSN, and some have hybrid technologies. There are many event detection systems, which help to identify heat, gas, and smoke.

Today, smart houses and smart cities are equipped with different type of WSNs. In WSNs, more energy may be consumed because of communication overhead. Thus, most of the time, a sensor's battery is exhausted very fast and it may cause the failure of the sensor or the breakdown of whole network, as houses have different sub-portions and each portion is equipped with one sensor with a single function which in case of failure causes a system flaw. In this scenario, if an event occurs in a certain portion and the sensor fails to detect the accident, then there is no other way to detect the incident at its initial stage. As un-functional sensors are only be able to detect one event, there is another noticeable issue regarding the possibility of false alarms. For example, a heat detector detects temperature in the environment and produces the alarm if the temperature increases beyond a threshold. However, the increase in heat may be due to environmental changes or human activity in the room. In the case of smoke detectors, the smoke maycome from outside or from other sources. The cost of a false alarm is estimated between $30,000 and $50,000 per incident.

Today, sensors are very cheap and very small. Thus, to address the above-mentioned challenges, we propose an efficient, IoT-based intelligent house"fire prevention system" using multiple sensors. Each of the sensors uses its own mechanism for detection. Our method detects fire very efficiently and reduces false positives by using Global System for Mobile Communications. The contribution of this article is manifold.

- Problems and challenges related to the current approaches are identified. The existing methods use single sensor for each target regions. Nowadays, sensors are very cheap so we used multi-sensors for every critical region to address problems linked to single sensor detection.
- We use GSM communication to alert the user at early stages if the sensor reports a fire.
- The identification of the fire is made by the system after verification from two sources. These sources are;Response of the user to the GSM alert, i.e., if the user response is fire, then our system directly generates the alarm when two or more sensors report fire, then the system directly generates a fire alarm without waiting for the user response.
- We use star topology for the deployment of sensors and communication between sensors and main home sink. We use the ZigBee protocol to provide communication between the sensors and the sink.
- Finally, we evaluate the system concerning energy consumption.

Purpose, and object of research.This is the main purpose of the research we are proposing -Smart house features make our homes more convenient, livable, and can add some serious value to your home. So many different smart devices available to provide different benefits for our homes and our families.

In the last few years, sensors have been widely used for fire detection. Scientists proposed a work for fire detection in mines by using wireless sensor networks called WMSS. For determining the hazardous factor in the mines, they used gas sensors and designed a wireless sensor network. It collects and analyses the gas level in mines. The work proposed in used Zigbee-based wireless sensors for fire detection in forests. They used temperature sensors toestablish the intensity of fire in a forest. They used a CC2430 chip in their hardware design for network nodes. Similarly, Buratti et al. also designed a framework for forest fire detection. In their work, they used a model for fire detection using different clustering schemes and communication protocols. They performed the simulation for validation and evaluation of their work. W. Tan et al. implemented a work for forest fire detection. They used multi-sensor and wireless IP cameras to avoid false alarms. Their system also connected to the internet via gateways for uploading the data to the cloud. A work proposed in for forest fire detection was based on a ZigBee wireless sensor network in China. A work for forest fire detection is proposed in. A.Rehman proposed a work for WSN. South Koreans also designed a system for fire detection in their mountains. They named their system FFSS (Forest fire Surveillance system). They developed their system by using WSN, middleware, and web applications. Network nodes (i.e., temperature sensors and humidity sensors) collect measurements and send them to the sink node. Afterwards, the sink node transmits that data to the cloud via a transceiver (gateway). Later, by using a formula, the fire risk level is determined in the middleware program. After detecting the fire, FFSS is activated automatically. TinyOSis used as an operating system for network nodes.

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