ISSN: 2278-4632
Vol-10 Issue-4 No. 1 April 2020

Design and Implementation of the Mobile Fire Alarm System Using Wireless Sensor Networks

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Abstract— **The surveillance of home or industrial places through sensors and the prevention of problems via prediction are of vital importance for the safety of these areas. This paper shows how to increase wireless sensor network (WSN) techniques by composing new design methods and improved a low-cost industrial and home safety systems. So as to guarantee and present accurate solutions to the system, not only temperature and humidity sensors but also flame and gas sensors were used in this study. The design of simple hardware circuit allows every user to utilize this wireless home safety system. A notification was used as a method of informing users related to system. The installed Arduino device which was programmed with Android Studio takes received gas, flame, the temperature, and humidity signals from the sensors. In order to pre-monitor the capability of occurrence of a fire, when it detects that the collected data with control levels exceed a predefined threshold it will enable the communication with WIFI network and send the notification alarm message to the mobile users.**

Index Terms— Fire Alarm System, WIFI, Notification, WSN.

I. INTRODUCTION

Advances in wireless networks and electronic devices give rise to the development of low-power sensors and the deployment of large-scale wireless sensor networks. With the abilities of pervasive monitoring, sensor networks have attracted important attention in many application areas, such as, object tracking, environment monitoring, military, habitat monitoring, smart environments, as well as disaster management [1].

The main purpose of sensor networks is to collect the monitoring raw data and provide basic information and decision support for base station [2].

Wireless sensor technology enable to make life easy and interact with the physical environment. In the not remote future, tiny, dirt-cheap sensors can be orderly deploy into the roads or machines, creating a digital output that senses a variety of physical events, detecting forest fires to help rapid emergency response [3].

Using technological advances come new challenges for information processing in sensor networks. So, it must been ensured that novel computational representations, algorithms and methods, design methodologies and tools to support distributed signal processing, information storage and management, networking and application development [4].

Temperature and humidity control of the tunnels study in case of perform the security in the dams, was implemented using wireless sensor networks [5]. In a study, it has been exhibited a remote screen and control caution framework in view of GSM and ARM [6]. Another study concentrates on, intelligent private thief alert, crisis caution, fire caution, poisonous gas spillage remote programmed sound caution and remote control framework, which depends on 89c51 single chip PC [7]. The paper [8] presents the remote observing framework, in light of the fact that the remote checking framework has increasingly application, a remote observing framework taking into account SMS through GSM.

There are four basic components in a sensor network:

- an assembly of deployed or localized sensors;
- an interconnecting network
- a central point of data collecting;
- a set of computing resources at the central point to handle data correlation, event trending, status querying and data mining [9].

In order to aware of the existing and potential applications for WSNs, complicated and extremely efficient communication protocols are required [10]. Communication, sensing and processing are three key items whose combination in one integrated device led to a vast number of applications [11, 12]. In this study, in purpose of designing smart home applications, flame, gas and temperature and humidity sensors were used. Obtained data values taken from these sensors modules readings, were sent to mobile phone for users. Also, these values can be transmit to other remote accessible devices. The programming of sensor nodes was performed with the Arduino program, and the retrieval of sensor values from the base station and their subsequent recording in the computer processing and simulation operations were performed in the Android Studio software development environment using JAVA programming language.

The rest of the paper is organized as follows: section 2 provides background concerning wireless sensor networks and related technologies. In section 3, the implementation steps of the study conducted and the technologies used are explained in detail. Finally, in section 4, the results of the implementation are briefly identified.

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II. WIRELESS SENSOR NETWORKS

Wireless sensor network is a combination of large sensor nodes each can sense, process, and communicate with its peers so as to work together in a cooperative manner. A sensor network is consisting of thousands of battery processed sensors that collect data and transmit it to a number of sink nodes as shown in Figure 1. Wireless sensor networks are occurring to be distributed at an accelerated structure [13]. This is achieved by embedding numerous distributed sensor nodes into the physical world and networks so that they can coordinate to perform higher-level identification and tasks. They get the collected data to a sink. The sink is wired to a gateway which provides out-of-network connectivity (e.g., Internet).

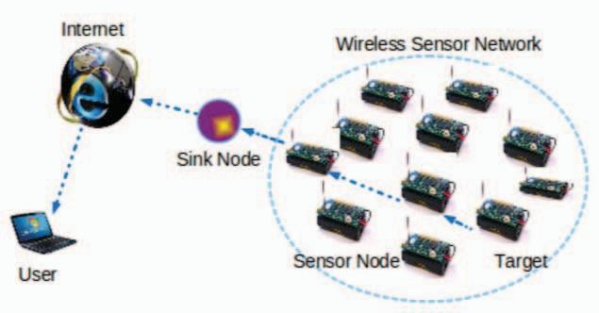


Figure 1. A wireless sensor network

Wireless Sensor Network is a set of sensors which are used in the transmission or physical or chemical phenomenon given such as temperature, humidity, magnetic field, pressure etc.) and then move the information on the wirelessly to the data processing station to take usefulness of them without human intervention in the location of the physical environment [14].

A Sensor node is an instrument that has a microprocessor, a monitoring ability and wireless connectivity. It can show the sensor readings by a small screen. Memory size of the sensor is generally small hardship, constant and changeful. Also, sensors have limited energy stock components. Sensor components consist of the following modules:

1. Sensor Module
2. The unit of data storage and micro-controller for processing.
3. Unit transmission and reception
4. Power supply unit.

Localization is the significant matter of the routing principle in WSN. The position detecting system aids the sensor node to discover its location in the environment. The power unit presents the constant power supply to the sensor nodes which is the main destination area of the intruders [15-17].

Monitoring node includes a sensor module, displaying and an alarm module microcontroller module, wireless transmission module and power module. Microcontroller module adopts Arduino-UNO-R3 microprocessor WIFI shield CC300, which can accelerate of data processing and data obtain precision and reduce power losing.

III. IMPLEMENTATION OF THE SYSTEM

This paper presents a implementation of the mobile fire notification system for measuring some physical data with gas, flame and temperature and humidity sensors in the home or buildings where people live. Figure 2 shows the design of the mobile fire alarm system. Thanks to the self-organization manner sensor nodes form the network and the nodes collect information such as temperature, humidity, gas, flame or other fire monitoring arguments, and sent the data to the cluster head which are responsible for the data aggregation and the data packets transmission. Finally, data is wirelessly transmitted to the gateways.

The sensor modules which are used in this work, can be explained in briefly as follows:

Flame Detection Sensor Module: This sensor is sensitive to the flame, but also can detect ordinary light. The sensor

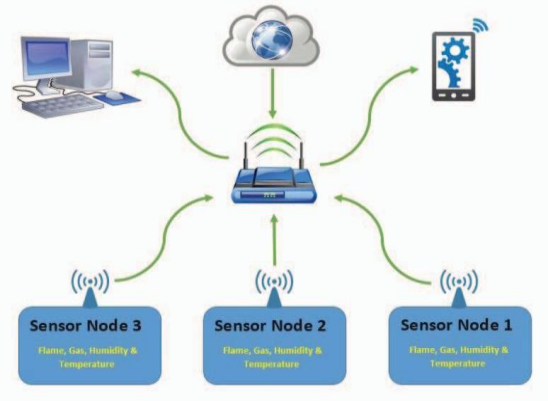


Figure 2. Design of the mobile fire alarm system

module usually is used as a flame alarm.

Gas Sensor MQ-6: In homes and industry, this sensor module is suitable for detecting of LPG, ISO-butane, propane, LNG so as to avoid from the noise of alcohol and cooking fumes and cigarette smoke.

Humidity and Temperature DHT11: This DHT11 Temperature and Humidity Sensor consists of a temperature and humidity sensor complex with a calibrated digital signal output.

The proposed network structure consists of several sensor nodes organized in an HDG204 Wireless LAN 802.11b/g. For this preliminary study considered for gas monitoring in homes or other buildings, the sensor nodes were programmed as a star topology configuration. One of the nodes is the HDG204 coordinator, and the others were end devices. The coordinator is always active and it is mains powered, therefore, its energy depletion is not so significant in the network. On the other hand, end devices were battery-powered and reducing their energy depletion is an important matter for the longevity of the network. So as to decrease the power consumption of the hardware as much as possible, it has been decided to design novel wireless sensor node, with the possibility of balancing activation of its components [18].

Figure 3 demonstrates the Arduino WIFI Shield enable an Arduino circuit to connect to the internet by the WIFI wireless applications.

In this study, three integrated sensor modules were utilized in the board. Figure 4 demonstrates the hardware design of the

ISSN: 2278-4632
Vol-10 Issue-4 No. 1 April 2020

fire alarm system. As shown in Figure 4, it has been used three sensor modules and between WIFI and Arduino board.

The programming was performed as follows: Sensor nodes flame, gas and temperature and humidity would send their values obtained from the room to the sink node, which was programmed as base station. The function of the sink node is to ensure that the sensor data acquired from the room is transmitted to computer through serial port. Figure 5 shows the code block for the reading of sensor values.

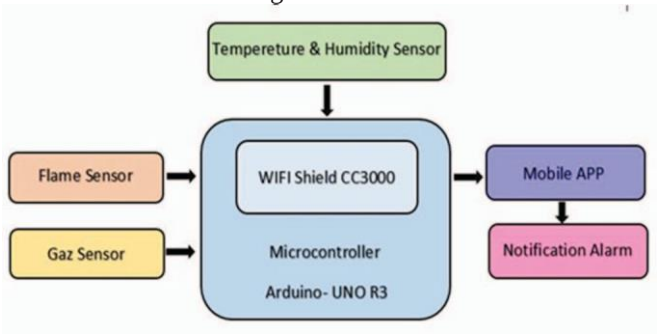


Figure 3. Block diagram of monitoring node

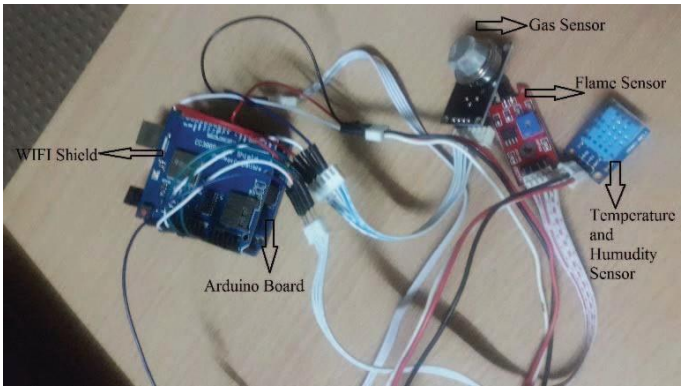


Figure 4. Hardware design of the fire alarm system

```
//Read value :
void loop(void){
uint8_t chk = DHT11.read(DHT11PIN);
int sensorValue1 = digitalRead(9);//fire
int sensorValue = analogRead(A1);//fire
int val=analogRead(A0);//gaz
int va2=digitalRead(8);//gaz
//condition data :
if(va2==0)
{ client.println("GAS: No GAS");}
if(va2==1) { client.println("GAS: Has GAS");}
if(sensorValue1==0) { client.println("Fire: No Fire"); }
if(sensorValue1==1) { client.println("Fire: Has Fire");}
client.print("Humidity: ");
client.println(DHT11.humidity, DEC);
client.print("Temperature (C):");
client.println(DHT11.temperature, DEC);
```

Figure 5. Code block for the reading of sensor values

These values are transferred to the mobile device via network connection installed. Sensors evaluate the existence and absence the physical measurements and sensations as logical 1 and logical 0, respectively. In the measurements performed with designed sensor nodes in different home rooms, therefore, temperature has ranged between 26°C and 29 °C and humidity ranged between 28 and 29 %, 30 °C and 30% as average values were selected as threshold values for temperature and humidity in this study, respectively. If flame sensor senses presence of flame or gas sensor senses the presence of gas or temperature indicate 30 °C or above or humidity is 30% or above, system will alarm as “Has Problem” message to the users. In other conditions, system will give “No Problem” message. Thanks to this notification on mobile devices, users can intervene in possible fire calamity. Figure 6 presents a flow chart of the fire alarm system.

In this work, designed sensor circuit including these three sensors, was set up for 5 home rooms different with each other. The physical statuses in terms of temperature, humidity, flame or gas of these rooms were different, too.

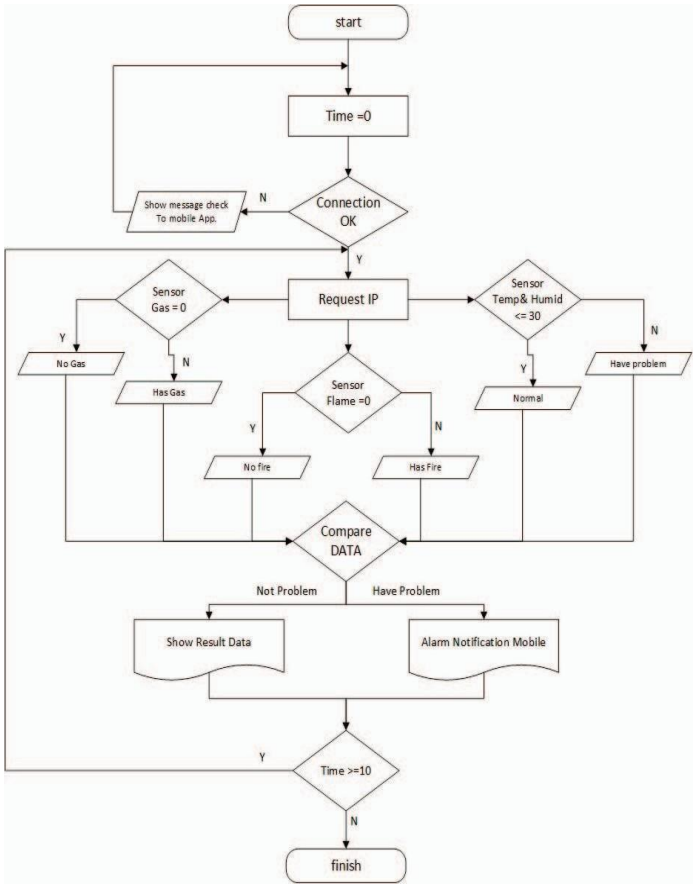
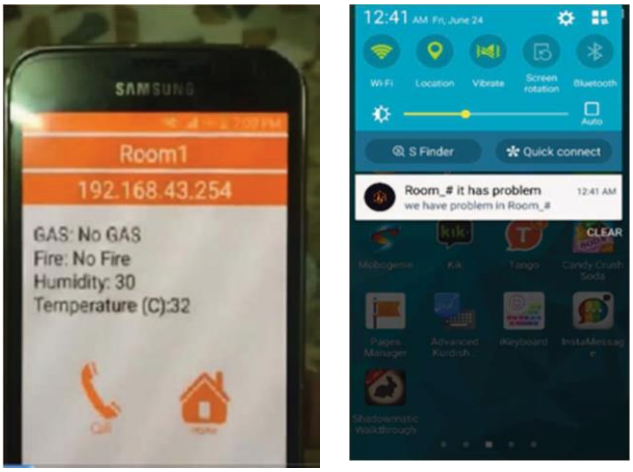


Figure 6. Flow chart of the fire alarm system

Figure 7.a demonstrates the results obtained from the Room 1 on the mobile phone. It is obviously seen due to the fact that temperature is 32 °C and humidity is 30 %, the notification message is “Has Problem”, as shown in Figure 7.b. Experimental measurements and notification results which

ISSN: 2278-4632
Vol-10 Issue-4 No. 1 April 2020

have done in other rooms having different network IP addresses, could be summarized as shown in Table 1.



(a) Reading and showing data obtained (b) Notification manager

Figure 7. Mobile interface of the system

TABLE 1. Notification results of the other home rooms

Home Rooms	GAS	FLAME	Humidity	Temperature	Notification Result
Room 2	No GAS	No Fire	28	26	**No Problem**
Room 3	Has GAS	No Fire	29	26	**Has Problem**
Room 4	No GAS	Has Fire	35	28	**Has Problem**
Room 5	No GAS	No Fire	29	27	**No Problem**

According to Table 1, because of not detected gas, fire and temperature and humidity values have not exceeded the determined threshold in the Room 1, It has been seen “No Problem” notification massage on the mobile phone. On the other hand, it has been detected and sensed gas in the Room 3, it can be clearly said that there may be a problem in the room and will be a “Has Problem” massage on the mobile device.

IV. Conclusions

Wireless sensor networks play significant role in real environment. This paper presents a preliminary study of a smart WSN able to detect fire alarm. It has been set up useable a wireless sensor network with these three sensors. An application was developed for determining physical 5 home information with digital output. It has been designed a system android with Arduino hardware which consists of three sensors (flame, gas, heat) in home rooms. If these sensor readings values exceeds the pre-defined threshold level, the application system of the sensor network interface on mobile phone can be visible to users as notification form whenever they want. In this sense, they can be informed if the temperature rises, can be ready to prevent the possible fire disaster. This means that the application sends a piece of alarm as notification to the personal mobile in case of any alarm activity has been detected at home or office or build, etc. So, the users will be able to keep track of their safety within the limits of the presence of the router connected between mobile phones and devices.

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