VOL. 16, NO. 1, JANUARY 2021 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

AN EFFICIENT MONITORING SYSTEM FOR EARLY FIRE AUTOMATIC DETECTION

Adam R. H. Alhawari, A. H. M. Almawgani, Nasser Aboud Alsaleh, Saeed Ali Alyami and Abdullah Mahdi Aslloum
Department of Electrical Engineering, College of Engineering, Najran University, Najran, Kingdom of Saudi Arabia
E-Mail: aralhawari@nu.edu.sa

ABSTRACT

In this paper, an instantaneous monitoring system that automatically early detects the existence of fire is proposed. The detection system is developed and controlled by using an Arduino Mega microcontroller and other main components that operates the entire fire alarm system. The key feature of the system is the ability to remotely send an alert to the authorities by using a GSM module whenever a fire is detected. Also, when the presence of smoke is detected, the GPS module is used to indicate the location where the fire is occurred for the fire extinguishing car. The experimental results show that this monitoring system is capable to early detect smoke, flame, heat, temperature, and humidity with high efficiency. Furthermore, compared to the existing systems, this monitoring system is working automatically in all-weather conditions and showed its potential in solving the fire detection problems at lower cost.

Keywords: alert, arduino, fire detection, monitoring system, sensor.

INTRODUCTION

Nowadays, securing people lives and properties against fire disaster is becoming more important and curial issue. Therefore, many efforts were devoted in most countries to design an automatic alarm system for early detection. A fire alarm system should be reliable and is usually implemented using a smoke sensor due to its early fire detection capability, fast response time as well as relatively low cost. Other options for the fire detection are generally based on flame sensors, heat or temperature sensors. To date, several systems of fire detection were proposed in [1]-[6]. However, some of these methods are either complex and expensive to be applied or not suitable for local measurement of the relevant parameters involved in fire risk and, hence, in its early detection. Consequently, there is an urgent need to develop an efficient system that could detect and alert the concerned authorities about the fire as early as possible at lower cost.

Arduino is microcontroller used for collecting data from various sensors [7]. It is an open-source platform built on easy-to-use software and hardware. It was used in developing and programming numerous electronics circuits as reported in [8]-[12]. Thus, the main purpose of this work is to provide an efficient and low-cost monitoring system for early fire detection based on Arduino. The researchers in [13] provided a wireless fire detection system using GIS technology. This system helps the users to protect their life, properties, and Earth natural resources from the fire hazards. The GIS technology would help fire and rescue service to work in unfamiliar indoor environments. However, the usage of GIS applications in indoor environments is limited by the 3G capabilities of mobile devices and by the required computing power for analysing such complex systems. A monitoring system for fire detection is reported in [14]. It detects the existence of the fire and captures images through a camera and display the results it on a screen. In the proposed design, when the output of the sensors is increased above the threshold value, the system will alert the user via a GSM module. The system in [14] has an advantage of detecting the presence of fire early, however, the cost of installation of cameras is very high.

In [15], a fire alarm system based on Arduino was proposed to avoid the occurrence fire accidents in houses. As a result, this will finally allow the users to protect their lives and properties. When the system in [15] detects the heat from the fire or temperature more than 40^{o} C, it will directly show an alert notification on LCD display and instantaneously sending an SMS alert to the users regarding the high raise temperature in the house via a GSM module. Nevertheless, smoke sensor was missing in the developing the reported system since it plays a vital role in detecting the presence of fire although its cost is low. Another fire detection system using an Arduino was presented in [16]. In the proposed system, IOT technology with temperature sensor were used to avoid the damage caused by fire outbreak risk. However, the system in [16] is expensive to be implemented and it lacks to the presence of a GPS module that is capable to indicate the location where the fire occurred. Therefore, in this paper, a low-cost and efficient monitoring alarm system for fire detection based on Arduino has been designed, implemented, and tested. The proposed system can send an alert message through a GSM network and indicating the location of the fire via a GPS module.

SYSTEM DESIGN AND WORKING PRINCIPLE

Figure-1 shows the block diagram of the proposed fire alarm monitoring system while Figure-2 demonstrates the hardware architecture of the proposed system. The structure of this appliance system has components such as fire (flame) sensor for detecting the presence of fire or flame, temperature and humidity sensor, smoke sensor, LED and buzzer for alarming, GSM module for sending SMS services, and GPS module to determine the location of fire existence. All the mentioned

sensors will sense the main factors that are changeable during the occurrence of fire where the threshold values under normal conditions of all factors are feed in the Arduino Mega 2650 board. The main purpose of the Arduino Mega 2650 microcontroller is to manage the circuit and process the analog inputs from various sensors and then send SMS using the GSM module. This proposed system can detect smoke, flame, heat, and humidity. Finally, the data is shown in the control panel LCD display all the time.

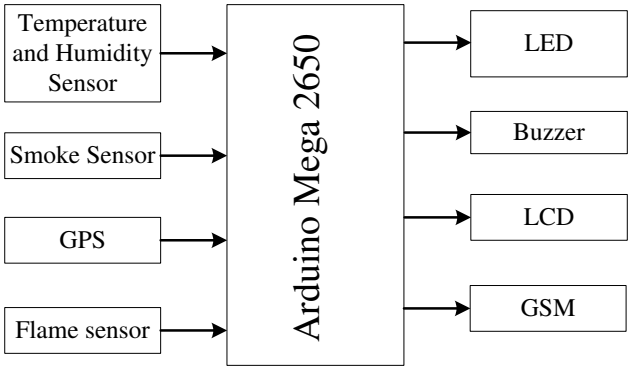


Figure-1. Block diagram of the appliance fire monitoring system.

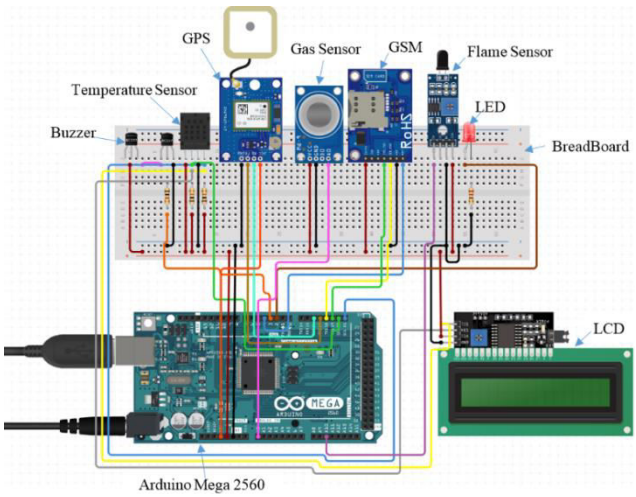


Figure-2. Hardware architecture of the fire monitoring system.

The working principle of the proposed fire alarm system is depicted in Figure-3. When a fire outbreak happened, the temperature and humidity sensor will trigger the heat and measure the temperature from surrounding. Upon the temperature reaching the of 40^{o} C, it will directly send signal data to the Arduino informing about the high temperature in the exact area. In addition, when the flame and smoke reach the threshold values under normal conditions simultaneously, then the flame and smoke sensors will motivate the Arduino to alert the user about the fire risk situation via GSM module. In this case, LED and buzzer operate for alarming. Moreover, an SMS will be sent promptly to let the fire extinguishing car identify the location of the fire through a GPS module. Simultaneously, the existence of the fire is notified as well on the LCD display.

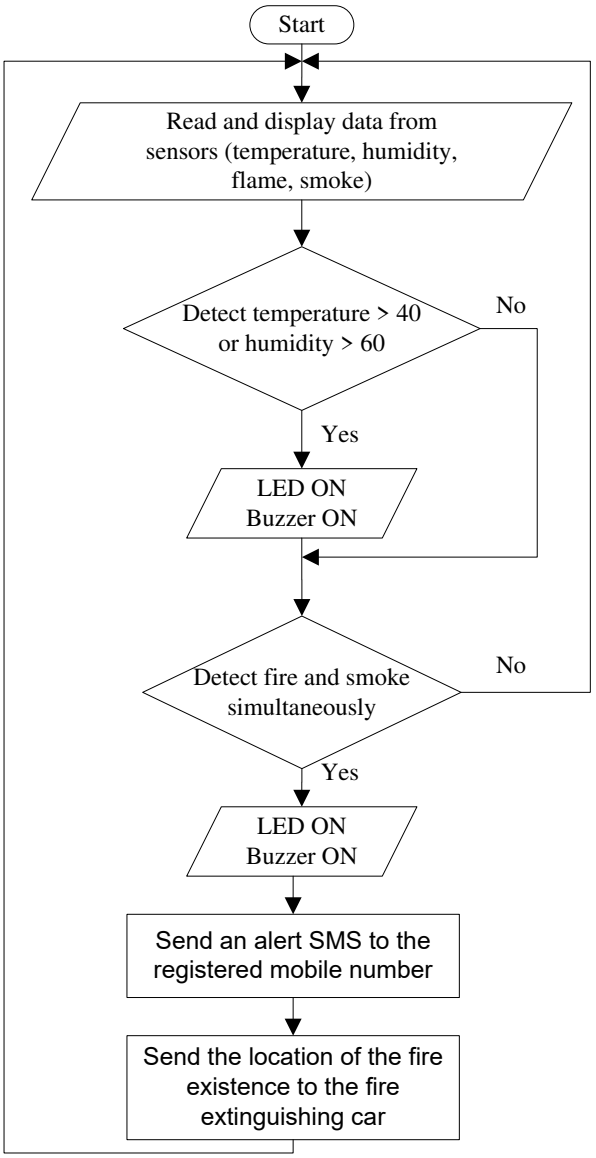


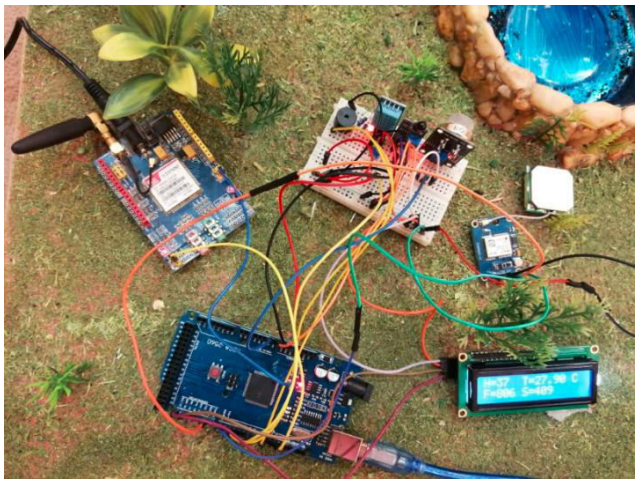
Figure-3. Working principle flowchart of the appliance system.

RESULTS AND DISCUSSIONS

The design and the implementation of the proposed efficient Arduino-based monitoring system for early fire automatic detection was successfully carried out and effectively tested. Figure-4 shows a photograph of proposed system prototype. Generally, this system can be applied to be used for any properties like houses, farms, forests, and gardens, but in this work the prototype was designed and implemented for a small farm. Thus, several experimental tests were done to validate the system's designed method and observe its performance. The tests were completed by applying heat and smoke near to the flame and smoke sensors, respectively. Normally, in this system, the condition of the temperature from surrounding can easily be known by using LCD as well as the values of

smoke, flame, and humidity. Once it increases and cross the threshold, then automatically the LED and buzzer operate for alarming and alerts the registered authority's mobile number by an SMS. Besides, the location of the fire existence for the fire extinguishing car will be determined thru the GPS module. Figure-5 displays the SMS received by the user when fire alert is notified by the system.

(a)



(b)

Figure-4. Photograph of the proposed fire alarm system prototype (a) perspective view and (b) top view.

The results show that by implementing this fire system in actual practice, it can help authorities to improve their safety standards by having instant response in preventing accidents. This will eventually allow the users to protect their lives and properties from the disaster. Moreover, this proposed fire system is efficient in detecting the existence of fire, built is cheap compared to other existing alarm systems and easy to be applied in varied areas due to its flexibility and simplicity in handling; for example in houses, forests, gardens, factories, and many other properties.

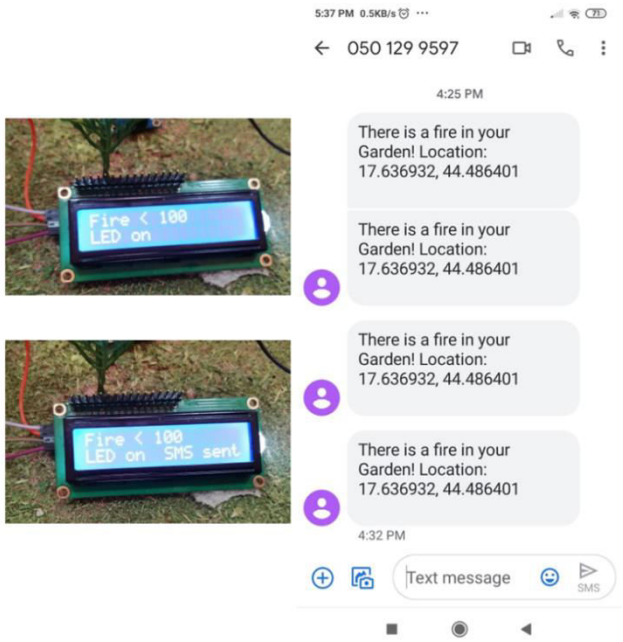


Figure-5. Result of the received SMS.

CONCLUSIONS

In this work, low-cost monitoring system for early fire detection based on smoke, flame and heat detection is proposed and tested effectively. This fire alarm system was successfully implemented using Arduino Mega 2650 microcontroller with a combination of another electronic equipment that working together to detect the presence of fire in a certain area. When this system detects a fire, it will immediately send an alert SMS to the authorities via the GSM model. Furthermore, the GPS module will specify the location where the fire is occurred. Also, the alarm buzzer will be turned to "ON" as well. The results show that this monitoring system offers a reliable solution that can detect fire to allow the protection of people lives and properties and avoid any damage of this disaster when it happens.

REFERENCES

[1] D. Kolarić, K. Skala and A. Dubravić. 2008. Integrated system for forest fire early detection and management. Periodicum Biologorum. 110(2): 205-211.

[2] J. Fernández-Berni, R. Carmona-Galán and L. Carranza-González. 2008. A vision-based monitoring system for very early automatic detection of forest fires. WIT Transactions on Ecology and the Environment. 119(October 2016): 161-170.

[3] A. Kumar Sharma, M. Faiz Raza Ansari, M. Firoz Siddiqui, M. Ataullah Baig, and G. Noida. 2017. Iot Enabled Forest Fire Detection and Online Monitoring System (By Using Atmega 328-P Microcontroller).

International Journal of Current Trends in Engineering & Research. 3(5): 50-54.

[4] S. R. Vijayalakshmi and S. Muruganand. 2017. Internet of Things technology for fire monitoring system. International Research Journal of Engineering and Technology (IRJET). 4(6): 2140-2147.

[5] S. Vungarala and A. Kasi. 2018. Automatic Fire Detection System Using IOT. International Journal of Current Engineering and Scientific Research (IJCESR). 5(4): 39-42.

[6] J. Fernández-Berni, R. Carmona-Galán, and L. Carranza-González. 2008. A vision-based monitoring system for very early automatic detection of forest fires. WIT Transactions on Ecology and the Environment. 119(August): 161-170.

[7] M. Banzi and S. Edition. 2011. Getting Started with Arduino, Second Edi. O'Reilly Media, Inc.

[8] A. H. M. Almawgani. 2018. Design of Real Time Smart Traffic Light Control System. in ISER- 318th International Conference on Science, Technology, Engineering and Management (ICSTEM). pp. 51-55.

[9] A. T. Hindi. 2020. Efficient automated monitoring system for water tanks. ARPN Journal of Engineering and Applied Sciences. 15(4): 470-474.

[10] H. Alghamdi and A. H. M. Almawgani. 2019. Smart and Efficient Energy Saving System. in IEEE 2019 Smart City Symposium Prague (SCSP). pp. 1-5.

[11] F. Alshehri, A. H. M. Almawgani, A. Alqahtani and A. Alqahtani. 2019. Wrong Parking. 2019 2nd International Conference on Computer Applications & Information Security (ICCAIS). pp. 1-6.

[12] A. R. H. Alhawari, A. F. Alshehri, M. A. Alwadi, F. A. Blih, A. H. M. Almawgani and A. S. Alwadie. 2017. Design and development of electronic cooling and heating pad for hot and cold therapy. ARPN Journal of Engineering and Applied Sciences. 12(24).

[13] M. S. A. Azmil, N. Ya'Acob, K. N. Tahar and S. S. Sarnin. 2015. Wireless fire detection monitoring system for fire and rescue application. ARPN Journal of Engineering and Applied Sciences. 10(3): 84-89.

[14] D. Singh, N. Sharma, M. Gupta and S. Sharma. 2017. Development of System for Early Fire Detection using Arduino UNO. International Journal of Engineering Science and Computing. 7(5).

[15] N. N. Mahzan, N. I. M. Enzai, N. M. Zin and K. S. S. K. M. Noh. 2018. Design of an Arduino-based home fire alarm system with GSM module. Journal of Physics: Conference Series. 1019(1).

[16] N. Abdul Khaleq, O. Khalaf and D. Addulsahib. 2019. IOT fire detection system using sensor with Arduino. REVISTA AUS. 26(1): 74-78.