JAET

Journal homepage: http://jae-tech,com

Journal of Applied Engineering & Technology

ISSN : 2523-6032 ISSN-L : 2523-2924

IOT Based Fire Safety System

Meeral Dangrach[1], Sayed Mazhar Ali Shah[1], Agha Zain ul Abdin[1], Adeel Ali[1], Mukhtiar Ahmed[1]

[1]Department of Electronic Engineering,
Quaid-e-Awam University of Engineering, Science & Technology Nawabshah, Sindh, Pakistan

*Corresponding Author

Abstract: In the past few decades there were no facilities to protect the valuable things from fire, smoke and high temperature & humidity automatically because the technology of that time was not advanced and the people usually do these things manually, and to avoid that or to minimize the damage caused by fire outbreak an IoT technology is used to control such a kind of risk. IoT is a modern system that consist of sensors and switches associated with a focal center (Arduino nano). In this project we have used flame sensor, gas sensors, temperature &humidity sensor and Nod mcu with Arduino device and actuators to extinguish the fire and smoke automatically, and the data will be sent to the webpage also to let us know the situation and take any other desirable action, as system starts sensor senses the environmental conditions and sends to the central hub main controller board (Arduino nano) than Arduino nano commands the actuators if there is any alert condition otherwise system shows there is no any alert.

Keywords: Fire Safety, IoT, Arduino Nano, ESP8266, DC motor, Relay, Exhaust Fan

1. Introduction

'Web of Things' (IoT) is the augmentation of the Internet availability into actual gadget and consistently object inserted with hardware, Internet network and different types of equipment, for example, sensors. These gadget can convey and Interact with one another over the Internet and they can be distantly observed and controlled.

The meaning of IoT has developed because of the change of different innovation, continuous investigation AI product sensors and inserted frameworks. Conventional field of implanted framework, remote framework organization, control framework, computerization including home and building mechanization and others all add to the Internet of Things. Few years ago there were no facilities to protect the households from fire and high temperature & humidity automatically because the technology of that time was not advanced and the people usually do these things manually.

**Corresponding author:* 17es12@quest.edu.pk

As worldwide society perceives the need to look for another creation show and improve the utilization of normal assets, the way toward checking deforestation, particularly identified with timberland fires, turns into a need in Brazil, by goodness of its huge region. The natural and social harms from ecological corruption increase every year, and earnest activities are requested from legislative and private powers meaning to switch the circumstance, which expects outrageous gravity in dry periods. Fire in the early identification and early admonition are two significant approaches to smother the fire instantly and keep away from incredible setbacks and property misfortune. Subsequently, the prerequisite of putting shrewd fire caution and control framework is significant inside structures particularly in the structures where contain numerous individuals inside or important possessions.

This project "IoT Based Fire Safety System" is developed to protect the valuable things from fire, dangerous gases and high temperature & humidity controlled anywhere with IoT. This fire and smoke safety system with IoT could manage to achieve the aim to cover up the things under it and could be controlled anywhere with the help of IoT. It will mail automatically to the owner when the rain will start or high temperature & humidity condition and after the owner's response sheet cover the area with the help of motor operating circuit. A pair of actuators help to extinguish the fire and exhaust the smoke.

2. Project Methodology

The project consists of two parts. The first part consists of Arduino Nano coupled with NodMcu ESP 8266, which is connected with the temperature and humidity sensors, gas sensors, flame sensors and LCD display. This section is powered by 5V DC as shown in Fig. 1.

The second part consists of four channel relay interfaced with the motor pumps and exhaust fans powered by 12V DC. The relay is interfaced with the Arduino Nano. When sensors detect any change in environment, generate signal and send to ESP8266 with is coupled with Arduino Nano. ESP8266 triggered the relays and operates the motor pumps and exhaust fans to avoid risk of burning fire. Also a real time update status is visualize at webpage by Wifi and LCD display.

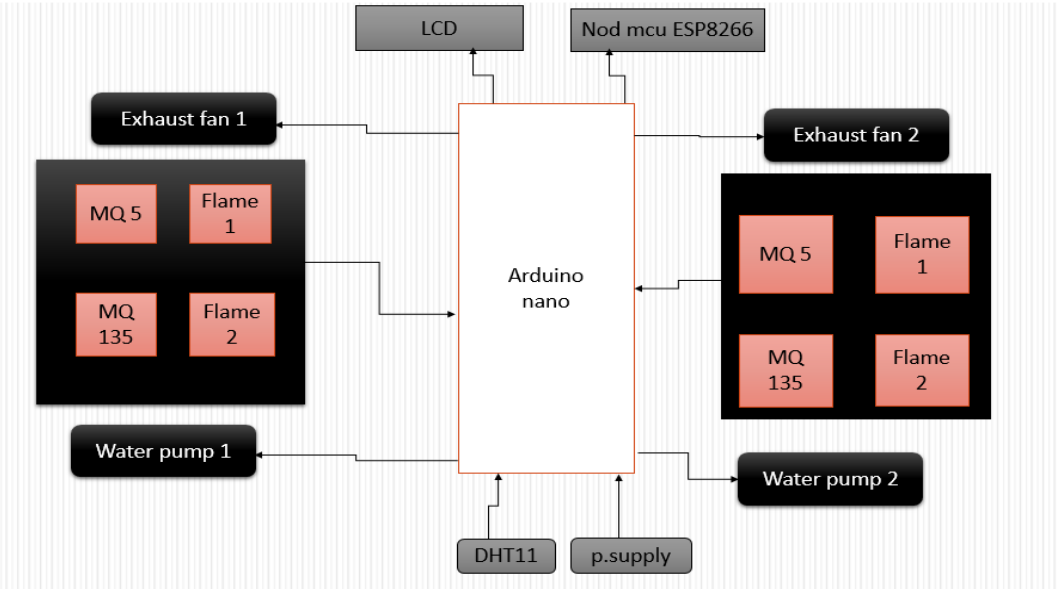

Fig 1 – Block Diagram IoT Based Fire Safety

2.1 Project Circuit Diagram

Gas sensors are analog sensors that are interfaced with the analog pins of Arduino Nano board and flame sensors are analog as well as digital but here we have connected digitally to Arduino Nano board. DHT11 is a digital sensor so we have connected with digital pin of Arduino Nano. IIC is coupled with liquid crystal display LCD to make connection simple and easy with Arduino Nano. NodMcu ESP8266 is digitally communicated with Arduino Nano. In four channel relay one terminal of supply is common and other terminal of supply is grounded. Ground pin of relay is connected with ground pin of Arduino Nano and Vin of Arduino Nano is connected with Vin of relay switch as shown in Fig. 2.

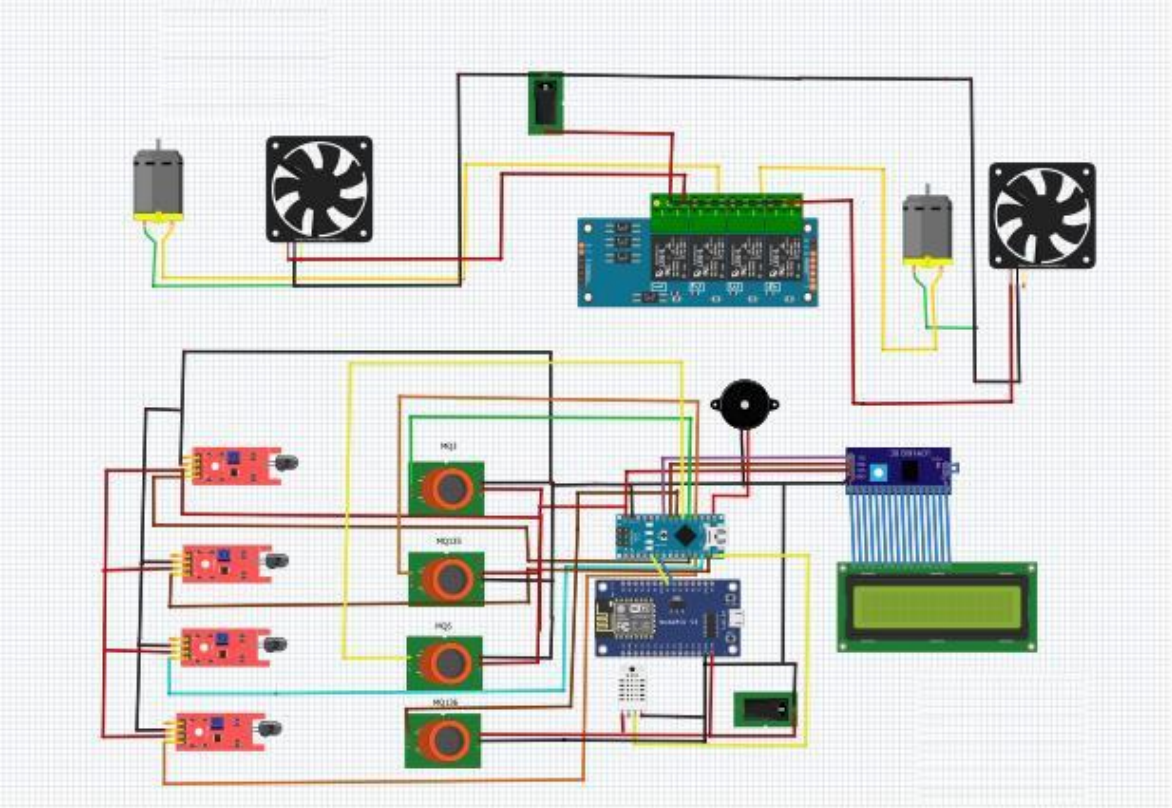

Fig 2 – Interfacing of components

3. Description of Hardware and Software

The project comprises of two parts hardware and software. The hardware consist of major components Arduino Nano, ESP8266, DHT11, Flame sensor, gas sensor, 12V DC motors, 12V DC Exhaust fans, LCD and 4-Channel Relay. The software part has Arduino IDE using C programming and World HTML for webpage programming.

3.1 Description of Components

Arduino Nano: The Arduino Nano is a little, complete, and breadboard-accommodating board dependent on the ATmega328 (Arduino Nano 3. x). It has pretty much a similar usefulness of the Arduino Duemilanove, yet in an alternate bundle. It needs just a DC power jack, and works with a Mini-B USB link rather than a standard one as shown in Fig. 3.

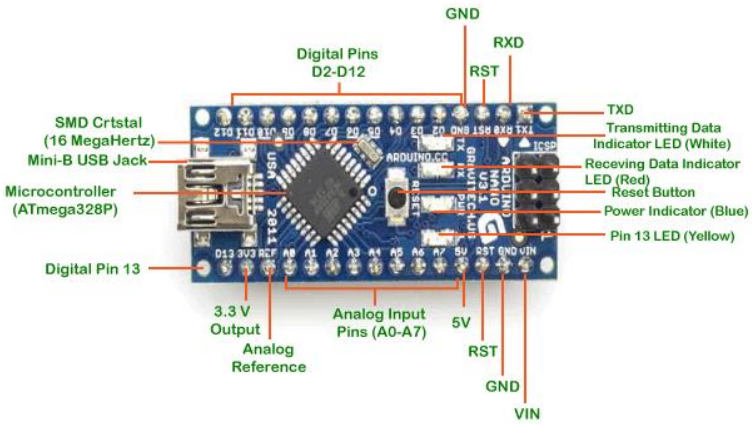

Fig 3 –Arduino Nano with pin descriptions

NodMCU ESP8266: The Nod mcu (Microcontroller unit) is an Arduino-compatible board that features the ESP8266 at its core. It became popular because it is a Wi-Fi-ready microcontroller by itself - no need for an Arduino.

Nod mcu is an open source IoT stage. It incorporates firmware which runs on the ESP8266 Wi-Fi SOC from express if frameworks, and equipment which depends on the ESP-12 module. The expression "Nod mcu" as a matter of course alludes to the firmware as opposed to the improvement units. The firmware utilizes the scripting language as shown in Fig. 4.

Fig 4 – NodMcu ESP8266

Infrared IR Flame Sensor: The Infrared flame sensor is used to find the presence of fire or other infrared source (Flame or a light source which has a wavelength in the range of 760 nm to 1100 nm can be detected). It is usually used in firefighting robot or heat seeking devices as shown in Fig. 5.

Fig 5 – IR Flame sensor

MQ-135 Gas Sensors: The MQ 135 Air Quality Detector Sensor Module for Arduino has lower conductivity in clean air. The MQ135 gas sensor has high affectability to Ammonia, Supplied and Benzene steam, additionally delicate to smoke and other destructive gases as shown in Fig. 6.

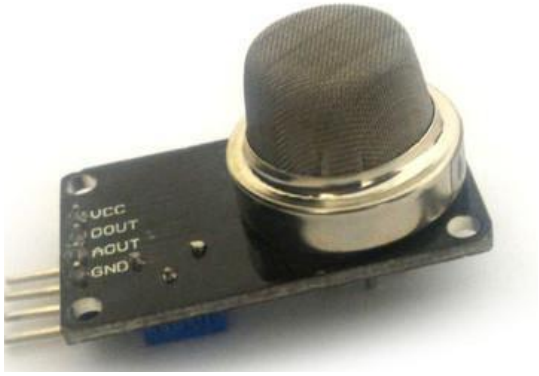

Fig 6 – Fig 6 – MQ – 135 Gas Sensor

Temperature & Humidity sensor DHT11: The DHT11 is a fundamental, ultra-minimal effort digital temperature and humidity sensor. It utilizes a capacitive dampness sensor and a thermistor to quantify the encompassing air, and lets out an advanced sign on the information pin (no analog pins required) as shown in Fig. 7.

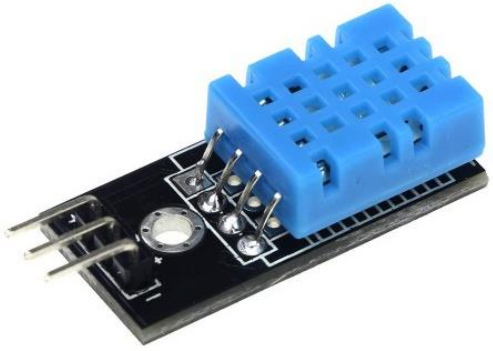

Fig 7 – DHT11 Humidity and Temperature sensor

12V DC motor : A DC motor is any of a class of turning electrical engines that converts direct flow electrical energy into mechanical energy. The most well-known sorts depend on the powers created by attractive fields as shown in Fig. 8.

Fig 8 – 12V DC Motor

12V DC Exhaust fan: These sort of Devices are put between your venture and whatever surface it very well may be laying on, considering better ventilation of air to the base side of the PC. Extra fans help to make the trading of air more proficient as shown in Fig. 9.

Fig 9 – 12V DC Exhaust Fan

Liquid crystal display (4×20): Liquid crystal display (LCD) 4x20 showcase which is worked in with ST7066 regulator IC; its default interface is 6800 4/8-cycle equal, 5V force supply. These LCD shows 4x20 modules are likewise accessible in SPI and I2C interface by utilizing RW1063 regulator IC as shown in Fig. 10.

Fig 10 – Fig 10 – LCD 4x20

Two switch relay: A relay is an electrically worked switch. It comprises of a bunch of information terminals for a solitary or numerous control signals, and a bunch of working contact terminals. The switch may have quite a few contacts in different contact structures, for example, make contacts, break contacts, or mixes thereof as shown in Fig. 11.

Fig 11 – Four Channel Relay

3.2 Software Required

Arduino IDE: The Arduino Integrated Development Environment (Arduino IDE) is the free programming needed to connect with your Arduino regulator board, without the Arduino IDE you can't program your Arduino microcontroller. World HTML tool: Word HTML is the perfect tool to edit the source code of WordPress articles or any other content management system when their built in composer doesn't provide all functionalities we need. Compose the content right in your browser window without installing any extension or plugin to handle the syntax highlighting and other text editing features.

4. Project Description

Power the Arduino nano by 5V Battery or Charger, IR flame sensor, Temperature & Humidity sensor DHT-11, Nod mcu, gas sensors MQ2, MQ135 are connected to Arduino via connecting wires and placed on a hard board. Actuators are connected with Arduino and 12v dc power by relay switching. IR Flame sensor, DHT-11, Nod mcu ESP8266, Gas sensors and actuators are programmed with Arduino ide. Software. The language used here is C language.

The sensors and actuators are programmed in such a way that, When there detects fire or smoke on sensor, it detects it by making a closed circuit then a feedback is sent to Arduino and Nod mcu. Nod mcu is already connected to Wi-Fi, it sends data to webpage an also on LCD informing about the status (about fire or smoke), then actuators (for fire it starts water pump and for gas exhaust fan) are triggered by Arduino and hence the motor or fan operates and protects the valuable things under it. When the fire or smoke stops, the contact/circuit breaks, hence the Arduino is un triggered, Nodmcu sends the data to the webpage and also to the LCD and informs about the status that the FIRE OR SMOKE has stopped, then we can see on webpage and LCD that there is no alert all the stations are ok. Same for the Humidity & temperature Nod mcu sends update on webpage and LCD after every 10sec (or may be after 1sec depends on program that how much delay we have used here) and then system repeats the loop as mentioned in Fig. 12.

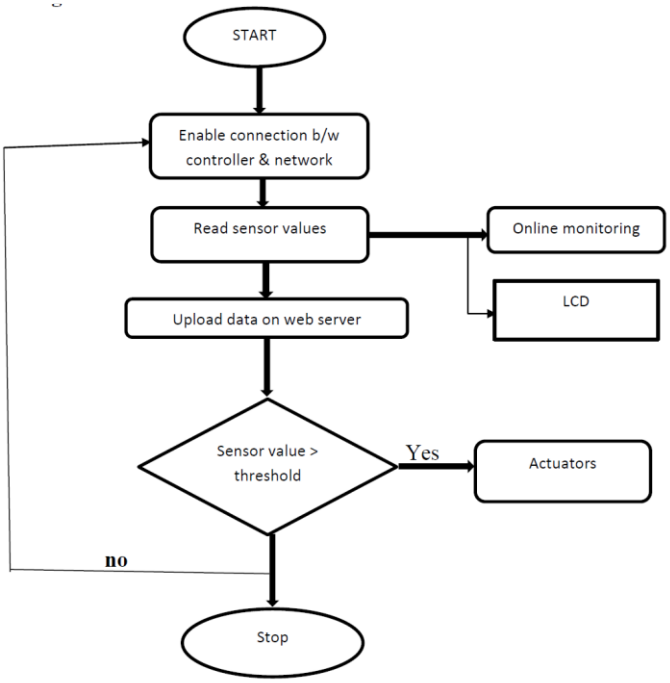

Fig 12 – Flow Diagram Iot Based Fire Safety System

5. Scope of Project

- Low cost solution for fire with reliabilities.
- Design criteria will focus on application, economical aspect and flexibility.
- This project focuses on the 12V standard DC voltage for domestic purpose for house application which is provided by the battery at the same time this project can be enhanced to a big project for industrial purpose for the safety of sensitive device such as electronic equipment.
- The safety circuit very helpful to protect the departments, industries, forest areas and many more as it works automatically by sensing fire, humidity & temperature.
- A fire ready framework diminishes the likelihood of injury or death toll and cutoff points harm because of fire, smoke, heat and different components.
- This project is developed to apply IOT technique to provide semiautomatic, fully control on fire and smoke anywhere in the world.

6. Results and Discussions

The results obtained from the hardware of this project the status of actuators and the values of temperature & humidity, the status of IR flame sensors and gas sensors on the LCD and on to the webpage. Conclusion of the results has been described with satisfactory evidences. Future scope have also been discussed for more advancement in the innovative field of technology as shown in Fig. 13. The Result on webpage at normal condition are demonstrate din Fig. 14 and Result on webpage for incidental fire are depicted in Fig. 15

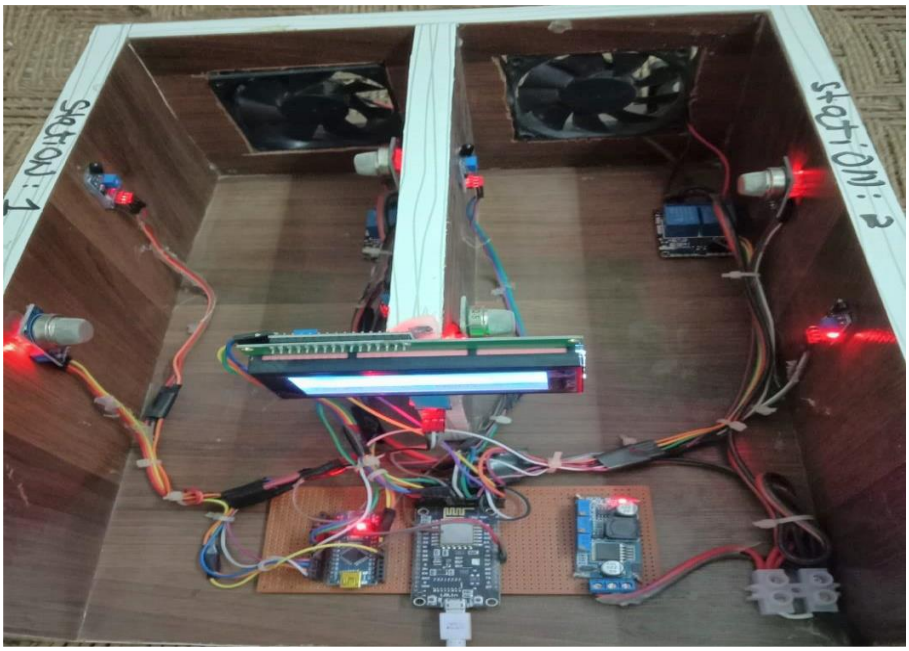

Fig 13 – Prototype IoT Based Fire Safety System

6.1 Testing Procedure

I. Observe the normal/rest position of all sensors and actuators.

II. Now give flame to the IR flame sensor module and check your webpage and LCD ('Alert' status).
III. Go into the web page connect your Wi-Fi to Nod MCU's Wi-Fi and go the link 192.168.0.100 at goggle (Indicating the value of temperature & humidity, status of actuators and sensors) update after every 10sec because we have sated in program to update data after 10sec.
IV. Observe the status of actuators.
V. When fire is extinguished from fire sensor, now check your webpage and LCD ('No Alert' status).
VI. Go into the webpage there will be same data and status of normal position.
VII. Repeat the same procedure for gas sensors.

TEMPERATURE:	26
HUMIDITY:	48

- **STATION 1**

FLAME SENSOR1:	NO ALERT
FLAME SENSOR2:	NO ALERT
SMOKE MQ-5 :	NO ALERT
FLAME MQ135 :	NO ALERT
FAN STATUS :	OFF
MOTOR STATUS :	OFF

- **STATION 2**

FLAME SENSOR1:	NO ALERT
FLAME SENSOR2:	NO ALERT
SMOKE MQ-5 :	NO ALERT
FLAME MQ135 :	NO ALERT
FAN STATUS :	OFF
MOTOR STATUS :	OFF

Fig 14 - Result on webpage at normal condition

TEMPERATURE:	27
HUMIDITY:	42

- **STATION 1**

FLAME SENSOR1:	NO ALERT
FLAME SENSOR2:	ALERT
SMOKE MQ-5 :	NO ALERT
FLAME MQ135 :	NO ALERT
FAN STATUS :	OFF
MOTOR STATUS :	ON

- **STATION 2**

FLAME SENSOR1:	NO ALERT
FLAME SENSOR2:	NO ALERT
SMOKE MQ-5 :	NO ALERT
FLAME MQ135 :	NO ALERT
FAN STATUS :	OFF
MOTOR STATUS :	OFF

Fig 15 - Result on webpage for incidental fire

7. Conclusion

This project is a semi-automatic, fully controlled based on IOT interface with hardware. The work is successful and application of such a method in a department, houses and industries etc. seems to be fire can be extinguish by water pump automatically and smoke by exhaust fan also by user via IOT when fire occurs to protect the valuable things from rain fire, humidity & temperature, and smoke. It is controlled from anywhere but the necessary condition is that the system and the user both must be connected to the Internet.

This project is developed in such a way that if fire or gas occurs this system will try to oppose that and also inform the user to protect valuable things and send values of humidity and temperature to the LCD and web page also. By making this project we faced a lot of problems in circuit, IOT connectivity but after some practice & few tests we did this successfully and have introduced a new system in market which was not available before.

This project we have made using Arduino nano, 12v DC motor, 12v DC exhaust fan, IR Flame sensor, MQ5 & MQ135 Gas sensors, DHT-11 SENSOR, Nodmcu ESP8266, DHT-11, Arduino Software 1.8.5 & webpage, connecting wires etc. is as a model that could be further implemented and enhanced by the project industries on high level on the basis of its advantages and requirements.

8. Suggestions for the Future Work

This project can be further enhanced by interfacing it with a wireless camera so that the person that using webpage can view the automatic operation. It can be enhanced by making the same system without Wi-Fi using any other technique in future. It can be enhanced by using wireless sensors which will better than wired system and having large range of sensation.

Acknowledgement

The authors would like to thanks Department of Electronic Engineering, Quaid-e-Awam University of Engineering, Science and Technology, Nawabshah, Sindh, Pakistan for their support in carrying this work without their support work accomplishment of the work wouldn't possible.

References

1. Khalaf, O.I., Abdulsahib, G.M. and Zghair, N.A.K., 2019. IOT fire detection system using sensor with Arduino, 74-78.
2. Idris, F., Hashim, N., Kadmin, A.F. and Yee, L.B., 2019. Intelligent fire detection and alert system using labVIEW. International Journal of Electrical and Computer Engineering, 9(3), p.1842.
3. Omar Chamorro-Atalaya, Dora Arce-Santillan. "Fire alert system through text messages, with arduino mega technology and GSM SIM 900 module." Vol. 18, No. 3, June 2020, pp. 1215~1221.
4. Sung, W.T., Lu, C.Y.: Smart warehouse management based on IOT architecture. In: 2018 International Symposium on Computer, Consumer and Control (IS3C). pp. 169–172. IEEE (2018).
5. Sassani, B.A., Jamil, N., Malik, M.A. and Tirumala, S.S., 2019, November. Fire Not-An IOT Based Fire Alerting System: Design and Implementation. In International Conference on Intelligent Technologies and Applications (pp. 14-21). Springer, Singapore.

6. Osamah Ibrahim Khalaf, Bayan Mahdi Sabbar "An overview on wireless sensor networks and finding optimal location of node' 'Periodicals of Engineering and Natural Sciences, Vol 7, No 3(2019).
7. Devan, P.A.M., Manisha, G., Rajarajeswari, K.G.T., Priyanga, M. and Sangeetha, K., 2018, May. FIRE SAFETY AND ALERTING SYSTEM IN RAILWAYS. In 2018 3rd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT) (pp. 535-539). IEEE.
8. Kumar, S. and Jasuja, A., 2017, May. Air quality monitoring system based on IoT using Raspberry Pi. In 2017 International Conference on Computing, Communication and Automation (ICCCA) (pp. 1341-1346). IEEE.
9. Lee I, Lee K. The Internet of Things (IoT): Applications, investments, and challenges for enterprises. Business Horizons. 2015 Jul 1; 58(4):431-40. 51
10. Roberto Barbosa, M., Carlos Sicoli Seoane, J., Guimaraes Buratto, M., Santana de Oliveira Dias, L., Paulo Carvalho Raivel, J. and Lobos Martins, F., 2010. Forest Fire Alert System: a Geo Web GIS prioritization model considering land susceptibility and hotspots–a case study in the Carajás National Forest, Brazilian Amazon. International Journal of Geographical Information Science, 24(6), pp.873-901.
11. Saeed, F., Paul, A., Rehman, A., Hong, W.H. and Seo, H., 2018. IoT-based intelligent modeling of smart home environment for fire prevention and safety. Journal of Sensor and Actuator Networks, 7(1), p.11.
12. Ryu, C.S., 2015. IoT-based intelligent for fire emergency response systems. International Journal of Smart Home, 9(3), pp.161-168.
13. Lule, E., Mikeka, C., Ngenzi, A. and Mukanyiligira, D., 2020. Design of an IoT-Based Fuzzy Approximation Prediction Model for Early Fire Detection to Aid Public Safety and Control in the Local Urban Markets. Symmetry, 12(9), p.1391.
14. Savitha, N. and Malathi, S., 2018, October. A survey on fire safety measures for industry safety using IOT. In 2018 3rd International Conference on Communication and Electronics Systems (ICCES) (pp. 1199-1205). IEEE.
15. Al-Nabhan, N., Al-Aboody, N. and Al Islam, A.A., 2019. A hybrid IoT-based approach for emergency evacuation. Computer Networks, 155, pp.87-97.
16. Yan, F., Jia, J., Hu, Y., Guo, Q. and Zhu, H., 2019. Smart fire evacuation service based on Internet of Things computing for Web3D. Journal of Internet Technology, 20(2), pp.521-532.
17. Almalki, F.A., 2020. Implementation of 5G IoT Based Smart Buildings using VLAN Configuration via Cisco Packet Tracer. International Journal of Electronics Communication and Computer Engineering, 11(4), pp.56-67.
18. Kodali, R.K. and Yerroju, S., 2017, December. IoT based smart emergency response system for fire hazards. In 2017 3rd International Conference on Applied and Theoretical Computing and Communication Technology (iCATccT) (pp. 194-199). IEEE.
19. Vijayalakshmi, S.R. and Muruganand, S., 2017. Internet of Things technology for fire monitoring system. Int. Res. J. Eng. Technol, 4(6), pp.2140-2147.
20. Bouabdellah, Kechar, Houache Noureddine, and Sekhri Larbi. "Using wireless sensor networks for reliable forest fires detection." Procedia Computer Science 19 (2013): 794-801.

21. Herutomo, Anton, et al. "Forest fire detection system reliability test using wireless sensor network and OpenMTC communication platform." 2015 3rd International conference on information and communication technology (ICoICT). IEEE, 2015.