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An Internet of Things (IoT)-Based Fire Alarm System for Residential Use with Data Logger

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Abstract:

A "smart home" is an example of a building that incorporates Fourth Industrial Revolution technology to increase a house's resistance to fire. The design of a smart home with fire detection and suppression capabilities is described in this article. An essential component of a house fire early warning monitoring system is an internet-of-things (IoT) data logger. Data loggers may also function as recorders in certain situations. The hardware system design includes a datalogger module, gas and fire sensors, an ESP8266, and an Arduino Mega2560. As a software design, the Blynk app for Android phones serves as a dashboard for system monitoring. The data-recording module was used to document the gas and fire sensors' activities. The gas cooker in the kitchen was the main focus of the system test. A mobile device was used to display the results of the system design using the Blynk app. In the event of a fire, the Virtual Button will change colour from its usual white to red. Nevertheless, the Virtual Level is adjusted to reflect the gas detection system's monitoring display the moment a gas leak is identified. To illustrate the activity data acquired from the fire sensor by the datalogger, a graph is shown demonstrating the relationship between the operating voltage and time. While the datalogger records the gas sensor's activity, a graph is shown illustrating the link between gas concentration and time. All of the system reaction's findings and visual data are presented in real-time using the Blynk app on a smartphone. For the sake of future study, a micro-

SD card also keeps track of the system's performance data. If everything goes as planned, this data storage system will be the standard for home monitoring systems to come.

Keywords: Fire Detection, Fire Monitoring, Vision Based System, IOT, Smart Home

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I. Introduction

In this study, we used an Arduino Mega2560, an ESP8266, many sensors, and the smartphone app Blynk to investigate potential designs for an IoT network. The study's results, which followed the early detection of likely fires using the Internet of Things, can be seen on a smartphone through the Blynk app. The absence of a data logger—a means to record data either constantly or at predetermined intervals—is an issue with the detection system. Using a data recorder will greatly simplify the process of retrieving previously recorded sensor data. Considering that there are components that include Important parts of every building's safety system are the fire detection and alarm systems, which are there to find fires and notify people inside so they can get out of the structure quickly if one breaks out.

Rapid reaction and damage mitigation are guaranteed by this all-encompassing system's combination of several technologies and devices. The purpose of this article is to provide a synopsis of important features of fire alarm systems. To reduce the chances of fires developing and spreading, as well as the risk of people being exposed to them, the fire detection system is designed to detect when fires are present and then either manually or automatically initiate control actions. A fire alarm system's primary function is to detect the presence of fire or other potentially dangerous situations inside a structure and to sound an auditory and/or visual warning to the inhabitants and supervisors of the facility**.**

II. Review of Literature

Eco-friendly structures rely heavily on fire detection systems. According to Kate Houghton, director of marketing for Kidde Fire Systems, a fire-detection system can reduce emissions of harmful byproducts of combustion and gases that contribute to climate change by detecting fires rapidly and accurately (i.e., without compromising speed or triggering false alarms) and by providing early warning notification. All fire situations inevitably include these environmental repercussions, which are often disregarded. Therefore, in planning a green building, it is essential to minimise the possibility of fires. One way to warn people of the possibility of a fire is using a smoke detector, sometimes called a smoke alarm. Figure 9.30 shows that most home smoke detectors come with a plastic housing that is disk-shaped and measures 150 mm in diameter and 25 mm thick. However, the exact dimensions and form of the housing might vary depending on the manufacturer. Most smoke detectors are placed on or near the ceiling because smoke tends to climb. Smoke detectors must be serviced and tested often to ensure they are functioning correctly. Because of this, emergency responders will be able to get warnings in plenty of time before a fire even starts to do significant harm.

Detecting soldered cables or overheated circuit boards is a standard feature of current systems. Saving lives and minimising damage and downtime may be achieved by early detection. The regulations that regulate the installation of smoke detectors vary from one jurisdiction to another. A plethora of methods exist for the purpose of detecting fires. Several methods for detecting fires will be discussed in the sections that follow. A. Smoke and gas detectors for fire detection There is a significant risk of false alarms when fire detection is only relied on smoke detectors. Alarms that have not been confirmed to be smoke are referred to as false alerting rate. This issue was addressed by developing smoke detectors and gas sensors for use in fire detection. Figure 1 shows the components of the fire detection system, which include smoke detectors, CO and CO2 sensors, and data. The light scattering technique is used to determine the concentration of smoke. In this case, a photoelectric smoke detector is used. After reaching the location under observation, the light from the LED is reflected back to the photodiode. As a result of smoke particle dispersion, the measured light intensity is lower. Notify someone if the light level drops below a certain point. Detectors for carbon monoxide and ozone are based on the diode laser absorption spectroscopy technique. Diode laser absorption spectroscopy is a top method for measuring gas concentrations. Gas absorption lines are used to adjust the wavelength of diode lasers. Because of this, the amount of light that may be absorbed is reduced. Using a photodiode to measure the light intensity allows one to detect the concentration of gases. The temperature and injection current of a diode laser are adjusted to tailor its wavelength. A distributed feedback diode laser (DFB) is what we're using here. The results are sent to the data processing module when the CO, CO2, and smoke levels have been detected.

III. Methodology

Each sensor node in this design is connected directly to the final destination after deployment in a predetermined area. Using a routing protocol, such dynamic source routing protocol, data is sent hop-by-hop until it reaches the base station. A simplified code editor, Visual Studio Code helps with development tasks including version management, task execution, and debugging. Its primary goal is to give developers with the essentials for a simple code-build-debug cycle, while letting more robust integrated development environments (IDEs) like Visual Studio handle more complicated processes. Visual Studio Code's core functionality is a quick source code editor, making it ideal for regular use. Syntax highlighting, bracket matching, auto-indentation, box-selection, snippets, and support for hundreds of languages make VS Code an immediate productivity booster [10]

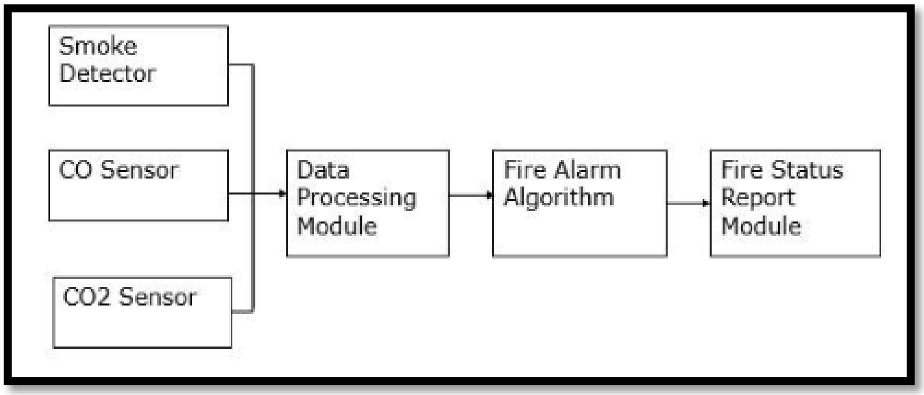


Fig. 3.1. Fire detection system

A branch of computer science, linguistics, and AI, natural language processing (NLP) focuses on how computers interact with human language, specifically on programming computers to handle and analyse massive volumes of natural language data. A computer that can "understand" documents—including the subtleties of context in the language used—is the ultimate aim. After that, the system can classify and arrange the papers according to their content and correctly extract insights and information from them.

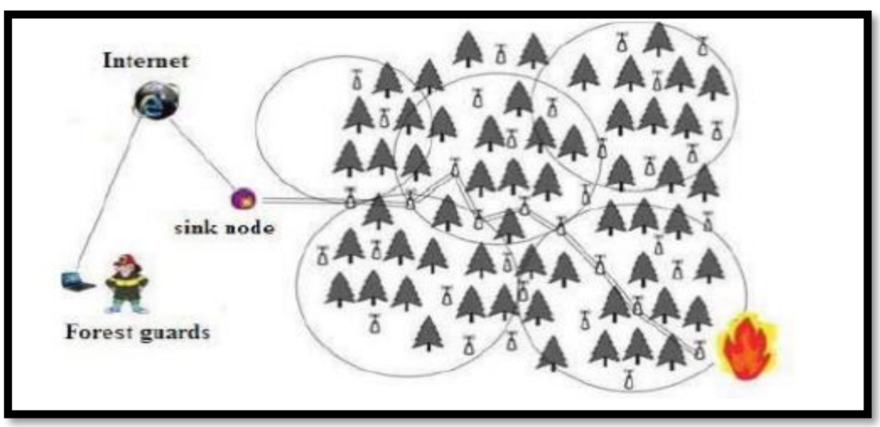


Fig. 3.2. System Architecture

Python 3.10 is pre-installed in Thonny, so all it takes to start learning programming is a single installation. (Alternatively, if needed, you may utilise a separate installation of Python.) There are no features that can be a distraction for new users in the basic user interface. A branch of computer science, linguistics, and AI, natural language processing (NLP) focuses on how computers interact with human language, specifically on programming computers to handle and analyse massive volumes of natural language data. A computer that can "understand" documents—including the subtleties of context in the language used—is the ultimate aim. After that, the system can classify and arrange the papers according to their content and correctly extract insights and information from them. Natural language processing (NLP) problems often include voice recognition, NLU, and NG generation [12].

IV. The Details Algorithm of system

In order to ensure the system is suitable for the building, it is important to install fire detection and alarm systems in accordance with the detailed design plan. Whenever there is a deviation from the original plan, the installer should check in with the designer to make sure the necessary adjustments still keep people and property safe. To keep the fire detection and alarm system in good working order and to keep the system disabled for as little time as possible while it is being serviced or modified, the installation work must be of a certain standard.

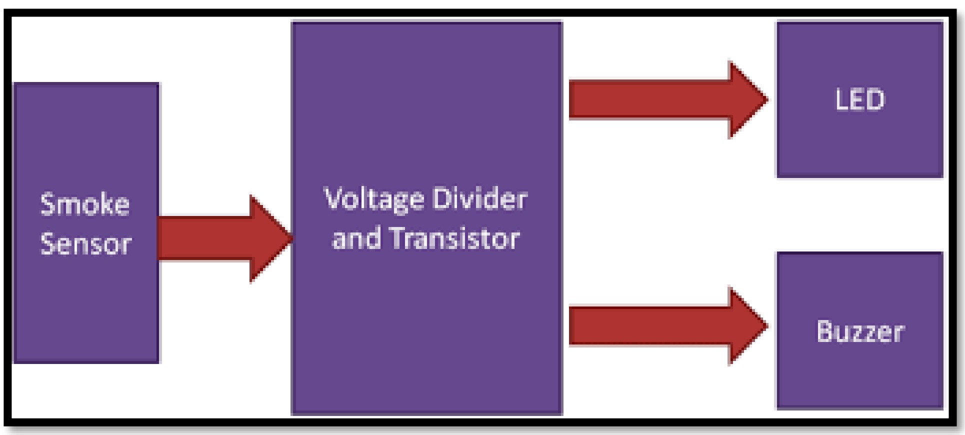


Fig. 4.1. The diagram of smoke sensor to voltage divider and transistor

Collecting requirements: At this stage, you need to figure out what the needs are. Outline the time and energy required to construct the project and describe any potential commercial prospects. You may assess the project's technical and financial viability using these data. Outline the necessary components: Collaborate with stakeholders to establish needs after the project has been selected. If you want to demonstrate how new features will interact with your current system, you may draw a user flow diagram or a high-level UML diagram. Building/Raising Edition: The process starts after the team determines what is needed. The project's designers and developers go to work on creating and releasing a functional product. There is little functionality since the product will be improved in phases. At this point, the QA group checks the product's functionality to see if they can find the issue. The team releases the product to the user's workplace during the deployment phase.

The person designated as the property's caretaker is responsible for performing weekly and monthly inspections of the fire detection and alarm system. In order to "identify fault indications at the panel for appropriate action," these tests will be performed routinely. In addition, testing should be done on a regular basis to make sure that the system as a whole or a substantial portion of it has not failed. An investigation on the project's viability will follow. A thorough definition of the system's scope may be achieved by conducting a feasibility study. Typically, a user's need is taken into account while designing a computer system. Consequently, determining whether or not a system is amenable to computerization is often the first step in the system life cycle. After a choice is made, a document called a Feasibility Report is sent along. In the following scenarios, we examine the feasibility: The first step is to figure out whether the issue can be solved by building a system. Project completion and the viability of the project's stated objectives are at the heart of the technical concerns voiced during this phase of the examination. Here, we address the practicality by analysing the costs and benefits. Some intangible advantages were mentioned, such as how user-friendly, robust, and secure it is. When this initiative is put into action, very little money will be spent. We guarantee that the final product will be both dependable and easy to use. It is doable to execute each and every one of the features and procedures that we have planned for our project. Because of this, the system will be easier to use and accept. It becomes completely comprehensible and operational with the user with the use of menus and the necessary validation.

Early detection of fire, smoke, or high temperatures is an essential capability of the system. Just to clarify: Timely reactions, containment of the fire, and safe evacuation are all dependent on early identification. Feedback is the final phase after product release. As part of this process, the team gets Product feedback and uses it to improve the product. In order to ensure the system is suitable for the building, it is important to install fire detection and alarm systems in accordance with the detailed design plan. Whenever there is a deviation from the original plan, the installer should check in with the designer to make sure the necessary adjustments still keep people and property safe. To keep the fire detection and alarm system in good working order and to keep the system disabled for as little time as possible while it is being serviced or modified, the installation work must be of a certain standard.

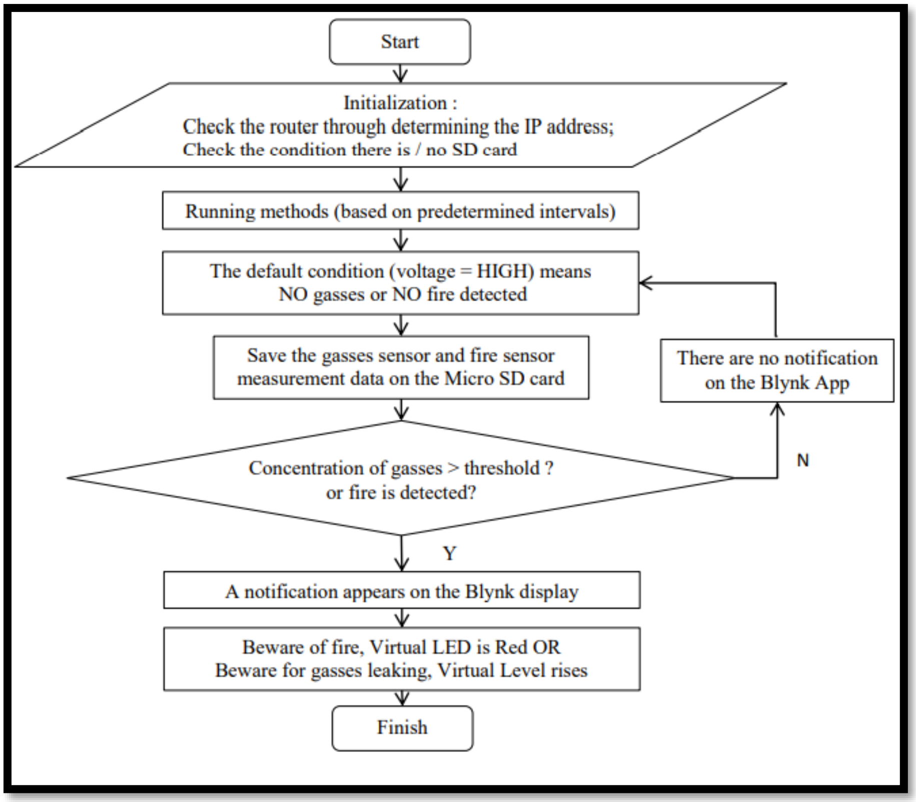


Fig.4.2. The algorithm of smart bins integrated monitoring system

Projects using the Internet of Things often make use of server service platforms like Blynk. Both the Android and iOS mobile operating systems make use of this technology. Visit the Google Play Store to get the Blynk app. Many different pieces of hardware used in the IoT project are compatible with it. Visual project management tools are available on the digital dashboard Blynk. Its primary motivation for development was to provide LAN-based remote control and monitoring of gear. Blynk simplifies the process of creating Internet of Things projects for novices by storing data and displaying it graphically using numbers, colours, or images. Blynk Apps, Blynk Cloud Server, and Blynk Library are the three primary parts of Blynk, as seen in Figure 6. As soon as the system detects smoke or fire, it must immediately activate the visual and auditory alerts. In order to ensure that people can react promptly and leave the building in the event of an emergency, alarms play an essential role. It is essential that the system works in tandem with emergency services to provide vital information and automated notifications. Integration allows for the quick dissemination of information to emergency responders, facilitating a coordinated and rapid reaction to incidents on the inside.

The house fire detection system's algorithm is shown in Figure 2. Arduino IDE is where the algorithm is programmed.As seen in Figure 2, the system is explained by an algorithm. It would seem from the method that the initial sensor state is HIGH, indicating that the highest voltage sensor has the greatest value when there is no stimulation of fire or gas. The sensor's voltage decreases in the event of a gas stimulation or fire. As a result, the potential difference between the conductor ends of the sensor diminishes as it responds to stimuli, which is in line with the principle of conservation of energy in physics. So, the voltage difference represents the reduction in electric potential energy, which occurs while the sensor is functioning (positive).

V. Results and Discussion

The Internet of Things (IoT) hardware prototype for a house fire alarm system. The Arduino Mega 2560 board serves as the primary controller, as seen in Figure 10. The Arduino Mega2560 get access to Wi-Fi 33 by the AT command, while the ESP 8266 board acts as a client of the WIFI Router. The availability of several analogue pins is one of the many benefits of the Arduino Mega 2560, which makes it appropriate for future development ideas. So, there won't be a plethora of pin configurations to worry about when adding additional analogue sensors to the fire detection system or other smart home systems in the future. The Arduino Mega 2560 has many more pins for system development, which is an additional benefit of the board.

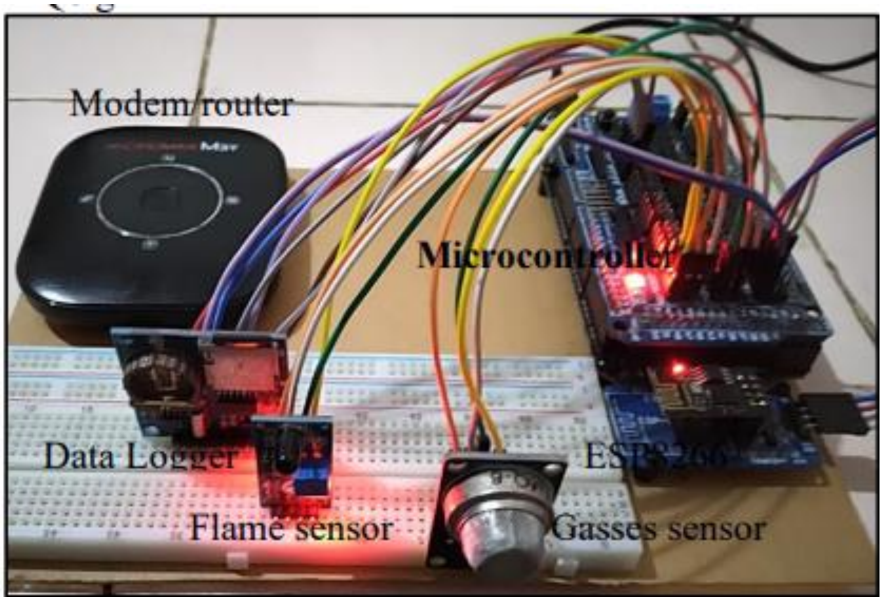
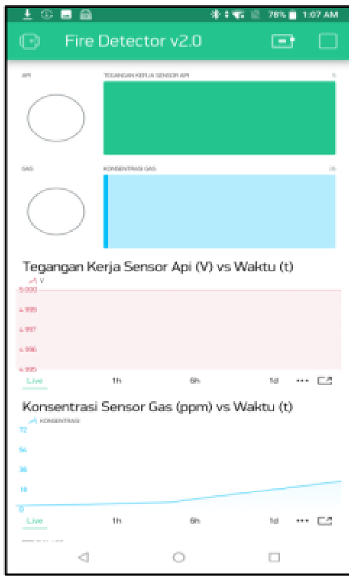


Fig. 5.1. Result of Hardware design

The Glyn Blynk app's design process is similar to that of creating a GUI in that it relies on drag-and-drop elements. The BLYNK app's graphical user interface (GUI) and the ArduioIDE sketch fragment serve as the end products of the software design process




```
#include <ESP8266_Lib.h>
#include <BlynkSimpleShieldEsp8266.h>
char auth[] = "xxxxxxxxxxxxxx";
char ssid[] = "xxxxxxxxxxxxxx";
char pass[] = "xxxxxxxxxxxxxx";
// Hardware Serial on Mega, Leonardo,
Micro...
#define EspSerial Serial1
// Your ESP8266 baud rate:
#define ESP8266_BAUD 115200
ESP8266 wifi(&EspSerial);
// Select your pin with physical button
const int flamePin = 22;
const int gasLevelPin = A15;
WidgetLED led1(V1);
WidgetTerminal terminal(V0);
BlynkTimer timer;
void setup() {
// Debug console
Serial.begin(9600);
// Set ESP8266 baud rate
EspSerial.begin(ESP8266_BAUD);
delay(10);
//  Blynk.begin(auth, wifi, ssid, pass);
//Blynk.begin(auth, wifi, ssid, pass,
"xxxxxxxx", 80);
Blynk.begin(auth, wifi, ssid, pass,
"xxxxXXXX", 8080);
.
.
.
void loop() {
Blynk.run();
timer.run();
```

Fig. 5.2. Fire detector results on system

So, there won't be a plethora of pin configurations to worry about when adding additional analogue sensors to the fire detection system or other smart home systems in the future. The Arduino Mega 2560 has many more pins for system development, which is an additional benefit of the board.

Fig. 5.3. Completed System design diagram

The procedure for gathering information on gas sensor performance. Placing an open plastic bottle at both ends retrieves gas detection data. Wrap the gas stove burner with one end of the bottle. The MQ6 gas sensor is connected to the opposite end of the plastic bottle's mouth, which allows the bottle to retain and contain gas.

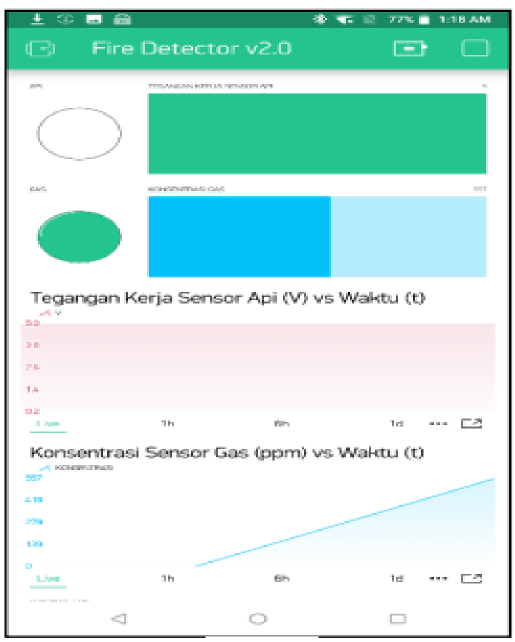


Fig. 5.4. The result with detection system

The procedure for gathering information on gas sensor performance. Placing an open plastic bottle at both ends retrieves gas detection data. Wrap the gas stove burner with one end of the bottle. The MQ6 gas sensor is connected to the opposite end of the plastic bottle's mouth, which allows the bottle to retain and contain gas. This is how the gas is supposed to be contained; the system will react to the gas's existence when its concentration in the pipeline exceeds the tolerance level determined by the algorithm. As a consequence of the system reaction, the Blynk app shows the outcomes, such as a change in colour for the Virtual Button display and an increase in gas concentration for the virtual level.

VI. Conclusion

Based on the idea of the Internet of Things, it is possible to design and construct smart homes with early warning systems for possible house fires. An Android smartphone, the Blynk app, an Arduino IDE, a datalogger, a gas detector, a fire detector, and an ESP8266 are all parts of the system's hardware and software assembly. The system's reaction to a fire or gas leak in the kitchen may be seen in the functioning outcomes of the design. By using the Blynk app on a mobile device, the outcomes of the system design may be seen. Changing the Virtual Button's colour from its original green to red indicates the system's success in detecting the presence of fire. If a gas leak is detected, the gas detection system's Virtual Level display will change. A graph showing the relationship of the operating voltage of the fire sensor vs time is shown to demonstrate the datalogger's recorded activity data from the fire sensor. A graph showing the connection between gas concentration and time is shown to represent the data recorded by the datalogger, which records the activity of the gas sensors. Using the Blynk app on a smartphone, all the results and visual data from the system reaction are shown in real-time. You should also make a note of the system performance data that is on the micro-SD card so you may analyse it later. It is anticipated that this system, if completed, would serve as a model for residential fire monitoring systems that include data storing capabilities.

References:

[1]. Benamar Kadri, Benamar Bouyeddou Djilali Moussaoui, “Early fire detection system using Wireless sensor networks,” IEEE International conference on Applied Smart Systems (ICASS), 2018.

[2]. T.-H. Chen, P.-H. Wu, and Y.-C. Chiou, “An early fire detection method based on image processing,” in IEEE. Int. Conf. Image Process. (ICIP), pp. 1707-1710, 2004.

[3]. Han, X.F., Jin, J.S., Wang, M.J., Jiang, W., Gao, L., Xiao, L.P., “Video fire detection based on gaussian mixture model and multicolour features,” SIViP 11(5), 1–7, 2017.

[4]. K. Muhammad, J. Ahmad, I. Mehmood, S. Rho, and S. W. Baik, "Convolutional neural networks-based fire detection in surveillance videos," IEEE Access, vol. 6, pp. 18174-18183, 2018.

[5]. P. Foggia, A. Saggese, and M. Vento, "Real-time fire detection for video surveillance applications using a combination of expertsbased on color, shape, and motion," IEEE Trans. Circuits Syst. Video Technol., vol. 25,no. 9, pp. 1545-1556, Sep. 2015.

[6]. Kazem Sohraby, Daniel Minoli, Taieb Znati "wireless sensor networks: Technology, protocols and applications," John Wiley and Sons, Inc, 2007.

[7]. M. Mueller, P. Karasev, I. Kolesov, and A. Tannenbaum, "Optical flow estimation for flame detection in videos," IEEE Trans. Image Process., vol. 22, no. 7, pp. 2786-2797, Jul 2013.

[8]. G. Marbh, M Loepfe, and T. Brupbacher, "An image processing technique for fire detection in video images," Fire Safety J., vol. 41, no. 4, pp. 285-289, 2006.

[9]. Horng,W.B., Peng, J.W., Chen, C.Y., "A new image-based real-time flame detection method using color analysis," In: Proceedings of IEEE International Conference on Networking, Sensing and Control, pp. 100–105,2005.

[10]. D. B. Johnson and D. A. Maltz, "The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks (DSR)", IETF Internet draft, 19 July 2004, http://www.ietf.org/internet-drafts/draft-ietf-manet-dsr-10.txt.

[11]. T. C¸ elik and H. Demirel, "Fire detection in video sequences using a generic colour model," Fire Safety J., vol. 44, no. 2, pp. 147- 158, 2009.

[12]. P. V. K. Borges and E. Izquierdo, "A Probabilistic approach for vision based fire detection in videos," IEEE Trans. Circuits Syst. Video Technol.,vol. 20, no. 5, pp. 721-731, May 2010.