World Journal of Advanced Engineering Technology and Sciences
eISSN: 2582-8266
Cross Ref DOI: 10.30574/wjaets
Journal homepage: https://wjaets.com/

(RESEARCH ARTICLE)

Check for updates

Development of a two-level parameter access control system

FRANCIS CHUKWUDI CHUKWUDI [1] and NASIRU ABDULSALAM [2,*]

[1] *Department of Electrical and Electronics Engineering, Faculty of Engineering, Abubakar Tafawa Balewa University (ATBU) Bauchi, Bauchi State, Nigeria.*
[2] *Department of Computer and Communications Engineering, Faculty of Engineering, Abubakar Tafawa Balewa University (ATBU) Bauchi, Bauchi State, Nigeria.*

World Journal of Advanced Engineering Technology and Sciences, 2024, 11(01), 200–208

Publication history: Received on 19 December 2023; revised on 02 February 2024; accepted on 05 February 2024

Article DOI: https://doi.org/10.30574/wjaets.2024.11.1.0037

Abstract

The necessity for safety and security-based systems has grown tremendously in our daily lives, and their significance has also increased notably. These systems are now essential for safeguarding people's homes, workplaces, valuable assets like gold stores, and countless other institutions. However, defense against the possibility of catastrophic incidents such as gas leaks, fire outbreaks, or burglary attempts emphasizes the significance of the same. The development of intelligent electronics and smart microcontrollers has led to a notable surge in technological advancements in recent times.

This paper outlines the design of a security system used in managing a multi-level home using the versatile Atmega328 microcontroller board. This management system is designed to operate seamlessly accepting both remote and local control. The results achieved from the proposed system commendably display an admirable level of performance reliability, hence making it suffice for integration within Internet of Things (IoT) applications.

This system stands out due to its ability to function independently of various points of failure, which makes it more dynamic and able to hold sustained service. The suggested system's affordability makes it a viable application for a cross-operation of upstream, midstream, and downstream settings, enhancing security and strengthening defenses against floods in different forms that could compromise the security architecture. Hence, the research described in this paper not only portrays a solution with strong security and safety aspects, but also establishes doors for its practical implementation across various circumstances.

Keywords: Security system; Management; IoT; OTP; Safety System

1. Introduction

Smart homes, intertwined with the burgeoning field of Internet of Things (IoT), have emerged as a pervasive and transformative aspect of modern life [1]. The security of people's lives, as well as personal and public property, is a critical issue that must be addressed in this twenty-first century. The evolution of methods has mirrored the progression of human life and technology, developing quickly due to rapid advancements in the relevant technological base, leading to the formation of automatic control as the focal point for device management of protection, and remote alarm systems [2]. This not only reduces material costs, but also minimizes human effort in the pursuit of enhanced security. At the heart of this security evolution, lies devices dubbed home management systems, which are adept at detecting unauthorized access or unforeseen events, and responding proactively – like alerting homeowner, notifying law enforcement, or triggering safety measures such as fire extinguishers and alarm systems [3]. Home automation is gaining traction, and dominating the market, this provides an enormous opportunity for engineers to conduct research

* Corresponding author: NASIRU ABDULSALAM

and further development of new innovations. This surge has been propelled by various wireless network technologies such as the internet, WI-FI, and GSM, which have increased the effectiveness of Home Automation systems [18]. Home automation has had its fair share of setbacks, but there are clear benefits such as privacy, security, and a system capable of effectively managing all user interference that household management encounters. Complicated algorithms presents [6] difficult challenges in hardware resource limitations, power consumption, and memory. The introduction of cloud-based platforms raises concerns about unauthorized access because interfaces are accessible via the Internet [7]. Furthermore, wireless communication protocols used in IoT are not resistant to attacks [8]. Configuration issues and a non-standardized programming interface make home management systems more complex, unfeasible, and, in most cases, not economically viable. In response to such problems, the project proposes and implements a multi-level-based security system for home management [20]. Arduino boards were used in order to ensure the economies of scale, Hyper Text Transfer Protocol (HTTP) was used in the packet transmission for the purpose. Uniquely, it addresses security and safety at multiple levels incorporating a diverse array of sensors. These results showcase the system as being characterized by significant reliability and flexibility underlining its effectiveness in managing and securing smart home environments.

1.1. Problem statement

Although surveillance technologies have advanced in their ever-changing home security and management system landscape, there are still inadequacies in the solutions that are currently in place, especially when it comes to handling unwanted access and offering complete multi-factor authentication. While some studies offer novel features for access control, including one-time passwords (OTP), these solutions don't offer multi-level authentication and don't alert users to unwanted attempts. A more reliable and effective solution is also required. Furthermore, two-layered systems are vulnerable, highlighting the critical requirement for a more thorough and secure multi-level access control mechanism.

To fill in the gaps in home security and management techniques, this study intends to design and build a multi-level access control system with OTP, Robust multi-factor authentication, alerts for unwanted access attempts, and seamless integration with home and office settings. These are all features that the proposed system ought to offer. This research aims to close the security gaps in access control systems currently present and create a more dependable and safe solution for user's home management system.

Aim and objective of the research

The aim of this research is to develop a two-level parameters access control system, which can be used to enhance both home security and enterprise-level protection using microcontroller, wi-fi module, sensors and liquid crystal display.

The study aims to achieve the following objectives:

- To develop the system program and debugged errors
- To interface the sensors and simulate the system
- To developed a web interface for remote monitoring
- To breadboard the system and soldier the components
- To integrate the system sub units to function as a single unit

1.2. Review of existing works

Several researchers have dealt with the complexities of home management systems providing their methodologies, algorithms, and systems in enhancing safety and functionality. A seminal proposal of methodology for robust fractal protection or any physical disruption via automatic microcontroller-oriented system [9]. Of great importance to note is that the system integrates a microcontroller with a passive infrared radiation system as well as a shock sensor and a display panel keyboard [19]. It comes with an emphasis on direct communication with law enforcement groups in times of security breaches.

Other authors [10] proposed a system in which two PIR sensors are involved in determining an obstacle. The processing of data and the transmission of SMS alert in that system, which is GSM, performs by the application in a GSM modem to predefined mobile phone numbers. It further includes a serial camera and an SD card module for saving important images. This approach, though efficient, is considered costly and complex for multilevel applications.

Another major work [11] has proposed Arduino-based surveillance through improving theft detection using vibration, PIR, as well as password pendant sensors. USB interfaces with Arduino microcontroller that converts analogue

photographs and saves in the digital form using signals saved on a cloud server. This methodology is based on a cloud as it can identify the user involved in theft because it sends warnings to the Android users.

Authors in [12][19] proposed an innovative low-cost design for both automated weather device and home security control. The proposed design uses Android app smartphone-based control and notifications through a server-based system. On the other hand, a recent approach [13] presented a basic and cheap prototype that utilized PIR motion detector sensor, TICC3200 Launch-Pad, and Energia software. However, brought by the recent concerns of the system's sensitivity whose mitigation was not done successfully.

More advancements on this progression were carried out in [14][17] where a home management system using a microcontroller, Bluetooth remote, mobile app supporting both Android and iOS, together with PIR sensors were proposed. This time the system used the timing mechanism for controlled light management. Another explored avenue [15] involves implementation of a smart home security system using GSM/GPRS. This two-module system, despite introducing computational complexities, lacks real-time processing tests that instigate reliability.

Researchers in a series of works [1][4] had developed an effective model of home management systems utilizing PIR sensors and Pizo buzzer connected to Node MCU as a microcontroller. However, this model had been mainly driven by the single-sensor approach deemed as inefficient by previous studies [1,5]. In the works above, the related works give a rich tapestry of methodologies, each contributing to the broader understanding and development of home management systems.

2. Material and methods

2.1. Review Of System Hardware and Software

- **Overview of the System Hardware:** The programmable and dependable Arduino Microcontroller serves as the system's core processing unit. A number of sensors, including as the DHT11 Temperature Sensor, PIR, Soil Sensor, Flame Sensor, and Gas Sensor MQ-02, improve the system's capacity to track a variety of home environment parameters. The NodeMCU microcontroller makes it easier to connect to the Internet of Things (IoT) for remote monitoring.
- **Overview of System Software:** The secure algorithm used by the two-level access control system includes a Wi-Fi connection, specific login information, and the creation of One-Time Passwords (OTPs). The Internet of Things is used to facilitate effective wireless communication. The software efficiently handles data from multiple sensors, guaranteeing precise and prompt information transmission. The intuitive dashboard's well-designed graphical user interface improves user experience by making it simpler for homeowners to understand and react to alerts.

2.2. Block Diagram of the System

The block diagram shows the hardware used in the project which includes;

- Arduino Nano
- Gas Sensor (MQ-02)
- Soil Moisture Sensor
- Light Dependant Resistor (LDR)
- Temperature Sensor (DHT11)
- Passive Infrared Sensor (PIR)
- Flame Sensor
- LCD, etc. as shown below.

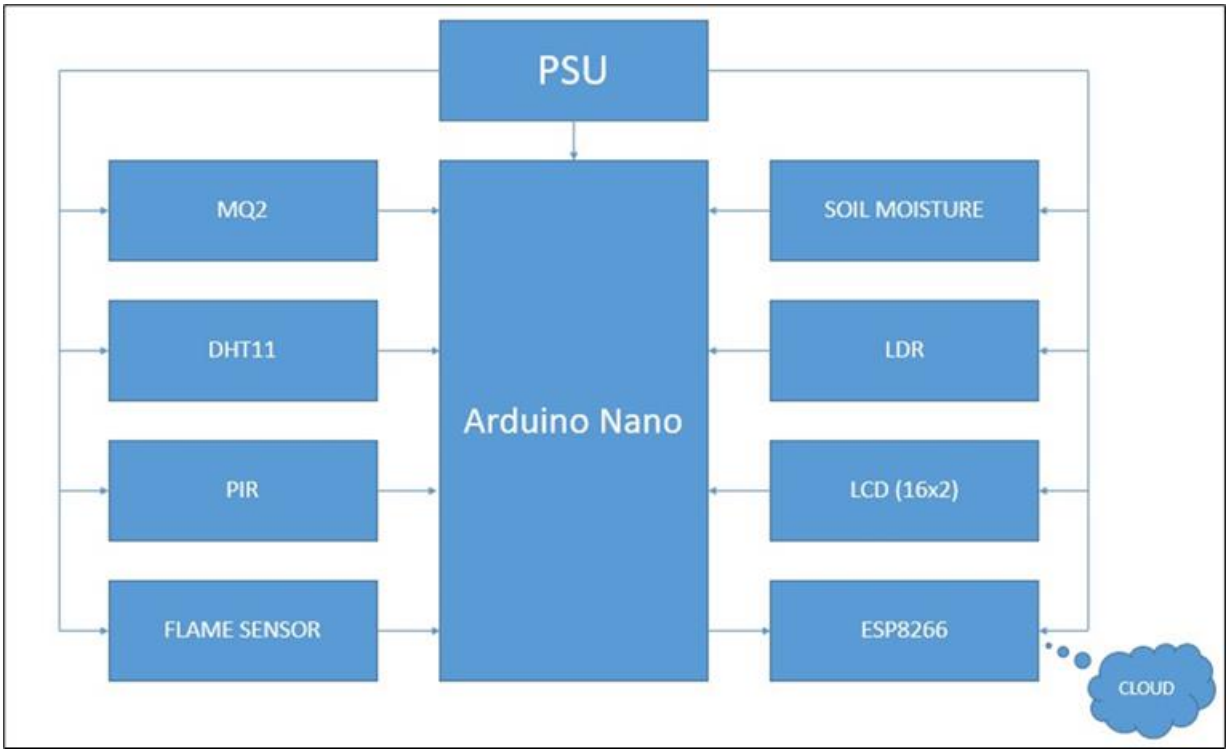

Figure 1 Block Diagram of the System

2.3. Model Setup

In the implemented system, a comprehensive house management system incorporating safety and security features has been developed, leveraging Arduino Microcontroller technology and various sensors. The system operates in two distinct parts, each serving specific functions.

The first part focuses on security and employs a two-level access control mechanism. The initial level utilizes a WIFI connection to establish an IP address, facilitating subsequent connections. The second level introduces an additional layer of security by requiring specified login details, which generate a One-Time Password (OTP) sent to the user for entry into the system. The second part of the system is dedicated to monitoring the home environment. It includes the detection of potential hazards, such as gas leaks identified by the MQ-02 gas sensor and fire detection through the flame sensor. Upon detecting fire or gas, the system promptly alerts the homeowner through a graphical user interface (GUI) dashboard. To enhance environmental awareness, a soil sensor is integrated to measure soil moisture and humidity levels. The entire house status is remotely monitored using the Internet of Things (IoT) technology, facilitated by the NodeMCU microcontroller. This grants the user a local IP, enabling wireless monitoring of the home. Furthermore, the user can convert the local IP into a public IP through algorithms or external services like NGROK, allowing global monitoring of the home from any location. The system offers additional features for homeowner convenience and security. It utilizes a passive infrared sensor (PIR) to detect potential intruders, providing an extra layer of security. Moreover, the internal temperature of the home is monitored using a Temperature sensor (DHT11), offering the homeowner insights into the home's comfort levels through the GUI.

2.4. Flow Chart of the System

A flowchart is a graphic depiction of the program's logic flow that makes it easier to see how the program statement will relate. The two-level access control system with parameter's working algorithm will be demonstrated through the flow chart below.

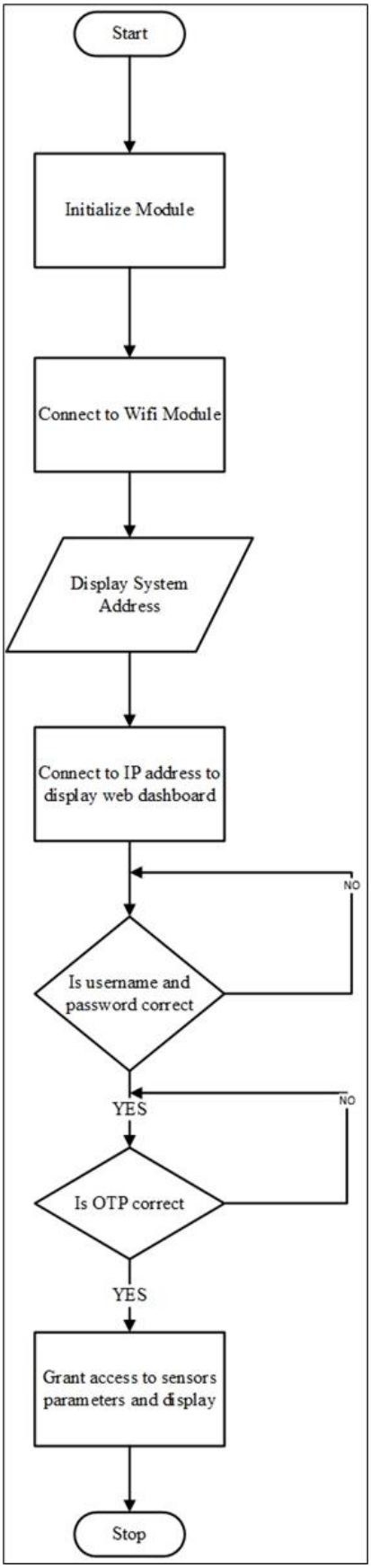

Figure 2 Flow chart of the system

2.5. Hardware Design of the System

The circuit diagram utilized in this project is depicted below. The hardware design process entails designing the circuitry for each functional block within the system.

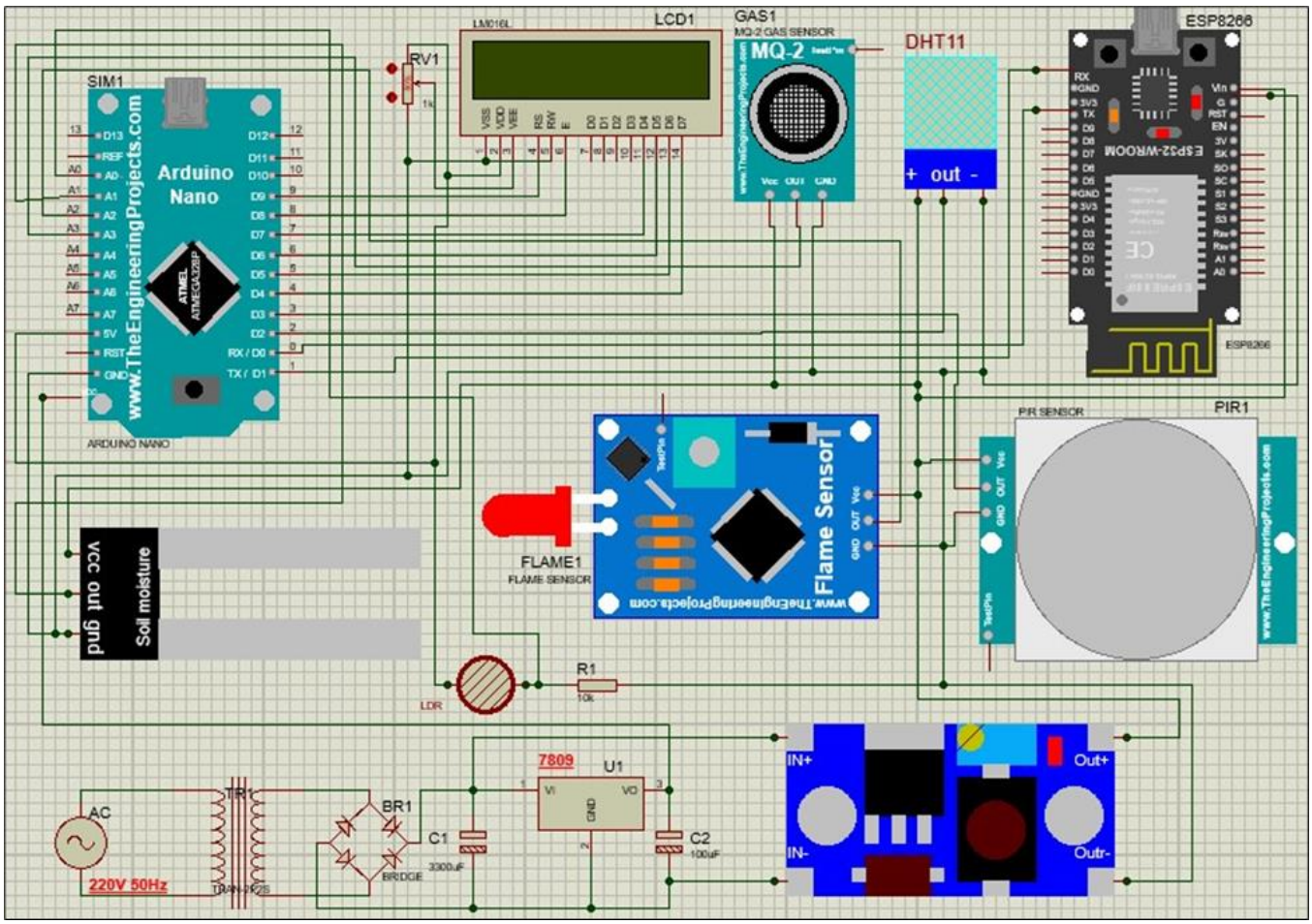

Figure 3 Circuit Diagram

3. Result and discussion

The implemented system that has been clarified in the previous section would be discussed in this section. In addition, the Hardware design for our proposed system can be seen in figure 4 with all attached and utilized sensors within our multilevel system. Additionally, the flowchart describing the workflow of our proposed system can be clarified as indicate below.

In order to get accessing to our SHMS, a GUI window has been designed for accessing the process based on the use of NodeMCU, which would be formed as a webserver as can be seen in figure 5. Hence, by placing the selected IP address on the browser of laptop or any smartphone to obtain the GUI for our home management system in figure 7.

Finally, an alerting message would be showed when there is any type of detection that faces each sensor operation.

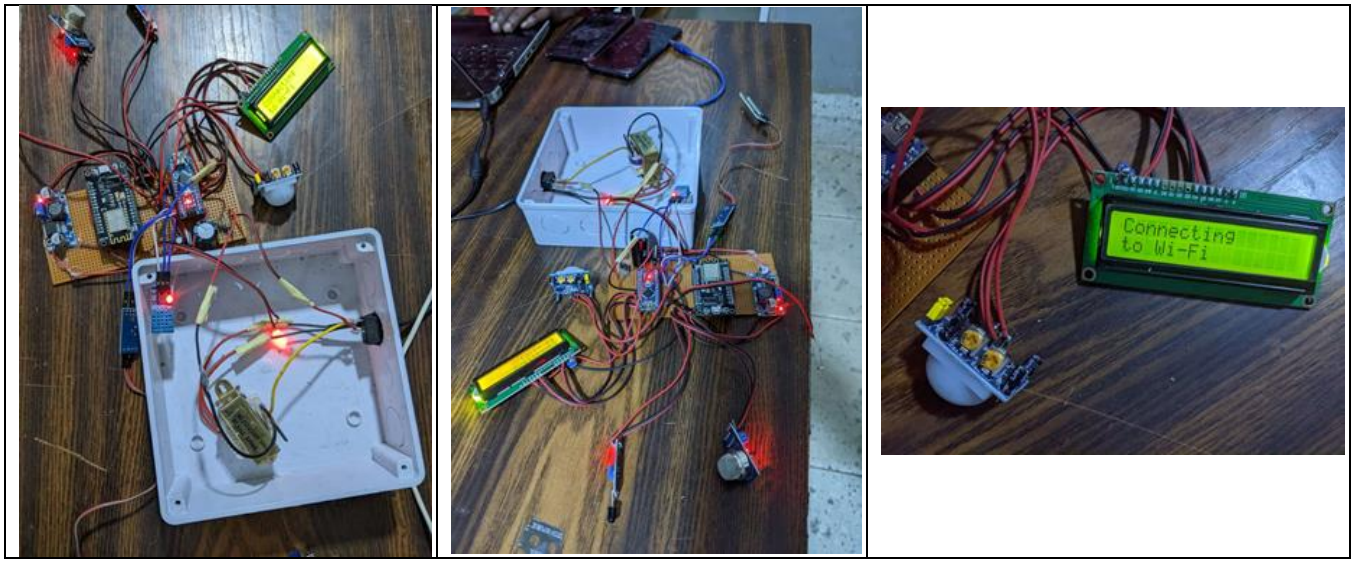

Figure 4 Hardware Implementation Testing

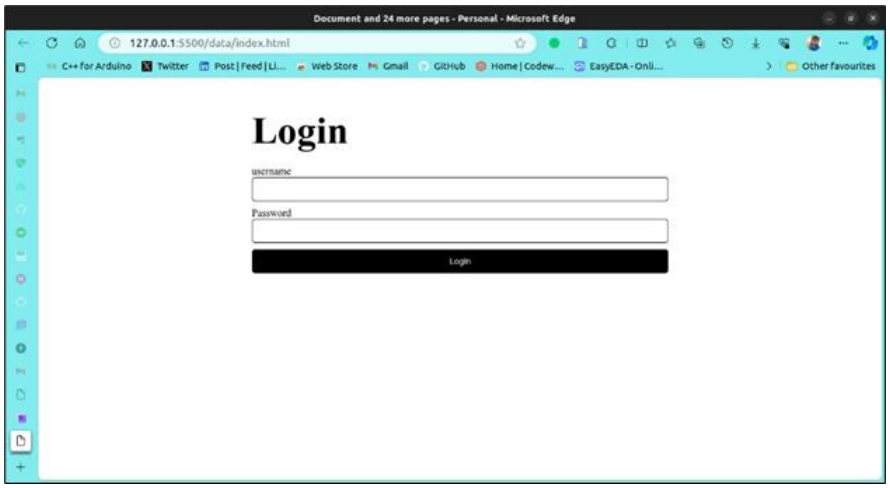

Figure 5 Login Page

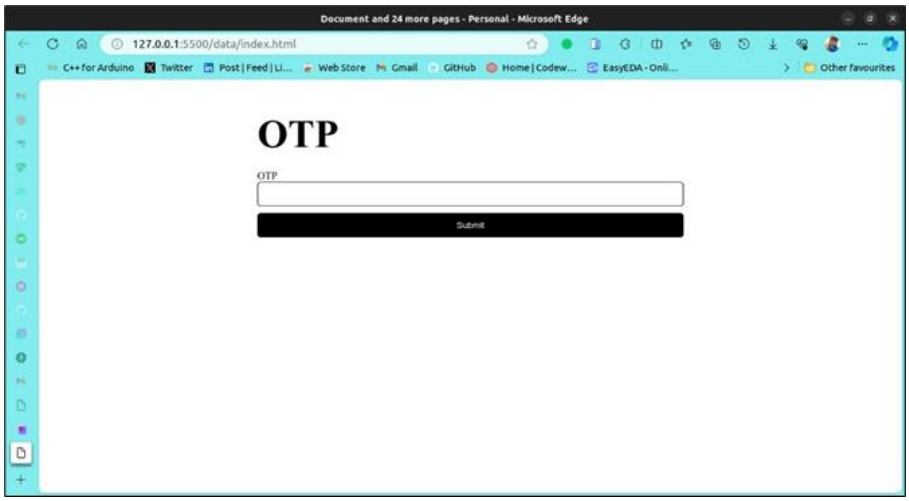

Figure 6 OTP Page

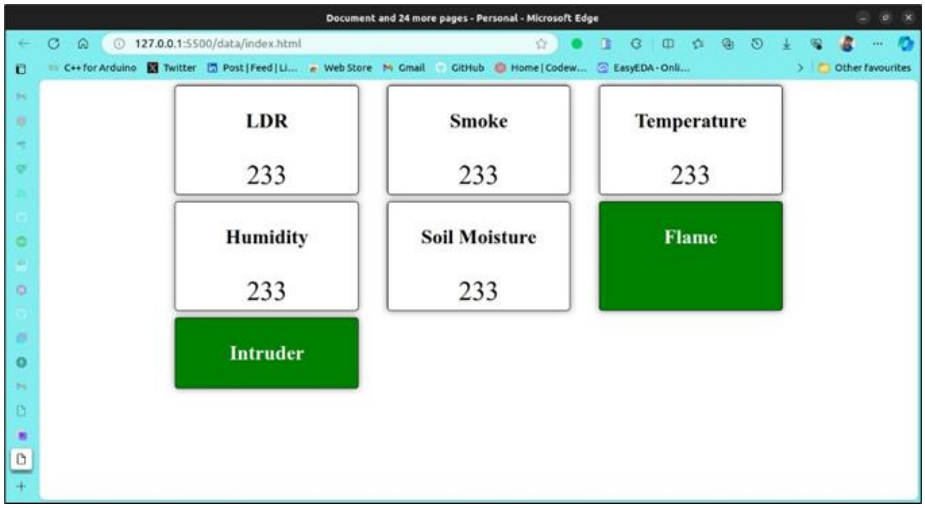

Figure 7 GUI for the home management

3.1. Enclosure

Enclosure The electrical enclosure was made from rigid plastics. The pictorial views of the enclosure used in this project is shown from various angle in figure 8 below.

Figure 8 Enclosure

4. Conclusion

In conclusion, the development of a two-level parameter access control system was designed successfully and tested to function and has yielded significant insights. Organizations can improve security further and accurately manage resource access by putting this system into place. Beyond just protecting sensitive data, the advantages also include improved process efficiency and streamlining. Going forward, continued research and refinement will ensure that this system remains robust and adaptable to evolving security challenges.

Compliance with ethical standards

Acknowledgments

We want to sincerely appreciate NASCOMSOFT EMBEDDED Hub for given us access to their laboratory and equipment.

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] S. A. Jamal, A. A. Ibrahim, M. M. Abdulwahid, and N. B. Mohamad Wasel, International Journal of Advanced Trends in Computer Science and Engineering, Available Online at

[http://www.warse.org/IJATCSE/static/pdf/file/ijatcse224942020.pdf], August 2020, ISSN 2278-3091. https://doi.org/10.30534/ijatcse/2020/224942020].

[2] C. Nwogu, M. Eze, and C. Okunbor, Design and implementation of access door control with mobile alert, International Journal of Engineering & Technology, vol. 9, no. 2, pp. 480-486, 2020. [Online]. Available: www.sciencepubco.com/index.php/IJET

[3] N. Wang, A. Pan, and L. Wei, Design and Implementation of Intelligent Home Management System Based on Wireless Control Module, in Journal of Physics: Conference Series, vol. 1237, no. 4, p. 042059, IOP Publishing, 2019.

[4] G. Sowjanya and S. Nagaraju, Design and implementation of door access control and security system based on IOT, in 2016 International Conference on Inventive Computation Technologies (ICICT), vol. 2, pp. 1-4, IEEE, 2016.

[5] O. Olayemi, V. Antti, H. Keijo, and T. Pekka, Security issues in smart homes and mobile health system: threat analysis, possible countermeasures and lessons learned, 2017.

[6] R. Kumar, P. Mittal, A Novel Design and Implementation of Smart Home Security System: Future Perspective, International Journal of Applied Engineering Research, vol. 14, no. 2, pp. 363-368, 2019.

[7] [15] S. Anand, M. U. Pranavya, G. S. Vaibhavi, R. Apoorva, and S. R. Shenoy, Efficient Model for Automated Home Management System, in 2020 International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE), pp. 1-4, IEEE, 2020. https://doi.org/10.1109/ic-ET

[8] M. M. Abdulwahid, M. S. Al-Hakeem, M. F. Mosleh, and R. A. Abd-alhmeed, Investigation and optimization method for wireless AP deployment based indoor network, MS&E, vol. 745, no. 1, p. 12031, 2020.

[9] Shareef O. A, M. M. Abdulwahid, M. F. Mosleh, and R. A. Abd-Alhameed, The optimum location for access point deployment based on RSS for indoor communication, International Conference on Modelling and Simulation (UKsim2019), vol. 20, p. 2.1, 2019.

[10] M. M. Abdulwahid, O. A. S. Al-Ani, M. F. Mosleh, and R. A. Abd-Alhmeed, Optimal access point location algorithm based real measurement for indoor communication, in Proceedings of the International Conference on Information and Communication Technology, pp. 49–55, 2019.

[11] R. R. Mohamed, M. A. Mohamed, K. Azmi, E. Rao, and W. Hashim, Indoor smart lighting controlling using human detection, International Journal of Advanced Trends in Computer Science and Engineering, vol. 9, no. 1.1 Special Issue, pp. 566-570, 2020. https://doi.org/10.30534/ijatcse/2020/7091.3

[12] J. L. Dioses Jr, AndroiDuino-Fan: A Speech Recognition Fan-Speed Control System utilizing Filipino Voice Commands, International Journal of Advanced Trends in Computer Science and Engineering, vol. 9, no. 3, 2020. https://doi.org/10.30534/ijatcse/2020/8493.3

[13] I. A. Taha and H. M. Marhoon, Implementation of controlled robot for fire detection and extinguish to closed areas based on Arduino, Telkomnika, vol. 16, no. 2, pp. 654-664, 2018.

[14] M. M. Abdulwahid, O. A. S. Al-Ani, M. F. Mosleh, and R. A. Abd-Alhmeed, A Comparison between Different C-band and mm Wave band Frequencies for Indoor Communication, Journal of Communications, vol. 14, no. 10, 2019.

[15] Y. R. Mohammed, N. Basil, O. Bayat, and A. Hamid, A New Novel Optimization Techniques Implemented on the AVR Control System using MATLAB-SIMULINK, May 2020.

[16] M. Murad, O. Bayat, and H. M. Marhoon, Design and implementation of a smart home system with two levels of security based on IoT technology, Indonesian Journal of Electrical Engineering and Computer Science, 2021

[17] S. Anand, M. U. Pranavya, G. S. Vaibhavi, R. Apoorva, and S. R. Shenoy, Efficient Model for Automated Home Management System, 2020 International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE), 2020

[18] M. A. Yousif-Ali, E. A. Hussein, and D. M. Abdulsahib, Multi-Security System Based on Fingerprint Biometric Sensor and Wi-Fi Camera, 2022 Muthanna International Conference on Engineering Science and Technology (MICEST), 2022

[19] www.warse.org

[20] openaccess.altinbas.edu.tr