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A Literature Review : Smart Home Security System Based on Internet of Things

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ABSTRACT

The smart home security system based on the Internet of Things (IoT) has become an increasingly important and relevant research topic in recent years. One of the main advantages of IoT-based security systems is their ability to integrate various devices, such as security cameras, door sensors, alarm systems, automated door controls, and others, into a centralized database for storing event data. This integration allows homeowners to conveniently control their homes using mobile devices or computers. Additionally, such systems can notify homeowners of suspicious events, such as fire incidents. In this literature study, the authors explore the methods, working principles, and benefits of IoT-based smart home security systems. The research employs the Systematic Literature Review (SLR) method, which involves identifying and analyzing previously published articles on the topic. This approach is expected to provide a comprehensive overview of the development of IoT-based smart home security systems, ranging from basic implementations to more complex configurations. The study aims to enable homeowners and researchers to make more informed decisions when adopting and developing IoT-based smart home security systems in the future.

Keywords: Database, Internet of Things, Home Security System, Literature Review

1. Introduction

Security has always been a primary concern for many people, particularly in ensuring home safety. Whether it is a simple house or a luxury residence, surveillance and signaling systems play an essential role in meeting home security needs [1]. To protect homes from potential threats, a security system capable of monitoring and safeguarding the house is essential, both when the residents are at home and when they are away. With the rapid advancement of modern technology, home security systems can now be integrated with the Internet of Things (IoT).

The Internet of Things (IoT) refers to the network of physical objects such as sensors, actuators, and other devices designed to capture real-time data and operate automatically via an internet connection [2]. Home security systems have evolved significantly over the years, and in the current era of technology, adopting IoT-based

systems allows homeowners to integrate smart devices that enhance the effectiveness and automation of home security.

IoT-based smart home security systems enable the integration of various devices, such as security cameras, door and window sensors, motion detectors, smart door locks, and more. Through this integration, homeowners can monitor and control their security systems remotely or from within the house using smartphone applications or other devices [2]. Furthermore, IoT-based home security systems offer greater flexibility compared to traditional systems. Homeowners can customize security features according to their needs and benefit from a wide range of smart devices available at affordable prices [1].

Despite its numerous advantages, IoT-based smart home security also presents unique challenges. Cybersecurity threats are a significant concern, as these systems are connected to the internet. Issues such as potential device hacking, data privacy breaches, and other security vulnerabilities must be addressed. Significant research and development efforts are being undertaken to enhance the security, efficiency, and functionality of IoT-based home security systems. These efforts include developing secure communication protocols, implementing advanced detection technologies, and conducting more rigorous security testing.

IoT-based smart home security systems are increasingly being adopted by the public. As a result, many large technology companies and startups are focusing on developing products and services in the IoT domain, reflecting the growing demand in this field [3].

Over the years, automated home security systems have gained remarkable popularity worldwide. Their primary purpose is to improve comfort, convenience, quality of life, and safety for everyone. However, one drawback of smart home security systems is their relatively high operational cost [4].

This literature review article will discuss IoT-based home security systems that feature low installation and maintenance costs to support smart home security systems that operate automatically. This approach aims to make such systems more accessible to the general public by utilizing readily available and affordable tools. Examples of previous studies on low-cost IoT-based systems include research by Nwe et al., titled “*IoT-Based Smart Home Security System Using RFID and Bluetooth*”, and Hoque et al., titled “*Design and Implementation of an IoT-Based Smart Home Security System*”. Another example is the study by Sirajuddin et al., “*Smart Home Automation Using IoT*”, which highlights the advantages of low installation costs using humidity sensors. Additional studies involve wireless systems such as RFID and face recognition technology, which are commonly employed.

Based on the background discussed above, the authors have reviewed key factors for analysis in discussing IoT-based smart home security systems. The following are the research questions (RQs) formulated for this study:

- **RQ1:** What methods are used?
- **RQ2:** What types of security systems are developed?
- **RQ3:** How do these systems work?

- **RQ4:** What devices are used?
- **RQ5:** What are the benefits of these systems?

In this literature review article, the authors will delve deeper into the development of IoT-based home security systems by examining previous studies. Researchers often employ similar system designs for security system development, as they are based on prior case studies that are further refined with similar benefits and objectives.

By conducting a comprehensive review of each identified study, this literature review aims to highlight the significant relevance of IoT implementation in the field of smart home security in the present day [5]. Additionally, it seeks to provide a general overview to encourage the continued development of IoT applications in smart home security systems for improved performance in the future.

2. Methods

2.1. Article Selection

Using previous research databases on Google Scholar, the authors selected and gathered relevant articles published between 2019 and 2023. Google Scholar was chosen because it is freely accessible and serves as one of the primary platforms for publishing journals and articles utilized by academics, including students, lecturers, and other researchers.

The keywords used for the search were ("Sistem Keamanan Rumah Pintar" AND "IoT"), and additional searches were conducted using English keywords to obtain more diverse references, namely ("Smart Home Security System" AND "IoT Based"). The study was conducted on September 22, 2023, with details as shown in Table 1.

Table 1: Article Selection on Google Scholar

No	Process	Number of Articles
1	Entering the keywords ("Sistem Keamanan Rumah Pintar" AND "IOT") and ("Smart Home Security System" AND "IOT Based") in Google Scholar based on the title, abstract, and keywords.	503 Articles
2	Excluding literature reviews, books, repositories, and conference papers.	198 Articles
3	Articles with closed access	80 Articles
4	Sorting out articles that are not related to the literature title	15 Articles
Final Number of Articles Used		15 Articles

2.2. Article Review Process

After the article selection process was completed, the authors downloaded 15 articles and reviewed them by answering the 5 research questions (RQs) that had been established. The authors also provided discussions and drew conclusions based on the findings from the reviewed articles.

3. Results and Discussion

3.1. Articles Metadata

Metadata of 15 articles used is provided with the following details Table 2 :

Table 2: Articles Metadata Used

No	Author	Year	Article Title	Journal Source
1	Hoque, M. A., & Davidson, C [7]	2019	Design and Implementation of an IoT-Based Smart Home Security System	International Journal of Networked and Distributed Computing
2	Nwe, K. M. et al. [8]	2019	IOT based Smart Home Security System using RFID and Bluetooth	International Journal of Scientific Research and Engineering Development
3	Yadav, U. S., & Tanupriya, E. S. S. [9]	2020	IoT based Advanced and Smart Home Security System using Arduino	International Research Journal of Engineering and Technology (IRJET)
4	Lata, M., & Kumar, V[4]	2022	IoT Network Security In Smart Homes	Researchgate
5	Prathibha, P. et al. [3]	2020	Smart Home Security System Using IoT	International Journal of Research in Engineering, Science and Management
6	Sirajuddin, A., & Ardana, R. M. Y. N. [6]	2022	Smart Home Automation Using IoT	Researchgate
7	Susanto, H., & Nurcahyo, A. [10]	2020	Design and Implementation of a Smart Home Security System Using Voice Command and Internet of Things	Khazanah Informatika: Jurnal Ilmu Komputer dan Informatika
8	Yanto, B. et al., [11]	2022	Smart Home Monitoring pintu rumah dengan identifikasi wajah menerapkan camera ESP32 berbasis IoT	Jurnal SISFOKOM (Sistem Informasi dan Komputer)
9	Anush, S. et al. [12]	2023	Architecture and Applications of IoT Devices in Socially Relevant Fields	Jurnal Networking and Internet Architecture
10	Veeramani, R. [13]	2021	Automation control for home Application using IoT	Journal of Science Technology and Research (JSTAR)
11	Kuswanto, J. et al. [14]	2023	Perancangan Prototipe Kunci Pintu Digital Berbasis IoT Menggunakan Metode HDLC	Jambura Journal of Electrical and Electronics Engineering
12	Putra et al., [15]	2023	Safe security system using face recognition based on IoT	SINKRON Jurnal & Penelitian Teknik Informatik
13	Hadiyanto, G. T. et al. [1]	2022	Pengaruh Waktu Respon Pada Sistem Keamanan Rumah Berbasis IOT dengan ESP32-Cam dan PIR Menggunakan SmartPhone Android	JURIKOM (Jurnal Riset Komputer)
14	Adhiwibowo, W. et al. [16]	2022	Peningkatan Keamanan Data End-To-End Smart Door Menggunakan Advanced Encryption Standard	Jurnal Teknik Elektro, Teknologi Informasi dan Komputer
15	Adamu, S. et al. [17]	2019	IOT Controlled Home Automation Technologies	IEEE Xplore

3.2. Article Review Results

Next, the summary of the article review results is provided as shown in the details below Table 3:

Table 3: Article Review Results

No	References	RQ1	RQ2	RQ3	RQ4	RQ5
1	Hoque, M. A., & Davidson, C [7]	Radio Frequency Identification.	smart door.	Detecting a reed switch attached to the door. If movement is detected, the RF signal will be activated and send a signal to the mobile phone.	The microcontroller is from Elegoo, and Raspberry Pi, along with RF signals.	Provides a security system with low user costs.
2	Nwe, K. M. et al. [8]	Radio Frequency Identification & bluetooth.	smart door lock & alarm.	Detects movement using a motion sensor. If movement is detected, the alarm will sound, and the door will automatically lock using RFID. Using Bluetooth, the system will send a message to the mobile phone.	Arduino UNO R3, RFID RC-522 and Master card, Bluetooth HC-05, Motion sensor (HCSR501), Buzzer, LDR Sensor.	Provides a home security system with low cost usage while ensuring home safety.
3	Yadav, U. S., & Tanupriya, E. S. S. [9]	Automatic Wireless System	smart alarm & fire detection.	Detects fire or disturbances and will immediately send a warning to the saved contacts and trigger an alarm inside the building. In addition to operating automatically, the system can also be controlled manually.	Arduino UNO, TMP36 temperature sensor, MQ-6 smoke sensor, passive infrared sensor, glass break detector, magnetic switch, and a password module.	Provides protection and security for the home against fire and theft.
4	Lata, M., & Kumar, V[4]	Internet of things (IoT)	IoT and Smart home Security.	Detects through LAN, which is then connected to the server and database. The smart home server transfers data remotely to the cloud via API, while the database stores and processes data to the cloud. This data is then transferred to the IoT sensor to generate an RSA encryption code.	Camera, Motor, Fingerprint sensor, Motion sensor, Relay, Gas or smoke sensor, Light sensor, Alarm.	Provides relief with low power consumption and minimal computational power to monitor sensitive movements.
5	Prathibha, P. et al. [3]	Global System for Mobile	Face recognition and detection.	Detects through the camera and captures data in real-time, which is then	Raspberry Pi 3 Microprocessor, GSM Module, PIR Sensor,	Provides home security by recognizing images in the database,

		Communication.		compared with the existing database. To save memory and power, a Passive Infrared (PIR) sensor is used, which activates the camera only when movement is detected. Additionally, there is remote access for guests, and the system can be operated remotely.	Raspberry Pi Camera Module v2, 2- Channel 5V Relay Module, Solenoid Lock	making it more user-friendly with internet usage, and this system can help lower home insurance premiums.
6	Sirajuddin, A., & Ardana, R. M. Y. N. [6]	Automation System & Wireless System	Home Automation.	Detects temperature changes using a Humidity sensor and Light sensor with the Wemos D1 Mini ESP8266 as the controller. These sensors detect temperature and send cellular messages to a mobile phone and website.	Microcontroller ESP8266, Wemos D1 Mini ESP8266, Relay Module - 2 Channel 24V, LED Light, Humidity sensor DHT11 module, Bluetooth speaker, USB Micro Cable, cable jumper, Solderless breadboard, Buzzer.	Provides cost reduction in installation. Offers easy connectivity to control the smart home at any time.
7	Susanto, H., & Nurcahyo, A. [10]	Global System for Mobile Communication	Face & speech recognition.	Detects intruders in the house using door switches and PIR sensors, which function properly and automatically activate the camera to capture objects, storing them on a MicroSD card.	ESP8266, Arduino Mega 2560, modul Kartu MicroSD, kamera serial VC0706, DHT22, perangkat Asisten Google, IFTTT aplikasi, Adafuit.io dan IoT NodeMCU + ESP8266 perangkat.	Develops a smart home security system to monitor fire hazards and theft, while also helping to control electronic devices using voice commands, which is especially beneficial for individuals with disabilities.
8	Yanto, B. et al., [11]	Experimental (Trial and error testing)	Face Recognition.	Detects the face of a person approaching the door using an ESP32 camera. If the detected face matches the one inputted into the system, the door will automatically open; otherwise, the door will remain closed.	Camera ESP32 Cam, Magnetic solenoid, Relay, USB TTL Board, power supply AC 220V, laptop/handphone.	Provides security for homeowners to ensure that unauthorized individuals cannot enter without permission.
9	Anush, S. et al. [12]	Experimental (Trial and error testing)	Smart door lock & Monitoring Control.	Home security testing reveals that the system is ineffective when someone is inside the house. The solution involves	Motion Sensor, biometrics lock, Smart camera, smoke sensor, Smart switches, Video door entry	Provides home security that can connect to the internet to send notifications to the homeowner.

				integrating IoT into the security system for enhanced effectiveness.	system, Microcontroller	
10	Veeramani, R. [13]	Wireless home automation	Home Application.	This system is connected to a Wi-Fi network, which allows for accessing and controlling all devices using sensors.	Arduino UNO, NODE MCU, Channel Relay Board, Smartphone, wifi module as ESP8266.	Provides low-cost internet-based security, where the home network is built using WiFi technology.
11	Kuswanto, J. et al. [14]	Metode Hardware Development Life Cycle (HDLC)	Door Security Systems	This system is connected to the internet, where opening the door requires a smartphone, RFID, or PIN. The system is integrated with a monitoring system, where notifications are sent whenever the door is opened or closed.	nodeMCU esp8266, LCD, Keypad, Relay, RFID, Magnetic door switch, solenoid, JACK DC, Touch Sensor, MT3608, PCF8574, BreadBoard	The HDLC method can produce digital door locks that mimic human natural intelligence. The characteristic of the digital door lock product is real-time, as its mechanism operates through an internet connection.
12	Putra et al., [15]	PCA (Principal Component Analysis) method and Face recognition	Smart home & Security safe	Detects images captured by the camera, then performs image preprocessing by converting the image to grayscale and adjusting its size. After feature extraction, the image is passed through classification and predicted to determine the classification result. If the face in the image is recognized, the door will open. If the face is not recognized, the system will send an email to the owner notifying them of an unrecognized visitor.	Raspberry Pi 3B, Camera, Relay, Solenoid, Smartphone, LCD.	Provides sufficient security when an unregistered person in the Face Recognition database arrives or when an unknown person unexpectedly approaches.
13	Hadiyanto, G. T. et al. [1]	Waterfall method	Smart home System based on IoT.	This system uses the internet, where when the PIR sensor detects motion, the alarm will sound. The sensor then sends data to the ESP32 CAM, which captures the image and sends it to the database.	PIR sensor, buzzer, ESP32 CAM, web hosting, database, software motion security sensor.	With the motion sensor installed in the room, all activities occurring can be closely monitored. If there is an intruder, it will be quickly detected, and recordings can be used as

				Once in the database, the data is forwarded to the mobile phone.		evidence by the authorities.
14	Adhiwibowo, W. et al. [16]	Design component , Topologi and algorithm mod	algoritma Advanced Encryption Standard	Enhances end-to-end data security, preventing external parties from performing masquerading or inserting external files into the system.	Raspberry Pi, Pi camera, relay, solenoid	Provides enhanced security by encrypting data end-to-end to prevent face modifications by external parties.
15	Adamu, S. et al. [17]	Wireless & Internet System	Sistem Keamanan "Smart door lock & Monitoring Control"	Detects movement using motion sensors and cameras to monitor security within the house. The system will send data to the monitoring control to detect anyone entering the premises.	ATMEGA 328P microcontroller, cameras, motion sensor, luminance sensor, LCD display, relays, switch, solenoid, humidity, light intensity, temperature sensor, keypad.	Provides a home security system focused on detecting the movement of individuals entering the house, which can be monitored.

3.3. Answering RQ's

The success rate of the smart home security system can be summarized from the 15 selected articles. The IoT-based smart home security system is influenced by several factors including the Internet of Things, Wireless Systems, Face Recognition, Arduino ATMEGA, PIR Sensors, ESP32 Camera, Raspberry Pi, and Node MCU. Below is a brief explanation of these factors :

Internet of Things : An integrated concept of technology in various objects such as sensors and software, with the aim of connecting, controlling, and exchanging data through the cloud with other devices as long as they remain connected to the internet [15].

Wireless System : The system is connected using wireless communication via radio channels (Radio Frequency Identification), which has a lower level of security due to the open channels, making strong encryption necessary. 59% of researchers use RFID, which is an object identification system that utilizes electromagnetic signals [8].

Face Recognition : Thirty-three percent of researchers use Face Recognition, which is employed to detect and recognize faces using facial recognition features [11].

Arduino ATMEGA : It is commonly used because it is easy to use, low-cost, and energy-efficient [7].

Raspberry Pi : A capable and low-cost single-board is used by 27% of researchers [15].

Node MCU : Open-source firmware, with low cost, is used for building Internet of Things prototypes [14].

Based on the article review results, RQ1 regarding "What method is used?" has been answered. From the research we conducted, we observed a variety of methods used in IoT-based smart home security systems. Among the diverse methods, one common characteristic is the use of wireless systems. Since the system is based on the Internet of Things (IoT), many of the methods employed utilize the internet or wireless systems such as Radio Frequency Identification (RFID) to ensure efficiency and remote usability. 87% of researchers use RFID for automatic identification via radio frequency to connect components wirelessly [8], [14]. Unlike other researchers, B, Yanto et al., and Anush, S et al. used an experimental method (trial and error testing).

Next, from the research we conducted, there are two types of security systems commonly used in homes: Face Recognition and Smart Door Lock. The Face Recognition System is a system that can recognize faces in photos, videos, or in real-time. Face recognition serves to verify a person's identity by matching it with the database. If the face matches, access to services or applications is granted; otherwise, access is denied [11], [18]. The Smart Door Lock System is an advanced locking system that allows the door to be automatically locked and unlocked, and it can be controlled remotely using a smartphone [8], [11], [13]. The smart door can be integrated with smartphones via wireless connections and some smart doors are equipped with Face Recognition features. This is used to detect automatic face recognition based on existing data, integrated with the home security system and the smartphone.

In relation to RQ3, "How does the smart home security system work?" Since the methods and systems used vary, the way each system works also differs depending on the method and technology implemented. According to data obtained from Google Scholar, about 95% of researchers use an integrated cloud database [6], [9]. The use of the Internet of Things (IoT) in smart homes allows data to be collected in real-time. Devices connected to a local network that is linked to the internet send data to the smart home server, which then transfers the data to the cloud to complete tasks remotely. Data is stored and processed in the cloud from the IoT devices, particularly sensor data. However, it can be concluded broadly that the smart home security system based on IoT works by using a processing system connected to a WIFI network, which is integrated with either the smartphone or the security system in use. Researchers apply IoT in smart home security systems so that they can be monitored remotely.

Related to RQ4, several components in the smart home security system based on the Internet of Things (IoT) share commonalities, such as using RFID, Arduino ATMEGA, Raspberry Pi, Node MCU, cameras, and more. These similarities arise because all systems are based on the Internet of Things (IoT) and require a wireless system to ensure everything operates seamlessly.

From the research we have conducted, it can be concluded that the smart home security system based on the Internet of Things (IoT) provides benefits in offering security and protection for homes, as well as convenience in controlling the home security system. The IoT system can be easily accessed using a mobile phone, providing a user-friendly way to monitor and manage security remotely.

4. Conclusion

The smart home security system based on the Internet of Things (IoT) enables the integration of intelligent devices to enhance security and comfort at home. Home security is a major concern, and IoT allows homeowners to control and monitor their homes more efficiently, both from inside the house and remotely via connected devices. While there are significant benefits, such as flexibility and greater device integration, smart home security based on IoT also faces challenges related to cybersecurity and data privacy. Research and development are ongoing to address these challenges and improve IoT-based smart home security systems. From the research we conducted, it is evident that IoT-based smart home security systems leverage various methods, such as facial recognition and smart door locks, with components like RFID, Arduino, Raspberry Pi, and others. The success of these systems heavily depends on the components and systems used. In this literature review article, we have explored various aspects of IoT-based smart home security systems and concluded that this technology holds great potential to improve home security while offering flexibility to users in managing security and comfort at home.

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References

- [1] G. T. Hadiyanto, H. S. Gurran, B. Apriyanto, and R. Saptarika, "Pengaruh Waktu Respon Pada Sistem Keamanan Rumah Berbasis IOT dengan ESP32-Cam dan PIR Menggunakan SmartPhone Android," *JURIKOM (Jurnal Ris. Komputer)*, vol. 9, no. 6, p. 1698, 2022, doi: 10.30865/jurikom.v9i6.4957.
- [2] A. I. Abdulla et al., "Internet of Things and Smart Homes," vol. 62, no. 05, pp. 101–102, 2020, doi: 10.1109/hsi47298.2019.8942608.
- [3] A. Prathibha, P., Kumar, A., Singh, A., Parul, K., Jaiswal, "Smart Home Security System Using IoT," *Int. J. Res. Eng. Sci. Manag.*, vol. 3, no. 5, pp. 2581–5792, 2020, doi: 10.31838/jcr.07.08.295.
- [4] M. Lata and V. Kumar, "IoT network security in smart homes," *Cybersecurity Smart Homes Archit. Solut. Technol.*, no. June, pp. 155–176, 2022, doi: 10.1002/9781119987451.ch4.
- [5] P. Chakraborty and S. Sultana, "IoT-Based Smart Home Security and Automation System," *Lect. Notes Networks Syst.*, vol. 373, no. February, pp. 497–505, 2022, doi: 10.1007/978-981-16-8721-1_48.
- [6] R. M. Y. N. Sirajuddin, A., Ardana, "Smart Home Automation using IoT," *researchgate.met*, no. August, pp. 0–7, 2022, doi: 10.13140/RG.2.2.24556.85128.
- [7] M. A. Hoque and C. Davidson, "Design and implementation of an IoT-based smart home security system," *Int. J. Networked Distrib. Comput.*, vol. 7, no. 2, pp. 85–92, 2019, doi: 10.2991/ijndc.k.190326.004.
- [8] K. M. Nwe, K. Wut, M. Khin, Z. M. Win, and Z. Sann, "IOT based Smart Home Security System using RFID and

- Bluetooth,” *Int. J. Sci. Res. Eng. Dev.*, vol. 2, no. 4, pp. 508–514, 2019, [Online]. Available: www.ijred.com
- [9] U. Yadav and E. Shubham Singh, “IoT based Advanced and Smart Home Security System using Arduino,” *Int. Res. J. Eng. Technol.*, no. July, pp. 5661–5665, 2020, [Online]. Available: www.irjet.net
- [10] H. Susanto and A. Nurcahyo, “Design and Implementation of a Smart Home Security System Using Voice Command and Internet of Things,” *Khazanah Inform. J. Ilmu Komput. dan Inform.*, vol. 6, no. 2, pp. 82–94, 2020, doi: 10.23917/khif.v6i2.9320.
- [11] B. Yanto, B. Basorudin, S. Anwar, A. Lubis, and K. Karmi, “Smart Home Monitoring Pintu Rumah Dengan Identifikasi Wajah Menerapkan Camera ESP32 Berbasis IoT,” *J. Sisfokom (Sistem Inf. dan Komputer)*, vol. 11, no. 1, pp. 53–59, 2022, doi: 10.32736/sisfokom.v11i1.1180.
- [12] S. A. Lakshman, S. Akash, J. Cynthia, R. Gautam, and D. Ebenezer, “Architecture and Applications of IoT Devices in Socially Relevant Fields,” 2014.
- [13] R. Veeramani, “Automatic Control for Home Applications using IoT,” *J. Sci. Technol. Res.*, vol. 2, no. 1, pp. 101–110, 2021, [Online]. Available: <https://philpapers.org/rec/VEEACF>
- [14] J. Kuswanto, “Perancangan Prototipe Kunci Pintu Digital Berbasis IoT Menggunakan Metode HDLC,” vol. 5, pp. 148–156, 2023.
- [15] O. E. Putra, R. Devita, and N. Wahyudi, “Safe Security System Using Face Recognition Based on IoT,” *Sinkron*, vol. 8, no. 2, pp. 1021–1030, 2023, doi: 10.33395/sinkron.v8i2.12231.
- [16] W. Adhiwibowo, A. M. Hirzan, and M. S. Suprayogi, “Peningkatan Keamanan Data End-To-End Smart Door Menggunakan Advanced Encryption Standard,” *J. ELTIKOM*, vol. 6, no. 2, pp. 186–194, 2022, doi: 10.31961/eltikom.v6i2.574.
- [17] S. Adamu, U. I. Bature, A. Y. Nasir, A. M. Hassan, K. I. Jahun, and U. S. Toro, “IOT Controlled Home Automation Technologies,” 2019 2nd Int. Conf. IEEE Niger. Comput. Chapter, Niger. 2019, pp. 1–7, 2019, doi: 10.1109/NigeriaComputConf45974.2019.8949655.
- [18] A. R. Syafeeza, M. K. Mohd Fitri Alif, Y. Nursyifaa Athirah, A. S. Jaafar, A. H. Norihan, and M. S. Saleha, “IoT based facial recognition door access control home security system using raspberry pi,” *Int. J. Power Electron. Drive Syst.*, vol. 11, no. 1, pp. 417–424, 2020, doi: 10.11591/ijped.v11.i1.pp417-424.