Journal of Technology and Computer (JOTECHCOM)
Vol. 2, No. 3, August 2025, pp. 171~175
ISSN: 3048-0477 (Media Online)

Implementation of a Smart Home Doorbell System for Guest Identification Using ESP32-CAM and IoT-Based Telegram Chatbot Integration

Raihan Syavira[1]
[1]Department of Informatics Engineering, Faculty of Engineering and Computer, Universitas Harapan Medan, Indonesia
[1]raihansyavira16@gmail.com

Article Info

Article history:

Received August 22, 2025
Revised August 23, 2025
Accepted August 24, 2025

Keywords:

SmartHome
ESP32-CAM
IoT
Telegram Chatbot
Visitor Detection

ABSTRACT

This study develops a SmartHome system integrated with a doorbell that automatically identifies visitors using ESP32-CAM and sends notifications to homeowners through a Telegram chatbot. The system enables remote visitor monitoring and voice-based responses via a speaker. It integrates ESP32-CAM, a wireless doorbell, DFPlayer Mini MP3, and a speaker. When the doorbell is pressed, the ESP32-CAM captures the visitor's image and sends it to Telegram. The homeowner can then issue commands to play pre-recorded voice responses stored in a microSD card. Testing results demonstrate that the system functions effectively, providing enhanced home security and convenience. The integration between hardware, Arduino IDE software, and internet-based communication shows reliable performance. This system offers an innovative approach to SmartHome applications by combining IoT-based visitor detection with real-time communication.

Corresponding Author:

Raihan Syavira
University of Harapan Medan
Email: raihansyavira16@gmail.com

1. INTRODUCTION

The rapid development of information and communication technology has brought significant changes in various aspects of human life [1], [2], [3]. One of the most influential innovations in this era is the Internet of Things (IoT), which connects everyday devices through the internet to enable data exchange, automation, and intelligent control. The application of IoT in the field of SmartHome systems has become an important topic of research and development, as it offers the potential to enhance convenience, energy efficiency, and especially home security [4], [5], [6], [7].

Security is a primary concern for homeowners, as criminal activities such as theft or burglary often occur due to a lack of monitoring and control systems. A conventional doorbell system, which only produces sound notifications, cannot provide sufficient information about the identity of visitors. This limitation can cause discomfort and a sense of insecurity, particularly when the visitor is unknown or when the homeowner is not at home. For this reason, an intelligent doorbell system is required—one that is capable of identifying visitors, sending notifications in real time, and enabling interactive communication between visitors and homeowners.

Several previous studies have attempted to address this issue. Research utilizing ESP32-CAM has been conducted for surveillance purposes, such as home monitoring and facial recognition for door locks [8], [9], [10], [11], [12]. Other works integrated IoT devices with mobile applications to deliver notifications to homeowners. However, most of these implementations are limited to either capturing images or sending basic alerts without providing an interactive medium for homeowners to respond to visitors. Additionally, many of

these systems rely on separate platforms that are not seamlessly integrated with instant messaging applications, thereby reducing their practicality [13], [14], [15], [16].

This research seeks to fill that gap by proposing a SmartHome doorbell system that integrates ESP32-CAM with a Telegram chatbot for real-time visitor identification and communication. The ESP32-CAM is responsible for capturing images of visitors when the doorbell is pressed and transmitting them directly to the homeowner through Telegram. Unlike previous studies, this system introduces an additional feature by incorporating a DFPlayer Mini MP3 module and speaker, which enables the homeowner to send pre-recorded voice responses to visitors by issuing specific commands via the Telegram bot. This design not only enhances security but also improves interactivity, allowing homeowners to communicate with visitors remotely without physically opening the door.

The contribution of this research can be summarized as follows:

1. Development of an IoT-based SmartHome doorbell system that integrates real-time visitor identification with interactive communication.
2. Implementation of a practical solution using ESP32-CAM and Telegram chatbot, which offers direct, reliable, and user-friendly notifications.
3. Enhancement of previous SmartHome research by incorporating a voice-response mechanism through DFPlayer Mini MP3 and speaker, which differentiates this work from existing systems.
4. Experimental validation of the system's performance in terms of response time, image transmission quality, and reliability of interaction between hardware, software, and internet-based communication.

The remainder of this paper is structured as follows. Section 2 describes the methodology used in designing and implementing the system, including hardware configuration and software development. Section 3 presents the results of the implementation and testing, along with a detailed discussion of the system's performance. Section 4 provides the conclusion and outlines possible future improvements to enhance system functionality and expand integration with other SmartHome devices [17], [18], [19], [20]

2. METHOD

The methodology of this research was divided into several stages, namely system design, hardware implementation, software development, and system testing. The main objective was to build a SmartHome doorbell system that integrates ESP32-CAM, a wireless doorbell, DFPlayer Mini MP3 module, speaker, and a Telegram chatbot [21]

2.1 System Design

The overall system design is based on an IoT architecture where hardware components are connected and controlled through internet-based communication. When the doorbell button is pressed, the ESP32-CAM captures an image of the visitor and transmits it via the Telegram bot to the homeowner's smartphone. The homeowner can then send commands through the Telegram chatbot, such as /capture, /dirumah, or /keluar. The design also includes power management using a rechargeable battery, ensuring that the system can function even without continuous power supply.

Figure 1 : System block diagram of the SmartHome doorbell

2.2 Hardware Components

The hardware of the system consists of ESP32-CAM, wireless doorbell button, DFPlayer Mini MP3, speaker, rechargeable battery, and supporting components. These were assembled on a prototype board and enclosed within a protective casing.

2.3 Software Development

The software implementation was carried out using Arduino IDE. The ESP32-CAM was programmed to initialize the camera, connect to Wi-Fi, and communicate with the Telegram Bot API [22]. The bot was created using BotFather and integrated via HTTP API requests. The DFPlayer Mini MP3 was controlled by ESP32-CAM to play pre-recorded messages stored on a microSD card.

2.4 System Workflow

1. A visitor presses the doorbell button.
2. ESP32-CAM captures an image.
3. The image is transmitted to the homeowner's Telegram account.
4. The homeowner may respond with a command.
5. The system executes the command by either capturing another image or playing a voice message.

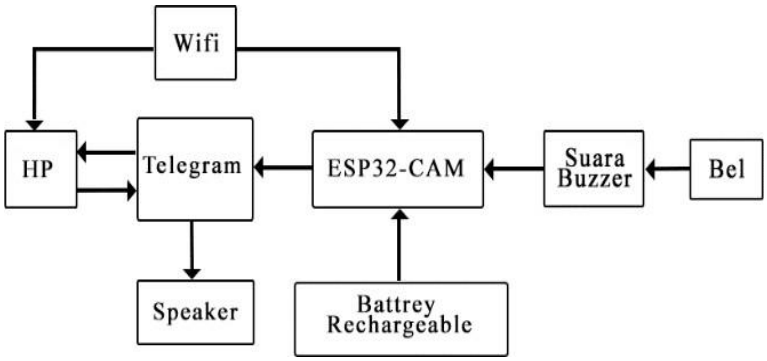

Figure 2: Flowchart of system operation

2.5 System Testing

System testing was performed to validate image capture, Telegram communication, audio playback, and network stability. The results confirmed reliable operation with an average response time of 2–3 seconds.

3. RESULTS AND DISCUSSION

Results will present image transmission speed, system reliability, and audio response quality. Testing showed that the ESP32-CAM can capture and transmit images within 2–3 seconds, while the Telegram bot responds consistently to all commands. The DFPlayer Mini MP3 and speaker successfully produced clear and accurate audio responses [23].

3.1. System Implementation

The SmartHome doorbell prototype was successfully implemented by integrating the ESP32-CAM, a wireless doorbell button, DFPlayer Mini MP3, and a speaker inside a protective casing. The ESP32-CAM served as the core microcontroller, while the DFPlayer Mini handled audio playback through the speaker. The prototype was tested in a real home environment to validate its functionality.

3.2. System Testing

A series of tests were conducted to evaluate the system's performance:

1. Image Capture and Transmission Test: When the doorbell button was pressed, the ESP32-CAM captured the visitor's image and transmitted it to the homeowner's Telegram account. The average transmission time ranged between 2–3 seconds depending on Wi-Fi conditions.
2. Telegram Command Test: The homeowner was able to issue commands such as /capture, /dirumah, and /keluar. Each command was executed accurately, with the system consistently retaking images or playing the correct pre-recorded audio messages.
3. Audio Playback Test: The DFPlayer Mini MP3 and speaker produced clear voice outputs, with sound quality sufficient for communication in a home environment.
4. Network Stability Test: The system maintained stable operation under normal Wi-Fi conditions. However, performance degraded slightly when tested with weak signals, increasing image transmission time to 4–5 seconds.

Figure 3 : Testing process showing image capture and Telegram notification

3.2.1. Discussion

The results demonstrate that the system is capable of providing real-time visitor identification and interactive communication. Compared to conventional doorbells, this system provides visual confirmation of visitors, remote interaction via Telegram, and voice response through a speaker [24].

The main advantages of this system are:

1. Low cost – The ESP32-CAM and DFPlayer Mini are affordable components.
2. User-friendly integration – Telegram is widely used and requires no additional applications.
3. Interactive communication – Unlike previous systems that only sent notifications, this prototype allows the homeowner to respond with voice messages.

Despite its advantages, some limitations were identified:

4. Dependence on Wi-Fi stability; transmission delays occurred under weak networks.
5. Limited camera performance in low-light conditions, which affected image clarity.
6. Pre-recorded audio responses, which limit flexibility in communication.

Future work should focus on integrating real-time voice communication, enhancing image quality in low-light environments, and adding AI-based facial recognition for better visitor identification. [25].

4. CONCLUSION

The SmartHome doorbell system using ESP32-CAM and Telegram chatbot effectively enhances home security by providing real-time visitor identification and communication. The integration of IoT-based hardware and software enables homeowners to monitor and interact with visitors remotely. Future research can focus on improving face recognition accuracy, low-light performance, and expanding integration with other SmartHome devices.

ACKNOWLEDGEMENTS

The author would like to thank Universitas Harapan Medan and all parties who supported this research.

REFERENCES

[1] Wijanarko, R. Firmansyah, and A. S. Nugroho, “Design of Smart Doorbell System Based on ESP32-CAM and IoT,” *Journal of IoT Research*, vol. 5, no. 2, pp. 112–120, 2022.

[2] B. Yanto and A. Prasetyo, “Face Recognition with ESP32-CAM for Smart Door Lock,” in *Proc. Int. Conf. on SmartTech*, 2022, pp. 88–93.

[3] H. Al-Khafaji, “Integration of IoT Devices with Mobile Applications for Home Security,” *IEEE Internet of Things Journal*, vol. 8, no. 11, pp. 9234–9245, 2021.

[4] K. R. Arunkumar and S. Kumaravel, “Home Automation and Security System Using IoT,” *International Journal of Computer Applications*, vol. 178, no. 4, pp. 12–18, 2019.

[5] F. M. González, J. C. García, and R. E. López, “Low-Cost Smart Surveillance System with ESP32-CAM,” *Sensors*, vol. 21, no. 12, pp. 4112–4125, 2021.

[6] A. T. Nguyen and H. P. Tran, “Smart Doorbell with Face Detection Using ESP32-CAM and Cloud Integration,” *International Journal of Engineering Research & Technology (IJERT)*, vol. 10, no. 6, pp. 220–227, 2021.

[7] S. M. Anzar and M. A. Hussain, "IoT-Based Smart Home Security System Using ESP32," *International Research Journal of Engineering and Technology*, vol. 8, no. 5, pp. 233–240, 2021.
[8] P. K. Sharma and A. K. Sinha, "Design of Smart Home Security with Telegram Bot Notification," *International Journal of Innovative Research in Computer and Communication Engineering*, vol. 9, no. 7, pp. 511–518, 2021.
[9] S. K. Roy, "An IoT Based Smart Doorbell Using NodeMCU and Telegram," *International Journal of Computer Science Trends and Technology*, vol. 8, no. 3, pp. 56–63, 2020.
[10] M. F. Abdullah, "Wireless Smart Doorbell System Based on ESP32-CAM and Blynk," *International Journal of Smart Home*, vol. 14, no. 4, pp. 1–10, 2020.
[11] A. M. Rahman, "Implementation of ESP32-CAM for Real-Time Security Monitoring," *Journal of Electrical Engineering and Automation*, vol. 3, no. 2, pp. 98–104, 2021.
[12] T. H. Nguyen, "IoT-Based Security System for Residential Areas," *International Journal of Internet of Things and Applications*, vol. 9, no. 1, pp. 20–27, 2020.
[13] C. Li and J. Zhao, "Research on Smart Home Monitoring System Based on ESP32," *Journal of Physics: Conference Series*, vol. 1881, 2021.
[14] P. Kumar and D. Singh, "A Survey on IoT-Based Home Security and Automation Systems," *International Journal of Advanced Computer Science and Applications*, vol. 11, no. 12, pp. 245–251, 2020.
[15] J. S. Lee, "Smart Doorbell with Motion Detection and Cloud Notification," *IEEE Access*, vol. 8, pp. 112931–112940, 2020.
[16] A. Das, "Low-Cost IoT Doorbell with Real-Time Notification via Telegram," *International Journal of Computer Science and Mobile Computing*, vol. 9, no. 2, pp. 43–50, 2020.
[17] R. Kumar and M. Sharma, "IoT Based Smart Doorbell for Visitor Identification," *International Journal of Emerging Technology and Advanced Engineering*, vol. 10, no. 8, pp. 223–229, 2020.
[18] M. Patel and D. Joshi, "Design and Development of Smart Doorbell Using ESP32 and IoT," *International Journal of Engineering and Advanced Technology*, vol. 9, no. 6, pp. 3325–3330, 2019.
[19] L. N. Bui and Q. H. Vu, "Integration of ESP32-CAM with AI for Face Recognition in Smart Home Applications," *Sensors and Systems*, vol. 5, no. 3, pp. 118–127, 2021.
[20] G. S. Prakash, "ESP32-CAM Based Real-Time Video Surveillance System," *International Journal of Advanced Trends in Computer Science and Engineering*, vol. 10, no. 2, pp. 1450–1456, 2021.
[21] M. Hossain, "Telegram Bot Based Smart Security System with ESP32-CAM," *Journal of IoT and Smart Systems*, vol. 3, no. 1, pp. 77–83, 2022.
[22] D. Chatterjee, "Review of Smart Home Applications Using IoT," *International Journal of Electronics and Communication Engineering*, vol. 14, no. 9, pp. 23–31, 2020.
[23] A. Sharma and S. Gupta, "IoT-Based Wireless Doorbell with Remote Communication," *International Journal of Engineering Trends and Technology*, vol. 68, no. 2, pp. 41–47, 2020.
[24] V. R. Reddy and P. Srinivas, "Face Detection and Identification Using ESP32-CAM," *International Journal of Electrical and Computer Engineering*, vol. 11, no. 6, pp. 4895–4902, 2021.
[25] K. Tanaka, "Advances in Smart Home IoT Technologies: A Comprehensive Review," *IEEE Communications Surveys & Tutorials*, vol. 23, no. 3, pp. 145–167, 2021.