STM JOURNALS

Journal of
VLSI Design Tools & Technology

https://journals.stmjournals.com/jovdtt

ISSN: 2249-474X (Online)
ISSN: 2321-6492 (Print)
Volume 15, Issue 2, 2025
May–August
DOI (Journal): 10.37591/JoVDTT

Review JoVDTT

# IoT-Based Smart Electrical Board Using Google Assistant: An Enhanced Approach

Sneha Pimpalkar[1], Sanskruti Gaddekar[1], Tejaswini Atram[1],
Mahek Sheikh[1], Snehal Naghate[2,*]

**_Abstract_**

*The Internet of Things (IoT) has revolutionized home automation by enabling seamless connectivity between smart devices and cloud services. By enabling intelligent and remote control of home systems like lighting, security, and climate control, this integration greatly enhances user control, convenience, and efficiency. The study introduces an improved IoT smart electrical board that can be connected to Google Assistant to enable voice commands for controlling household appliances. By combining modern voice-activated smart technologies with traditional electrical arrangements, the system aims to efficiently automate repetitive operations and simplify everyday household duties. The proposed method provides remote control and real-time monitoring of connected devices by utilizing microcontrollers like the ESP8266 and communication protocols like Message Queuing Telemetry Transport (MQTT). This approach provides a feasible and scalable smart home solution that encourages improved security, energy efficiency, and user-friendly functionality. Users may monitor and operate their home appliances from anywhere, increasing security, reducing energy use, and optimizing efficiency. In addition to considering recent advancements in the IoT, the paper fully examines the system's design and deployment methodology. It shows how smart home advancements may be used in practice to improve daily living by offering insights into the hardware and software components involved. The integration of these technologies presents a forward-looking approach to home automation and resource management.*

**Keywords:** IoT, smart home automation, Google Assistant, MQTT, ESP8266, voice-controlled devices, cloud communication

## INTRODUCTION

Smart home automation is only one of the many areas that have been profoundly affected by the growth of the Internet of Things (IoT). The IoT is a large network of linked devices that can gather, share, and act on data without continual human assistance. These smart devices use sensors, software, and communication technologies to communicate with cloud-based systems and with one another [1]. The IoT allows consumers to remotely manage appliances, lights, security systems, and climate settings in the context of home automation, frequently using voice commands or smartphone apps. This has resulted in increased convenience, improved security, and increased energy efficiency in residential settings. For example, smart cameras and locks offer real-time surveillance and access management, whereas smart thermostats may learn user preferences and modify temperatures accordingly [2]. It is anticipated that houses will become increasingly more responsive and adaptable as IoT technology advances and is integrated with

***Author for Correspondence**
Snehal Naghate
E-mail: naghatesnehal21@gmail.com

[1]Student, Department of Computer Engineering, Ballarpur Institute of Technology, Bamni, Chandrapur, Maharashtra, India
[2]Lecturer, Department of Computer Engineering, Ballarpur Institute of Technology, Bamni, Chandrapur, Maharashtra, India

Received Date: April 05, 2025
Accepted Date: April 11, 2025
Published Date: August 20, 2025

**Citation:** Sneha Pimpalkar, Sanskruti Gaddekar, Tejaswini Atram, Mahek Sheikh, Snehal Naghate. IoT-Based Smart Electrical Board Using Google Assistant: An Enhanced Approach. Journal of VLSI Design Tools & Technology. 2025; 15(2): 1–5p.

 

artificial intelligence and machine learning. The way individuals live, communicate, and governing their personal environments is being redefined by the continued development of the IoT. Home automation systems utilize IoT technology to enable users to control household appliances remotely through mobile applications and voice commands, thereby offering enhanced convenience and energy efficiency [3].

Traditional home electrical systems rely on physical switches for operation, which limits remote accessibility and energy management. However, IoT-integrated smart electrical boards address these limitations by providing real-time control, automation, and monitoring of the appliances. The integration of Google Assistant enables users to control devices using voice commands, thereby reducing the need for manual interactions.

The main goal of this project is to design a smart electrical board that seamlessly integrates Google Assistant and cloud-based services, enabling efficient home automation. The system utilizes an ESP8266 microcontroller as the central processing unit, which facilitates communication with home appliances through relay modules. It sends real-time status updates to a mobile application using the Message Queuing Telemetry Transport (MQTT) protocol, thereby ensuring accurate monitoring and control [4]. To ensure security, the system incorporates encrypted data transmission and authentication mechanisms, thereby providing a safe and reliable user experience [5]. This setup allows users to manage their home appliances remotely through voice commands and mobile apps, thereby improving convenience, energy efficiency, and security. Additionally, integration with cloud services enables scalability and remote access, making the system adaptable to various smart home environments (Figure 1). The goal of this project is to offer an easy-to-use, secure, and efficient solution for modern home automation.

Home automation has evolved significantly with the advent of IoT, allowing remote control of appliances through voice commands and mobile applications. Traditional switchboards require physical interaction; however, IoT-enabled systems provide smarter solutions by integrating microcontrollers with cloud-based services. This project aims to develop a smart electrical board that allows users to control and monitor home appliances via Google Assistant, thereby offering energy efficiency and security. An investigation examined the design, implementation, and benefits of an IoT-based smart electrical board integrated with Google Assistant. It focuses on the practical advantages of smart home automation, highlighting key aspects, such as energy efficiency, enhanced security, and user convenience. This study aimed to demonstrate how such innovations can improve home management and contribute to smarter and more sustainable living environments.

## LITERATURE REVIEW

Recent studies have explored various aspects of IoT-based home automation.

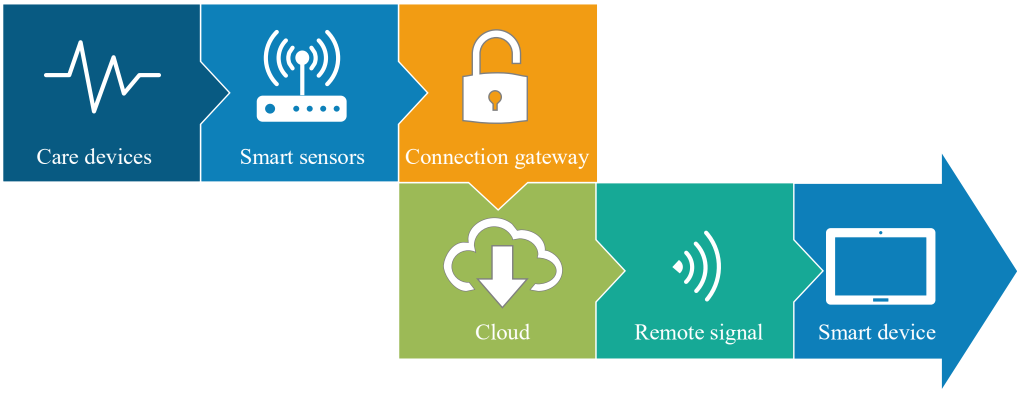


**Figure 1.** System overview.

 

Zhu *et al.* (2024) [1] proposed an MQTT-based configuration that enhanced the security and reliability of smart home systems. Their approach implemented Transport Layer Security (TLS), client authentication, access control lists (ACLs), and regular security audits, resulting in an 85% improvement in data transmission security and a 90% reduction in unauthorized access attempts.

Sima et al. (2024) [2] developed an IoT-based automatic light control system using the MQTT protocol. The system utilized light sensors and a NodeMCU ESP8266 to detect ambient light intensity and control lighting, accordingly, demonstrating efficient energy management.

Pham et al. (2024) [3] implemented an IoT-based home automation system using the MQTT protocol and NodeMCU. Their system enables users to monitor and control household appliances remotely via a mobile application, highlighting the practicality of MQTT in home automation.

Tamanna and Lima (2023) [4] integrated Google Assistant into a home automation system, allowing voice commands to control various smart appliances. Their implementation enhanced user convenience and demonstrated the effectiveness of voice-controlled home automation.

Google's Integration with Matter (2025) [5] announced integration with Matter to enable the local control of Matter devices on Google Home hubs. This allows devices to manage smart home appliances without requiring cloud connectivity, thereby offering greater reliability, privacy, and lower latency.

## SYSTEM ARCHITECTURE AND COMPONENTS

The IoT-based smart electrical board comprises several interconnected components that work together to ensure seamless automation and remote access. These components include the following.

- *Microcontroller (ESP8266/ESP32):* This microcontroller serves as the central hub for communication between appliances, cloud services, and user commands. It processes the input from Google Assistant and relays commands to the relay module for execution. Programmed through an Arduino IDE, the microcontroller supports the MQTT protocol, enabling efficient real-time data exchange. This setup ensures seamless automation, allowing users to control the devices remotely with ease and responsiveness. By leveraging MQTT, the system provides a reliable and scalable solution for home automation, ensuring fast and secure communication across various connected devices, optimizing performance, and enhancing user convenience [6].
- *Relay module:* This module controls the power supply to domestic appliances by acting as an electrically powered switch. It has many channels that allow multiple devices to be operated simultaneously. A microcontroller sends low-voltage signals to the module, which allows it to switch high-voltage loads. System dependability and user safety are guaranteed by this division. Relays are essential for putting energy-saving features, such as power optimization, which lowers wasteful energy use, and scheduled switching, which switches devices on or off at certain intervals, into practice. Relay modules significantly improve energy management and smart home efficiency by providing automatic and remote appliance control [7].
- *Cloud communication (MQTT protocol):* The system utilizes the MQTT protocol for efficient, lightweight communication between devices. MQTT ensures real-time updates and device synchronization by using a publish-subscribe model. Users can send control commands from mobile applications that are processed by the microcontroller and forwarded to the connected appliances. The protocol supports data encryption and authentication and enhances system security. This enables the secure and reliable control of home devices, ensuring that user commands are executed promptly and safely. MQTT's lightweight nature also minimizes data overhead, making it ideal for IoT applications and ensuring seamless performance even with limited network resources [8].
- *Google Assistant integration:* Google Assistant makes it simple and hands-free for customers to operate appliances using voice commands. Voice instructions are converted into structured data that a microcontroller can analyze to control devices using services like IFTTT (If This Then That). This integration improves accessibility, which is especially advantageous for the elderly

 

and disabled, and provides a quick and easy method of interacting with home equipment. Because voice control removes the requirement for face-to-face communication, home automation becomes more accessible and user-friendly for those with different needs, increasing convenience and the general quality of life.

- *Mobile application:* For consumers who handle their smart home gadgets manually, a specialized smartphone application was created as an alternate interface. Real-time appliance status monitoring is made possible by the app's connection to a cloud platform. Notifications for energy usage, scheduling automation tasks, and turning gadgets on and off are simple for users. The program guarantees a smooth experience for users with a user-friendly UI. Because it is designed to operate with both iOS and Android operating systems, a variety of users may effectively operate their smart appliances. This program improves the overall home automation management by providing customers with an extra layer of ease and control, enabling them to interact with their devices whenever necessary [9].
- *Security and authentication mechanisms:* Security is a critical component of the proposed design, given the risks associated with IoT-based smart systems. To safeguard communication, the system uses Secure Socket Layer (SSL) encryption. Two-factor authentication (2FA) is employed for user verification to ensure secure access. In addition, role-based access control is implemented to prevent unauthorized access to sensitive features. The system also prioritizes ongoing security by conducting regular software updates and applying firmware patches, which helps mitigate potential cyber threats and vulnerabilities. These measures collectively enhance the security framework, ensuring that the system remains resilient to emerging risks and attacks [10].

## IMPLEMENTATION AND WORKING

The implementation of the IoT-based smart electrical board followed a structured process (Figure 2).

1. *User interaction:* The system starts when a user gives a voice command via Google Assistant, such as “Turn on the fan.”
2. *Voice processing:* Google Assistant processes the commands and transmits them to the cloud server using the MQTT protocol.
3. *Cloud communication:* The MQTT broker receives the command and relays it to the microcontroller (ESP8266/ESP32) via a secure network connection.
4. *Microcontroller execution:* The microcontroller interprets the received command and activates or deactivates the corresponding relay module, which in turn switches the appliance to ON or OFF.
5. *Status feedback:* The system sends a real-time status update to the cloud, which is then reflected in the mobile application, allowing the user to monitor the current state of the appliance.
6. *Automation and scheduling:* Users can also preset schedules for devices via the mobile application, ensuring automated operation based on time-based or event-driven triggers.
7. *Security and reliability:* The system employs authentication mechanisms and data encryption to prevent unauthorized access and ensure the reliability of communication between components.

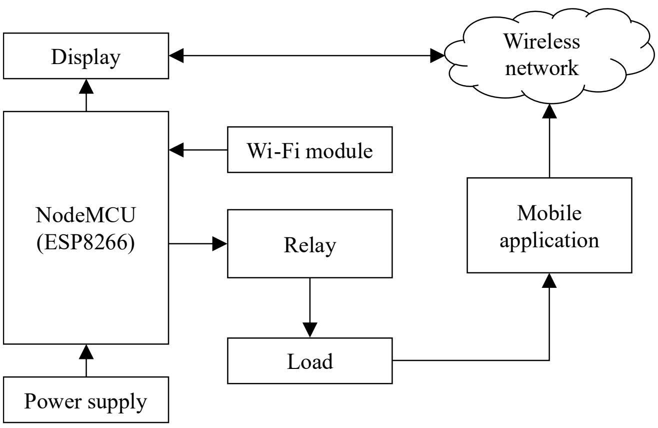


**Figure 2.** System workflow and functionality.

## ADVANTAGES OF THE SYSTEM

- *Remote control:* Users can manage appliances from anywhere.
- *Energy efficiency:* Optimizes power consumption by enabling scheduled automation.
- *Security:* Implements encrypted data transmission and authentication mechanisms.
- *Automation:* Allows pre-scheduled switching of appliances for convenience.
- *Scalability:* Supports integration with additional smart home devices in the future.

## CONCLUSION AND FUTURE SCOPE

The IoT-based Google Assistant Smart Electrical Board significantly improved home automation by enhancing user convenience, energy efficiency, and remote accessibility. Through the seamless integration of voice commands and cloud-based controls, users can operate home appliances virtually anywhere using devices connected to Google Assistant. This system not only simplifies daily tasks but also promotes smarter energy use by allowing users to monitor and control power consumption in real time. Its secure connectivity ensures reliable performance while maintaining safety standards. Potential advancements include the incorporation of AI-driven automation to enable predictive and context-aware control based on user habits and preferences. Adding support for a broader range of sensors, such as motion, temperature, and occupancy sensors, could further enhance system intelligence and responsiveness. In addition, developing compatibility across multiple platforms and smart ecosystems would improve flexibility, ensuring that the system can interact seamlessly with various devices and services. Overall, the smart board represents a promising step toward a more intelligent and sustainable home environment.

## REFERENCES

1. Sima BA, Buaton R, Sihombing M. IOT based automatic light control system using MQTT protocol. Int J Informatics Econ Manag Sci. 2024;3(1):1–9. doi:10.52362/ijiems.v3i1.1213
2. Tamanna I, Lima S. An IoT based smart home automation using Google Assistant. Int J Res Innov Appl Sci. 2023;8(9):112–9. doi:10.51584/IJRIAS.2023.8913
3. Mowla MN, Mowla N, Shah AFMS, Rabie KM, Shongwe T. Internet of things and wireless sensor networks for smart agriculture applications: A survey. IEEE Access. 2023;11:145813–52. doi:10.1109/ACCESS.2023.3346299
4. Rane N, Choudhary S, Rane J. Gemini versus ChatGPT: Applications, performance, architecture, capabilities, and implementation. J Appl Artif Intell. 2024;5(1):69–93. doi:10.48185/jaai.v5i1.1052
5. Motamed B, Shirvanimoghaddam K. The local co-working hub: A merging solution. Urban Sci. 2021;5(1):15. doi:10.3390/urbansci5010015
6. Al-Fuqaha A, Guizani M, Mohammadi M, Aledhari M, Ayyash M. Internet of things: A survey on enabling technologies, protocols, and applications. IEEE Commun Surv Tutor. 2015;17(4):2347–76. doi:10.1109/COMST.2015.2444095
7. Gubbi J, Buyya R, Marusic S, Palaniswami M. Internet of Things (IoT): A vision, architectural elements, and future directions. Future Gener Comput Syst. 2013;29(7):1645–60. doi:10.1016/j.future.2013.01.010
8. Miorandi D, Sicari S, De Pellegrini F, Chlamtac I. Internet of things: Vision, applications and research challenges. Ad Hoc Netw. 2012;10(7):1497–516. doi:10.1016/j.adhoc.2012.02.016
9. Zanella A, Bui N, Castellani A, Vangelista L, Zorzi M. Internet of Things for smart cities. IEEE Internet Things J. 2014;1(1):22-32. doi:10.1109/JIOT.2014.2306328.
10. Kasmi M, Bahloul F, Tkitek H. Smart home based on Internet of Things and cloud computing. 2016 7th International Conference on Sciences of Electronics, Technologies of Information and Telecommunications (SETIT), Hammamet, Tunisia. 2016. p. 82–6. doi:10.1109/SETIT.2016.7939846.

 