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Smart Home Control Prototype Based on Internet of Things Using Google Assistant

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Abstract: Smart home technology allows users to control household electronic devices automatically and remotely, including through voice commands. This study aims to design and develop a smart home control prototype based on the Internet of Things (IoT) using Google Assistant to control devices such as lights and fans. The system utilizes a NodeMCU ESP32 as the microcontroller, a 4-channel relay module as an automatic switch, and the Sinric Pro cloud service to connect voice commands from Google Assistant to the hardware. The research follows the ADDIE development model, which includes analysis, design, development, implementation, and evaluation stages. The test results show that the system can receive and execute voice commands with high accuracy in both Indonesian and English. However, the system still has limitations, such as dependence on a stable internet connection. Overall, this prototype functions well and has the potential to be further developed. In the Google Assistant analysis obtained from this system, Conversion and Calculation have the highest accuracy rate with 96.7%, while Voice command is the lowest with 85.3%.

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INTRODUCTION

In today's digital era, technology is rapidly advancing and has a significant impact on various aspects of life, including accessibility for individuals with disabilities. Disabilities refer not only to physical or mental limitations, but also to restrictions in performing daily activities, bodily functions, fulfilling roles, and environmental factors (Damanik et al., 2022). According to data from Indonesia's Central Statistics Agency (BPS), in 2020 there were approximately 22 million people with disabilities in Indonesia, encompassing a variety of disability types such as physical, sensory, and mental disabilities. The increasing number of people with disabilities highlights the need for greater attention in creating inclusive and accessible environments. One potential solution that can be implemented is the use of Smart Home technology integrated with voice assistants such as Google Assistant.

Smart Home is one of the options that must be developed today to help owners, especially those with special needs or disabilities (Hussain et al, 2023; Mtshali & Khubisa, 2019; Kumar et al., 2020; Gunawan et al., 2020). Some technologies have been developed in such a way, using the Internet of Things with various devices such as ESP32, LoRaWAN, and NB-IoT (Bhardwaj et al., 2024; Chouragadey et al., 2025; Verma et al., 2023; Siregar & Tandry, 2023). Smart Home can be managed in the server section and how to determine the analysis system on the Internet Server through the Uplink and Downlink Process, and a multi-point sensor system that requires a lot of analysis and methods for energy efficiency or maximization in terms of automation (Arigela et al., 2024; Salsabila et al., 2025; Latifov & Pradeep, 2023; Elizabeth et al., 2024; Shetty & NS, 2025).

Technology has developed rapidly and offers numerous benefits across various aspects of life, including improving human quality of life. One increasingly popular application of technology is the Smart Home. Smart Home technology provides many conveniences, such as controlling household devices through voice commands, which can be especially helpful for people with disabilities in carrying out their daily activities. The concept of a Smart Home enables users to control electronic household devices without needing to approach them physically. Users can turn devices on or off remotely, including through voice commands given by household members. The use of Smart Home systems provides ease and comfort in daily life, increases energy efficiency, enhances safety, and improves overall quality of life (Nugraha et al., 2023).

Creating a supportive environment for people with disabilities is not only crucial for their quality of life, but also for their mental and emotional well-being. Data from the World Health Organization (WHO) indicates that individuals with disabilities often experience social isolation and face challenges interacting with their surroundings. With the presence of disability-friendly Smart Home technology, it is hoped that a more inclusive atmosphere can be created, allowing them to feel more independent and engaged in daily life. The ability to control home devices through voice commands opens opportunities for people with disabilities to manage household needs without relying on others or physically interacting with the devices.

Considering this issue, the writer was motivated to explore the topic of a prototype for a Smart Home control system based on the Internet of Things using Google Assistant, which allows users to control household appliances using voice commands. A Smart Home system with voice control powered by Google Assistant can be an effective solution that enables users to operate electronic devices, such as lights and fans, simply through voice input. This solution is especially beneficial for individuals who have difficulty moving or using their hands to press buttons manually. The implementation of Google Assistant in a Smart Home system also offers advantages in terms of cost and efficiency. Google Assistant is an accessible platform that does not require significant hardware investment. According to a report from Statista (2022), more than 500 million active users utilize Google Assistant worldwide. This demonstrates the vast potential for integrating this technology into daily life, especially for people with disabilities who need practical and affordable solutions. Furthermore, this technology adds a sense of security by ensuring that household appliances are properly controlled. Through this tool, it is expected that individuals with disabilities can manage home electronics more independently and experience greater comfort and convenience in their everyday lives (Handayani & Khotimah, 2022).

METHOD

The research method used in this study is the ADDIE method. The ADDIE method is a development model used to design instructional systems with a systematic approach that focuses on continuous feedback (Mukin & P, 2023). A comparison between ADDIE, the Waterfall model, and the generic Systems Development Life Cycle (SDLC) is presented in Table 1 to highlight the strengths, limitations, and suitability of each method for this study (Ali & Yahaya, 2023; Subiksa et al., 2025; Roziqin & Indahyanti, 2024; Rustandi & Darmawati , 2025).

Table 1. Comparison of ADDIE, Waterfall, and SDLC Models

Aspect	ADDIE Model	Waterfall Model	Generic SDLC
Process Flow	Iterative; allows revisions at any stage	Linear; each phase must be completed sequentially	Flexible; can be iterative or linear depending on version
Main Focus	Continuous evaluation and instructional design	Structured sequential system development	Overall system development framework
Adaptability to Changes	High; supports revisions and feedback cycles	Low; changes are difficult once development begins	Moderate; depends on SDLC variant
Suitability for Application / IoT Development	Highly suitable due to iterative testing and feedback	Less suitable due to rigid structure	Suitable but lacks detailed instructional design components
Strengths	Systematic, flexible, evaluation at every phase	Simple, easy to understand, clear stages	Comprehensive and widely applicable
Weaknesses	Requires more time due to continual evaluation	Not flexible for iterative revisions	Too general; requires further model customization
Reason for Selection in This Study	Ensures iterative refinement, systematic design, and quality improvement	Not selected due to rigidity and limited flexibility	Not selected because it lacks continuous evaluation mechanisms

Based on the comparison presented in Table 1, the ADDIE model is selected because it provides a structured yet flexible framework with continuous evaluation, making it highly suitable for iterative application development in this study.

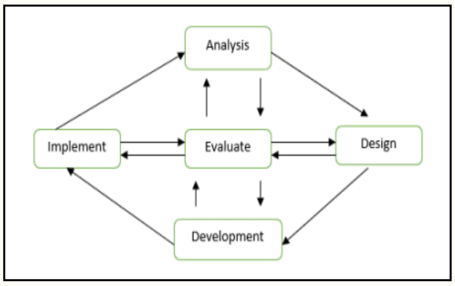

Figure 1. shows the stages of the ADDIE method

Based on Figure 1, the ADDIE model uses five development stages: Analyze, Design, Development, Implement, and Evaluate, with the following explanations:

1. The Analyze stage involves identifying and analyzing the needs.
2. The Design stage refers to the process of creating a design or blueprint.
3. The Development stage is the process of turning the design into an actual application.

4. The Implementation stage involves applying or deploying the developed product or application to the user.
5. The Evaluation stage is carried out at each phase to ensure the quality and effectiveness of the process.

RESULTS AND DISCUSSIONS

System Implementation

The implementation stage involves preparing the necessary tools and components, such as the NodeMCU ESP32, 4-channel relay module, lamp, fan, jumper wires, USB cable, and power plug. The next step is to prepare the source code using the Arduino IDE to control the relay through the NodeMCU ESP32, which is connected to Sinric Pro as a cloud platform to receive commands from Google Assistant. The final step is testing the Smart Home prototype to control the lamp and fan using voice commands via Google Assistant. The implementation of this Smart Home prototype produces an output in the form of control over turning electrical devices such as lamps and fans on or off, using a relay module managed by the NodeMCU ESP32. Voice commands are sent via Google Assistant and relayed through Google Home to Sinric Pro. The NodeMCU ESP32 acts as the main controller to activate or deactivate the relays, allowing the lamp or fan to be operated automatically based on the user's voice commands.

Software Implementation

Software implementation is the process of developing the program for the Smart Home prototype, which functions to control lamps and fans using voice commands based on Google Assistant. This stage is carried out after the software testing has been completed. The software used for developing this prototype is the Arduino IDE, which is utilized to program the NodeMCU ESP32 so that it can control the relay module according to the commands received through Sinric Pro. Sinric Pro serves as a cloud platform that connects the NodeMCU ESP32 with the Google Home service, which is responsible for receiving voice commands from Google Assistant. In this implementation, the software is designed so that the NodeMCU ESP32 can receive signals from Sinric Pro and activate or deactivate the relay connected to the electrical devices, such as the lamp and fan. The program also ensures that each command is executed responsively and according to the user's needs.

1. Arduino IDE

Arduino IDE is a software that can be used to write code, equipped with features in the toolbar that help in connecting the program with the Arduino microcontroller. (Damanik et al., 2022).

```
---------------------------------------------------------------
Algorithm 1: ESP32 Smart Switch Control
---------------------------------------------------------------
Input: SSID, Password, AppKey, AppSecret, SwitchID1, SwitchID2
Set RelayPin1 → 32 ; RelayPin2 → 33
Function onPowerState1(state)
    If state = ON then Set RelayPin1 → LOW else Set RelayPin1 → HIGH
End Function
Function onPowerState2(state)
    If state = ON then Set RelayPin2 → LOW else Set RelayPin2 → HIGH
End Function
Function setupWiFi()
    Connect to WiFi ; Wait until connected
End Function
Function setupSinric()
    Configure RelayPin1, RelayPin2 as OUTPUT
    Bind SwitchID1 → onPowerState1 ; Bind SwitchID2 → onPowerState2
    Connect to SinricPro
End Function
Function setup()
    Start Serial ; Call setupWiFi() ; Call setupSinric()
End Function
Function loop()
    Handle SinricPro communication
End Function
---------------------------------------------------------------
End Algorithm
---------------------------------------------------------------
```

Figure 2. Arduino IDE

Based on Figure 2, it illustrates the flow of the program code stages in the prototype to ensure it operates as implemented. After the process of entering the program code is completed, the device will process the compiled program from the Arduino IDE to the microcontroller.

2. Sinric Pro

Sinric Pro is a software that includes automation features to connect the functions of Google Assistant. Sinric Pro supports all types of IoT devices. In this research, Sinric Pro is used to create a switch that will be connected to Google Home, making it easier to control electronic devices with voice commands through Google Assistant (Solehudin et al., 2023).

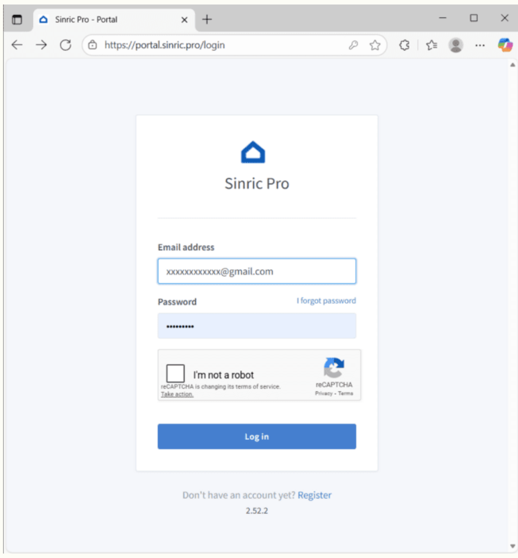

Figure 3. Login Sinric Pro

Based on Figure 3, it shows the user interface used for logging in before accessing the Sinric Pro platform. The login is done using the same email that will later be used in Google Home and Google Assistant.

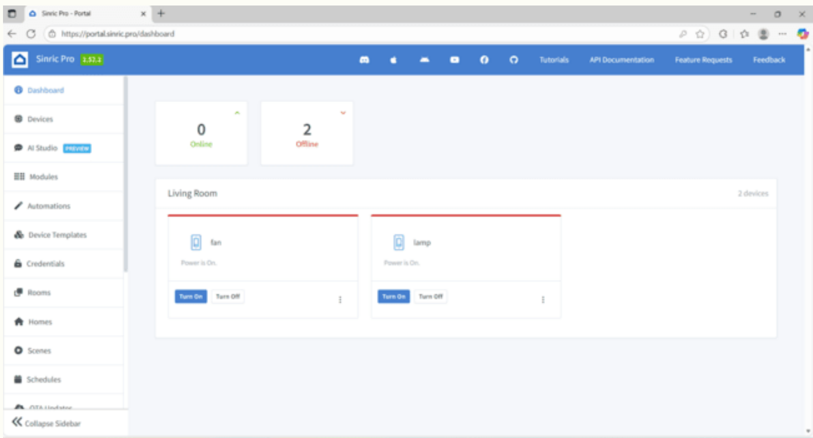

Figure 4. Dashboard Sinric Pro

Based on Figure 4, it shows the main interface after successfully logging into the Sinric Pro platform. This dashboard serves as the control center for all Internet of Things devices. It features a "Home" diagram where users can control the turning on and off of electronic devices such as lights and fans.

3. Google Home

Google Home is a software developed by Google that supports various smart devices and is integrated with Google Assistant (Zein et al., 2024).

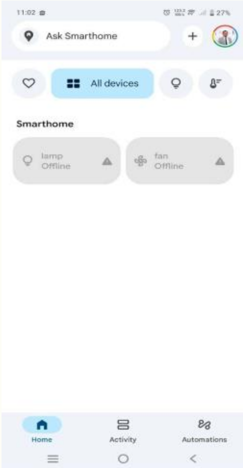

Figure 5. Google Home

Based on Figure 5, it shows the main interface of Google Home after the application is opened. In Figure 5, Google Home has been integrated with Sinric Pro, so the devices added in Sinric Pro are also connected to Google Home. These electronic devices will later be tested for voice commands using Google Assistant.

Hardware Implementation

Hardware implementation is the result of applying the circuit in the Smart Home Control Prototype using Google Assistant. This prototype is built using the NodeMCU ESP32, 4-channel relay, jumper wires, USB cable, lamp, and fan.

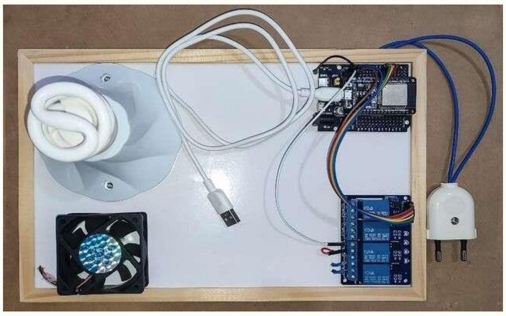

Figure 6. Hardware Implementation

Based on Figure 6, it shows the physical form of the Smart Home circuit prototype using Google Assistant. In the circuit, you can see the NodeMCU ESP32 as the main microcontroller that connects the system to the Wi-Fi network and Sinric Pro. The 4-channel relay module acts as an electronic switch that controls the power for the lamp and fan. Jumper wires serve as connectors between components. The USB cable provides power to the ESP32 module. Finally, the lamp and fan are the electronic devices representing household appliances that will be tested using voice commands through Google Assistant.

Test Results

Testing was carried out to ensure that the IoT-based Smart Home control prototype using Google Assistant functions properly. The testing process was conducted in real-time to examine how well the electronic devices—lamp and fan—respond to voice commands from Google Assistant. Several aspects were tested, including voice command accuracy, voice modeling, and the distance between the user and the device. The tests were performed in two languages: Indonesian and English.

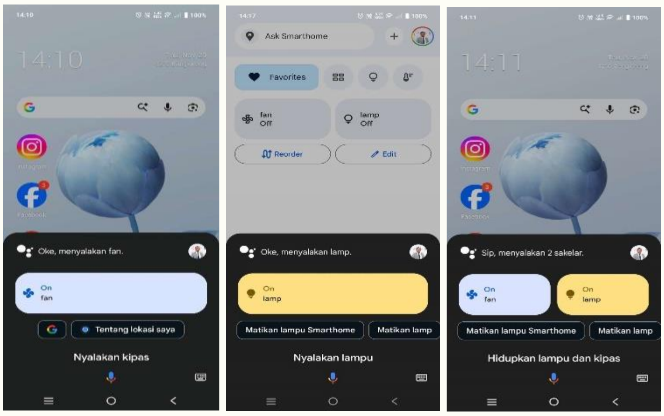

Figure 7. Google Assistant in Indonesian

Furthermore, Google Assistant Voice allows users to give commands or ask questions to connected devices or other devices that support Google Assistant. Using voice commands, users can easily and quickly control electronic devices such as lights and fans. Google Assistant Voice uses advanced natural language processing technology to understand and respond to user requests in a more intuitive way (Shaquille & Zen, 2023).

Based on Figure 7, it shows the Google Assistant interface when given several voice commands to control the lights and fan in Indonesian. The commands given were to turn on the devices.

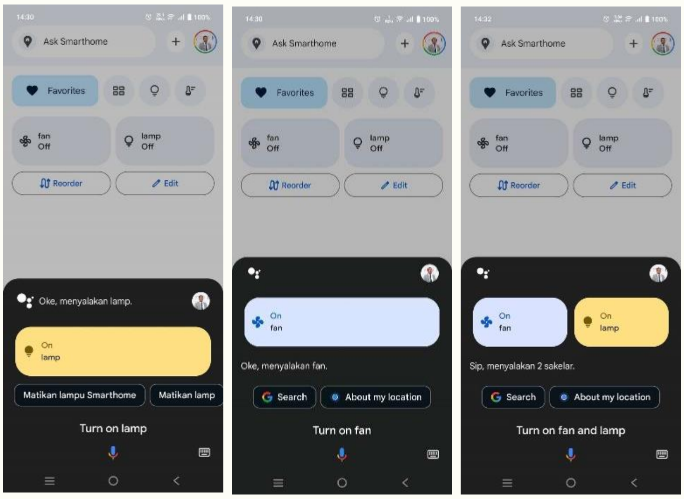

Figure 8. Google Assistant in English

Based on Figure 8, it shows the Google Assistant interface when given several voice commands to control the lights and fan in English. The commands given were to turn off the devices. Furthermore, a graph is needed that shows the accuracy or performance of Google Assistant from the translation process and other parameters, such as speed in translation, and other analysis. The following Figure 9 shows a detailed graph to show the accuracy of the system being built. Figure 9 is a Accuracy rate per function category on Google Assistant, Figure 10 is a Relationship of Number of Trials vs Accuracy on Google Assistant, and Figure 11 is a Accuracy Ranking on Google Assistant.

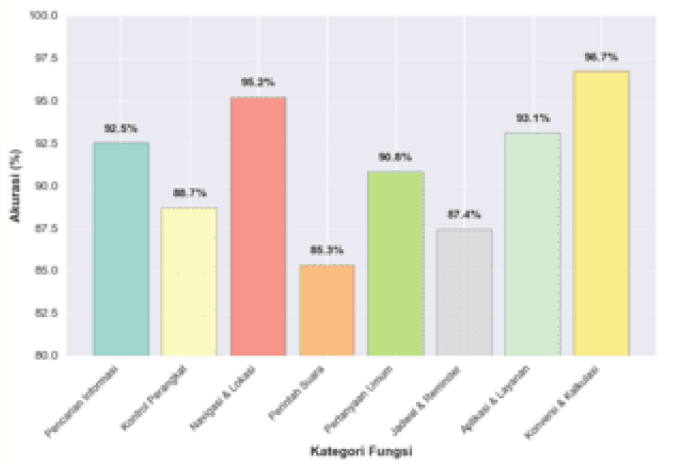

Figure 9. Accuracy rate per function category on Google Assistant

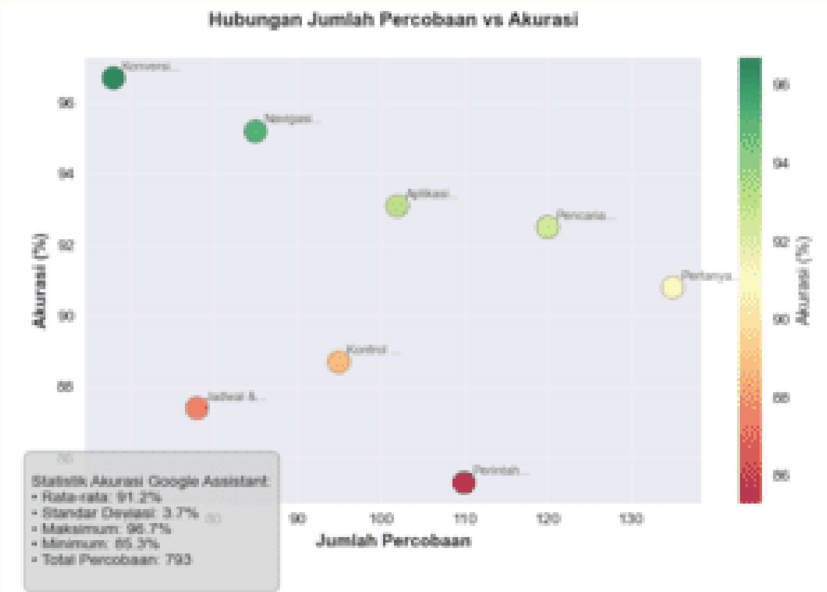

Figure 10. Relationship of Number of Trials vs Accuracy on Google Assistant

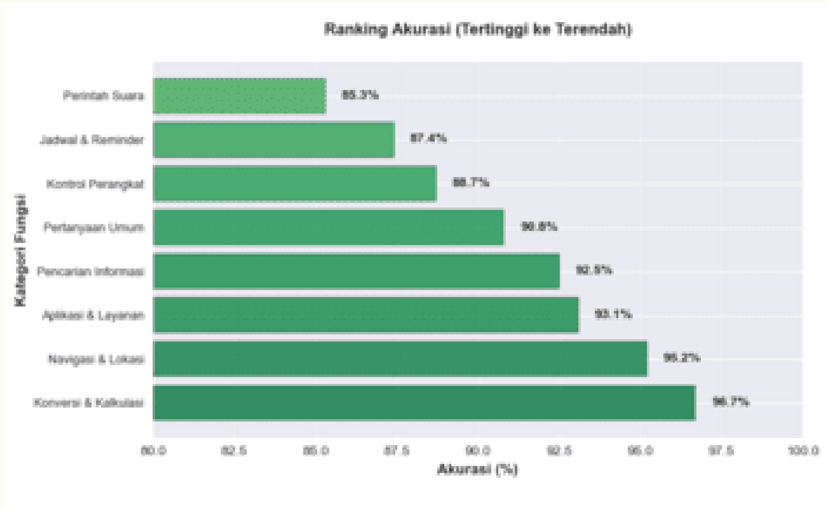

Figure 11. Accuracy Ranking on Google Assistant

CONCLUSIONS

Based on the results of the research and testing that have been conducted, it can be concluded that the Smart Home prototype based on the Internet of Things (IoT) using Google Assistant was successfully designed and implemented at a relatively low cost. This prototype is capable of controlling household devices such as lights and fans through voice commands sent to Google Assistant, relayed to Google Home, and processed via Sinric Pro to the NodeMCU ESP32. Testing results show that the device responds well to voice commands in both Indonesian and English, and it can recognize various voice types, including male and female voices. Additionally, the prototype can be controlled remotely from any location, even from different islands or provinces. However, the performance of this prototype relies heavily on a stable internet connection. In the Google Assistant analysis obtained from this system, Conversion and Calculation have the highest accuracy rate with 96.7%, while Voice command is the lowest with 85.3%.

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