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AtiqahSmart - IoT Speech Based Home Assistant

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1. Introduction

Smart home assistants have become an increasingly important part of modern living, offering users convenience in managing daily routines. By automating tasks and enabling hands-free interaction, these systems can significantly improve accessibility particularly for elderly users and those with physical limitations.

AtiqahSmart is a mobile application designed to address this need by providing a voice-driven solution for smart home management. The application focuses primarily on IoT device control which allowing users to switch devices on or off, adjust settings such as brightness, fan speed or temperature and manage multiple rooms seamlessly. In addition, it extends its functionality by delivering real-time weather updates that supporting everyday decision-making with contextual information.

2. Problem Statement

Unfriendly and not seamless assistants often limit the interaction between users and the system, resulting in responses and actions that feel rigid and less intuitive (Chinchane, Bhushan, Helonde & Bidua, 2022). By unfriendly system, it is meant that many assistants require very rigid phrasing and offer little personalization. If users don't say the exact words, the system may not respond correctly. On the other hand, users face challenges in giving natural commands and managing devices smoothly by not being seamless which makes the experience less convenient and more frustrating. This creates barriers for new adopters and reduces the effectiveness of speech-based technologies.

3. Objective and Significance

The objective of this project is to design and develop a mobile application-based smart home assistant that utilizes speech recognition for IoT device control. This will lead to a significance of AtiqahSmart that lies in its ability to enhance accessibility and personalization. By enabling speech-driven IoT commands, the application provides a tool that not only improves everyday convenience but also supports inclusive interaction for a wider range of users.

4. Authenticity / Novelty

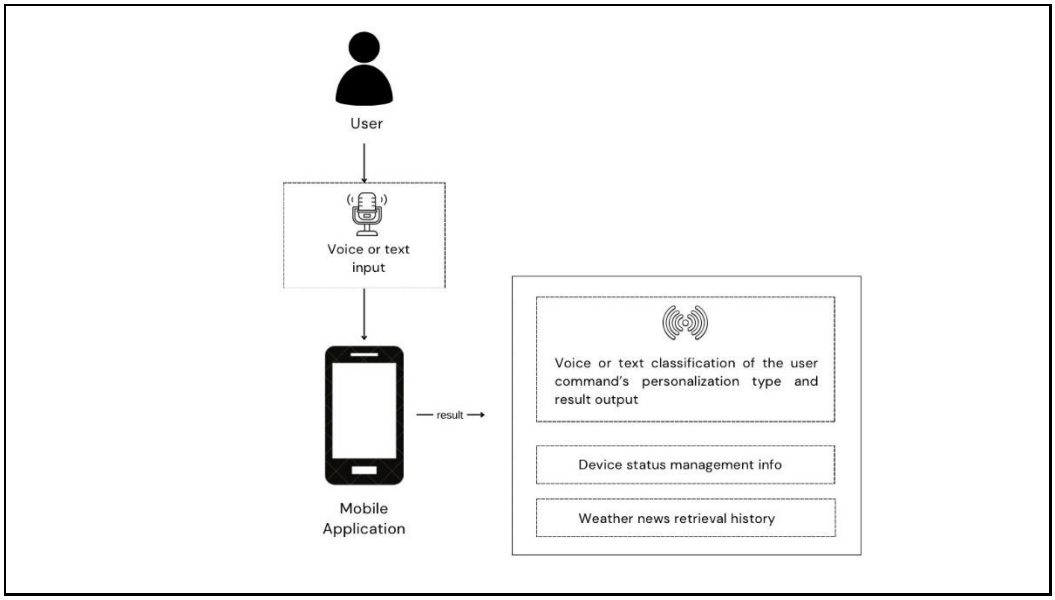


Figure 4.1 System Architecture of AtiqahSmart

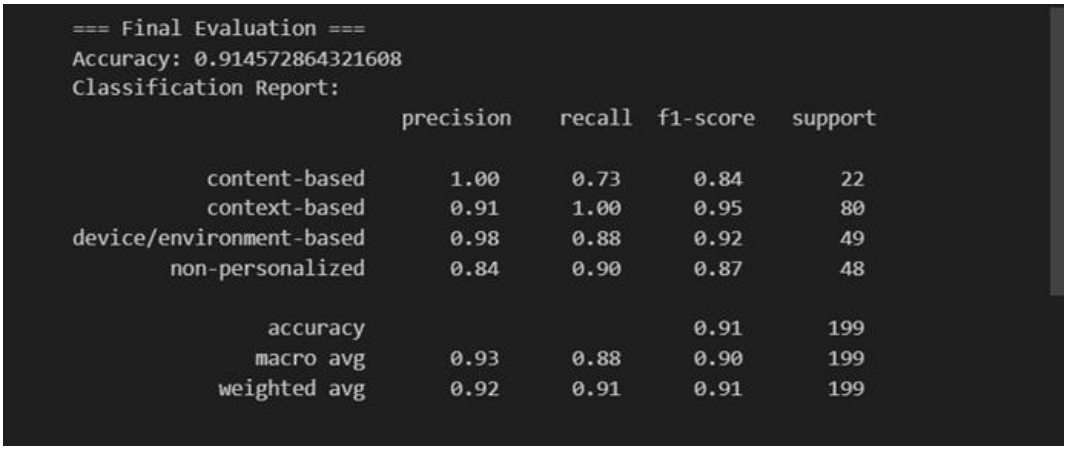
Based on Figure 4.1, AtiqahSmart introduces several key novelties compared to conventional smart assistants.

First, it enables voice-based IoT control, allowing users to manage devices through natural speech commands rather than rigid phrases. For example, saying “Turn on the bedroom light” is instantly recognized and executed by the system.

Second, the assistant delivers direct contextual results, with device states and weather news information displayed instantly in the app. This ensures feedback is immediate and easy to understand.

Finally, AtiqahSmart uses a hybrid approach which combining a BERT-based classification model with rule-based logic. This ensures that user commands are not only categorized accurately but also interpreted in context, producing clear and actionable responses.

5. Results of BERT and Rule-Based Generation



```
=== Final Evaluation ===
Accuracy: 0.914572864321608
Classification Report:
                          precision    recall  f1-score   support

          content-based       1.00      0.73      0.84        22
          context-based       0.91      1.00      0.95        80
device/environment-based      0.98      0.88      0.92        49
        non-personalized      0.84      0.90      0.87        48

               accuracy                           0.91       199
              macro avg       0.93      0.88      0.90       199
           weighted avg       0.92      0.91      0.91       199
```

Figure 5.1 Evaluation of Trained BERT Classification Model

To validate the design of AtiqahSmart, a BERT classification model as in Figure 5.1 was trained to classify user commands into four personalization categories. Among these, two key categories of context-based weather queries and device-based control are directly supported by rule-based modules.

The BERT classification model enables the system to distinguish between:

- Device-based commands (e.g., *"Turn on the bedroom fan"*)
- Context-based commands (e.g., *"What's the weather in Shah Alam tomorrow?"*)
- Other unsupported types, which are flagged accordingly

Table 5.1 Device Command Parsing and Firebase Update Results

Command Example	Extracted Room	Extracted Device	Action	Extra Setting	Result (Firebase Update)
Set the bedroom fan to high speed	Bedroom	Fan	On	Speed: High	/rooms/bedroom/fan/state = "on", speed = "high"
Switch off the living room air conditioner	Living Room	Air Conditioner	Off	None	/rooms/living room/ac = "off"

Turn on the kitchen light	Kitchen	Light	On	None	/rooms/kitchen /devices/light = "on"

The results on Table 5.1 shows some examples on device command parsing where rule-based logic is used then interprets essential factors such as:

- Time – *now, tomorrow, at 9PM*
- Location – *home location from Firebase or mentioned in the query*
- Device type – *fan, light, air-conditioner*
- Action – *turn on, turn off, adjust, switch, set*
- Extra settings – *brightness, speed, temperature*

This hybrid approach ensures that each classified command produces a clear, accurate and actionable response. In short, BERT handles classification while the rule-based logic makes the command executable.

6. Core Benefits

AtiqahSmart delivers two major benefits that directly improve user experience which are personalized and user-friendly interaction as well as seamless device management.

First, personalized and user-friendly interaction. By combining classification with rule-based logic, the system can understand natural and flexible speech commands. This allows users to interact with the assistant in a way that feels intuitive, replacing rigid command structures with seamless conversation.

Second, seamless device management. The system unifies IoT device control within a single platform. Users can add new rooms and devices, adjust extra settings (such as brightness, fan speed and temperature) and retrieve contextual information like weather news updates which all without hassle. This scalability ensures that AtiqahSmart grows alongside the user's smart home.

The application also has been tested and demonstrated with real-world scenarios to showcase its capabilities that aligned with both of the benefits:

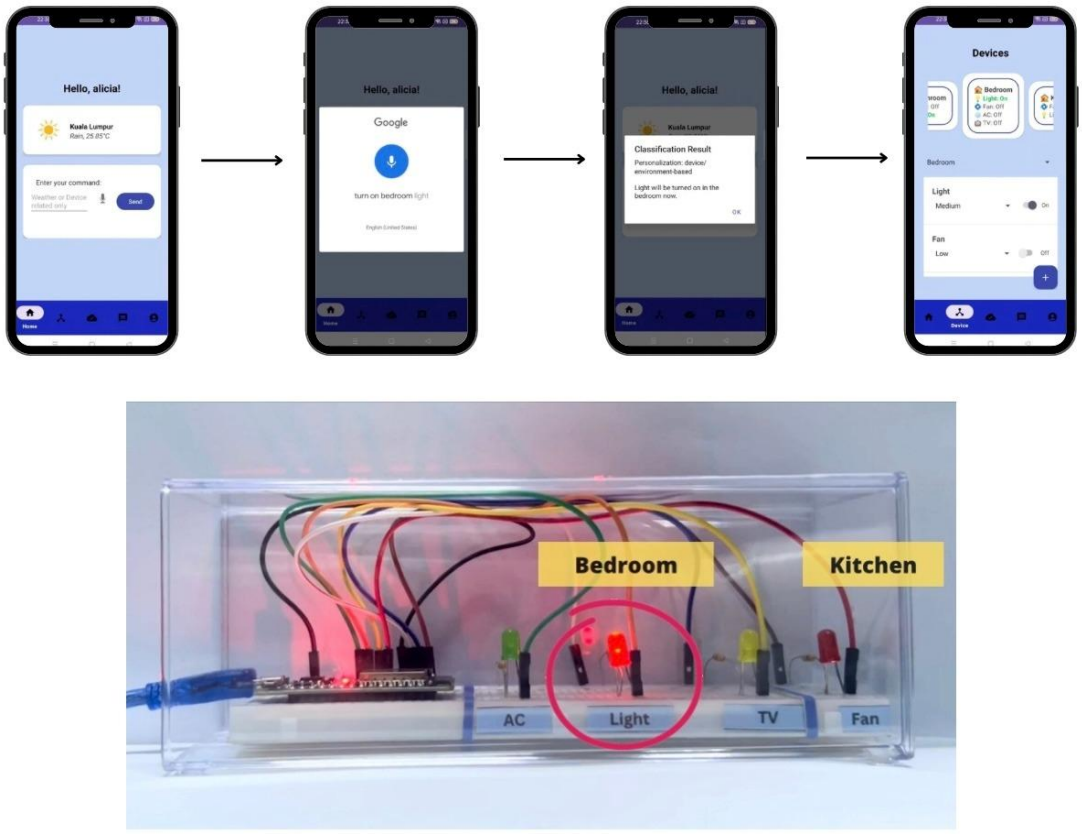


Figure 6.1 Demonstration Snapshots of Voice-based Device Control

- Voice-based Device Control: For example, Figure 6.1 shows the demonstration of the command *"Turn on the bedroom light"* is classified as a device-based action. Rule-based logic identifies the device and room then the command is executed instantly. The result is reflected in real time both in the app and through a connected IoT device (LED indicator).

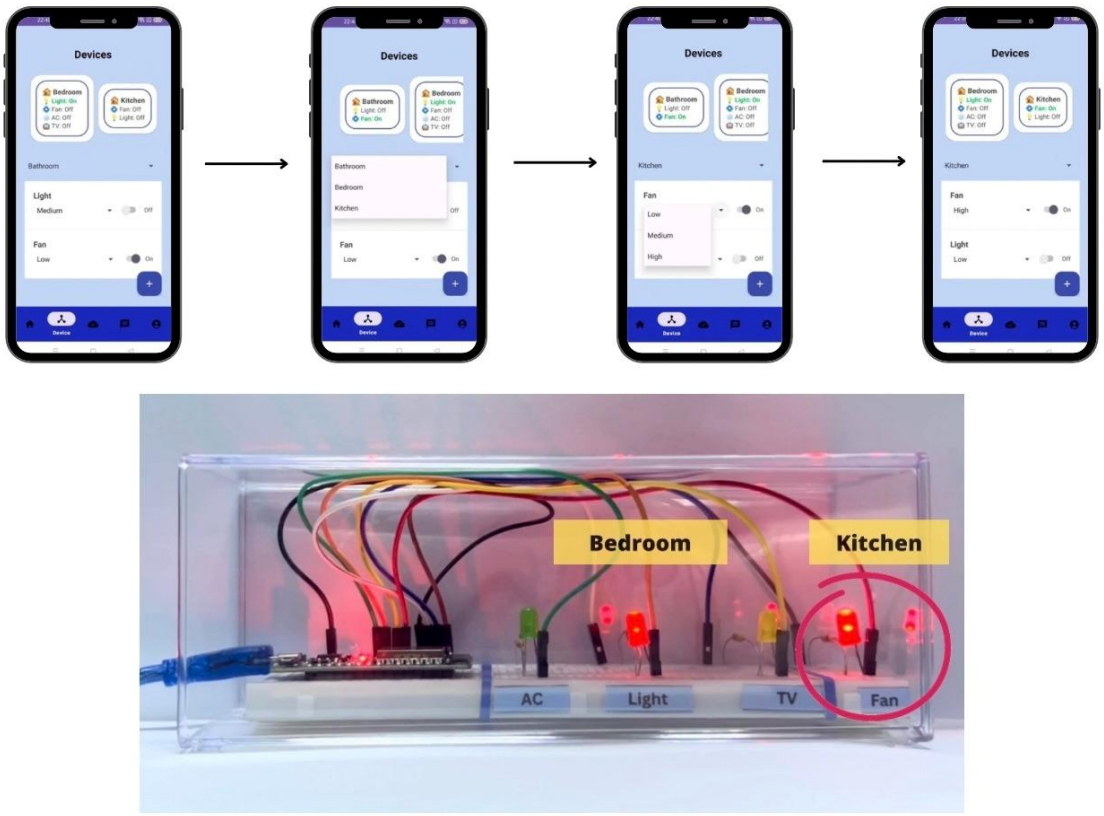


Figure 6.2 Demonstration Snapshots of View and Adjusting Device Settings

- View and Adjusting Device Settings: Figure 6.3 shows how users can view summary of device states across all rooms and also manually fine-tune IoT device control such as setting a fan to high speed or dimming a light. These commands are recognized and directly synchronized with Firebase, ensuring that device states are updated accurately.

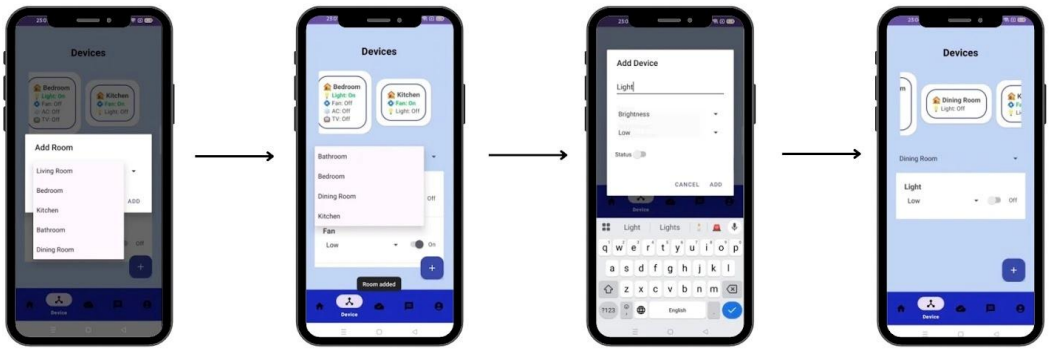


Figure 6.3 Demonstration Snapshots of Adding Devices and Rooms

- Adding Devices and Rooms: Figure 6.3 demonstrates the system supports scalability by enabling new rooms and IoT devices to be added easily. For instance, adding a *Dining Room* with a *Light* device configured with brightness settings demonstrates how the platform adapts to user growth.

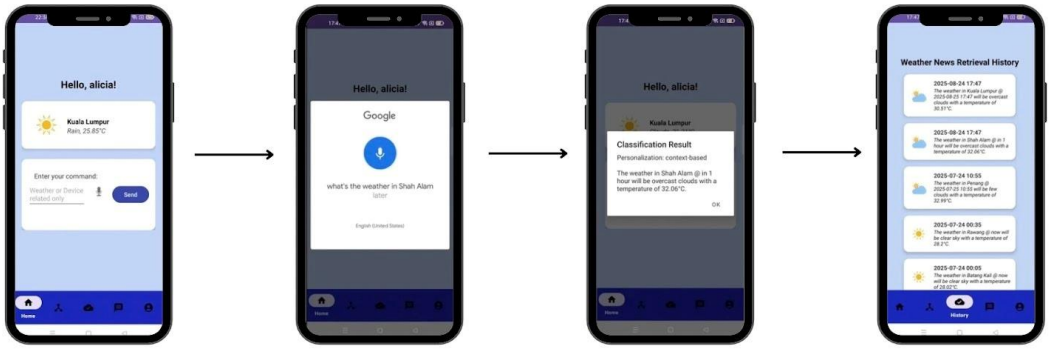


Figure 6.4 Demonstration Snapshots of Weather News Retrieval

Weather News Retrieval: Figure 6.4 demonstrates context-based queries such as *"What's the weather in Shah Alam tomorrow?"* are supported. The assistant retrieves real-time updates from the OpenWeatherMap API, considering both the user's home location (from Firebase) and any location specified in the query.

7. Commercialization Potential

AtiqahSmart is designed with accessibility and scalability in mind, making it suitable for multiple market segments.

- Who: Schools and training centers can use it as an educational module to demonstrate AI and IoT integration while first-time smart home adopters such as families, elderly users or rental units can enjoy a practical and low-cost assistant for daily use where hands-free interaction can support accessibility and teaching.
- How: The application can be distributed via the Google Play Store, supported by web-based advertisements and integrated into school or training modules.
- Cost: The system is cost-efficient due to its reliance on open-source programming frameworks and APIs as well as affordable IoT hardware like ESP32. Therefore, the deployment costs remain minimal which making it affordable for wider adoption.

This affordability combined with personalization and IoT integration highlights AtiqahSmart's value as both a consumer tool and a product with commercial viability.

8. Conclusion

In conclusion, AtiqahSmart demonstrates how AI-powered classification, rule-based logic and IoT integration can be combined into a cost-effective and user-friendly smart home assistant.

By focusing on speech-based IoT device control and contextual weather retrieval, the system delivers a hands-free, accessible and personalized experience. It addresses key gaps in existing assistants which improving user-friendliness, seamlessness and adaptability while showcasing potential for real-world commercialization.