RUAHA CATHOLIC UNIVERSITY

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE

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CONCEPT NOTE

1. Project Title

Offline Smart Home Voice Assistance

2. Background / Problem Statement

Home automation is becoming increasingly important for convenience, accessibility, and energy efficiency. However, most existing voice-controlled systems depend on cloud services (e.g., Google Assistant, Alexa), making them less suitable for areas with limited or unreliable internet connectivity.

There is a need for a low-cost, offline, voice-controlled system that can operate independently without internet access. Such a system would be useful for homes, offices, student projects, and small automation setups.

This project aims to design a simple offline voice-controlled system that can switch one electrical device (e.g., light bulb, fan, door lock) ON or OFF using voice commands.

3. Project Objective

To develop a low-cost, offline voice-controlled automation system using an ESP32 microcontroller and a relay module, capable of responding to simple wake words such as “Lights on” and “Lights off”.

4. Specific Objectives

- To implement offline voice recognition using the Pico voice Porcupine engine on ESP32.
- To design the hardware setup consisting of an ESP32, microphone, and relay module.
- To program the ESP32 to detect voice commands and perform switching actions.
- To demonstrate control of one device (light/fan/door lock) using voice.
- To test reliability, responsiveness, and offline accuracy of the system.

5. Project Scope

This project focuses on controlling one electrical device only. It covers:

- Voice capture using a digital microphone

- Wake-word recognition (“Lights on”, “Lights off”)
- Switching via relay
- Device operation without internet
- Demonstration with a light bulb or equivalent output
- It does not include cloud integration, multiple device control, or mobile app interfaces—though these can be added in future expansions.

6. Methodology

a. Hardware Setup

- ESP32 microcontroller
- INMP441 / MAX4466 microphone
- 1-channel relay module
- Light bulb or LED lamp
- Wires and breadboard

Connections will be made between the ESP32 GPIO pins, microphone module, and relay driver.

b. Software Setup

- Arduino IDE for coding
- Pico voice Porcupine offline wake-word engine
- Custom wake words generated (“Lights on” and “Lights off”)
- Code uploaded to ESP32 to continuously listen and trigger relay actions.

c. Testing

The system will be tested under different noise levels and distances to evaluate recognition accuracy and switching reliability.

7. Expected Outputs / Deliverables

- A fully working offline voice-controlled prototype.
- Arduino code for the ESP32 using Pico voice SDK.
- Wiring diagram and hardware assembly.
- Demonstration of turning a light ON and OFF using voice.
- A short report explaining the results and performance.

8. Significance of the Project

- Provides a cost-effective automation solution **(37,000-80,000 (tsh))**
- Works completely offline, suitable for areas with poor internet connectivity.
- Enhances convenience for elderly or physically challenged users.
- Serves as a practical learning project for embedded systems and IoT students.
- Can be expanded to control multiple devices or integrated with smart home platforms.

9. Estimated Budget

Items	Estimated Cost (tsh)
ESP32 microcontroller	**12,280-24,560**
Relay module	**5000-9000**
Microphone module	**8000-15,000**
Power supply	**8000-12,280**
Misc wires & breadboard	**5000-12,280**
total	**37,000-80,000 (tsh)**

10. Conclusion

This project demonstrates an affordable, offline, and practical approach to smart device automation using the ESP32. By enabling voice control without the need for internet connectivity, it offers a resilient and flexible solution suitable for schools, homes, and small-scale automation experiments. Its simplicity and expandability make it a valuable learning tool and a foundation for more advanced smart systems.