Design And Implementation of a Bluetooth-Enabled Smart Home Automation System Using Mit App Inventor

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Abstract- This project aims to automate various household functions (lighting, fans, appliances, security, etc.) using smart technology for greater convenience, energy efficiency, and enhanced security. By integrating an Arduino-based controller with a wireless mobile app, users can control home devices remotely via a smartphone, eliminating the need for manual switches. The system promotes energy savings through scheduled or automatic device control and provides security alerts or status updates, improving safety and peace of mind. In summary, the project demonstrates how IoT and app-driven automation can simplify home management and make living spaces smarter and more efficient.

I.INTRODUCTION

1.1 SIMPLIFY HOME CONTROL:

Develop an in-built automation system to control household devices (lights, fans, appliances) with minimal user effort.

1.2 REMOTE ACCESSIBILITY:

Allow users to operate and monitor home systems from anywhere using a mobile app, removing the constraints of manual operation.

1.3 ENERGY EFFICIENCY:

Automate device operation (e.g., turn off idle lights/fans) to reduce power consumption and support sustainable living.

1.4 ENHANCED SECURITY:

Provide real-time status and alerts (e.g., notifications for unusual activity) to improve home safety and give users peace of mind.

II.MATERIALS AND METHODS

COMPARISON OF EXISTING AND PROPOSED SYSTEMS

1.5 EXISTING (TRADITIONAL) SYSTEMS:

Traditional home control is largely manual and isolated. Devices like lights and fans are operated by physical switches or basic timers. Conventional security setups (alarms, cameras) rely on local audible alerts and often do not notify homeowners remotely. These systems require manual arming/disarming and lack integration, meaning no real-time smartphone updates; they are less convenient and more prone to oversight. For example, a standard alarm system might sound a local siren but cannot send a notification to the owner's phone.

1.6 PROPOSED SYSTEM (ARDUINO + APP):

The proposed solution uses an Arduino Uno microcontroller connected to a Bluetooth module and relay circuits, controlled via a custom Android app built with MIT App Inventor. Users can remotely turn appliances on/off through the app, and the Arduino activates the corresponding relay in real time. This architecture adds capabilities missing in legacy systems: it enables wireless operation and monitoring (e.g., users receive immediate feedback and alerts on their smartphones). In effect, it provides the remote access and real-time alerts that characterize modern smart-home systems, improving overall convenience, efficiency, and security.

III.EXPERIMENTAL SETUP AND PROCEDURE

WORKFLOW

1.7 HARDWARE SETUP:

An Arduino Uno board is connected to a Bluetooth communication module (e.g., HC-05) and multiple relays. Each relay is wired to a household appliance (such as lamps, fans, or outlets). The Arduino's digital

output pins drive the relays to switch these devices on or off.

Table **Error! No text of specified style in document.**.1: Hardware list details

Sl. No	Hardware list
1	Arduino Uno
2	8 Channel relay module
3	HC-05 Bluetooth Module
4	Jumping wires

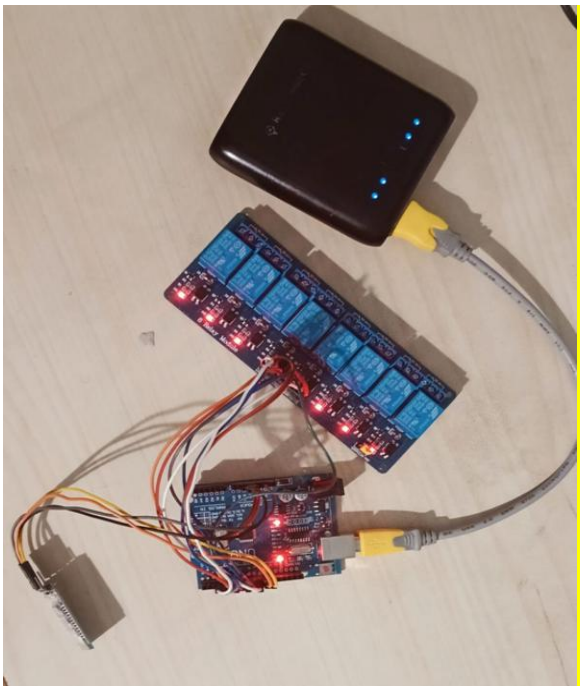

Figure 4.1: SMART HOME AUTOMATION SYSTEM

1.8 ARDUINO PROGRAMMING:

The Arduino is programmed in the C language using the Arduino IDE. The code establishes serial communication over Bluetooth and continuously listens for commands. When a valid command is received (e.g., "LIGHT_ON"), the program sets the appropriate output pin high or low to activate the corresponding relay.

1.9 MOBILE APP DEVELOPMENT:

A user interface is created using MIT App Inventor for Android. This app pairs with the Arduino's Bluetooth module and displays controls (buttons or toggles) for each appliance. When a user taps a control, the app sends a command string via Bluetooth to the Arduino.

1.10 SYSTEM OPERATION:

During use, a command from the app is transmitted wirelessly to the Arduino. The Arduino's program interprets the command and switches the designated relay, thereby powering the appliance. For example, pressing "Light On" in the app causes the Arduino to activate the relay for the living-room light. This process enables true remote control and monitoring of home devices, delivering the real-time responsiveness and wireless management typical of smart systems.

Table **Error! No text of specified style in document.**.2: Software list details

Sl. No	Software list
1	Programming language C
2	Mobile App – Smart Control
3	App Creating website – MIT Inventor

IV.RESULTS AND DISCUSSION

1.11 RESULTS

The Bluetooth-enabled smart home automation system was successfully designed and implemented using an Arduino Uno, HC-05 Bluetooth module, relay circuits, and an Android application developed on MIT App Inventor. The system allowed accurate and reliable wireless switching of household appliances such as lights and fans. All test cases confirmed that the Bluetooth commands were received without delay, and the relays responded instantly to user inputs from the mobile app.

The Android app provided a simple interface where each appliance could be toggled on or off, and the pairing with the HC-05 module remained stable within the typical Bluetooth range (8–12 meters). The Arduino program correctly interpreted all command strings and executed the appropriate switching actions. The system operated with minimal power consumption and demonstrated consistent performance during repeated tests.

Overall, the prototype successfully met the core objectives: remote control, energy-efficient operation, and enhanced convenience compared to traditional manual switching systems.

1.12 DISCUSSION

The results show that Bluetooth-based control is an effective and low-cost approach for basic home automation. The system provided immediate responsiveness, which is a major advantage over Wi-Fi–based systems that may experience latency due to network congestion. The use of MIT App Inventor enabled fast and user-friendly app development, making the system suitable even for beginners in IoT or embedded systems.

A key observation from the testing phase is the system's limited range, which is an inherent characteristic of Bluetooth technology. While Bluetooth performs well within a single room or nearby spaces, it is less suitable for large homes or multi-storey buildings without signal boosters. Despite this limitation, Bluetooth remains ideal for small-scale automation projects where reliability and simplicity are more important than long-range capability.

Energy efficiency was noticeably improved due to the app-based switching mechanism. Users could easily turn off idle appliances without physically reaching the switchboard, reducing unnecessary power consumption. This supports the global trend of using automation to promote sustainable energy use.

Security also improves compared to manual systems, as users can instantly verify the status of appliances via the mobile app. Although Bluetooth security is weaker compared to encrypted Wi-Fi IoT systems, pairing-based access provides basic protection against unauthorized use.

The system's modular design means additional features—such as sensors for temperature, motion, or gas detection—can be integrated in the future. Similarly, the architecture can be expanded to Wi-Fi or cloud-based IoT platforms for remote access beyond Bluetooth range.

V.CONCLUSION

- The design and implementation of the Bluetooth-enabled smart home automation system successfully demonstrate how low-cost embedded hardware and user-friendly mobile app development tools can be combined to create an efficient, modern home-control solution. By integrating an Arduino microcontroller with MIT App Inventor, the system provides seamless wireless control of household appliances, enabling users to operate lights, fans, and other devices with ease from a smartphone interface.
- The project not only enhances convenience but also promotes energy efficiency through precise and timely device management. Its ability to deliver real-time updates, remote access, and automated control makes it superior to traditional manual systems. Furthermore, the modular architecture allows for future expansion, such as adding sensors, voice control, or IoT-based cloud connectivity.
- Overall, this work demonstrates a practical, scalable, and cost-effective approach to smart home automation, highlighting how accessible technologies can significantly improve comfort, safety, and energy management in modern households.

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