بِسْمِ اللهِ الرَّحْمٰنِ الرَّحِيْمِ

INTERNATIONAL ISLAMIC UNIVERSITY CHITTAGONG

MICROPROCESSOR, MICROCONTROLLER & EMBEDDED SYSTEM LAB

COURSE CODE : CSE-3524

PROJECT REPORT

SPRING'25 (5BF)

Group – C

SUBMITTED TO

Sultana Tasnim Jahan (ma'am) ;
Assistant Lecturer ; Dept of CSE, IIUC

SUBMITTED BY

Sanzida Nishat Nishi (C231442)
Saima Binte Soyeb (C231449)
Kazi Namira Meyheg Sanam (C231450)
Umme Benin Yeasmin Meem (C231452)

2025

Final Report

SMART HOME AUTOMATION

A Smart Home System Featuring Password Based Door Lock & Google Assistant Voice Control Integration

(Developed Using Arduino UNO & Embedded Systems)

ABSTRACT

This project presents the design and implementation of a cost-effective **Smart Home Automation System** that integrates secure access control with voice-enabled appliance management, built around the **Arduino UNO** microcontroller. Aiming to enhance home security, convenience, and energy efficiency, the system features two core functionalities: **a password-protected door lock** and **voice-controlled device operation**. The locking mechanism uses a **4x4 matrix keypad** for password entry and a servo motor to unlock and automatically re-lock the door, ensuring secure access. Meanwhile, voice commands issued **via Google Assistant** are transmitted to the Arduino through the **HC-05 Bluetooth module**, enabling users to toggle lights, fans, and other appliances using coded signals like "L1" or "F0." This modular and low-cost design, based on readily available components, makes it ideal for students, beginners, and DIY enthusiasts exploring embedded systems, **IoT**, and home automation.

Beyond the working prototype, the project highlights the value of interdisciplinary engineering—combining microcontroller programming, actuator control, wireless communication, and mobile interfacing to create a functional smart home solution. Its scalable structure leaves room for future upgrades such as Wi-Fi integration, biometric access, or sensor-based automation, bridging theoretical learning with real-world application. Ultimately, this project demonstrates how embedded automation technologies can transform ordinary living spaces into intelligent, secure environments, offering both academic insight and practical value.

TABLE OF CONTENTS

1. **ABSTRACT** — 01
2. **TABLE OF CONTENTS** — 02
3. **INTRODUCTION** — 03
4. **OBJECTIVES** — 04
5. **MOTIVATION BEHIND THIS PROJECT** — 05
6. **PROBLEM STATEMENT** — 05
7. **LITERATURE REVIEW** — 06
8. **SYSTEM OVERVIEW** — 07
9. **HARDWARE COMPONENTS** — 08
    - 9.1 Arduino UNO
    - 9.2 4x4 Keypad
    - 9.3 Servo Motor
    - 9.4 HC-05 Bluetooth Module
    - 9.5 Relay Module
    - 9.6 Power Supply
10. **SOFTWARE REQUIREMENTS** — 08-09
    - 10.1 Arduino IDE
    - 10.2 Bluetooth Terminal App / IFTTT
11. **SYSTEM FEATURES & ARCHITECTURE** — 09-10
    - 11.1 Flow Chart
    - 11.2 Password-Protected Door Lock
    - 11.3 Voice-Controlled Appliance Operation
12. **SYSTEM DESIGN AND IMPLEMENTATION** — 10-11
    - 12.1 Circuit Diagram
    - 12.2 Working Principle
13. **PROJECT PREVIEW** — 11-15
14. **RESULT AND DISCUSSION** — 16
15. **QUANTITATIVE RESULTS TABLE** — 16
16. **PERFORMANCE EVALUATION** — 17
17. **PROJECT USEFULNESS** — 17
18. **REAL LIFE VALUE** — 17
19. **PO-CO-K-P-A** — 18-19
20. **ENGINEERING COMPLEXITY AND INTEGRATION** — 20
21. **LIMITATIONS AND FUTURE ENHANCEMENT** — 20
22. **TECHNICAL DEPTH** — 21
    - 21.1 Technical Limitations & Considerations
23. **CONCLUSION** — 21-22
24. **REFERENCES** — 22
25. **APPENDICES** — 23-27

INTRODUCTION

In the age of digital transformation, smart home technology has become an integral part of modern living, offering enhanced convenience, improved energy management, and increased security. The ability to control various aspects of a home environment through automation and remote access has reshaped how people interact with their personal spaces. Among the available technologies, microcontroller-based systems have gained popularity due to their affordability, flexibility, and ease of implementation. This project aims to design and implement a smart home automation system using the **Arduino UNO microcontroller**, focusing on secure access and hands-free appliance control.

The proposed system consists of two core components: **a password-protected door lock mechanism** and **voice-controlled appliance automation**. The access control unit employs a 4x4 matrix keypad for user input and a servo motor to operate the door lock. Upon entering the correct password, the system triggers the servo to unlock the door briefly before automatically re-locking it, ensuring secure and temporary access. This adds a fundamental layer of physical security to residential entry points while demonstrating the application of embedded control systems in real-world scenarios.

To enhance user convenience, the project integrates voice control using Google Assistant. Voice commands such as "**Turn on the light**" or "**Switch off the fan**" are interpreted through a Bluetooth terminal or **IFTTT**-based routine on a smartphone, which then communicates with the **Arduino UNO via the HC-05 Bluetooth module**. The system responds by toggling relays connected to the respective appliances. This voice-driven control not only improves accessibility but also supports energy efficiency and modern lifestyle expectations.

Designed with modularity and scalability in mind, this system allows for future upgrades such as Wi-Fi connectivity, mobile app integration, and sensor-based automation. It serves as a solid platform for exploring embedded systems, wireless communication, actuator control, and smart home applications. Ultimately, the project bridges the gap between academic learning and practical implementation, offering a robust prototype that embodies the principles of modern engineering in a compact and efficient home automation solution.

CORE OBJECTIVES

- **Enhancing Residential Security**
  Implement a password-protected door locking system using a 4x4 keypad and servo motor to ensure secure and automated access control.

- **Improving User Convenience**
  Enable voice-controlled appliance automation through Google Assistant and Bluetooth communication with Arduino for hands-free operation.

- **Ensuring Affordability and Scalability**
  Use low-cost, accessible components with a modular design to support future expansion into IoT and mobile-based controls.

- **Demonstrating Real-World Embedded Applications**
  Showcase practical integration of microcontroller programming, wireless communication, and automation for educational and prototype development.

KEY OBJECTIVES

- **Secure Access Control**
  Facilitate safe entry with password verification and automatic re-locking; block unauthorized attempts for enhanced protection.

- **Voice-Controlled Automation**
  Use voice commands and Bluetooth modules to control home appliances via relays, offering modern and responsive control.

- **User-Friendly Interface**
  Provide intuitive interaction through keypads and mobile apps with clear feedback to simplify system use.

- **Future-Ready Design**
  Prepare for sensor integration and network upgrades by maintaining flexible hardware and modular code structure.

- **Educational Value**
  Support learning in automation and embedded systems by offering a practical, hands-on platform for students and developers.

MOTIVATION BEHIND THE PROJECT

The motivation for this project stems from the growing demand for safer, smarter, and more convenient living environments, coupled with the desire to make such solutions affordable and accessible to everyday users. With increasing urbanization and busy lifestyles, homeowners seek systems that can secure entry points, reduce manual effort, and enable effortless control of household appliances.

By utilizing the widely available **Arduino UNO** and **low-cost modules**, this project aims to show that advanced home automation features—like password-protected door locks and voice-controlled devices—can be implemented without expensive commercial systems. It also serves as an educational platform, encouraging students and enthusiasts to learn embedded systems, wireless communication, and real-world problem solving, while inspiring further innovation in the evolving field of smart home technology.

PROBLEM STATEMENT

Traditional residential setups typically rely on **manual locks and basic switches**, which often fail to meet modern demands for **security**, **flexibility**, and **ease of use**. These systems do not provide advanced security features such as controlled access or automatic locking, nor do they offer convenient, hands-free control of household appliances.

As technology becomes an integral part of daily life, there is an increasing need for a cost-effective, reliable solution that brings essential smart features to home environments without the high costs and complexity of commercial systems. This project aims to bridge the gap between conventional manual systems and fully integrated smart home platforms by introducing **secure, password-protected door access** and **voice-controlled appliance automation using affordable**, **readily available components**.

By addressing these limitations, the system seeks to enhance residential **safety, improve user convenience, and lay a foundation** for scalable smart home solutions that can evolve with future technological advancements.

Additionally, the project emphasizes modularity and user-friendliness, ensuring that even beginners or students can adopt and extend the system. Ultimately, it reflects the practical potential of embedded systems to transform everyday living into a **smarter, safer, and more efficient experience.**

LITERATURE OVERVIEW

Emergence of Smart Home Systems:

- Growth in demand for convenience, energy efficiency, and security.
- Increased adoption of automation in homes, with affordable microcontrollers like Arduino.

Arduino-Based Home Automation:

- Arduino UNO is a popular choice due to its low cost, open-source nature, and ease of integration with sensors and wireless modules (Bluetooth, Wi-Fi).

Password-Protected Security Systems:

- Keypad-based locking systems are effective for providing low-cost, secure access control in embedded systems.

Voice Control Integration:

- Integration of voice assistants like Google Assistant enhances accessibility, particularly for elderly or disabled individuals.
- Communication typically via Bluetooth or Wi-Fi, often using platforms like IFTTT.

Bluetooth Communication in Home Automation:

- Bluetooth modules (e.g., HC-05) offer a reliable, short-range wireless solution for controlling home appliances, enabling easy setup without requiring an internet connection.

Modularity and Scalability in IoT Systems:

- Modular designs in embedded systems allow for future expansion, such as adding sensors or integrating with cloud-based services and mobile apps.

Educational Importance of Embedded Projects:

- Microcontroller-based projects are widely used in engineering education to bridge theory and practical application, enhancing students' understanding of automation and embedded systems.

🛠 SYSTEM OVERVIEW

Password-Protected Door Lock:

- A 4x4 matrix keypad is used to input a predefined password.
- Upon correct password entry, a servo motor unlocks the door for a limited time.
- The door locks automatically after the set time to ensure security.

Voice-Controlled Appliance Management:

- The system integrates with Google Assistant to allow voice control.
- Commands are sent via the **HC-05 Bluetooth module** to control appliances like lights and fans.
- The system supports hands-free control for user convenience.

Central Control Unit:

- The **Arduino UNO** microcontroller serves as the central control unit for both features.
- Ensures seamless communication between components, such as the keypad, servo motor, and Bluetooth module.

Modular and Scalable Design:

- Designed for easy expansion with future IoT integration, sensor support, and mobile app compatibility.
- Affordable and accessible, making it suitable for DIY enthusiasts and educational purposes.

User-Friendly and Secure:

- Provides a simple and intuitive interface for both door lock access and appliance management.
- Offers security features with password protection and ease of use through voice control.

HARDWARE COMPONENTS

ARDUINO UNO

The Arduino UNO is the heart of the system, acting as the main controller. It processes inputs from the keypad and Bluetooth module, and controls the servo motor and relays.

4X4 KEYPAD

The 4x4 keypad serves as the user interface for entering the password. It communicates directly with the Arduino, sending keypress signals.

SERVO MOTOR

The servo motor is responsible for physically unlocking and locking the door based on commands from the Arduino.

HC-05 BLUETOOTH MODULE

The HC-05 Bluetooth module enables wireless communication between the system and the user's smartphone, allowing voice commands from Google Assistant.

RELAY MODULE

The relay module is used to control household appliances like lights and fans based on the voice commands received via Bluetooth.

POWER SUPPLY

The system is powered by a 5V DC supply, ensuring adequate power for the Arduino, sensors, and other components.

SOFTWARE COMPONENTS

ARDUINO IDE

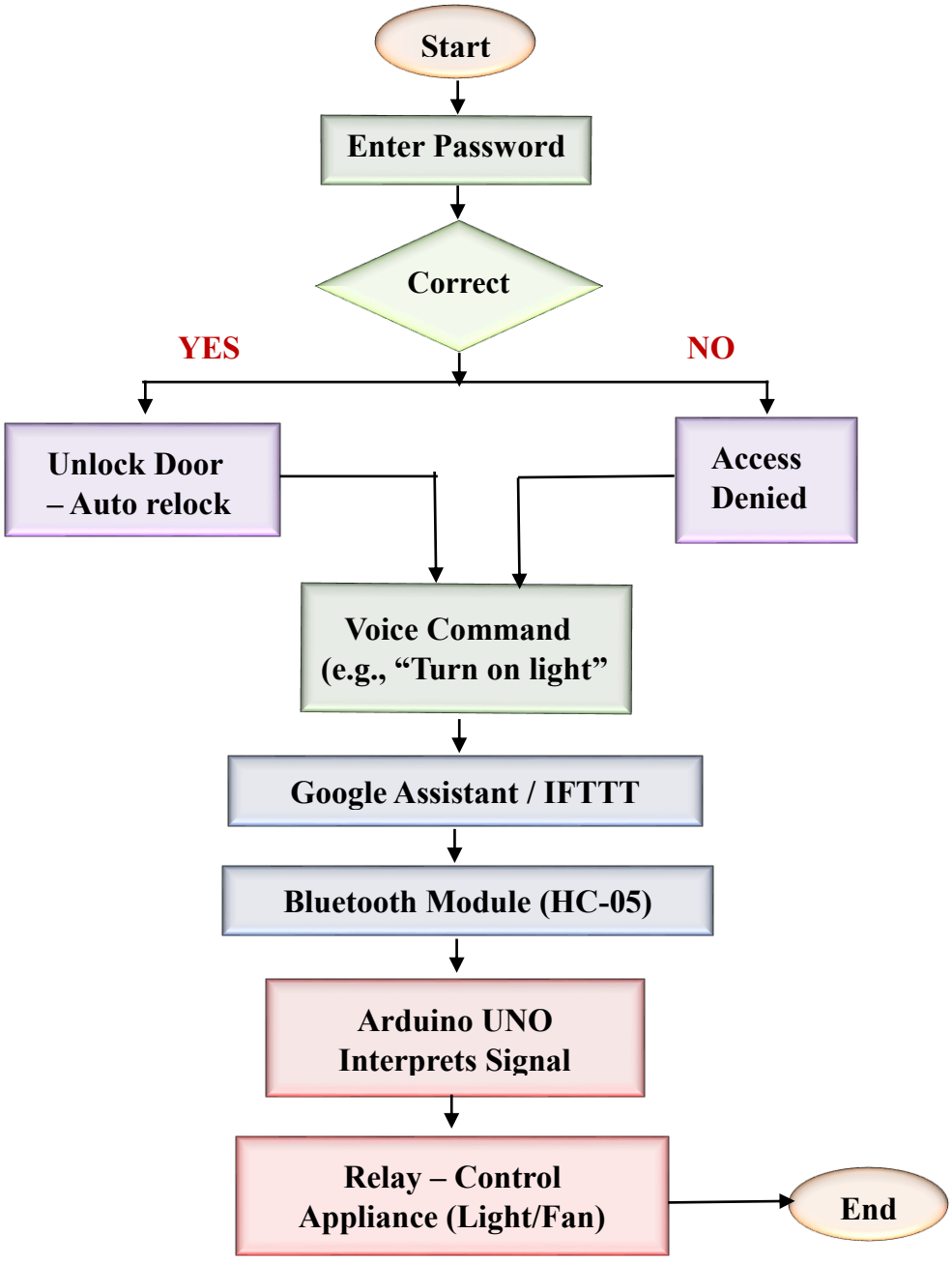
The Arduino Integrated Development Environment (IDE) is used to program the Arduino UNO, providing the necessary functionality for keypad input, Bluetooth communication, and appliance control.

BLUETOOTH TERMINAL APP / IFTTT

The Bluetooth terminal app or IFTTT-based routines are used to transmit voice commands from the smartphone to the Arduino via the HC-05 module. These commands are then processed and sent to the appropriate relay modules.

SYSTEM FEATURES & ARCHITECTURE

FLOW CHART



PASSWORD-PROTECTED DOOR LOCK:

- Users enter a **4-digit password** to unlock the door.
- If the **password is correct**, the **door is unlocked** for a short time before it locks again automatically.
- Incorrect passwords result in a denied access attempt.

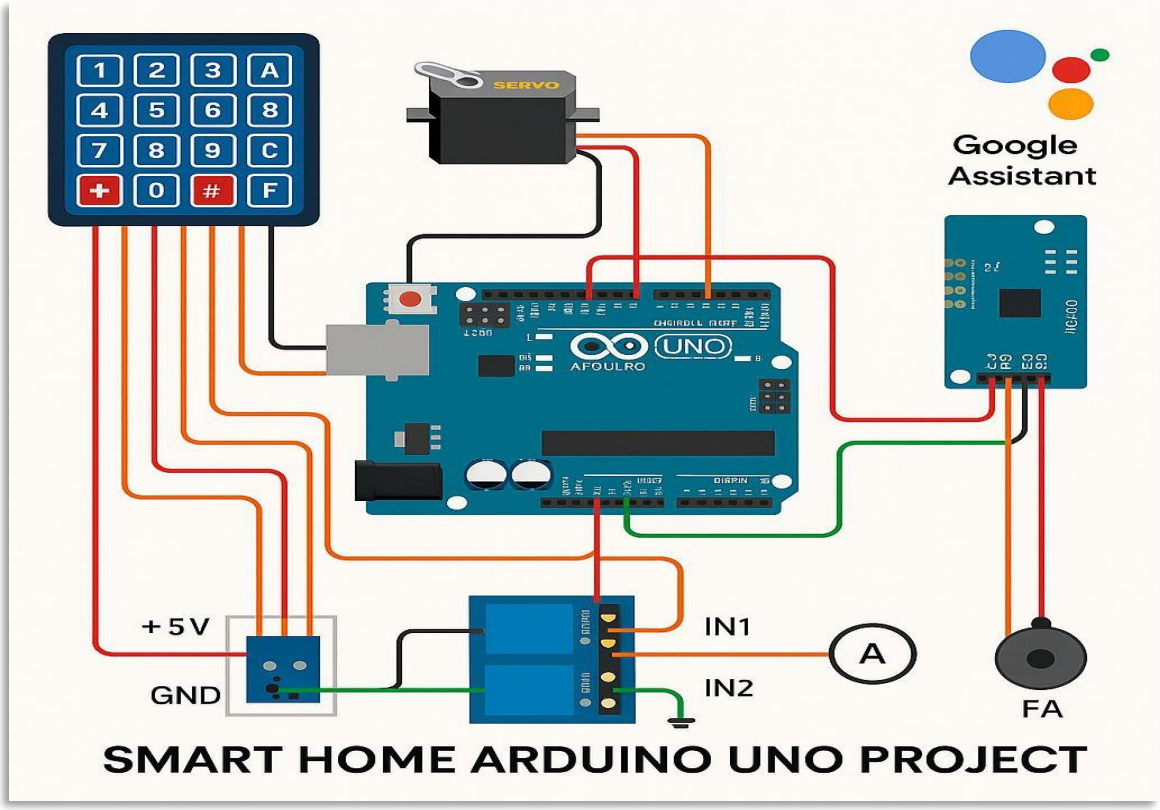
VOICE-CONTROLLED APPLIANCE OPERATION:

- Users can give commands like **"Light ON"** or **"Fan OFF"** using **Google Assistant.**
- Commands are translated into Bluetooth signals, which are then interpreted by the Arduino to control relays.

🛠 SYSTEM DESIGN & IMPLEMENTATION

🗺 CIRCUIT DIAGRAM

- **Circuit Diagram of our project (SMART HOME AUTOMATION)**



⚙ WORKING PRINCIPLE

The smart home automation system operates based on two functionalities:

❖ Password-Based Door Access:

A **4×4** matrix keypad is used for password input. When the user enters the correct predefined **4-digit password**, the **Arduino UNO** sends a signal to a servo motor, causing it to rotate and unlock the door. After a brief delay, the servo automatically returns to its original position, relocking the door. If an incorrect password is entered, the system ignores the input, maintaining door security.

❖ Voice-controlled Appliance operation:

Users issue voice commands such as "**Turn on light**" or "**switch off fan**" via Google Assistant, which are routed through a **smartphone Bluetooth terminal app on an IFTTT** setup. The commands are converted into specific Bluetooth signals **(e.g., L1, L0, F1, F0)** and transmitted to the Arduino via the **HC-05 Bluetooth** module.

📷 PROJECT PREVIEW

✸ SCREENSHOT DETAILS

To clearly demonstrate our project, we have divided the testing process into **two main parts**, as the system includes two integrated modules:

- **Password-Protected Door Lock**
- **Voice-Controlled Appliance Automation via Bluetooth**

Each module was first tested **individually** to ensure proper functionality, and then integrated into a single working system.

The following **step-by-step screenshots** shows:

- **LCD outputs** (e.g., password prompts, lock/unlock status)
- **Serial monitor logs from Arduino**
- **Photos of the hardware responding to inputs** (e.g., relay switching, appliances on/off)

All images are clearly labeled (e.g., *Figure C1, C2*, etc.) and arranged in order. This helps illustrate how both parts operate independently and together in a complete smart home setup.

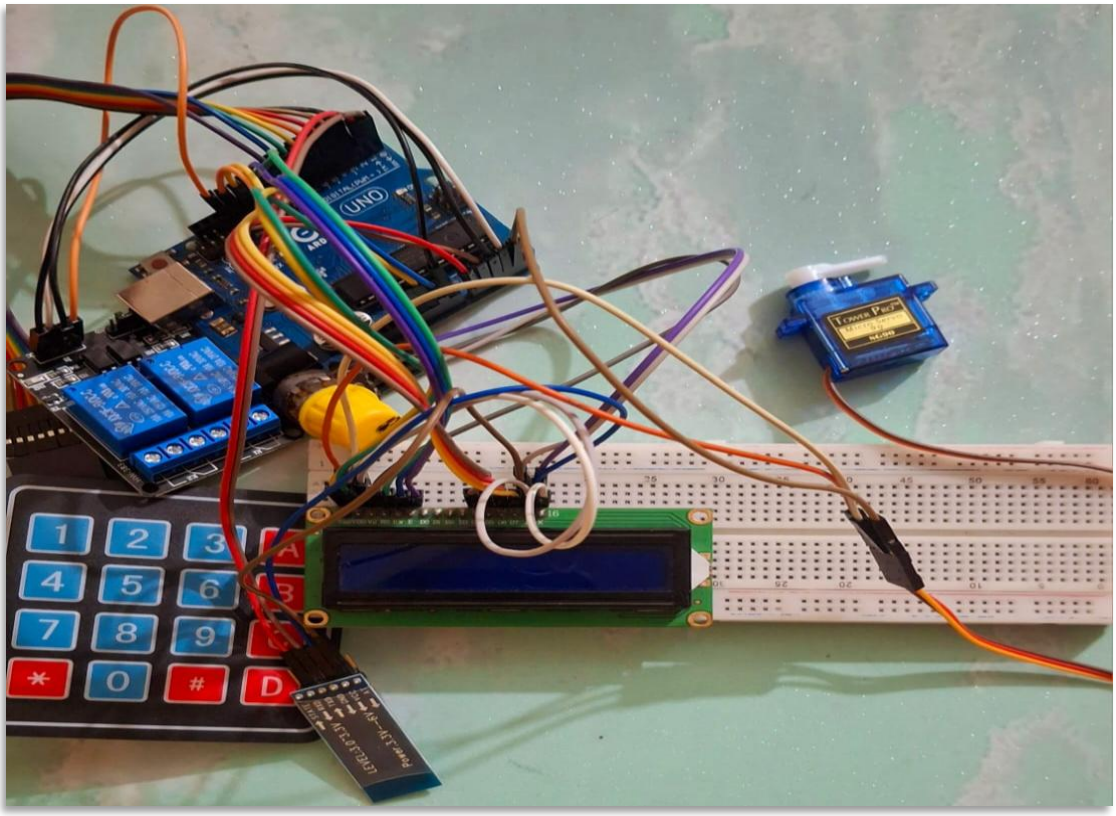


Fig C1 : Overall connection of our project

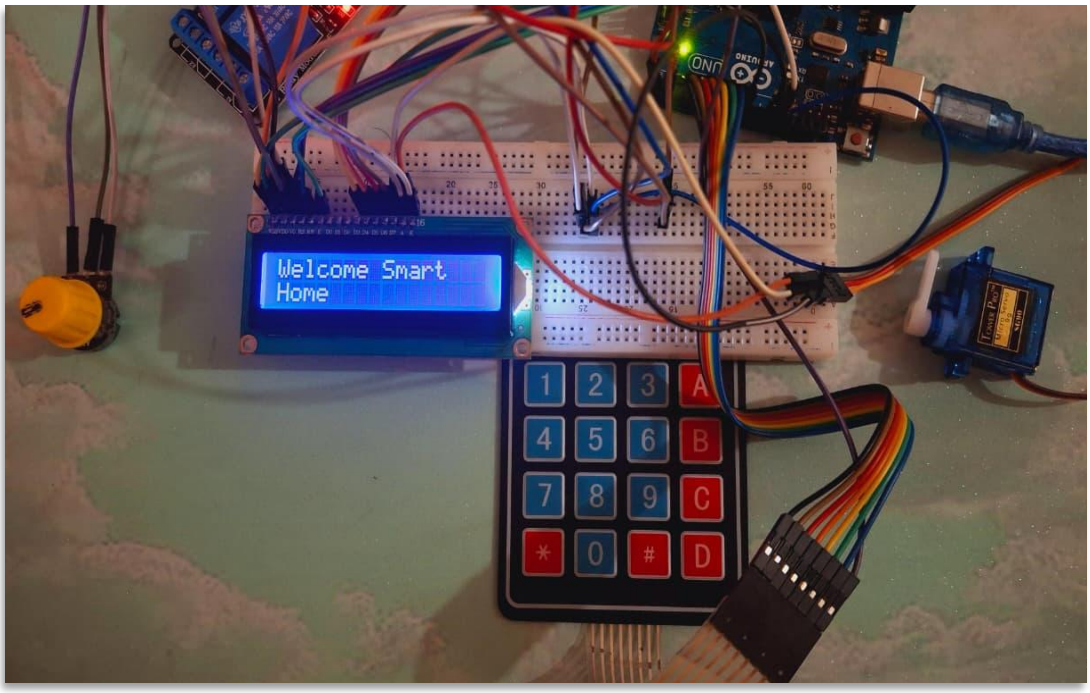


Fig C2 : The project will be activated and show the “Welcome Smart Home” message

Fig C3 : After that, will have to enter the password, and once the password is entered, it will show an "Access Granted" message.

Fig C4 : After access is granted, it will show me a "SafeZoneIsYours" message, and through this, we will be able to access our project.

Fig C4 : Picture of the "DOOR LOCK" feature

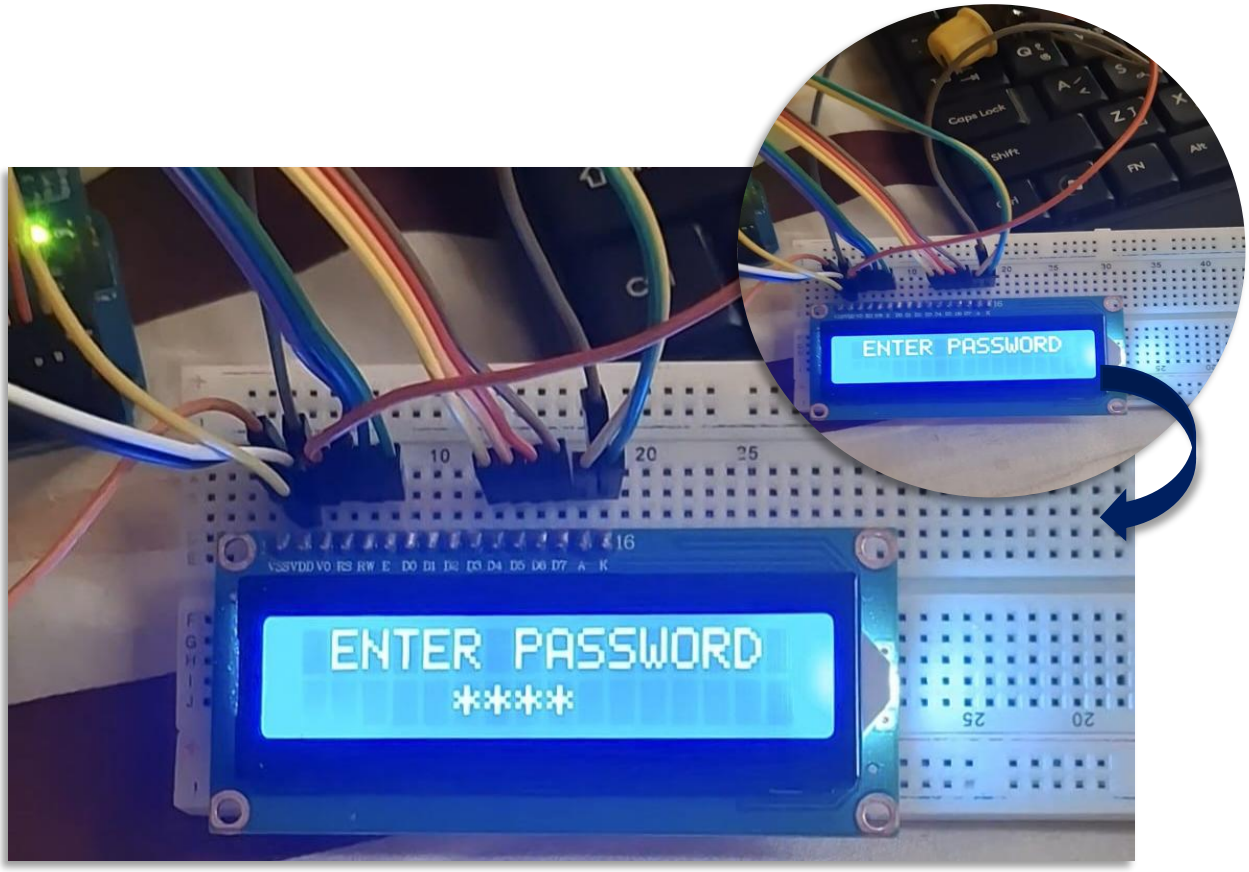


Fig C5 : To unlock the DOOR, the message, "ENTER PASSWORD" will appear, and then will need to enter the password

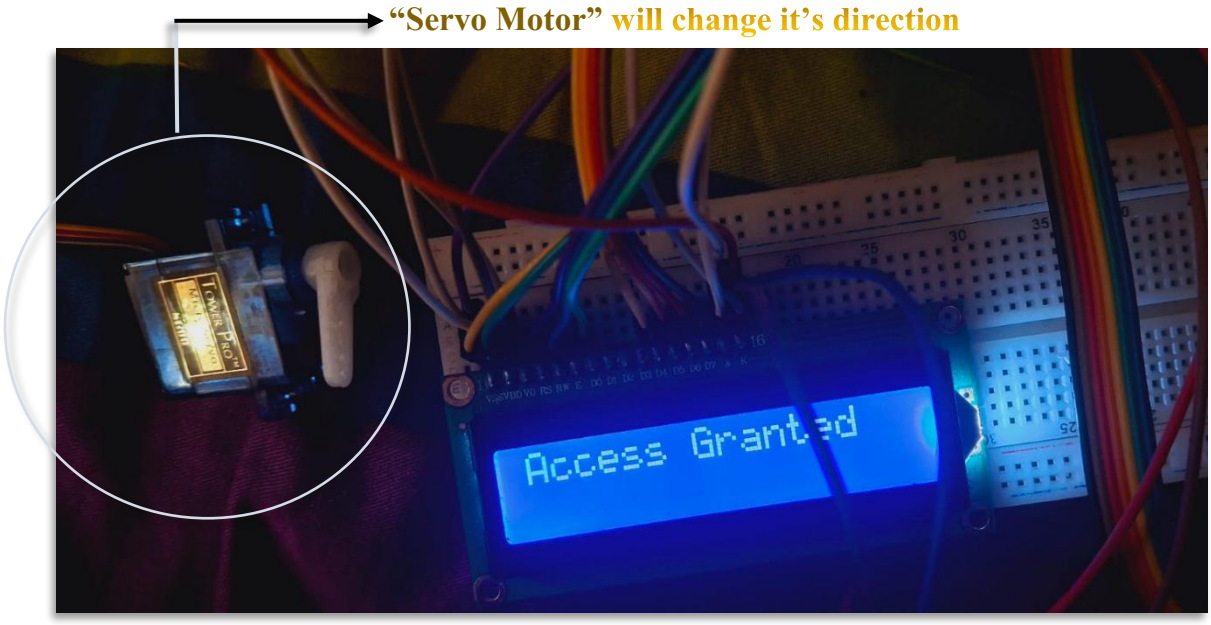


Fig C6 : After entering the correct password and access is granted, the direction of the SERVO MOTOR will change, meaning the door Will open

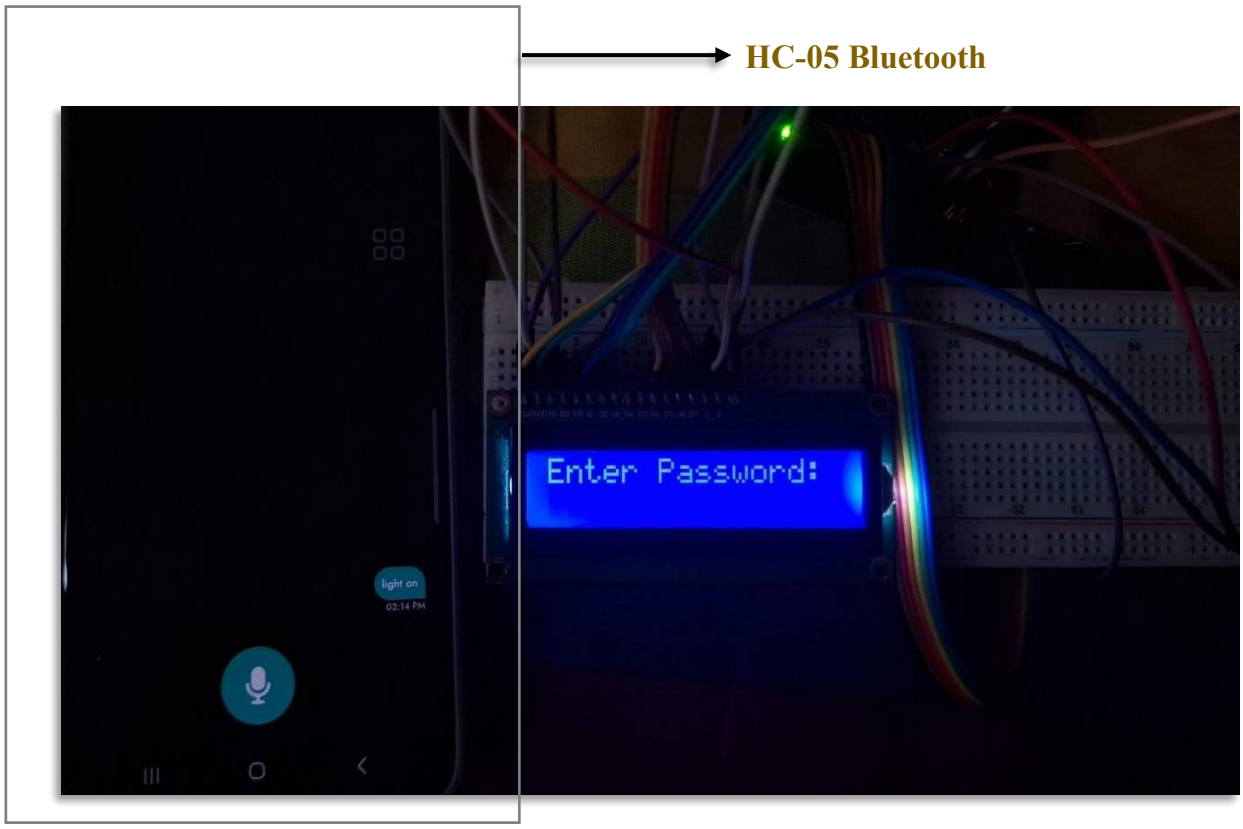


Fig C7 : This is our voice control feature, where after entering the password Will be able to use "voice commands" to turn off the lights and fan

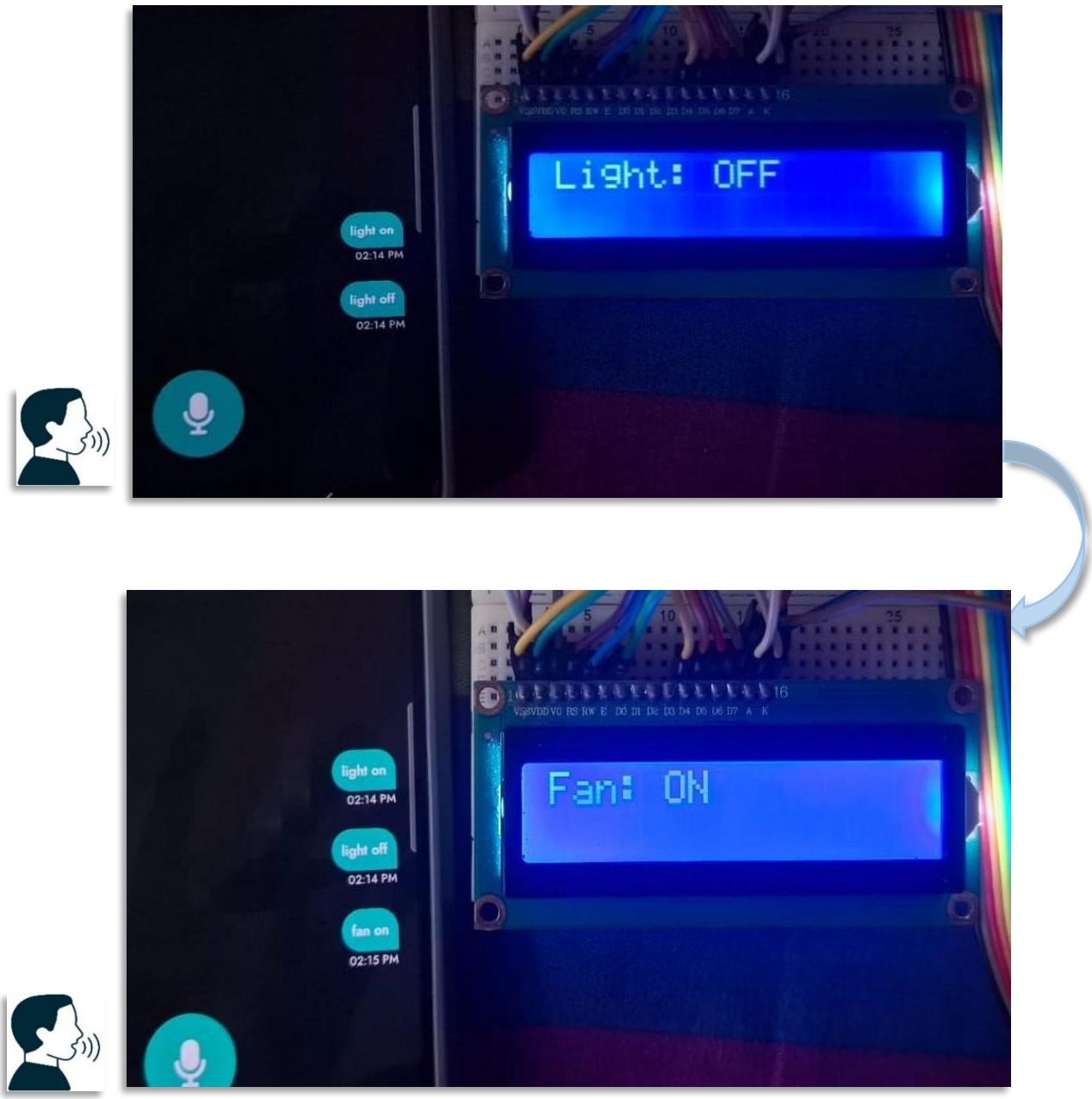


Fig C8 : "Voice Commands" for LIGHT & FAN

✅ All the above images and logs provide clear evidence that both modules—password-based access and voice-controlled automation—functioned correctly, both individually and after full system integration. **This confirms the successful implementation and testing of our smart home project.**

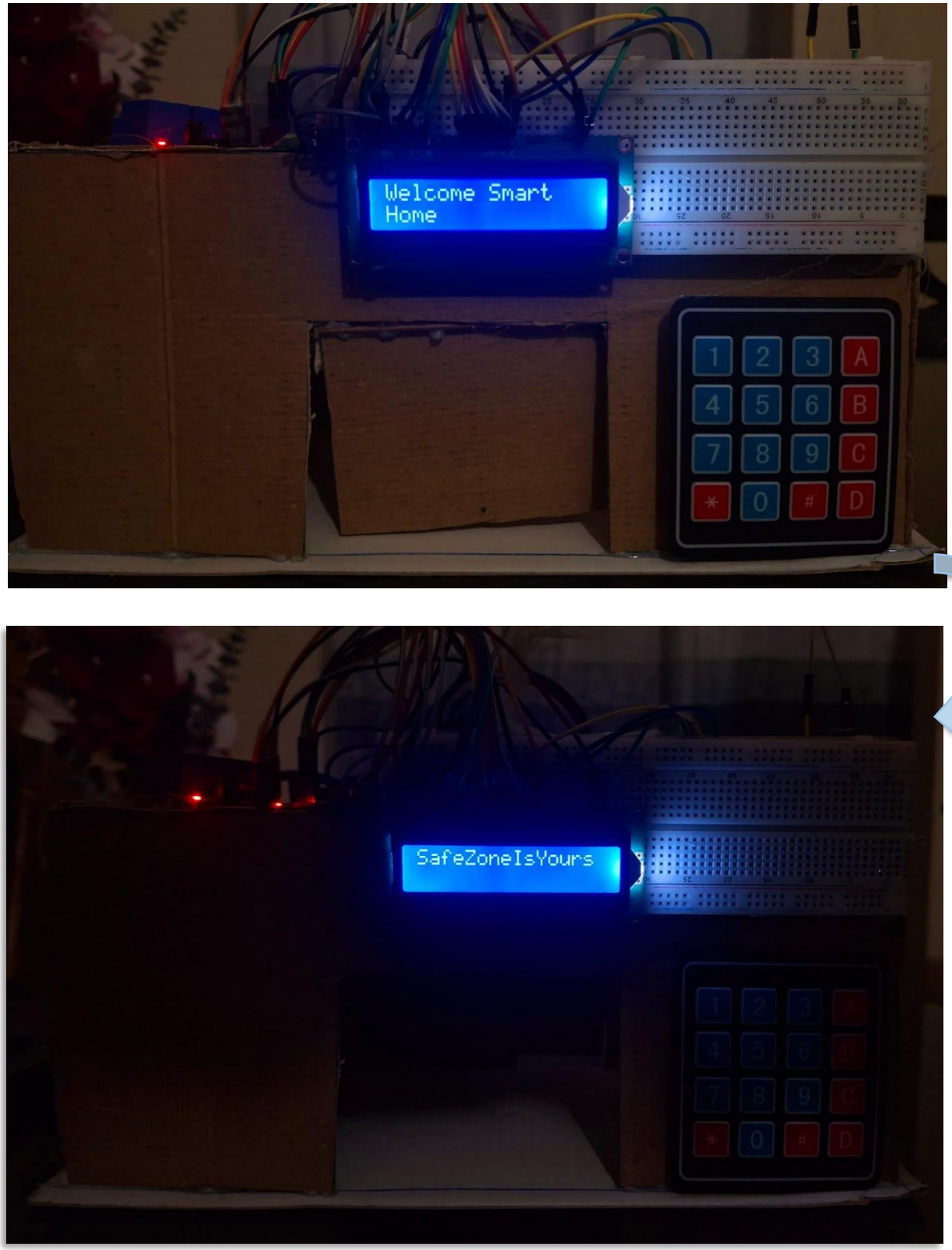


Fig C8 : FINAL OVERVIEW of our project

✓ RESULT & DISCUSSION

- **RESULT**

The developed smart home automation system effectively met its objectives of secure access and voice-based control. The password-protected door lock operated accurately, validating user input via the 4x4 keypad and controlling the servo motor to unlock and relock the door as expected. Unauthorized access attempts were reliably blocked, ensuring robust security.

Simultaneously, voice commands issued through Google Assistant—via **IFTTT** or a Bluetooth terminal—were correctly processed by the Arduino UNO using the **HC-05 module**. The system successfully activated relays to control appliances such as lights and fans with minimal delay, demonstrating stable performance and seamless module communication.

- **DISCUSSION**

This project demonstrates the practicality of building a scalable and affordable smart home system using accessible hardware. The integration of a password-based door lock with voice-controlled appliances reflects an effective balance between security and convenience.

The use of Arduino technology and wireless communication provided a responsive and **user-friendly experience**. Its modular design allows for future enhancements, including IoT connectivity and sensor integration. Overall, the system lays a solid foundation for more advanced home automation solutions in both **educational** and **practical applications**.

📈 QUANTITATIVE RESULTS TABLE

Test Scenario	Observed Behavior	Response Time	Accuracy
Correct password Entry	**Door Unlocked & Relocked**	**~1S**	**100%**
Wring Password Entry	**Access Denied**	**<1S**	**100%**
Light ON command	**Light Turned ON**	**~1S**	**100%**
Fan OFF command	**Fan Turned OFF**	**~1S**	**100%**

PERFOMANCE EVALUATION

- **Response for Time:** ~1 second relay activation.
- **Accuracy:** Correct rejection of wrong passwords.
- **Reliability:** Consistent results across tests.
- **Scalability:** Easily expandable.

PROJECT USEFULNESS

- Provides an affordable, scalable smart home solution suitable for students, DIY enthusiasts, and educational institutions.
- Enhances residential safety with password-based access, reducing risks of unauthorized entry.
- Improves daily convenience through voice-controlled appliance management, making home operation simpler and more efficient.
- Serves as a hands-on learning platform for understanding embedded systems, wireless communication, and automation.

REAL LIFE VALUE

- Offers practical benefits for households seeking modern security and comfort without **high installation costs**.
- Supports elderly or mobility-impaired users by enabling **touch-free, voice-based** control of lights and fans.
- Demonstrates how widely available components **(like Arduino, Bluetooth modules)** can create effective real-world smart home applications.
- Lays a foundation for future integration with **IoT, mobile apps,** and **additional smart features,** matching trends in modern home automation.

PROGRAM OUTCOME (PO) RELEVANCE

PO	Description (Short)	How It Applies to Your Project
PO1	Engineering knowledge	We applied electronics, programming, and control theory to build the system.
PO2	Problem analysis	We identified real-world issues (home security, convenience) and proposed an embedded solution.
PO3	Design/development	Designed a working prototype for door lock and appliance automation.
PO4	Investigation	Tested the system through multiple cases (correct/incorrect password, voice command).
PO5	Modern tool usage	Used Arduino IDE, microcontroller, LCD, relay, and Bluetooth module.
PO6	Engineer and society	Our system addresses safety and security issues (lock system, safe access).
PO7	Environment & sustainability	Promotes energy saving by remotely turning off unused appliances.
PO8	Ethics	Ensures access control and responsible use of electrical appliances.

PO9	**Individual/team work**	**We collaborated as a team to plan, code, and implement.**
P10	**Communication**	**Documented the report clearly, demonstrated project and explained working.**
P11	**Project management**	**Planned modules (lock + voice control), tested in parts, then integrated.**
P12	**Lifelong learning**	**Learned new tools (Bluetooth, Arduino, IFTTT) beyond textbooks.**

📚 COURSE OUTCOME (CO)

CO	Course Outcome	Relation to Project
CO1	**Apply knowledge of microcontrollers to real-world systems.**	**Used Arduino UNO for home automation.**
CO2	**Design and simulate embedded systems with sensors and actuators.**	**Integrated keypad, servo, Bluetooth, and relay with Arduino.**
CO3	**Analyze and debug embedded code and hardware systems.**	**Tested password logic, command responses, and verified serial logs.**

ENGINEERING COMPLEXITY & INTEGRATION

✓ **WP2**: Managed multiple input **systems (keypad + Bluetooth)** with potential technical conflicts.
✓ **WP3**: Designed custom logic—no direct solution available, required creative thinking.
✓ **WP4**: Combined uncommon modules **(servo, relay, HC-05, LCD)** in one system.
✓ **WP5**: Went beyond standard kits—required custom integration and testing.
✓ **WP7**: Involved multiple components and tasks—**servo, relay, voice, security**—all working together.
✓ **EA1**: Used diverse tools and components: **hardware + software + mobile.**
✓ **EA3**: Applied engineering knowledge in a unique way **(hybrid password + voice system).**
✓ **EA5**: Extended learning—combined new tech **(Bluetooth + IFTTT)** not covered in basic labs.

LIMITATION & FUTURE ENHANCEMENT

The current system is limited to Bluetooth communication and does not support internet-based connectivity. Future enhancements may include:

- **Wi-Fi Control:** Integration with **IoT** platforms **(such as Blynk or Firebase)** to allow remote access and cloud-based monitoring.
- **Biometric Access:** Adding fingerprint scanning or facial recognition for enhanced security and user authentication.
- **Mobile App Integration:** Developing a dedicated mobile app for real-time control, status monitoring, and user-friendly interaction.
- **Voice Assistant Support:** Connecting with smart assistants like Google Assistant or Alexa to enable seamless voice-activated control over appliances.

These upgrades would significantly improve the system's flexibility, accessibility, and security — making it more suitable for real-world smart home applications.

TECHNICAL LIMITATIONS AND CONSIDERATIONS

- **Power Consumption:** The system depends on continuous power; unexpected outages may cause failure of the lock mechanism or Bluetooth module.
- **Security Vulnerabilities:**
  - Bluetooth HC-05 can be paired by nearby attackers if default pairing code isn't changed.
  - Password could be shoulder-surfed; consider adding random keypad layout or biometric upgrade.
- **Range Limitations:** Bluetooth communication typically limited to ~10 meters.
- **System Complexity:** Adding more devices increases wiring complexity and power requirements.

This project successfully demonstrates the development and practical implementation of an **integrated smart home automation system**, combining secure access control and intuitive voice-activated appliance management within a single cohesive platform. By utilizing **affordable and widely available components**—including the Arduino UNO, HC-05 Bluetooth module, SG90 servo motor, 4x4 matrix keypad, and relay modules—the system proves that sophisticated home automation is achievable without the complexity or high cost typically associated with commercial smart home products.

The password-protected door lock mechanism showcases a tangible improvement in residential safety by providing controlled, temporary access, while the **voice control integration with Google Assistant** illustrates how modern AI-driven interfaces can make daily life more convenient and accessible. This hands-free operation is particularly beneficial for users with mobility challenges, highlighting the inclusive design potential of the system.

From a technical perspective, the project embodies the principles of **modularity, scalability, and interdisciplinary engineering**. Its architecture is flexible enough to support future enhancements, such as IoT connectivity for remote monitoring and control, integration of biometric authentication like fingerprint or facial recognition, sensor-based

automation for environmental awareness, and the development of dedicated mobile applications for enhanced user interaction.

Beyond its immediate functionality, this project serves as a **valuable educational prototype**, bridging the gap between theoretical concepts and real-world applications. It encourages students and hobbyists to explore the fields of embedded systems, wireless communication, actuator control, and user interface design, ultimately fostering innovation and skill development.

In summary, this work not only delivers a **practical and reliable solution** for smart home automation but also establishes a solid foundation for continued research and advancement in the evolving landscape of intelligent living environments—demonstrating how simple, cost-effective technologies can transform traditional homes into smarter, safer, and more responsive spaces.

🕮 REFERENCES

 Simon Monk, *Programming Arduino: Getting Started with Sketches*, 2016, McGraw-Hill Education.
– Offers foundational guidance on programming Arduino, relevant for developing the core control logic in the smart home system.

 Michael Margolis, *Arduino Cookbook*, 2020, O'Reilly Media.
– Provides practical code examples and problem-solving techniques, which support the implementation of modules like the keypad, servo motor, and relays.

 John Nussey, *Arduino For Dummies*, 2018, Wiley.
– Covers beginner-to-intermediate concepts, useful in understanding hardware integration and system prototyping.

 T. Martin, *Home Automation with Arduino*, 2017, Packt Publishing.
– Specifically focused on smart home projects, this book offers insights into automation scenarios similar to voice-controlled appliances.

 C. Hightower, *Bluetooth Essentials for Programmers*, 2015, Cambridge Press.
– Useful for understanding the Bluetooth HC-05 module and serial communication necessary for voice command processing via smartphone.

APPENDIX A: CIRCUIT DIAGRAMS

- Complete wiring diagram for the password-protected door lock system, showing connections between the 4x4 matrix keypad, Arduino UNO, and SG90 servo motor.

PICTURE

- Circuit layout illustrating the relay-controlled appliance automation, including integration with the HC-05 Bluetooth module and connections to appliances (light/fan).

PICTURE

APPENDIX B: SOURCE CODE

- Arduino sketch for implementing the door locking mechanism based on user password input.
- Arduino program enabling Bluetooth-based voice command interpretation and relay activation.
- Code snippets demonstrating the setup for Google Assistant integration through IFTTT, converting voice commands into Bluetooth signals readable by the Arduino.

[Note : Full code listings are provided below]

APPENDIX C: TEST RESULTS

- **Summary table** documenting different test scenarios, including correct and incorrect password entries, and the system's corresponding actions.
- Observations on system responsiveness to voice commands, highlighting latency and accuracy.
- Serial monitor logs captured during testing, showing received Bluetooth commands and Arduino responses, validating system functionality.

< /> SOURCE CODE

```
// ======================================================
// SMART HOME AUTOMATION SYSTEM
// Password-Protected Door Lock + Voice-Controlled Appliances
// ======================================================

#include <Keypad.h>
#include <Servo.h>
#include <LiquidCrystal.h>
#include <SoftwareSerial.h>

// Bluetooth Module
SoftwareSerial BT(10, 11);  // HC-05 TX to pin 10, RX to pin 11

// LCD Configuration: RS=A1, E=A2, D4=A3, D5=A4, D6=A5, D7=D0(RX)
LiquidCrystal lcd(A1, A2, A3, A4, A5, 0);
```

```
// Servo Motor
Servo lockServo;

// Relay Pins
#define relayLight 12
#define relayFan   13

// Keypad Setup
const byte ROWS = 4;
const byte COLS = 4;
char keys[ROWS][COLS] = {
  {'1','2','3','A'},
  {'4','5','6','B'},
  {'7','8','9','C'},
  {'*','0','#','D'}
};
byte rowPins[ROWS] = {2, 3, 4, 5};
byte colPins[COLS] = {6, 7, 8, A0};
Keypad keypad = Keypad(makeKeymap(keys), rowPins, colPins, ROWS, COLS);

// Password Configuration
String password = "1234";
String input = "";

void setup() {
  lcd.begin(16, 2);
  BT.begin(9600);

  pinMode(relayLight, OUTPUT);
  pinMode(relayFan, OUTPUT);

  lockServo.attach(9);
  lockServo.write(0);  // Start in locked position

  // Welcome Message
  lcd.setCursor(0, 0);
  lcd.print("Welcome Smart");
  lcd.setCursor(0, 1);
  lcd.print("Home");
  delay(5000);

  lcd.clear();
  lcd.print("Enter Password:");
}

void loop() {
  // Handle Bluetooth Commands
```

```
if (BT.available()) {
  String cmd = BT.readStringUntil('\n');
  cmd.trim();

  if (cmd == "light on") {
    digitalWrite(relayLight, HIGH);
    lcd.clear();
    lcd.print("Light: ON");
    delay(5000);
  }
  else if (cmd == "light off") {
    digitalWrite(relayLight, LOW);
    lcd.clear();
    lcd.print("Light: OFF");
    delay(5000);
  }
  else if (cmd == "fan on") {
    digitalWrite(relayFan, HIGH);
    lcd.clear();
    lcd.print("Fan: ON");
    delay(5000);
  }
  else if (cmd == "fan off") {
    digitalWrite(relayFan, LOW);
    lcd.clear();
    lcd.print("Fan: OFF");
    delay(5000);
  }
  lcd.clear();
  lcd.print("Enter Password:");
}

// Handle Keypad Input
char key = keypad.getKey();
if (key) {
  if (key == '#') {
    if (input == password) {
      lcd.clear();
      lcd.print("Access Granted");
      lockServo.write(90);  // Unlock Door
      delay(5000);

      lcd.clear();
      lcd.print("SafeZoneIsYours");
      delay(5000);

      lockServo.write(0);   // Re-lock door
    } else {
```

```
      lcd.clear();
      lcd.print("Wrong Password");
      delay(5000);
    }
    lcd.clear();
    lcd.print("Enter Password:");
    input = "";
  }
  else if (key == '*') {
    input = "";
    lcd.clear();
    lcd.print("Cleared");
    delay(1000);
    lcd.clear();
    lcd.print("Enter Password:");
  }
  else {
    input += key;
    lcd.setCursor(0, 1);
    lcd.print(input);
  }
 }
}
```

✓ TEAM INFORMATION

TEAM INFORMATION

PROJECT TITLE : SMART HOME AUTOMATION

COURSE TITLE : MICROPROCESSOR, MICROCONTROLLER & EMBEDDED SYSTEM LAB

COURSE CODE : CSE-3524
PROJECT REPORT

SPRING'25 (5BF)

Group – C

REVIEWER : Sultana Tasnim Jahan (ma'am) ;
Lecturer ; Dept of CSE, IIUC

TEAM MEMBERS :

Sanzida Nishat Nishi (C231442)

Saima Binte Soyeb (C231449)

Kazi Namira Meyheg Sanam (C231450)

Umme Benin Yeasmin Meem (C231452)

DATE : 06.08.2025

◆ SECTION 01 : INDIVIDUAL MEMBER EVALUATION

Criteria	Nishi (Member 1)	Saima (Member 2)	Sanam (Member 3)	Benin(Member 4)
Contribution to Task Completion	5	4	4	4
Technical Knowledge & Implementation	5	4	4	4
Communication & Team Coordination	4	5	5	5
Participation in Meetings & Discussions	5	4	4	4
Use of Tools (GitHub, Proteus, etc.)	4	5	5	5

Commitment to Deadlines	**5**	**5**	**5**	**5**
Innovation & Problem-Solving	**5**	**4**	**4**	**4**

◆ SECTION 02 : QUALITATIVE FEEDBACK

▯ Which team member(s) showed leadership or took initiative?

ANSWER :

NISHI initiated the project by providing the main idea and demonstrating strong leadership throughout. All members collaboratively set up the hardware and participated in testing. The team worked together to connect the components successfully.

Here's how each member contributed:

◆ NISHI: (C231442)

Nishi showed clear leadership throughout the project. She led the hardware setup, connected all components, and fixed major issues—like the servo motor malfunction. She also combined code from all members into a single working program and took the lead in testing and debugging. Her initiative and problem-solving skills made her the technical backbone of the team.

◆ SAIMA: (C231449)

Thoroughly reviewed the report, made necessary corrections, and suggested valuable improvements. She was responsible for wiring the servo motor and LED connections during the hardware setup. Additionally, Saima and Benin worked together to connect the pins of the 4x4 keypad. She actively participated in team discussions and testing phases.

◆ SANAM: (C231450)

Collaborated with Benin to write and organize the project report, ensuring it was well-structured and clear. She implemented the code for the password lock system and worked with Nishi to integrate the Bluetooth module for voice control. Sanam also helped in connecting components during the hardware setup and actively participated in every stage of testing. Her consistency, focus, and teamwork made her a reliable contributor throughout the project.

◆ BENIN: (C231452)

Played a key role in designing and formatting the report with Sanam. She implemented the code for the voice control system and worked on combining the code for both the password and voice-controlled modules. She also worked with Saima to connect the 4x4 keypad pins. Benin actively participated in discussions, handled final integration, and resolved critical issues during testing.

□ Were there any challenges or conflicts in your team? If yes, how were they handled?

ANSWER :

Yes, some confusion occurred during **hardware testing** and **pin connections**. These were resolved through group discussions and dividing roles more clearly.

□ What is one thing your team did well?

ANSWER :

We successfully integrated **two systems (keypad + Bluetooth)** into one seamless smart home solution and tested them thoroughly with documented results.

□ What is one area your team could improve?

ANSWER :

Use of development tools like version control **(GitHub)** and simulation tools **(Proteus)** could be improved. Also, some members could be more involved in the hardware phase.

◆ SECTION 03 : OVERALL TEAM REFLECTION

On a scale of 1 to 10, how would you rate your team's collaboration?
☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☑10

FINAL COMMENT :

We are proud of building a functional and secure smart home automation system that can be further expanded. Collaboration, learning, and innovation were strong in this project.

THE END

"We hope this project demonstrates the practical value of embedded systems in real-world applications."