CHITTAGONG UNIVERSITY OF ENGINEERING AND TECHNOLOGY

ETE 416

Project Name: Smart Home Automation

Submitted by:

Sheikh Sayduzzaman Noyan, Md. Arif Islam, Md. Najmul, Anik Paul

ID: 1908033, 1908038, 1908040, 1908054

Submitted to:

Md. Ibrahim Khalil

Assistant professor

Dept. of ETE, CUET

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1 Introduction

Smart Home Automation is a revolutionary advancement in the field of technology, where residential environments are equipped with devices that can be controlled and monitored remotely. This involves integrating everyday household appliances and systems such as lighting, security, ventilation, and entertainment with communication technologies and microcontrollers. The goal is to make homes more intelligent, convenient, and energy- efficient. In this project, an IoT-based smart home system is developed using Bluetooth tech- nology, enabling users to operate various devices through their mobile phones. This wire- less automation provides a cost-effective and user-friendly solution that eliminates the need for complex wiring systems. The entire setup uses an Arduino UNO as the central controller and allows switching appliances on or off with simple mobile commands.

2 Aims and Objectives

The primary aim of this project is to design and implement a smart home automation system using IoT technologies that can control home appliances wirelessly via a mobile phone.

- To develop a cost-effective and scalable smart home system using Arduino UNO and Bluetooth communication.
- To ensure ease of operation for end-users through a simple mobile interface.
- To demonstrate the automation of basic home devices such as lights, a door lock, and indicators.
- To explore the potential for future enhancements including additional sensors and cloud connectivity.

3 Importance in the Developing World

Smart home automation holds immense potential for improving quality of life, particularly in developing countries. These regions often face challenges such as power shortages, security concerns, and the need for affordable housing solutions. The importance of smart home systems in such contexts includes:

- **Energy Efficiency:** Automated systems can turn off unused appliances, helping conserve electricity and reduce bills.
- **Security Enhancements:** Automated door locks and surveillance integration improve home security and peace of mind.
- **Accessibility:** People with disabilities or the elderly benefit greatly from voice or app-based controls that reduce dependence on physical switches.
- **Scalability:** Low-cost components and ease of installation allow smart home systems to be widely adopted in urban and rural areas.
- **Job Creation:** The rise of IoT technology opens new avenues for technical education, entrepreneurship, and employment in local markets.

4 Components

Table 1: List of Components Used in the System

Component	Description
Arduino UNO	Microcontroller board for controlling the system
4-Channel Relay Module	Used to switch appliances (bulbs, locks, etc.)
5V Power Supply Battery	Powers the circuit components
HC-05 Bluetooth Module	Enables wireless communication with mobile devices
Jumper Wires	Connects components on the breadboard
Bulb and LED	Indicators and output devices
Door Locker	Electromechanical lock controlled via relay

4.1 Arduino UNO:

The Arduino UNO is an open-source microcontroller board based on the ATmega328P. It contains 14 digital input/output pins, 6 analog inputs, a USB connection, and a power jack. In this project, the Arduino acts as the control unit that receives Bluetooth commands and accordingly triggers outputs through the relay module. Its versatility and simplicity make it ideal for prototyping IoT applications.

Figure 1: Arduino UNO

4.2 4-Channel Relay Module:

The relay module functions as an electrically operated switch. It allows the low-voltage digital signals from the Arduino to control higher voltage appliances such as light bulbs and door locks. Each channel of the module corresponds to a different device in the home automation system.

Figure 2: 4-Channel Relay Module

4.3 HC-05 Bluetooth Module:

The HC-05 module is a serial Bluetooth module designed for wireless communication. It allows the Arduino to receive commands from a Bluetooth-enabled mobile device. This eliminates the need for a Wi-Fi network or wired connection, making the system more accessible in areas with limited infrastructure.

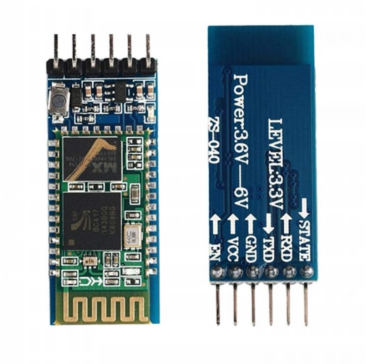

Figure 3: HC-05 Bluetooth Module.

4.4 IR Sensor Module:

The IR (Infrared) sensor module is used to detect the presence of objects or motion by emitting infrared light and measuring the reflection. When an object comes within the sensor's range, the reflected IR light is detected by the receiver, triggering a response in the system. This functionality makes it suitable for applications like automatic lighting, motion-based control, and security alerts in home automation systems.

Figure 4: IR Sensor Module.

4.5 Jumper Wires:

Connection wires, often referred to as electrical or electronic wires, are fundamental components used to establish electrical connections between various devices, components, and circuit elements in an electrical or electronic system. They serve as conductive pathways for the flow of electric current.

Figure 5: Wires

4.6 Bulb and LED:

These components serve as output devices. The bulb is used for basic on/off testing, while the bulb demonstrates the control of higher voltage devices. They showcase the practical applicability of the system in everyday home scenarios.

Figure 6: Bulb

4.7 Door Locker:

A motorized door locking system is included to demonstrate security integration in the smart home model. The relay controls the locking and unlocking mechanism, allowing secure access via Bluetooth commands.

Figure 7: Door locker

4.8 Servo motor

: A servomotor is a rotary or linear actuator that allows for precise control of angular or linear position, velocity, and acceleration in a mechanical system.

Figure 8: Servo motor

5 Methodology

This Arduino-based home automation project allows control of two bulbs and a door lock (servo motor) using a Bluetooth module and an Android app. Additionally, an IR sensor automatically turns on a bulb when someone enters the room.

- **2** bulbs and door lock via Bluetooth app commands (A, a, B, b, O, C).
- **I**R sensor auto-turns ON a bulb on detecting motion.
- **R**elay module switches AC bulbs on and off safely.
- **S**ervo motor simulates door lock mechanism.

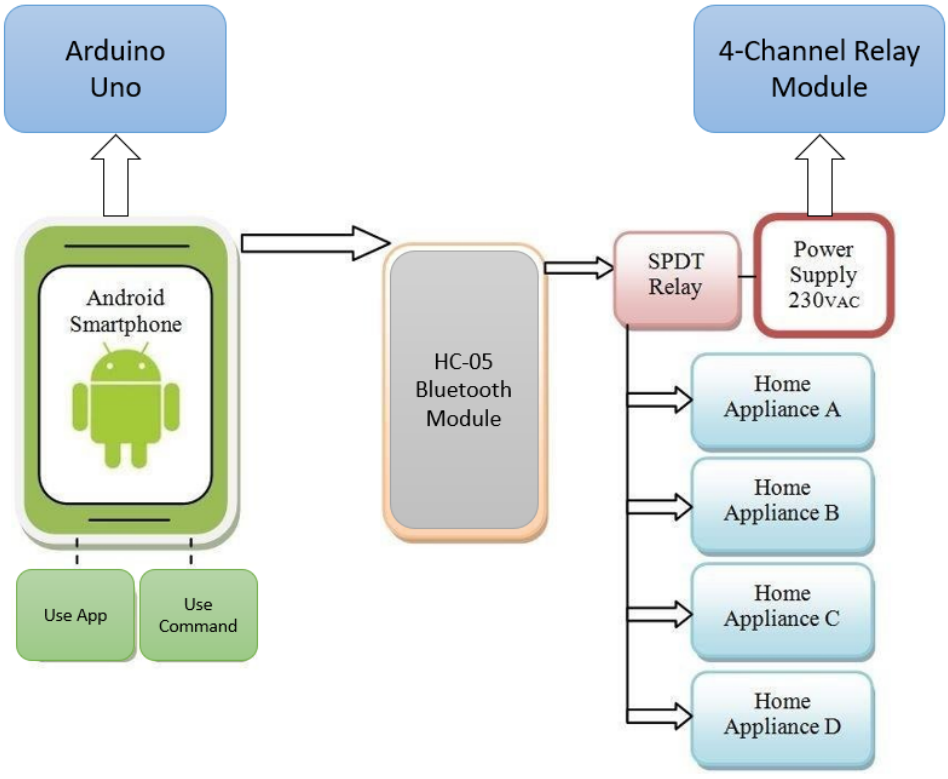

Figure 9: Flow chart of methodology

Wire connection:

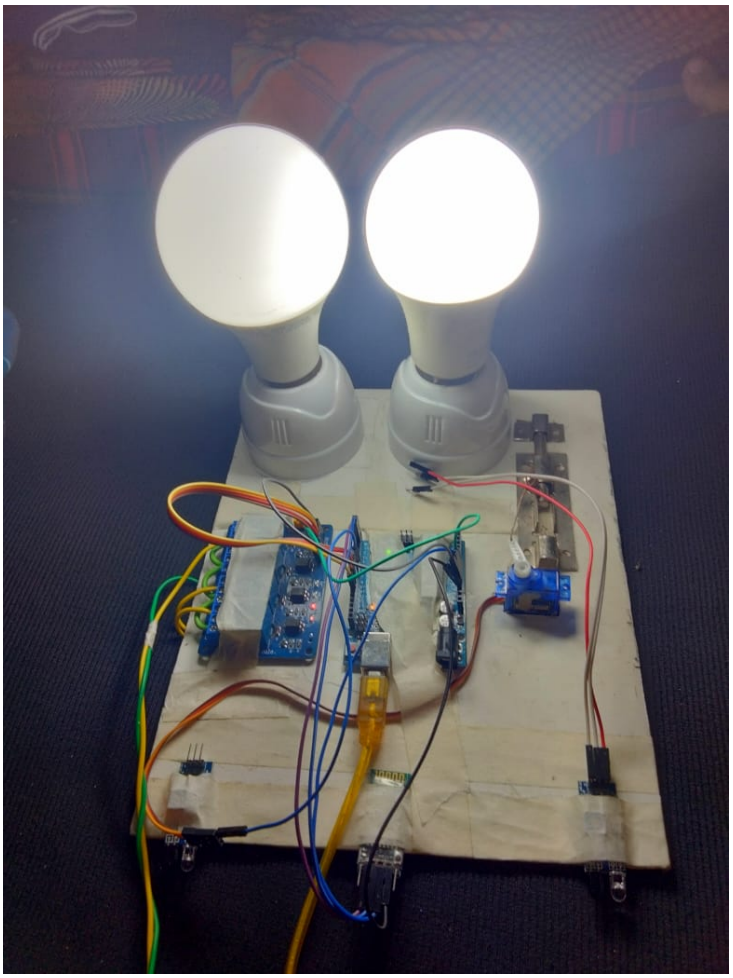

Figure 10: Final wire connection

6 Advantages and Disadvantages:

Advantages

The IoT-based Smart Home Automation system developed in this project demonstrates the practical application of embedded systems and wireless communication in modern living environments. While the prototype offers many benefits in terms of cost, control, and convenience, it also presents certain limitations that must be considered. The following points outline the main advantages and disadvantages of the system:

Cost-Effective: The system uses affordable components like Arduino UNO and Bluetooth modules, making it suitable for low-budget implementations.

Wireless Operation: Devices can be controlled without physical wiring, offering ease of use and installation.

User-Friendly: The mobile interface allows simple on/off control through Bluetooth, accessible to users with minimal technical skills.

Energy Efficiency: Appliances can be turned off remotely, helping to reduce power consumption and electricity bills.

Scalable Design: More appliances and sensors can be added easily in the future, with potential upgrades to Wi-Fi or voice control.

Improved Security: The project includes a door locking mechanism, contributing to home security features.

Disadvantages

Limited Range: Bluetooth has a short-range (typically 10–15 meters), restricting control to nearby locations.

No Internet Access: Remote control over the internet is not possible unless upgraded with Wi-Fi or GSM modules.

Security Concerns: Bluetooth communication can be vulnerable to hacking or unauthorized access if not properly secured.

7 Future Work:

1. Wi-Fi or GSM Integration: Upgrading the system to use Wi-Fi or GSM modules (e.g., ESP8266, SIM800L) would allow remote control of home appliances from anywhere in the world via the internet.

2. Mobile Application Development: Creating a dedicated Android or iOS app with a graphical user interface (GUI) would improve user experience and control over devices.

3. Sensor-Based Automation: Integrating motion sensors, temperature sensors, or light sensors would allow automated control of devices based on environmental conditions.

4. Security Enhancements: Implementing authentication methods, such as passwords or fingerprint modules, can improve the security of the smart lock system.

5. Emergency Alerts: The system can be enhanced to send SMS or app notifications in case of emergencies like intrusion, fire, or gas leakage

8 Conclusions

I successfully completed my project by integrating Arduino UNO, a 4-channel relay module, HC-05 Bluetooth module, and various household components such as bulbs, LEDs, and a door lock. By connecting these with jumper wires on a breadboard and controlling them wirelessly via a mobile phone, the system was able to switch devices on and off using simple Bluetooth commands. This setup offers a reliable and efficient means of controlling home appliances without the need for physical switches or wired communication.

In conclusion, the IoT-based Smart Home Automation project provides a practical and modern approach to home control and monitoring. It enhances user convenience, promotes energy efficiency, and introduces a layer of smart technology into everyday life. While the system is easy to implement and cost-effective, it is limited by its reliance

on Bluetooth, short-range communication, and lack of advanced features like real-time remote access or automation through sensors.

The success of such a system relies on thoughtful design, proper hardware connections, and understanding user needs. Future developments may include Wi-Fi or GSM connectivity, integration with mobile apps, or voice-activated systems to further improve functionality and accessibility. References

References

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