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SMART TOUCH SWITCH BOARD WITH VOICE RECOGNITION

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Abstract: In the era of smart homes, the "Smart Switch Board" project aims to revolutionize traditional home appliance control by integrating Bluetooth technology and touch switches into a centralized system. The core components of the system include touch switches, Bluetooth modules, and a NodeMCU microcontroller, providing both tactile and voice-controlled automation capabilities. The touch switches serve as the interface for manual control, allowing users to interact with their home appliances effortlessly. Simultaneously, the integration of Bluetooth technology enhances the project's versatility, enabling voice-controlled commands for a hands-free experience. The NodeMCU microcontroller acts as the brain of the system, orchestrating communication between touch switches, Bluetooth modules, and connected appliances. Through this centralized hub, users gain the ability to manage multiple devices remotely, fostering a seamless and interconnected smart home environment. This project not only introduces convenience but also contributes to energy efficiency and sustainability. By automating the control of home appliances, users can optimize their energy consumption, leading to reduced environmental impact. In conclusion, the Smart Switch Board project represents a leap forward in home automation, combining tactile and voice-controlled functionalities to create an intelligent and user-friendly solution for modern living.

Keywords: Proximity Switch Sensor, Solenoid Electric Lock, Fingerprint Reader Sensor Module, Digital Temperature Controller.

I. INTRODUCTION

Literature is like a vast tapestry woven with the threads of human imagination and expression. It encompasses a wide range of written works, including novels, poetry, plays, and essays, each offering a unique glimpse into the human experience. Literature possesses the capacity to transport us to alternate realms, elicit deep-seated emotions, and stimulate contemplation. It's not just about storytelling; literature often reflects the cultural, social, and historical contexts in which it is created . Literature is a dynamic and ever-evolving reflection of our collective imagination.

Figure 1 illustrates the block diagram of the Internet of Things.

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Smart touch panel switchboards utilize touch or Bluetooth commands to control household appliances through Internet of Things (IoT) technology. The IoT can be described as a network of physical devices or persons called "things" that are integrated with some software, electronic components, networking, and sensors to capture the External data sources enable these devices to gather and exchange information [13-22]. The main aim of this to increase the internet connectivity from devices like computers, mobiles and tablets. IoT drive everything becomes virtually "smart and fashionable" by upgrading other facets of our lives with the power of data integration, representation and collection.

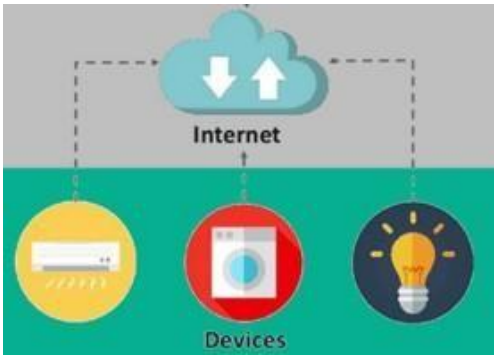

Figure 1.1: How IoT works

II. HOW IT WORKS

Though, this is not a conveying of information. Depending on the implementation of application to be used and the system design complexity, the users can also perform some steps which produces result. For instance, to observe the changes in the temperature of the air conditioner with the help of technology invented by IoT, the user can able to make the adjustments Users can monitor temperature fluctuations using their mobile app.

Home Automation Systems presently focus on Smart Phone based utilization as the easiest way to associate with the Smart Home appliances. Nevertheless, this has not always been the situation. It has discharged from different architectures and systems into the developed architecture it is now. In this regard following Papers were considered and the technologies were differentiated.

Home automation based on IoT utilizing an Android application [1]. The authors suggested a device that is secure and safe. Here the user can send commands from the android mobile to the Arduino controller to control the home appliances. The main interest of this proposed work is to control the voltage levels of house hold appliances like we can control the speed of the fan or light intensity of the lights etc and we can also get the status of all the devices which are controlled by Arduino controller through our smart phones . This paper is developed to help for physically handicapped people. Mobile based Home Automation using Internet of Things (IoT) [2]. In this paper, the authors demonstrated about how IoT works and how it can be used to control house hold appliances by using Arduino based microcontroller and smart phone apps. Real Time Smart Home Automation based on PIC Microcontroller, Bluetooth and Android Technology [3].In this paper authors proposed smart home automation using PIC technology and this system is fully operational features to control different appliances. IoT based monitoring and control system for home automation [4].this paper proposes an efficient implementation of IoT, which is used for monitoring the house hold devices through smart phone using low power communication protocols such as Wi-Fi, Zigbee and raspberry pi as a server.

III. SYSTEM OVERVIEW

In Due to evaluation in technology, conventional switch panels are gradually replaced with the modern switch boards. This will not only enhance the aesthetic appeal of our home but also make the appliances more convenient and safe to use. These new touch keys have additional features. Here no more other operating portions are involved in fabrication and also prevailing than the conventional switches. But a modern touch switch panel with wireless connectivity is utterly expensive. So the goal of this paper is to furnish the same services as that of a costly touch switch board but within an affordable budget. This is feasible by replacing the expensive LCD touch display with a TFT (Thin Film Transistor) touch display.

The below figure shows the proposed system overview. In this we are using Arduino Uno ATMEGA328P, Bluetooth module HC-05, Relay, TFT LCD display and bulb.

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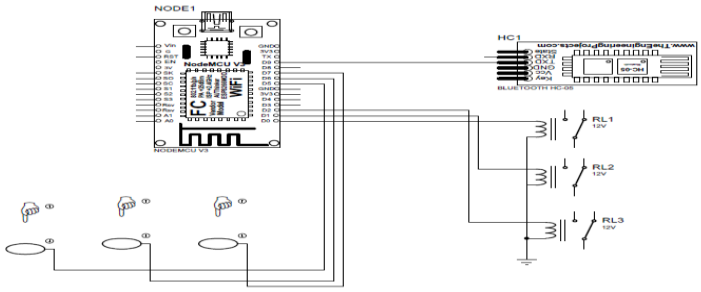

Figure 3: System Block Diagram

IV.HARDWARE DESCRIPTION

A. Node MCU

NodeMCU is a firmware and development kit that is open-source and built on the ESP8266 WiFi module. The ESP8266 is a low-cost, highly-integrated wireless microcontroller that gained significant popularity for its ability to provide WiFi connectivity to various electronics projects. The goal of the NodeMCU project is to simplify the process for developers and hobbyists to utilize the ESP8266 module, achieved through offering user-friendly firmware and development tools.

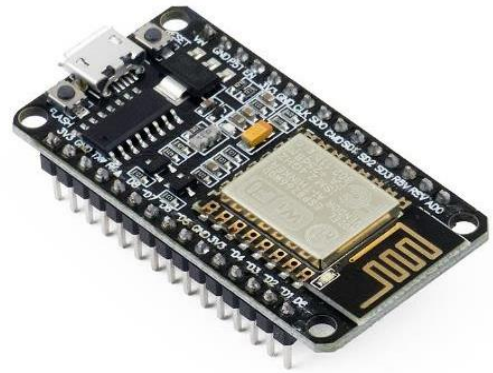

Figure 4: Node MCU

Lua Scripting: NodeMCU originally provided a Lua-based scripting environment, allowing developers to write code directly on the module using the Lua programming language. This made it accessible to individuals who lacked familiarity with embedded programming.

WiFi Connectivity: The main purpose of the NodeMCU firmware is to enable WiFi connectivity for IoT (Internet of Things) applications. The module can connect to local WiFi networks and communicate with other devices over the internet.

Arduino Compatibility: While the original NodeMCU firmware was based on Lua, there are also Arduino-compatible firmware options available for the ESP8266. This allows developers to program the module using the Arduino IDE, which is a popular platform for creating embedded projects.

GPIO Pins: The ESP8266 module has a set of General Purpose Input/Output (GPIO) pins that allow you to interface with external components such as sensors, actuators, LEDs, and more.

Integrated Development Environment (IDE): NodeMCU development can be done using various IDEs, such as the Arduino IDE or the NodeMCU-specific IDE. These IDEs provide tools for writing, compiling, and uploading code to the module.

Community and Documentation: NodeMCU has a vibrant and active community that provides tutorials, documentation, and support for users. This makes it easier for beginners to get started with the technology.

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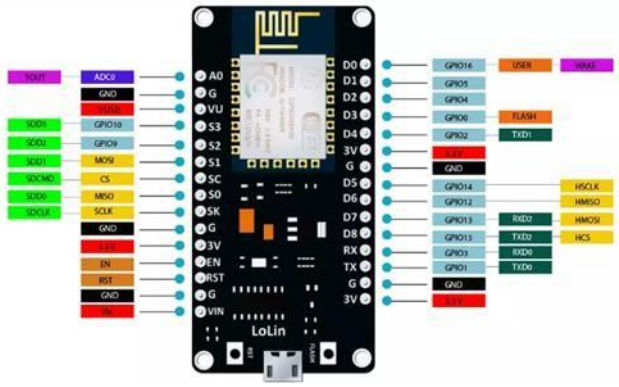

Figure 4.1: Pin Description of NodeMCU

3V3 (3.3V): Supplies a regulated 3.3V power source for external components. Many components on the board operate at this voltage level.
RST (Reset): Allows you to trigger a reset of the ESP8266, restarting your program or resetting the module.
GND (Ground): Provides the common ground reference for the circuit. Connect components' ground connections here.
D0 (GPIO16): General-purpose digital I/O pin, usable for input or output tasks. Can also wake the ESP8266 from deep sleep.
D1 (GPIO5, SCL): Serves as the clock (SCL) pin for I2C communication, a two-wire serial communication protocol used to connect sensors and devices.
D2 (GPIO4, SDA): Acts as the data (SDA) pin for I2C communication, facilitating the exchange of data between devices.
D3 (GPIO0): General-purpose digital I/O pin. During boot-up, it influences the boot mode of the ESP8266.
D4 (GPIO2): General-purpose digital I/O pin. Also affects boot mode during the boot-up process.
D5 (GPIO14, SCLK): Clock (SCLK) pin used in SPI communication for synchronizing data transfer between devices. It also supports PWM.
D6 (GPIO12, MISO): Master In Slave Out (MISO) pin used in SPI communication for data transmission from the slave to the master. It also supports PWM.
D7 (GPIO13, MOSI): Master Out Slave In (MOSI) pin used in SPI communication for data transmission from the master to the slave.
D8 (GPIO15): General-purpose digital I/O pin. It supports PWM and can be used as an input or output.
TX (GPIO1): Transmit pin for UART serial communication, allowing data to be sent from the board to other devices.
RX (GPIO3): Receive pin for UART serial communication, receiving data from other devices.
A0 (ADC): Analog input pin for reading analog voltages using the ADC (Analog to Digital Converter). Useful for reading sensors that provide analog output.
Vin: Input voltage pin for external power supply. Typically 5V, used to power the board externally. EN (Enable): Used to enable or disable the ESP8266 module.

Specifications

Microcontroller	ESP8266E
Operating Voltage	3.3V
Digital I/O Pins	11 (D0 - D10)
Analog Input Pins	1 (A0)
Clock Speed	80 MHz
Flash Memory	4 MB
Wi-Fi	802.11 b/g/n (2.4 GHz)
Wireless Range	indoor 100 meter Outdoor 400 meter
Operating Temperature Range	-40°C to +125°C
Input Voltage	5V (via USB or VIN pin)
Output Voltage	3.3V
Current Consumption	~80 mA (average), ~170 mA (peak)
USB-to-Serial Chip	CH340G

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Programming Interface	Micro USB
GPIO Pins	PWM, I2C, SPI, and 1-Wire
Onboard Antenna	Yes
Dimensions	49.3mm x 25.5mm
Compatible IDEs	Arduino IDE, PlatformIO, NodeMCU Lua

Working

The NodeMCU v1.0 is a development board that utilizes the ESP8266 microcontroller module, allowing for WiFi connectivity and versatile digital and analog input/output capabilities. Here's a general overview of how the NodeMCU v1.0 works:

• Microcontroller and CPU: The NodeMCU v1.0 is centered around the ESP8266EX microcontroller, which features a 32-bit RISC processor. This processor carries out commands, manages tasks, and oversees input/output operations.

• Voltage Regulation: The board operates at a voltage of 3.3v,which is controlled by an internal voltage regulator. This ensures that the components receive a stable voltage level for reliable operation.

• Digital and Analog I/O: The NodeMCU offers 11 digital I/O pins (D0-D10)to interface with digital components and devices. These pins can be used as inputs or outputs to interface with various devices. Additionally, the A0 pin serves as an analog input with a 10-bit ADC, allowing you to measure continuous voltage levels from sensors.

• Wi-Fi Connectivity: One of the standout features of the NodeMCU is its WiFi connectivity. The ESP8266 module supports a range of WiFi modes, including Station mode for connecting to existing networks and SoftAP mode for creating its own access point. This capability allows the board to establish communication over the internet and with other WiFienabled devices.

• Programming and Communication: To program the NodeMCU, you can use different Integrated Development Environments (IDEs) like the Arduino IDE or the NodeMCU firmware with Lua scripting. The USB-to-Serial chip (CH340G) facilitates the connection between your computer and the board, allowing you to upload code, monitor output, and debug. • GPIO and Communication Protocols: The General Purpose Input/Output (GPIO) pins are versatile and can be configured for various communication protocols. PWM allows you to modulate the duty cycle of digital signals, I2C lets you connect multiple devices with just a few wires, SPI enables high-speed communication, and 1-Wire simplifies data exchange with sensors.

• Operating System and Applications: The NodeMCU runs firmware that provides a way to execute your code. This firmware can be written in various languages like C++, Lua, or MicroPython. This versatility opens the door to a multitude of applications, including IoT projects like weather stations, home automation systems, smart appliances, and remote monitoring devices.

• Power Consumption: The NodeMCU has varying power consumption levels depending on its operational state. It's important to manage power effectively, especially when running on battery power. You can implement strategies like using deep sleep modes to reduce energy consumption during idle periods.

B. Relay Module

A relay is an electrical or electromechanical device that is used to control a circuit remotely by opening or closing contacts in response to an input signal. Relays are commonly used in various applications to isolate high-voltage circuits from low-voltage control circuits, to switch power to different components, and to control complex systems.

Figure 4.2: Relay

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Pin Description

VCC / +5V: This pin is used to supply the relay module with a 5V power source. It powers the coil of the relay and the associated circuitry on the module.

GND / Ground: This pin is connected to the ground of your power supply or microcontroller to complete the circuit.

IN / Signal Input: This pin is used to provide the control signal to the relay module. Applying a HIGH (5V) or LOW (0V) signal to this pin will activate or deactivate the relay, respectively. This is typically connected to a digital output pin of a microcontroller.

COM / Common: This terminal of the relay is referred to as the common terminal.It's the terminal that's connected to one end of the load (such as a light bulb or a motor).

NO / Normally Open: This terminal is normally not connected to COM. When the relay is activated (due to a signal on the IN pin), the COM and NO terminals are connected, allowing current to flow through the load.

NC / Normally Closed: This terminal is normally connected to COM. When the relay is activated, the COM and NC terminals disconnect, interrupting the current flow through the load.

Specifications

Operating Voltage	5V DC
Input Voltage	5V DC
Maximum Current Consumption	70-100 mA
Maximum Switching Current	10A
Maximum Switching Voltage	250V AC, 30V DC
Contact Rating	10A at 250V AC, 10A at 30V DC
Operate Time	Around 5-10 ms
Release Time	Around 1-5 ms
Coil Resistance	Around 50-100 Ω
Isolation Voltage	Around 1000V between input and output circuits Dimensions commonly around 40mm x 30mm x 18mm

Working

The working of a 5V relay module involves using a small electrical signal to control the switching of a larger electrical load, such as turning a light bulb on or off. Here's a step-by-step explanation of how a 5V relay module typically works:

- Activation Signal: To control the relay, you need a small control signal, usually from a microcontroller, a sensor, or any other digital device. This signal is usually 5V, which is why these modules are called "5V relay modules."
- Relay Coil: The relay module has a coil that is wound around an iron core. This coil is connected to the activation signal. When the control signal is applied (usually a HIGH signal or 5V), current flows through the coil, creating a magnetic field around the iron core.
- Attracted Armature: The magnetic field generated by the coil attracts an armature (a metal piece) that is connected to a set of movable contacts inside the relay.
- Contact Switching: When the armature is attracted, it moves towards the stationary contacts, either closing or opening the circuit, depending on the type of relay and the initial state of the contacts.
- Load Control: The stationary contacts are connected to the load circuit, which can be a high-voltage or high-current device like a lamp, motor, or heater. If the contacts were initially open, they close when the relay is activated, allowing current to flow through the load. If the contacts were initially closed, they open when the relay is activated, cutting off the current to the load.
- Release Signal: When the control signal is removed (usually set to LOW or 0V), the current through the coil stops, and the magnetic field dissipates. This causes the armature to return to its original position due to spring tension, and the contacts switch back to their original state.

C. BLUETOOTH MODULE HC-05

AT commands are the only means through which the functionality of the Bluetooth module HC-05 can be altered. HC-05 Bluetooth module can be used for wireless communication for Bluetooth enabled devices. It is in master slave configuration. Slave modules are unable to establish a connection with another Bluetooth device independently;however,they can permit incoming connections.The master module has the capability to establish connection with other devices. To establish connection between microcontroller and GPS, PC to embedded device, the user must use it for a serial port replacement etc. The Bluetooth communication is a 2.4GHz frequency based RF communication with a range of 10 to 15 meters. In this, the circuit is connected to the HC-05 Bluetooth module to the Arduino Uno board. The module is paired with an android phone and controlled via a simple android app that reads the

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data from the Bluetooth module through the Arduino, responds as per the commands and finally controls the device connected to the circuit.

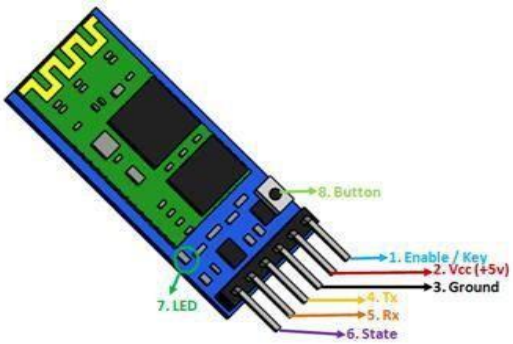

Figure 4.3: BLUETOOTH MODULE HC-05

D. Touch Sensor TTP224

The TTP224 is a capacitive touch sensor module that allows you to add touch-sensitive inputs to your projects. The "4 Channel" designation indicates that it has four touch-sensitive channels, meaning you can configure it to detect touch on up to four different sensor pads or areas.

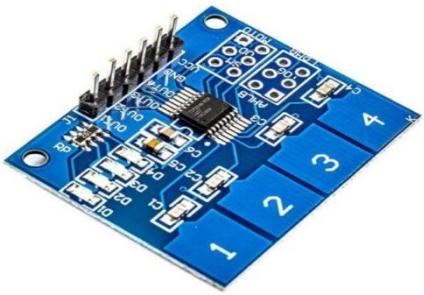

Figure 4.4: TOUCH SENSOR TTP224

Pin Description

VCC: This is the power supply pin. Connect it to a voltage source (usually between 2.0V and 5.5V) to provide power to the module.

GND: This is the ground pin. Connect it to the ground of your power supply and microcontroller/development board.

OUT1: This output pin corresponds to the first touch-sensitive channel (CH1) on the TTP224 module. When a touch is detected on the sensor pad connected to this channel, the OUT1 pin's state will change. This change in state serves as an indicator of a touch event. Connect OUT1 to a digital input pin on your microcontroller. In your microcontroller code, you can monitor the state of this pin to detect when a touch is registered on the first sensor pad.

OUT2: Similarly, OUT2 is associated with the second touch-sensitive channel (CH2) on the module. It operates in the same way as OUT1 but corresponds to the touch events detected on the second sensor pad.

OUT3: This output pin corresponds to the third touch-sensitive channel (CH3) on the module. Just like OUT1 and OUT2, it changes its state when a touch is detected on the third sensor pad.

OUT4: Finally, OUT4 is tied to the fourth touch-sensitive channel (CH4) on the module. When this channel detects a touch, the OUT4 pin's state will change.

Working

The TTP224 is a capacitive touch sensor module that works by detecting changes in capacitance caused by a person's touch.

Capacitance is a property that describes how electrical charge is stored between two conductive surfaces with an insulator (dielectric) between them. When a person touches a capacitive touch sensor pad, their body's electrical capacitance combines with the sensor's capacitance, causing a change in the overall capacitance. The TTP224 module detects this change and registers it as a touch event.

Here's a basic explanation of how the TTP224 works:

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• Initialization: To use the TTP224 module, you need to provide it with power by connecting the VCC and GND pins to a suitable power supply. The module usually operates within a voltage range of 2.0V to 5.5V.

• Sensor Pads: Connect touch sensor pads to the OUT1, OUT2, OUT3, and OUT4 pins. These sensor pads can be any conductive material like a piece of metal or a conductive pad. When a person touches a sensor pad, their body forms a capacitive connection with the pad.

• Capacitance Change: When the sensor pad is untouched, the capacitance between the pad and the environment remains relatively stable. However, when a person touches the pad, their body's capacitance is added to the existing capacitance. This additional capacitance creates a detectable change.

V. SYSTEM FLOW

1. Connect TOUCH Sensor With NODEMCU
2. Connect the Bluetooth module with NodeMCU
3. Connect the relay module between the bulb holders and the NodeMCU
4. Import the source code to the NodeMCU with the help of USB cable.

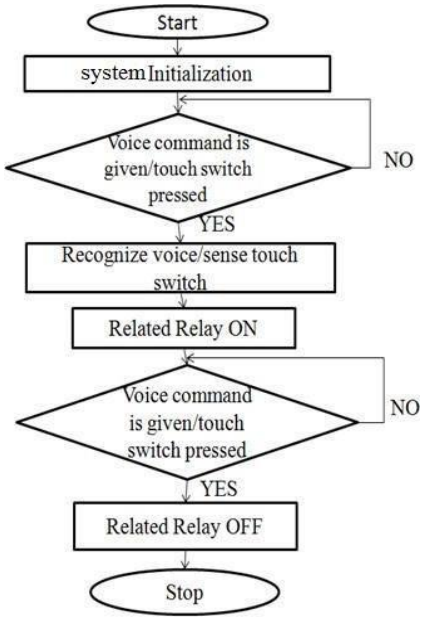

Figure 5: Flow Diagram

VI. RESULT AND DISCUSSION

Result analysis for this project involves evaluating the performance, user satisfaction, and the achievement of project objectives. The result analysis should be comprehensive, considering both quantitative and qualitative data to provide insights into the success and areas for improvement of the Smart Touch Switchboard with Voice Recognition for Home Automation using IoT project. Regular monitoring and feedback collection contribute to ongoing system refinement and optimization.

Some key points are:

• Conduct thorough functionality testing to verify that each component and feature of the system works seamlessly. • Compare energy usage patterns before and after implementing the system, considering user preferences and environmental conditions.

• Conduct penetration testing and security audits to identify and address potential vulnerabilities.

• Collect user feedback through surveys, interviews, or user testing sessions to identify areas of improvement and gauge overall satisfaction.

• Assess the responsiveness, speed, and reliability of the mobile app in real-world usage scenarios.

• Evaluate user engagement with customization options and gather feedback on the flexibility and adaptability of the system.

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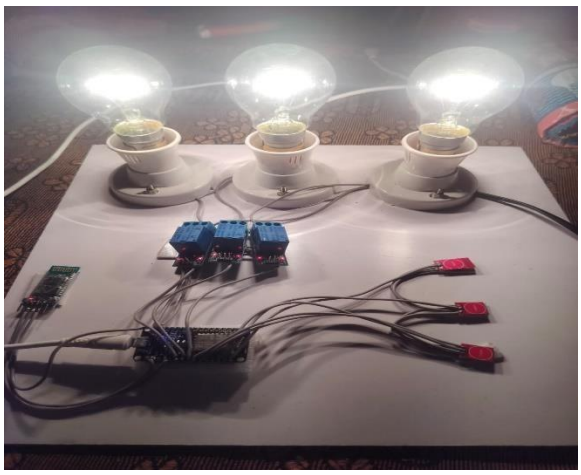

Figure 5.1 demonstrates the process of activating the light bulb using the smart touch switch panel.

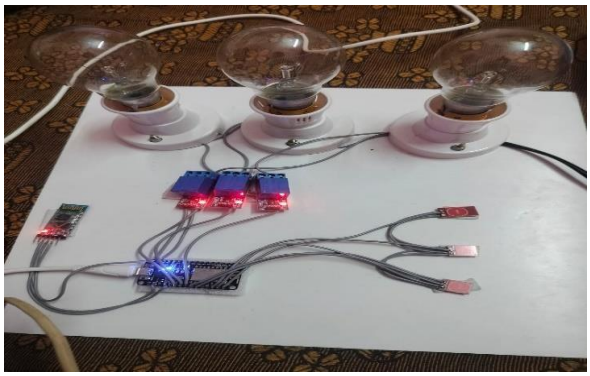

Figure 5.2 illustrates the procedure for deactivating the light bulb using the smart touch switch panel.

VII.CONCLUSION

In conclusion, the Smart Switch Board project represents a cutting-edge advancement in home automation, seamlessly blending touch switch interfaces, Bluetooth technology, and a NodeMCU microcontroller. This innovative system not only provides users with tactile and voice-controlled options for managing home appliances but also introduces a new level of convenience and energy efficiency. By centralizing control and enabling remote connectivity, the project not only aligns with the demands of modern living but also contributes to a sustainable and intelligent home environment. The convergence of these technologies not only enhances user experience but also sets the stage for the evolution of smart homes, where intuitive automation becomes an integral part of our daily lives.

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