National University of Sciences and Technology (NUST)
School of Electrical Engineering and Computer Science

Department of Electrical Engineering

Instrumentation and Measurements

Voice Controlled Home Automation

Project Report

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Abstract:

This report introduces an advanced home automation system leveraging Google Assistant for voice-controlled management of electrical loads. It offers a seamless experience through Online, Manual, and Timer modes, allowing real-time remote control and alternative manual operation for enhanced user flexibility and convenience.

Introduction:

The fusion of artificial intelligence and smart home technology has revolutionized domestic living, empowering households with intuitive control mechanisms. "Voice Controlled Home Automation using Google Assistant – Control Multiple Loads in Online, Manual, and Timer Mode" represents an innovative foray into this dynamic landscape, aiming to harness the power of Google Assistant for seamless management of diverse household appliances. This project embarks on a journey to redefine the home automation experience by integrating Google Assistant, a prominent voice-controlled interface, enabling users to effortlessly control multiple electrical loads. Through meticulous hardware selection, software development, and interface design, this report showcases the creation of a comprehensive system capable of operation through Online, Manual, and Timer modes. With a spotlight on user-centric functionalities, including remote access, scheduled routines, and manual overrides, this report navigates through the intricacies of this home automation solution, emphasizing its potential to redefine convenience, efficiency, and interaction within contemporary living spaces.

In the pursuit of enhancing the functionality and user experience of the Voice Controlled Home Automation system, the integration of additional sensors has been identified as a valuable addition. This includes infrared sensor (IR), and temperature sensor. These sensors serve as additional input devices, allowing users to control electrical loads through detect presence or movement using infrared technology, and monitor environmental conditions with temperature sensing capabilities. This expanded sensor integration not only enriches the system's responsiveness but also broadens the scope of interaction within the smart home ecosystem.

This report delves into the integration, calibration, and optimization of these sensors within the existing Voice Controlled Home Automation system. By combining the power of Google Assistant with these additional sensors, the aim is to create a more versatile and adaptive smart home solution that not only responds to vocal commands but also reacts intelligently to environmental stimuli and user presence. The subsequent sections detail the technical aspects, benefits, and potential applications of infrared, and temperature sensors into the existing framework, highlighting the strides taken to elevate the home automation experience to new heights.

Components:

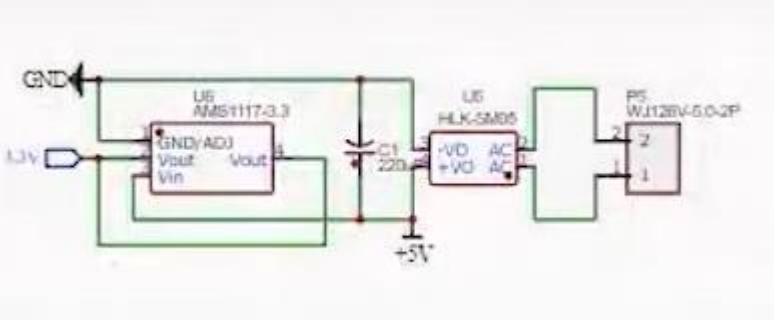
1. ESP32
2. Relays
3. AC-DC Converter
4. Voltage Regulator/Sensor
5. IR Sensor
6. Temperature Sensor
7. Transistors
8. Resistors
9. Capacitors

Literature Review:

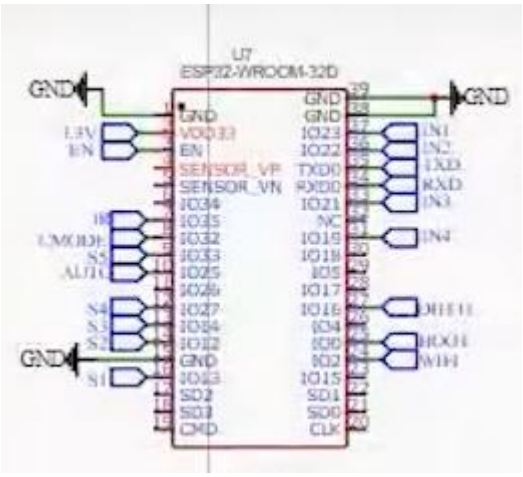
Recent studies emphasize the integration of voice recognition systems like Google Assistant in home automation, enhancing user accessibility and experience. Microcontrollers, specifically the ESP32, play a pivotal role in instrumentation within home automation, enabling interaction with sensors and relay systems, aligning with principles taught in the course. Additionally, discussions underscore the significance of reliable measurement systems and accurate control mechanisms in ensuring the safety and efficiency of home automation setups. Studies highlight the necessity of appropriate sensor interfacing, relay control mechanisms, and energy-efficient operations, resonatingwith core principles of instrumentation and measurement in optimizing energy consumption and ensuring precise data acquisition. In summary, the literature emphasizes the importance of accurate, reliable, and energy-efficient control mechanisms within home automation systems, aligning with principles taught in the Instrumentation and Measurement course and validating the relevance of the project's objectives.

Design:

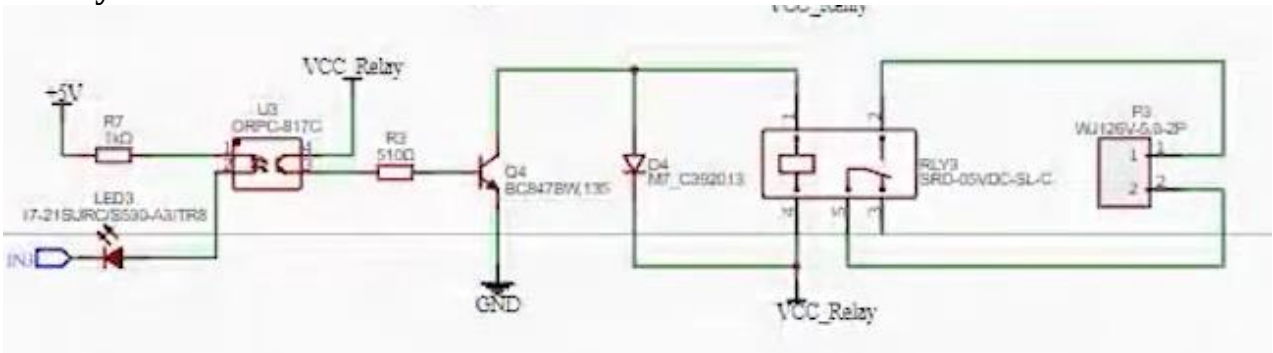
Power Supply:



NODE MCU:



Relay Module:



Working:

Home Automation System with Google Assistant, ESP32, and Multi-Sensor Control

This home automation system leverages Google Assistant as the primary interface for users to control various household devices through voice commands. The ESP32 Wi-Fi Module acts as the central processing unit, interpreting commands and executing them based on three operational modes:

Online Mode: With an internet connection, users can remotely control devices through Google Assistant, offering convenient access from anywhere.
Manual Mode: Physical switches or buttons connected to the ESP32 provide direct control, even without voice commands or internet access, ensuring immediate device response.
Timer Mode: Users can pre-schedule device operations using the ESP32's internal timer, automating tasks based on desired timing parameters.

The system receives input from various sources:

Input Pins (IN1 to IN4): These pins connect to physical switches or sensors, allowing for diverse control options tailored to user preferences.
IR Sensor: This sensor detects infrared signals, typically emitted from remote controls, enabling additional control methods using familiar devices.
Temperature Sensor: Monitoring ambient temperature allows for automation based on environmental conditions, such as automatically adjusting fan settings for optimal comfort.

Relay output pins (R1 to R4) control electrical loads through relay driver circuits, ensuring safe and efficient power management for connected devices. An AC-DC converter transforms household 220V AC to 5V DC, providing the necessary power supply for the system.

Key Advantages:

- **Multi-faceted control:** Voice commands, physical buttons, IR signals, and timed schedules offer flexibility and convenience for users.
- **Remote and local operation:** Enjoy control whether you're at home or away, thanks to internet-enabled remote access and local manual options.
- **Enhanced automation:** Sensors like the IR sensor and temperature sensor expand the system's capabilities, enabling automated actions based on specific inputs or environmental conditions.

This system provides a robust and versatile home automation solution, empowering users with effortless control and intelligent automation possibilities for a truly connected and comfortable living experience.

Code Overview:

Our Arduino code is for home automation sketch that integrates various components such as relays, switches, DHT11 sensor, IR receiver, and Blynk for remote monitoring and control. Here's a brief overview of the code:

Libraries:

Our code includes several libraries such as `DHT`, `WiFi`, `BlynkSimpleEsp32`, and `IRremote`.

Blynk Configuration:

Blynk template ID, template name, and authentication token are defined.
WiFi credentials (SSID and password) are specified.

Hardware Pin Definitions:

Pins for DHT sensor, IR receiver, relays, switches, and status LEDs are defined.
Virtual pins for Blynk buttons, temperature, and humidity are specified.

Initializations:

The IR receiver is enabled, DHT sensor is initiated, and pins are set as input or output.
Initial states for relay toggles and switch states are set to LOW.

Blynk Callbacks:

`BLYNK_WRITE` functions handle changes in Blynk app widgets, updating the state of relays accordingly.
`BLYNK_CONNECTED` function is triggered upon Blynk connection, syncing the state of virtual pins.

Functions:

`all_SwitchOff`: Turns off all relays and updates Blynk app accordingly.
`checkBlynkStatus`: Checks Blynk connection status and updates the WiFi status LED.
`readSensor` and `sendSensor`: Read DHT sensor values and send them to Blynk.
`ir_remote`: Handles IR remote control signals, toggling relay states based on the received IR codes.
`manual_control`: Controls relays based on the state of physical switches.

Setup:

Pins are initialized, IR and DHT are enabled, and initial relay states are set. Blynk is configured, and initial states are sent to the app if `fetch_blynk_state` is set to false.

Loop:

The main loop runs functions for manual control, IR remote control, Blynk processing, and timer events.

Timer:

A timer is set to check Blynk status and send sensor data periodically.

Overall Functionality:

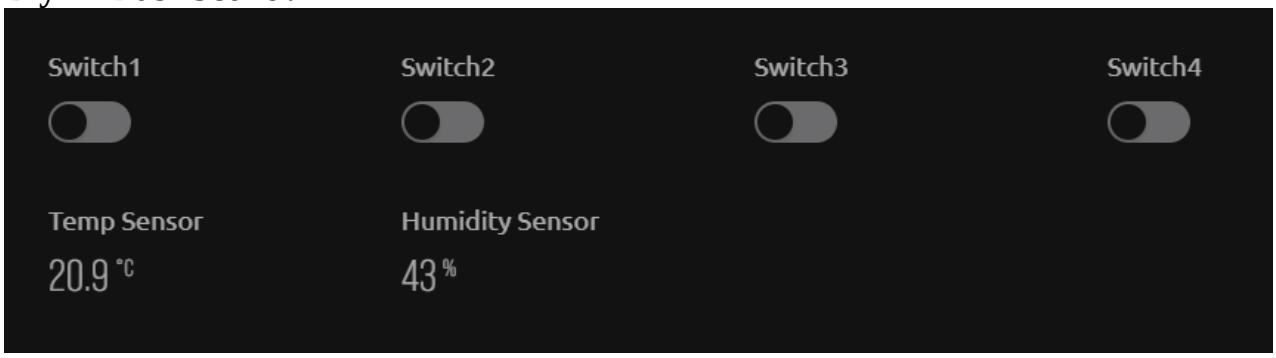
The code allows manual control of relays through physical switches, IR remote control, and remotely through the Blynk app.

Temperature and humidity data from the DHT sensor are sent to the Blynk app.

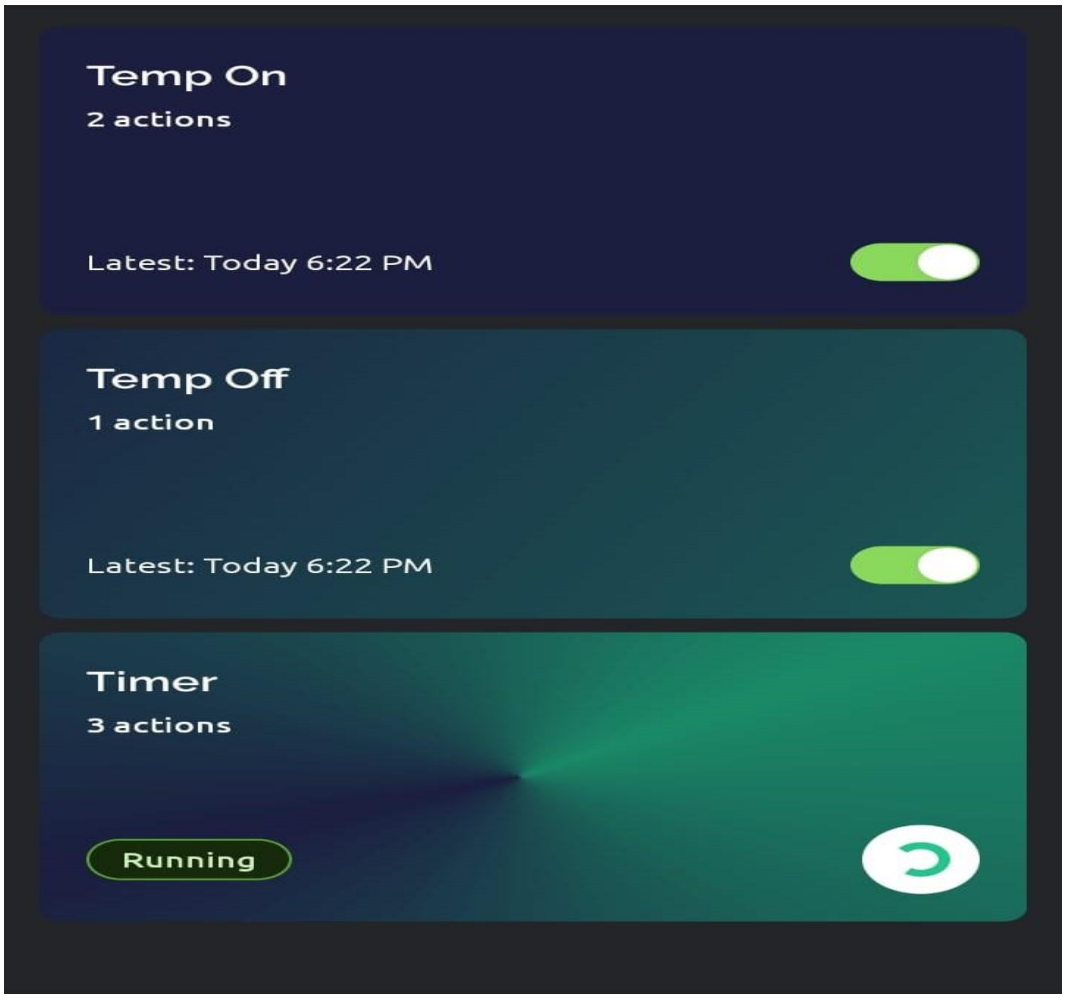
This code handles Blynk connection status, syncing initial states, and updating the app based on physical interactions.

Results:

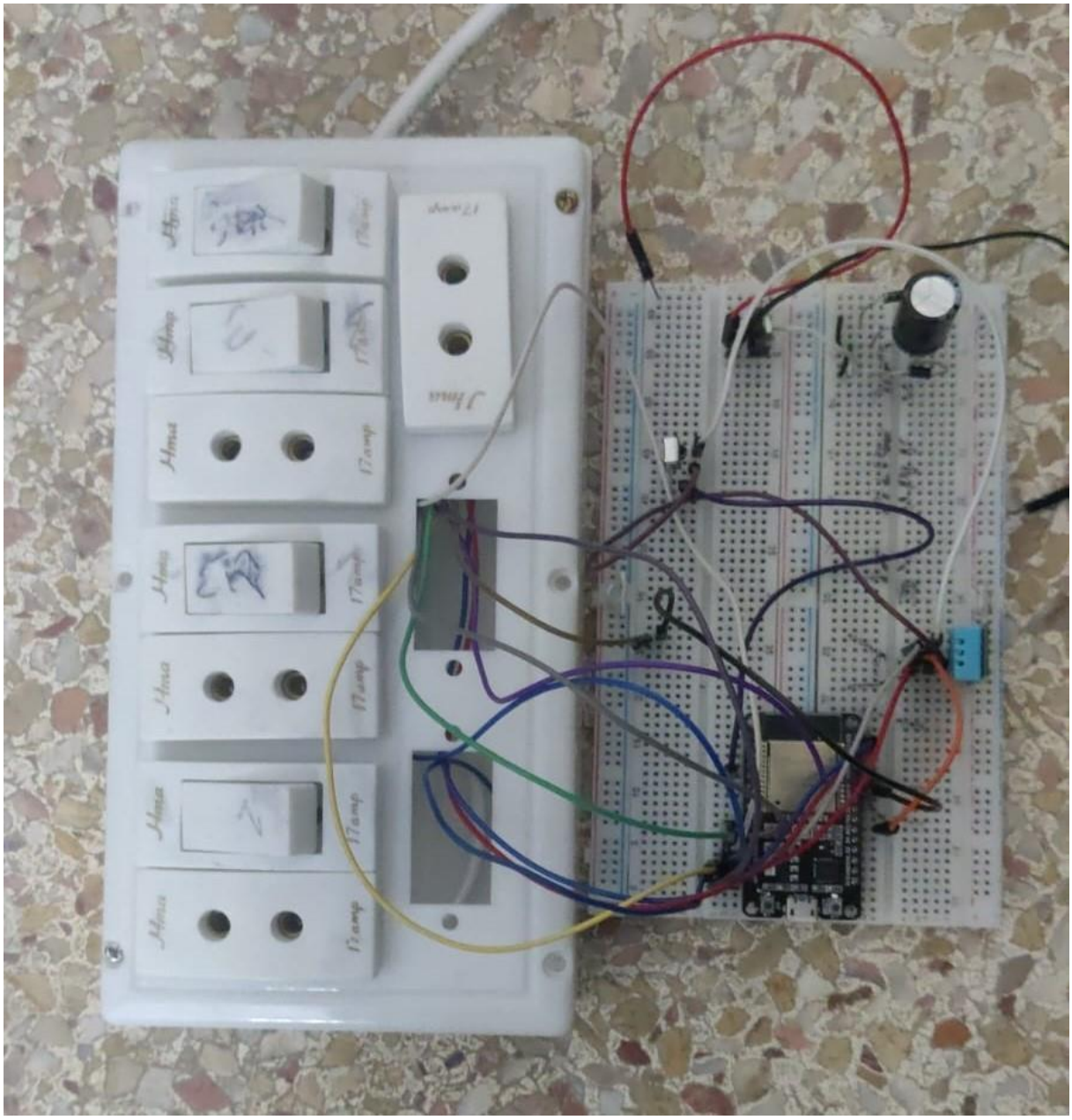
Blynk Dashboard:



Automation Panel:



Hardware:



Improvement Over Market Product:

1. Voice Control Integration with Google Assistant:

Many existing home automation products may not have seamless integration with popular voice assistants like Google Assistant. Our system leverages Google Assistant for intuitive voice control, providing users with a familiar and widely used interface.

2. Multi-Mode Operation:

Our system operates in Online, Manual, and Timer modes, offering users a range of control options. This flexibility exceeds the capabilities of some existing products that may focus on only one or two modes of operation.

3. Incorporation of Additional Sensors:

The integration of infrared (IR) and temperature sensors distinguishes our system. While some existing products may lack these additional sensors, our solution broadens the scope of automation by allowing users to control devices based on presence, movement, or environmental conditions.

4. Timer Mode for Energy Efficiency:

The Timer Mode enables users to schedule routines for devices, promoting energy efficiency by reducing unnecessary power consumption. This scheduling feature may be absent in some existing products, limiting their ability to optimize energy usage.

5. Potential for Expansion and Integration:

Our project's modularity and incorporation of additional sensors create a scalable foundation for potential expansion and integration with other smart home devices. This flexibility sets our system apart from products that may lack compatibility with diverse smart home ecosystems.

In summary, the combination of voice control, multi-mode operation, additional sensors, and a focus on user customization and efficiency sets our Voice Controlled Home Automation system apart from existing products in the market. These improvements contribute to a more comprehensive and adaptable smart home solution.

Applications:

1. **Convenient Home Automation:**

   The system offers users the convenience of controlling multiple electrical loads through voice commands facilitated by Google Assistant. This convenience allows for hands-free operation, especially beneficial for individuals with mobility issues or those seeking seamless interaction with household devices.

2. **Remote Accessibility**:

   The Online Mode enables remote access to home appliances from any location with an internet connection. This application proves invaluable for managing devices while away from home, enhancing security by allowing users to remotely control lights, fans, or other appliances, providing an illusion of occupancy when no one is home.

3. **Energy Efficiency**:

   The Timer Mode facilitates scheduling routines for devices to turn on/off at specific times, promoting energy efficiency. Users can program lights or other appliances to operate only when needed, reducing unnecessary power consumption, and contributing to lower utility bills.

4. **Customizable Control:**

   The flexibility of operating in Manual Mode allows users to have immediate control over devices using physical switches or buttons connected to the system. This customizable control option is useful for instances when voice commands or internet connectivity may not be available or practical.

5. **Potential for Expansion:**

   The project's modularity allows for potential expansion and integration with other smart home devices or systems, creating a scalable foundation for building a comprehensive smart home ecosystem. It can be integrated with sensors for environmental monitoring or security systems for enhanced functionality.

6. **Comfort and Lifestyle Improvement:**

   Overall, the project's application contributes to an improved lifestyle by offering convenience, energy savings, remote accessibility, and customizable control options, enhancing comfort and efficiency within homes.

7. **Hands-Free Control:**

   The temperature sensor adds an extra dimension to hands-free control by allowing users to trigger actions through temperature, providing an alternative tovoice commands.

8. **Accessibility:**

   Individuals with speech impairments or those in environments where voice commands may be impractical can benefit from the IR and Temperature sensor functionality.

Conclusion:

The culmination of the project focusing on Voice Controlled Home Automation reflects a successful integration of Google Assistant with the ESP32, demonstrating an innovative approach to modern home management. The implementation of distinct operational modes - Online, Manual, and Timer -underscores the adaptability and versatility of the system to accommodate varieduser preferences and lifestyle needs. The project emphasizes the growing significance of voice-controlled interfaces in shaping the future of smart homes, offering unparalleled convenience, energy efficiency, and remote accessibility.

Through the seamless control of multiple electrical loads via voice commands, manual interaction, or scheduled routines, this system redefines domestic comfort and efficiency. Its ability to bridge technology with everyday living setsthe stage for further advancements in intelligent home automation systems. This project marks a foundational stride towards fostering user-friendly, energy- conscious smart homes, laying the groundwork for future innovations in this rapidly evolving field.

The integration of a temperature sensor enhances the versatility of the Voice Controlled Home Automation system, offering users an additional means of interaction and control. This expansion aligns with the project's overarching goalof creating a user-centric, adaptable, and feature-rich smart home solution. The temperature sensor not only augments the system's accessibility but also showcases the potential for further innovation in the realm of sensor-based home automation.