Iot Based Smart Control Of Fans And Lights And Monitoring Of Home Environment

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Abstract

This paper presents a practical method for managing and monitoring household appliances and their surroundings. The current paper is about using phase control with the Triac approach to make voltage input modulation easier. Arduino and NodeMCU are used to send a PWM signal to the trigger. Each lamp and fan has its slider for individual brightness and speed control, as well as on/off buttons. The proposed project makes use of the Blynk App, which provides individual sliders and buttons for control. Temperature and humidity are monitored using a DHT11 humidity and temperature sensor, as well as an MQ-135 gas sensor and an IR flame sensor to detect smoke or fire. Data from the above sensors are also collected and sent by the NodeMCU to the Blynk Control App and a ThingSpeak Channel. WiFi and the Blynk Cloud will be used for all of the aforementioned control and communication. Our system's encryption and security are provided by the Blynk Cloud.

Keywords: *NodeMCU, Arduino, Smart Home, TRIAC, Zero Cross Detector, Brightness Control, Speed Control, IoT, Blynk, ThingSpeak, Fritzing.*

1. Introduction

Home automation, also known as domotics, is the automation of a home, often known as a smart home or smart house. Lighting, climate, entertainment systems, and appliances are all monitored and/or controlled by a home automation system. Home security systems, such as access control and alarm systems, may also be included.

Switching on and off appliances is simple in home automation, but the real challenge emerges when smooth control of lighting and fan brightness and speed is required. The old manual approach controls the voltage input to the fan or bulb by tapping at different voltage divisions. These don't allow for easy transitions, which can be an issue.

Our project tries to propose a viable answer to this problem. To manage the input voltage to the bulbs and fans, this system employs the phase control mechanism of TRIACs. The monitoring system is straightforward and collects data through a variety of sensors. It's clever and simple to apply.

There are three parts to the phase control mechanism:

- Zero-Cross Detection.
- PWM Signal Generation using a microcontroller.
- Triggering the TRIAC gate using the PWM Signal through a TRIAC Trigger IC.

2. Literature Review and Related Work

This project intends to create a smart control system for lighting and fans, as well as monitor other parameters such as temperature, humidity, smoke, and fire. The suggested system allows users to remotely monitor the situation at home, such as temperature, humidity, gas leaks, and so on, as well as control lights and fans.

This project also aims to create a hardware prototype of the previously mentioned paradigm.

The following pieces of work were referred to gain knowledge and develop a certain temperament on the topic:

[1] A comparison of this newly created controller with the traditional regulating method was made and examined in the publication "Investigations on TRIAC Based Speed Controller for Single Phase Induction Motor Ceiling Fans." Single Phase Induction Motors are utilized in most ceiling fans to allow for speed adjustment, which is accomplished through voltage control via a potentiometer. This research presents a novel energy-efficient TRIAC-based voltage controller. SPIM is built in such a way that odd space harmonics coexist with triplen harmonics. This causes a lot of torque ripple in the motor, which causes noise and vibration. Furthermore, using a TRIAC-based voltage controller causes time harmonics, which exacerbates the situation. The effect of these harmonics on the performance of ceiling fan SPIMs is investigated in this research. Three different commercial ceiling fans were examined and compared to typical resistive voltage control systems in this study.

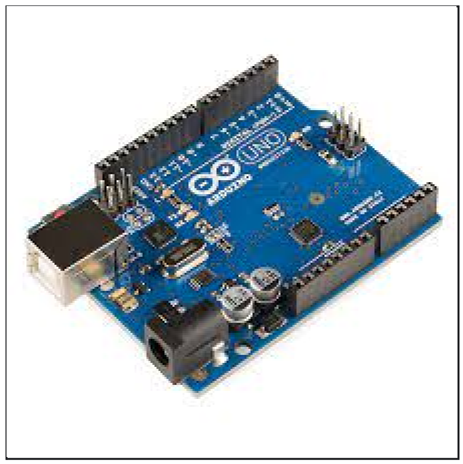
[2] The paper "Microcontroller-Based Single-Phase Automatic Voltage Regulator" offers a microcontroller-based single-phase automatic voltage regulator's design and implementation (A VR). A PIC 16f 628 microcontroller, a TRIAC, a step-up transformer, a zero-crossing circuit, and load voltage sensor circuitry are the main building elements for this design. This design is based on the notion of utilizing a TRIAC to adjust the phase of the ac voltage. The microcontroller delays the TRIAC trigger pulse to give the desired regulator terminal voltage. To provide a continuous control system, this voltage is constantly measured and supplied back to the microcontroller via a measuring device. One of the goals of developing this A VR is to utilize it to regulate residential heating and lights. By altering a variable resistor in the voltage detecting circuitry, it can also be utilized as an adjustable voltage source. It also aims to introduce a small A VR and demonstrate the PIC microcontroller's use in the power control industry.

[3] The paper "Integrated Smart Home Model: An IoT Learning-Inspired Platform" suggests the use of an IoT smart home model and a web-based interface as a learning platform to encourage students to engage in hands-on learning. The Raspberry Pi, motion sensor, analog gas sensor, atmospheric sensor, ultrasonic proximity sensor, and rain detector sensor are all integrated into a Lego-built smart home model, and their connectivity and readings are shown in a simple web interface to encourage and support learning. As a reference for students to set up and further explore the functionalities and capacities of "things," a manual for setting up the full model is also produced.

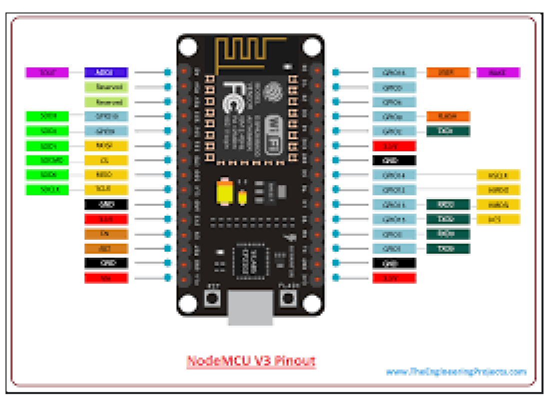
3. Methodology

3.1. Components Used

1. The ATmega328P Processor is used in the Arduino Nano, which is an open-source hardware and microcontroller board. It contains a total of 22 pins (6 of which are PWM), with 8 analog input pins and the rest being digital I/O pins. The device has a 5V operating voltage, 32KB flash memory, 2KB SRAM, 16MHz clock speed, 1KB EEPROM, and 40mA DC per I/O pin.

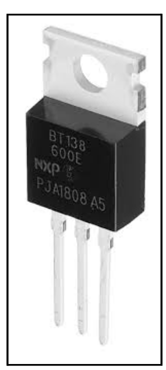


2. NodeMCU is an open-source hardware and microcontroller board based on the ESP-8266 32-bit microprocessor. There are 11 digital I/O pins and 1 analog input pin on this board. 3.3V is the operational voltage. A total of 4MB of Flash memory and 64KB of SRAM are available. A clock speed of 80MHz is used.

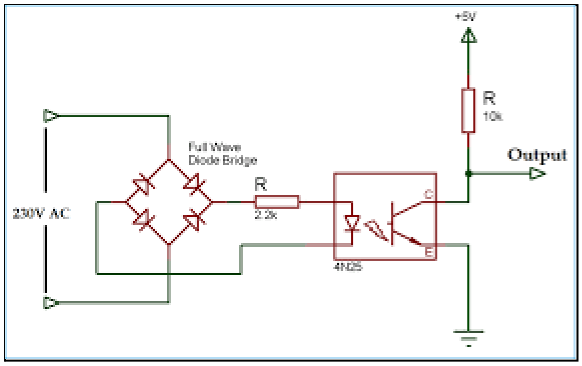


3. Based on the ESP-8266EX, the Wemos D1 Mini Pro is a small wifi board with 16MB of flash, an external antenna connector, and a built-in ceramic antenna. There are 11 digital input/output ports and one analog input port on this device. This device includes a built-in PCB antenna as well as a Lithium battery interface with a maximum charging current of 500mA.

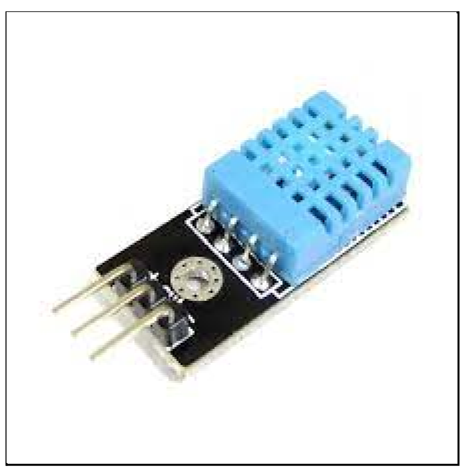
4. A TRIAC is a three-terminal AC switch that differs from other silicon-controlled rectifiers in that it can conduct in both directions, meaning that it will conduct whether the gate signal is positive or negative. As a result, this device can be utilized as a switch in AC systems. This is a bi-directional, three-terminal, four-layer semiconductor device that controls AC power. In the market, there is a TRIAC with a maximum rating of 16A.



5. On every zero-voltage reference of a sine wave, the Zero Cross Detector (using an optocoupler) generates a pulse output. During both positive cycles, the 4N25 optocoupler remains active. Since a full-bridge circuit turns a negative cycle into a positive cycle. Because the output is a ground reference, the output will be zero when the optocoupler is turned on. The optocoupler switches off when a sine wave reaches zero crossing, and a pulse of Vcc magnitude occurs at the output.



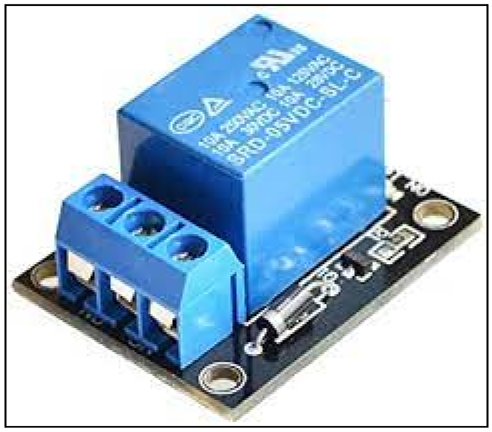
6. The DHT11 is a temperature and humidity sensor that is widely used. The sensor includes a dedicated NTC for temperature measurement and an 8-bit microprocessor for serial data output of temperature and humidity values. The sensor is factory calibrated, making it simple to connect to other microcontrollers. With an accuracy of 1°C and 1 percent, the sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90%.



7. The MQ-135 Gas Sensors are excellent for detecting or measuring NH3, NOx, Alcohol, Benzene, Smoke, and CO2 in air quality control systems. The MQ-135 sensor module has a Digital Pin that allows it to work without a microcontroller, which is useful when you simply want to detect one gas. If you need to measure gases in PPM, you'll need to use the analog pin. The analog pin is TTL-driven and operates at 5V, making it compatible with the majority of microcontrollers.

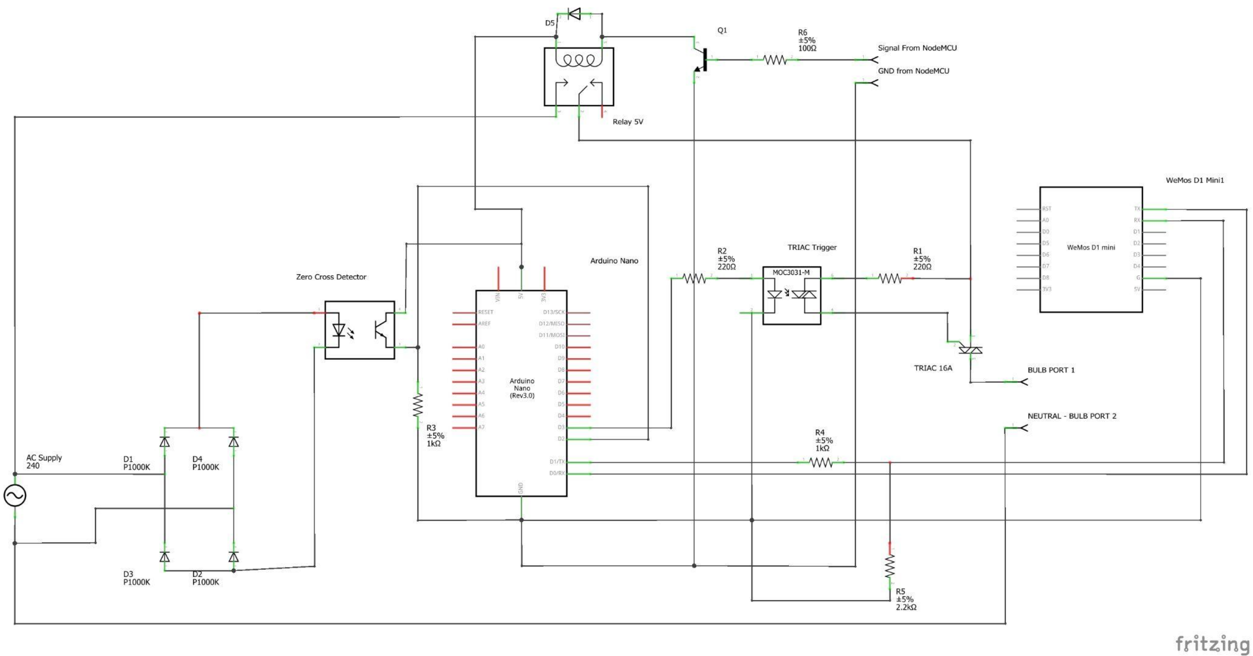
8. A flame sensor is a type of detector that is primarily used to detect and respond to the occurrence of a fire or flame. The reaction of the flame detector can be affected by the way it is installed. An alarm system, a natural gas line, propane, and a fire suppression system are all included. Because of the mechanism used to detect the flame, the reaction of these sensors is faster and more precise than that of a heat/smoke detector. This sensor/detector can be made with an electronic circuit and an electromagnetic radiation receiver. The infrared flame flash method is used in this sensor, allowing it to work through a layer of oil, dust, water vapor, or ice.

9. A relay is an electromechanical device that opens or closes the contacts of a switch using an electric current. The single-channel relay module is more than simply a relay; it also includes components that facilitate switching and connection, as well as indicators that show if the module is powered and whether the relay is active or not.

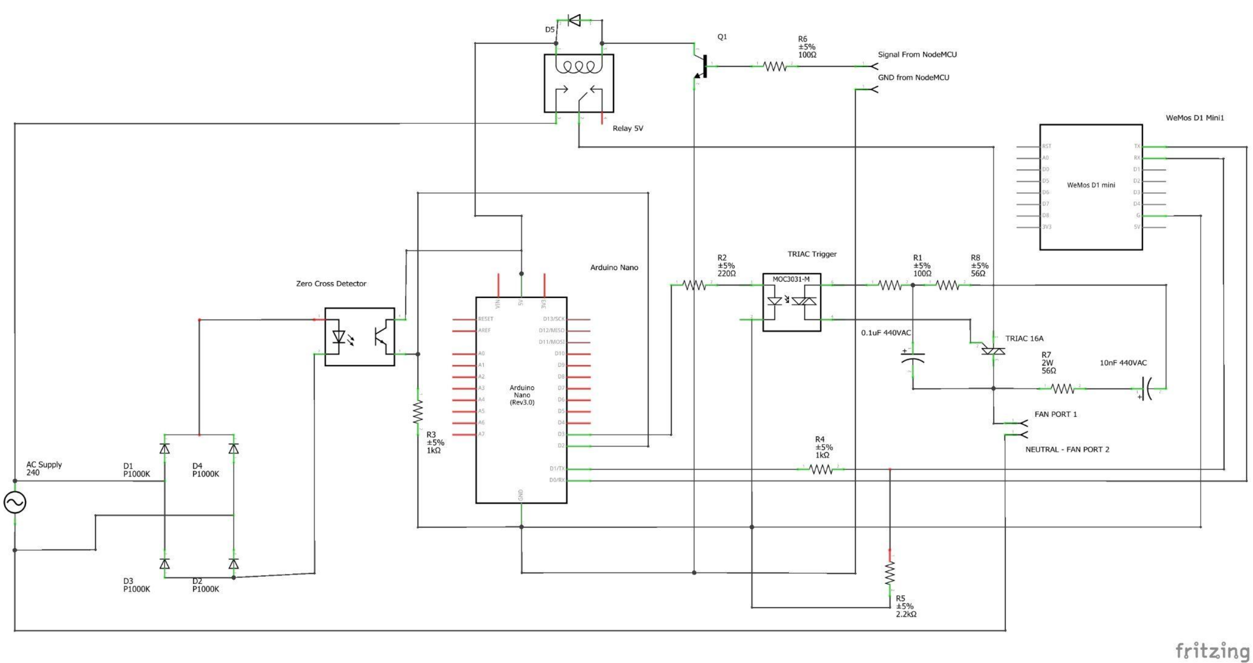


3.2. Schematic Diagram

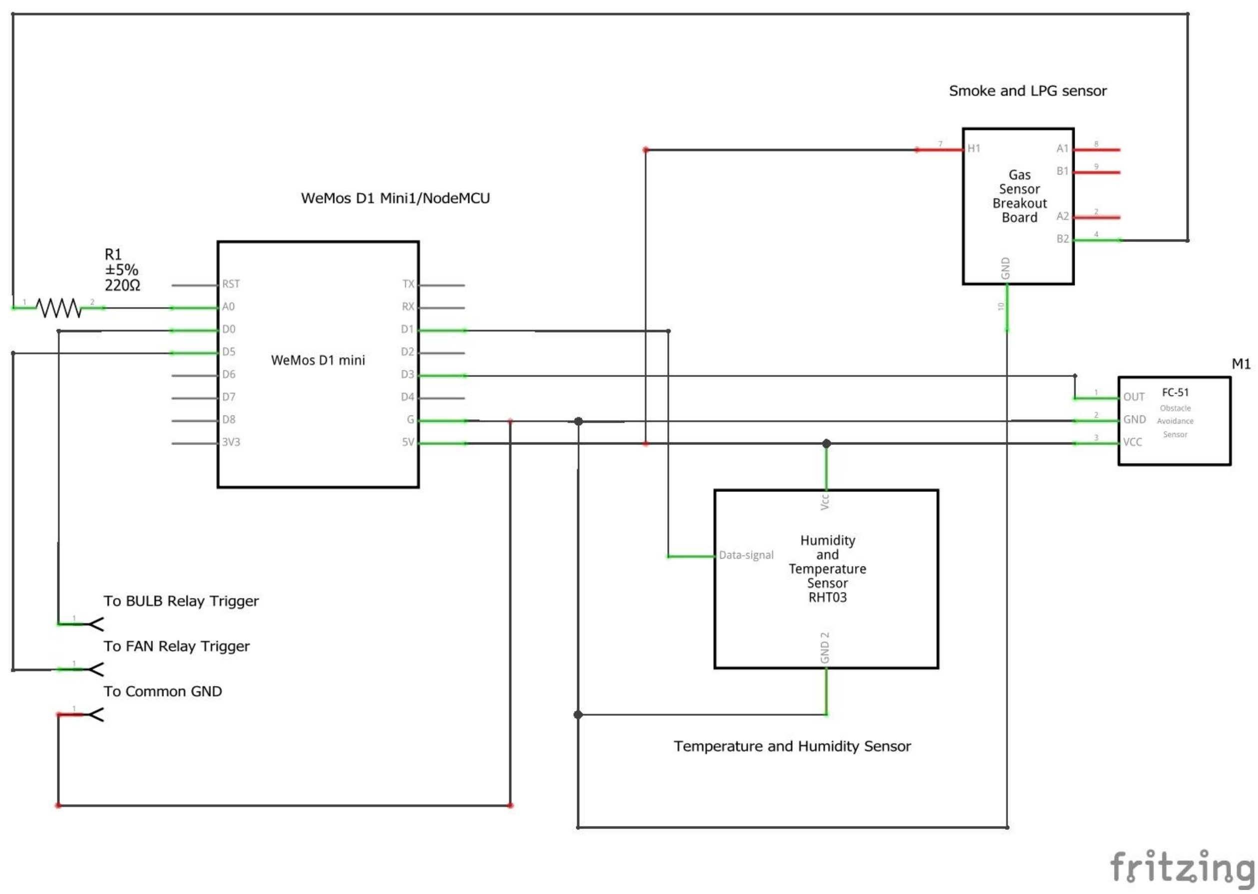
3.2.1. Bulb Brightness Control Circuit Schematic



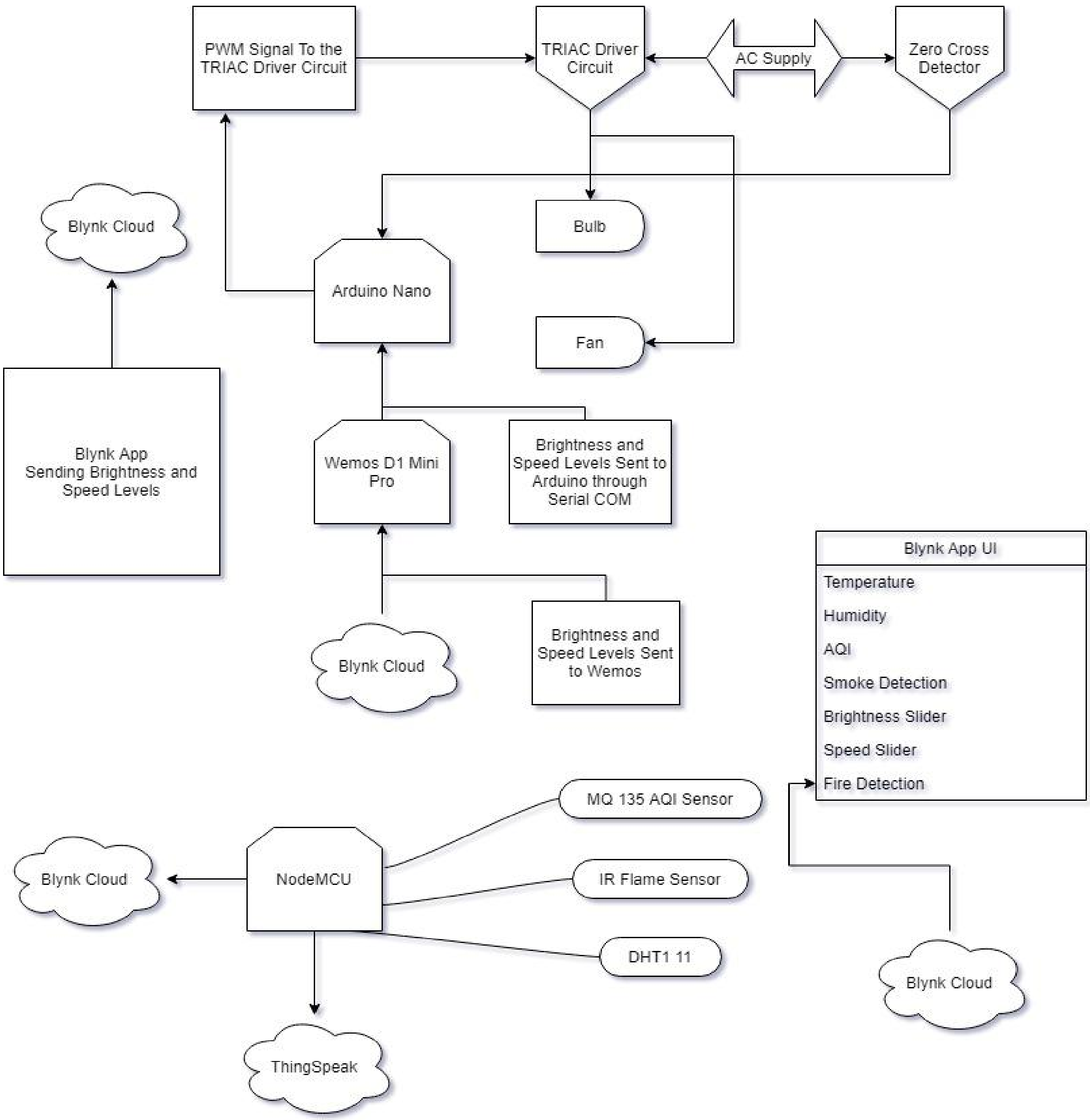
3.2.2. Fan Speed Control Circuit Schematic



3.2.3. Monitoring System Circuit Schematic



3.3. Working of the System



3.3.1. The Blynk App

A speed adjustment slider, a brightness adjustment slider, and value boxes for AQI, Temperature, and Humidity are all included in the app. It also has switches and buttons for the lamps and fans. Finally, for smoke and fire detection, it has an alarm LED and a message display.

The slider values, which range from 150 to 255 (8-bit values), are sent to the Blynk Cloud, along with the button/switch state (on or off).

3.3.2. Zero-Cross Detector

A bridge rectifier is used in our system. The AC input is rectified before being passed to the optocoupler. A high pulse is created by the optocoupler whenever the rectified sine wave hits 0 or touches the x-axis, which is then read by the Arduino interrupt pin 2.

3.3.3. PWM Signal Generation

When the Arduino detects a high pulse on interrupt pin 2, the serial data sent by the Wemos is read as well. We try to map the 8-bit slider values received from the Blynk app, given to the Arduino through Wemos, between 1000 and 5000 (1ms and 5ms) because each half of the sine wave is 10ms (assuming 50Hz power frequency). The PWM signal is delayed by that many milliseconds with this mapped value, and then a PWM signal is generated for 100 microseconds - 'on' time. The produced PWM signal is applied to the TRIAC trigger via pin 3 of Arduino.

3.3.4. Triggering the TRIAC using the TRIAC Trigger IC

A MOC3021 TRIAC trigger IC is used here. The PWM signal from the Arduino is received by this IC, which then sends a firing pulse to the TRIAC linked to it, regulating the input voltage. The brightness or speed of the fan or light can be controlled by regulating the input voltage. As a result, we may manage the brightness and speed in this manner.

3.3.5. Monitoring System

The DHT11, IR Flame Sensor, and MQ 135 Sensor are all connected to the NodeMCU. The temperature and humidity data, as well as the AQI, are read every 2 seconds by the DHT11 and MQ135 sensors, and these values are received by the NodeMCU. The IR Flame Sensor has no latency; if it detects flames, it sends a high signal to the NodeMCU; if it doesn't, it sends a low signal. The data is subsequently delivered to the Blynk Cloud, which ultimately transmits it to our Blynk App. The data is also published to a ThingSpeak Channel by the NodeMCU. These values are then shown on the user interface of our Blynk App. We keep an eye on the house's AQI to see if there are any smoke or gas leaks. A red led illuminates in the app and a warning message appears if the system detects any smoke, fire, or gas leaks in the residence.

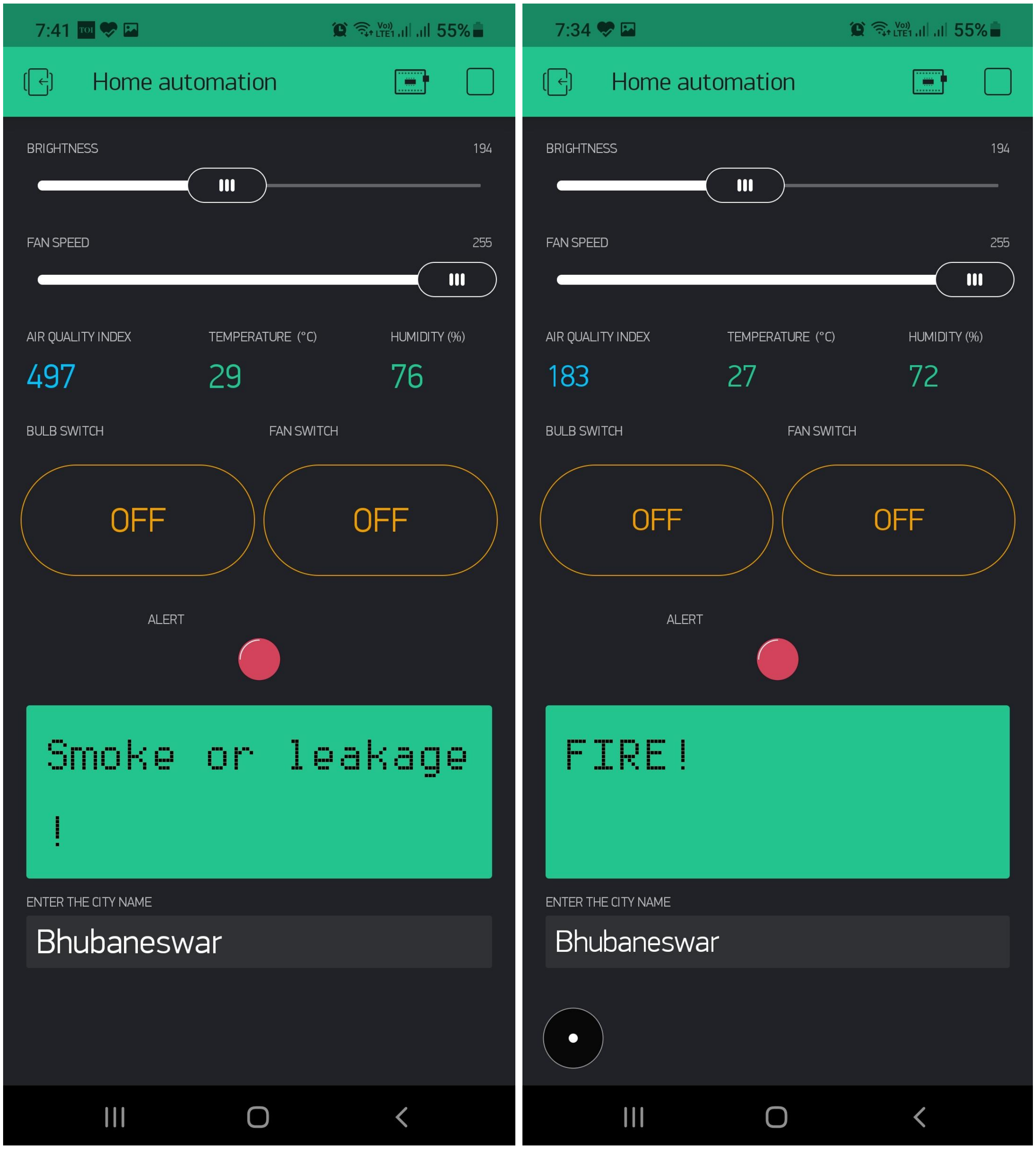
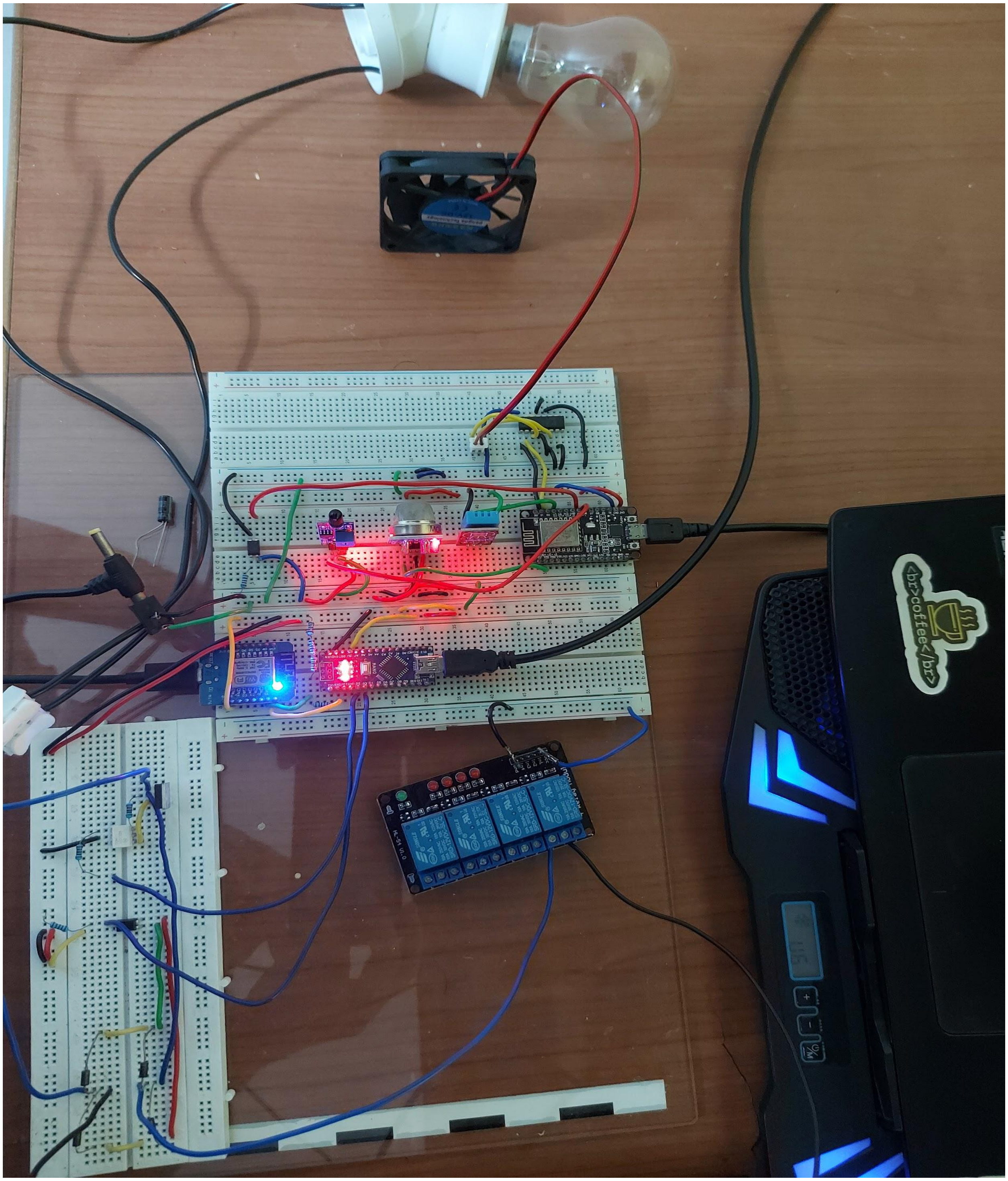


Figure Showing the UI and Alert Mechanism of Our System on the Blynk App

Our ThingSpeak Channel Recording the AQI, Temperature, and Humidity Values



The Actual Hardware Setup we built

Demo Video Link:
https://drive.google.com/file/d/1kO7NmrCyv2FRPtvQoHjD0JY-aaR_NmNz/view?usp=sharing

4. Feasibility Analysis

There are several nodes/modules in this system. Each module is self-contained, however, all nodes/modules are linked to a single Blynk app. These nodes/modules are small and easy to connect with existing house wiring, eliminating the need for drilling or cutting. This makes installing these modules in switch boxes a lot easier. The software is simple to use and has an interactive user interface. The data is adequately encrypted and secured on Blynk cloud servers. This system will be very straightforward to install and will limit the possibilities of component failures with good PCB design and production employing accurate sensors and high-quality components.

5. Conclusion

5.1. Summary of Work

The existing systems of control and regulation do not essentially control the speed and brightness, rather just divide voltage at certain points. Furthermore, the implementation of these systems commands physical control by the user, which turns out to be a real hassle. For instance, if we consider a hall with 15-20 fans, numerous bulbs, and we wish to control the brightness or speed of each bulb or fan.

Our proposed system solves this problem. Our module uses phase control of the TRIAC method to decrease or increase the voltage input. The PWM signal to the trigger is done using Arduino and NodeMCU connected to the Blynk app. Each bulb or fan has its slider for control in the app. Along with this, our system also facilitates temperature & humidity monitoring and smoke & fire detection.

Along with solving the above problem, our system can also be of benefit to senior citizens, injured people on bed rest, etc., who find it difficult to move around, by facilitating remote control of bulbs and fans.

5.2. Plagiarism Report:

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5.3. Future Scope of Work

- The TRIAC-based ceiling fan speed controller is inefficient, resulting in a lot of power loss and the introduction of a lot of harmonics. As a result, this work can be expanded to create an efficient system.
- Ceiling fans and incandescent lamps are currently compatible with the system. This can also be applied to other appliances.
- As of today, the technique for temperature and humidity monitoring is quite straightforward. To enhance it further, we intend to use Machine Learning-based methodologies.
- We'll also try to add a monitoring system that allows power to be switched off to the house in the case of a fire or smoke.

6. References

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