SMART HOME AUTOMATION SYSTEM

A MINI-PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project **"SMART HOME AUTOMATION SYSTEM"** is the bonafide work of **" RAGAVENDAR K (210701202) ,RAGHAV V (210701203)"** who carried out the project work under my supervision.

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

ABSTRACT

The use of automation is emerging with the help of internet providing possibility of objects to work it-self. With recent advancements to the fast speed internet, IoT will be playing a vital role in our daily tasks in present and future. IoT is offering feasibility and effectiveness to the system that are based upon it. These modern technologies are creating comfort and standard way of living because of its time, energy and cost efficiency. In this modern world, where things are going to be on our finger tips, our daily household appliances will also be controlled with our smartphones. This will allow us to manage the usage smartly, and can help in building of an eco-friendly environment. This paper will conduct a study based on how household appliances may be automated smartly with software applications that are integrated with hardware board. It presents the complete architecture of the system with its working capabilities. Also, it explains the internal mechanism of the system which mainly considers the software application and hardware board interaction. As we know the smart home automation is a costly process, so in this paper we would be looking at its low-cost implementation.

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RAGHAV
RAGAVENDAR

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CHAPTER 1
INTRODUCTION

With the span of time passing, mobile applications industry has grown rapidly. In this century, the increase in the usage of mobile phones is tremendous. The increase in the usage of phones demands developers to create user friendly mobile applications. By merging the essence of mobile development accompanied by Internet of Thing (IOT) facilitate users in controlling or monitoring hardware devices by using mobile applications. Things that are working under IOT have the ability to sense, collect and share data over network from any part of the world where that data utilized for various purposes. Internet of things is making every possibility for the objects to work by its own [1]. Internet of things (IOT) is defined as an environment where all the devices communicate with each other without the interaction of human-to-human or human-to-computer [2]. IOT involves things that are connected with internet can interact, communicate and exchange data between them. By doing objects connectivity with internet, there are countless possibilities that can be done [3]. They are now having more importance as they are becoming the part of the system. It also involves the proficient way to collect and analyze data over a wireless connection that makes the communication between the objects faster. in controlling and automating the objects, the use of internet of things has provided a lot more flexibility, which is making this technology pervasive. IOT has makes our life easier by introducing the concept of Smart Homes. Smart home automation systems has given its users the power to control their electrical appliances with their single tap on their cellphones. Internet of things is already implemented in many others areas and it is performing its work in a well-organized way. Internet of things support is already given in many applications, also helpful in building large embedded systems. Many automated systems for medical, commercial, transport and large industries are adapted the concept of internet of things [4]. After the implementation of smart home systems become common that are developed using IOT, the research on IOT with different implementation is experiencing and it is still going on [5]. A new era communication technologies has been started with the enhancements enabled by this [6]. One of the main advantages of introducing IOT based Smart home is user can save electrical power and energy. Furthermore, through smart home user can monitor energy consumption of appliances on daily basis. Once users know the status of unit consumption, they will put effort to reduce it ultimately result in less electricity bills [7]

CHAPTER 2
LITERATURE SURVEY

Internet of thing is becoming one of the emerging technologies from the last few years. It is the expansion of internet services and it has changed the human's lifestyle by providing everywhere connectivity with anyone [14]. IOT is the combination of electronic devices connected with sensors, actuators, software's and a Wi-Fi that allow these objects to exchange information [15]. Some of work related to the field of Smart Home automation has been discussed here.

Sehgal and More (2017) provide a comprehensive foundation for understanding home automation through IoT and mobile applications. Their work emphasizes the seamless integration of various home appliances controlled via a centralized mobile app, offering users convenience and enhanced control over their household devices .

Yadav and Borate (2017) further explore smart home automation by leveraging IoT, detailing a system architecture that utilizes sensors and actuators connected through a common IoT platform. This system enables remote monitoring and control, thus improving home security and energy management .

Moser et al. (2014) delve into the energy efficiency aspect of smart homes. They propose an IoT-based system that not only automates home functions but also optimizes energy consumption, thereby contributing to sustainable living practices .

Thati, Kumari, and Narayana (2017) focus on controlling home appliances via the internet. Their research highlights the use of web-based interfaces and mobile applications to manage home devices, underscoring the user-friendly aspect of modern home automation systems .

Hong, Yang, and Rong (2016) introduce a smart home security monitor system. This system employs IoT technology to provide real-time surveillance and alerts, ensuring enhanced security measures for households .

Kodali et al. (2016) present a comprehensive smart security and home automation system that integrates various sensors and IoT devices to monitor and control home environments. Their approach emphasizes robustness and scalability, making the system adaptable to different household needs .

Gupta and Chhabra (2016) explore IoT-based smart home designs with a focus on power and security management. They propose a system architecture that uses smart meters and security cameras to monitor energy usage and secure the home, thereby providing dual benefits of safety and efficiency .

Chayapathy, Anitha, and Sharath (2017) investigate the use of personal assistants in IoT-based home automation. Their work highlights how voice-controlled assistants can enhance user interaction with smart home systems, making automation more intuitive and accessible .

Folea et al. (2012) discuss the utilization of Wi-Fi low power devices in smart home automation systems. Their study demonstrates how low-power devices can maintain efficient home automation without significant energy consumption, contributing to the sustainability of smart homes .

Vikram et al. (2017) present a low-cost home automation system using Wi-Fi-based wireless sensor networks. Their system is designed to be affordable while maintaining robust functionality, making smart home technology accessible to a broader audience .

Anvekar and Banakar (2017) focus on IoT application development for home security systems. They describe a system that uses various IoT components to create a secure environment, providing real-time monitoring and alert capabilities .

Al-Kuwari et al. (2018) introduce an IoT-based sensing and monitoring platform for smart homes. Their system uses advanced sensors and data analytics to provide comprehensive monitoring and control, pushing the boundaries of smart home capabilities .

Han and Liu (2017) discuss interactive smart home designs based on IoT. Their research emphasizes user interaction and feedback, creating a more engaging and responsive smart home environment .

Gaikwad, Gabhane, and Golait (2015) provide a survey on various smart home systems using IoT. They review different methodologies and technologies, offering a broad perspective on the current state and future trends in smart home automation .

Khan et al. (2018) describe the design of an IoT smart home system. Their work outlines a comprehensive approach to smart home design, incorporating various IoT technologies to create an integrated and efficient system .

2.1 EXISTING SYSTEM

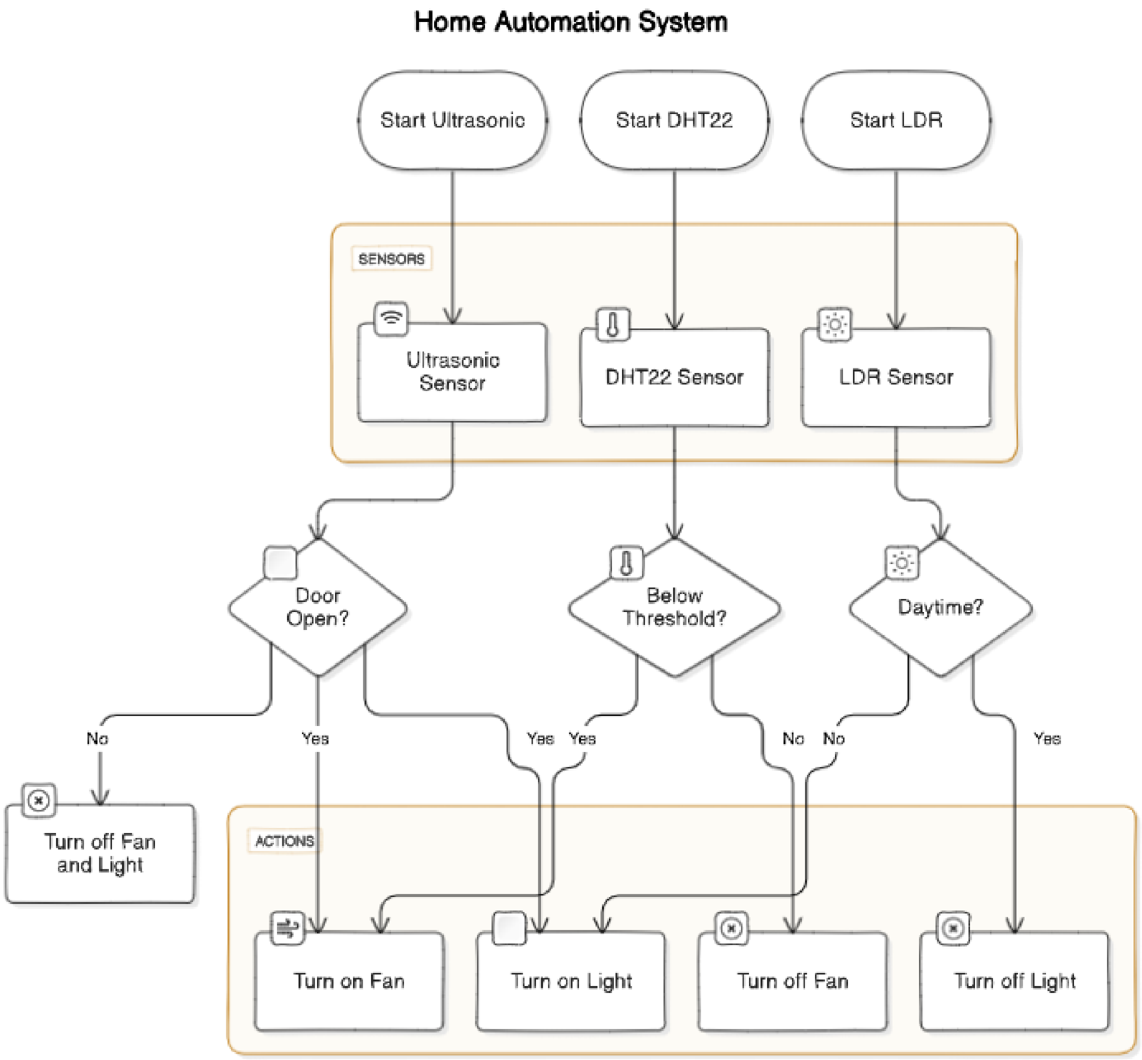
The existing system for home automation primarily relies on manual operation or basic remote control methods, such as physical switches or smartphone apps. In some cases, home automation systems may incorporate simple timers or motion sensors for limited automation capabilities. However, these systems typically lack comprehensive functionality and real-time monitoring capabilities.

Key Characteristics:

1. Manual Operation: Home devices are controlled manually via physical switches or basic remote control methods, requiring direct user intervention for operation.
2. Limited Automation: Automation features, if present, are rudimentary and may include basic timers or motion sensors for specific tasks like turning lights on/off.
3. Lack of Monitoring: The existing system lacks real-time monitoring capabilities, making it challenging for users to track home conditions or device statuses remotely.
4. Minimal Integration: Integration with environmental sensors or advanced control algorithms is absent, limiting the system's ability to adapt to changing conditions or user preferences.

CHAPTER 3

PROJECT DESCRIPTION



This project outlines the design and development of an automated room control system that utilizes various sensors to optimize ventilation (fan) and lighting based on room occupancy, ambient light levels, and environmental conditions (temperature and humidity).

Project Goals:

- Enhance comfort and energy efficiency in a room by automatically adjusting fan and light settings.
- Utilize readily available and cost-effective sensors (ultrasonic, LDR, DHT 22) for reliable data acquisition.
- Implement user-configurable thresholds for door opening detection, light activation based on daytime/nighttime, and temperature/humidity control for the fan.
- Provide a modular design that allows for future expansion with additional sensors or actuators.

System Functionality:

Door Detection: The ultrasonic sensor continuously monitors the doorway. If the door opens (within a user-defined threshold distance), the system triggers the fan and light (optional).

Daylight Detection: The LDR sensor measures ambient light levels. Based on a pre-defined threshold, it determines if it's daytime or nighttime. Light control (optional) is then triggered based on this information and door status.

Temperature and Humidity Monitoring: The DHT 22 sensor reads temperature and humidity in the room. If either value exceeds user-defined comfort thresholds, the fan is activated to improve airflow.

Control Logic: The Arduino code processes sensor readings and applies control logic based on pre-defined thresholds and user preferences. It manages the fan and light (optional) based on the combined information of door status, ambient light levels, temperature, and humidity.

3.1 PROPOSED SYSTEM

The proposed system aims to revolutionize home automation by leveraging Internet of Things (IoT) technology to create a seamless and efficient living environment. This system offers a comprehensive solution for monitoring and controlling various household devices remotely, enhancing convenience and energy efficiency for users.

Utilizing a combination of sensors, actuators, and a central processing unit, the system enables users to manage devices such as lights, fans, and appliances through a user-friendly web interface accessible from anywhere with an internet connection. The heart of the system lies in its ability to intelligently respond to environmental changes and human presence, ensuring optimal comfort and energy savings.

Key Features:

1. Remote Accessibility: Users can monitor and control home devices remotely via a web interface, providing convenience and flexibility in managing household tasks.
2. Environmental Sensing: Integrated sensors measure environmental parameters such as temperature, humidity, and light intensity, allowing the system to adjust device settings accordingly for comfort and energy efficiency.
3. Presence Detection: Utilizing ultrasonic sensors, the system detects human presence in designated areas, enabling automated actions such as turning on lights or adjusting room temperature based on occupancy.
4. Real-time Monitoring: Users can receive real-time updates on home conditions and device statuses, empowering them to make informed decisions and optimize energy usage.

3.2 REQUIREMENTS

3.2.1 HARDWARE REQUIREMENTS

- ESP32
- Ultrasonic Sensor (HC-SR04 or equivalent)
- LDR (Light Dependent Resistor)
- DHT 22 Sensor
- Fan
- Light
- Jumper Wires
- Breadboard

3.2.2 SOFTWARE REQUIREMENTS

- Thonny IDLE
- DHT Library
- Ultrasonic Sensor Library
- MicroPython

3.3 ARCHITECTURE DIAGRAM

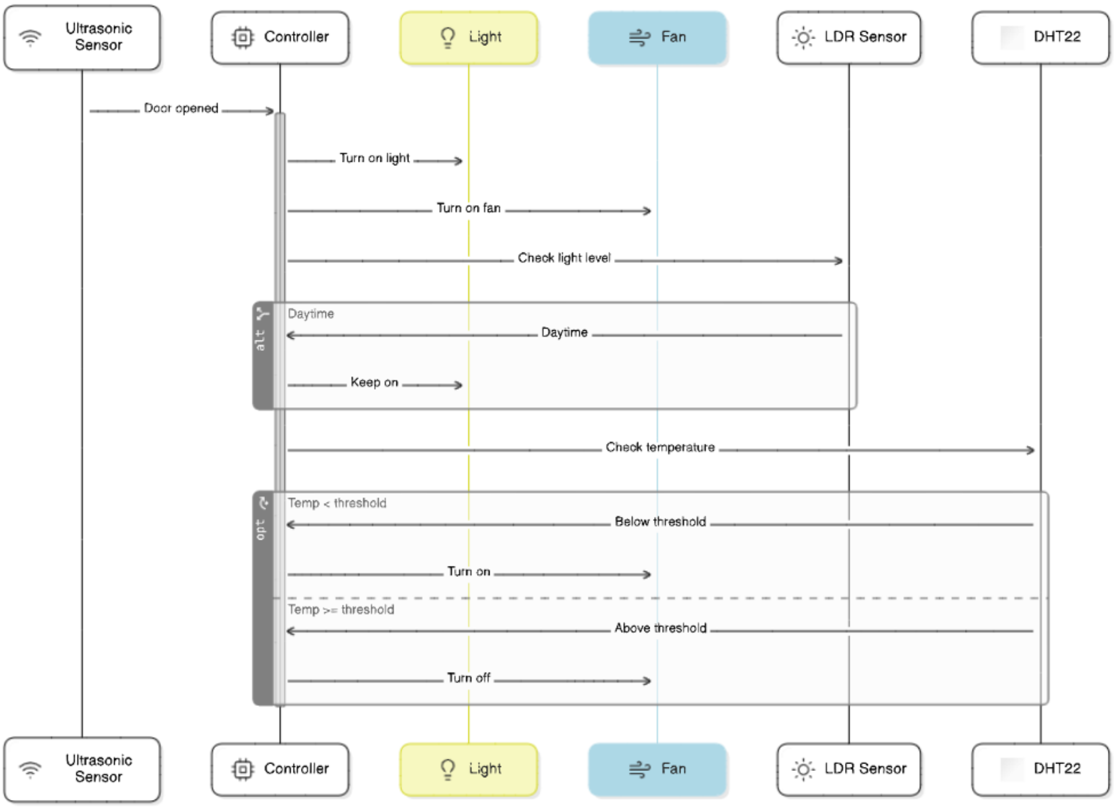
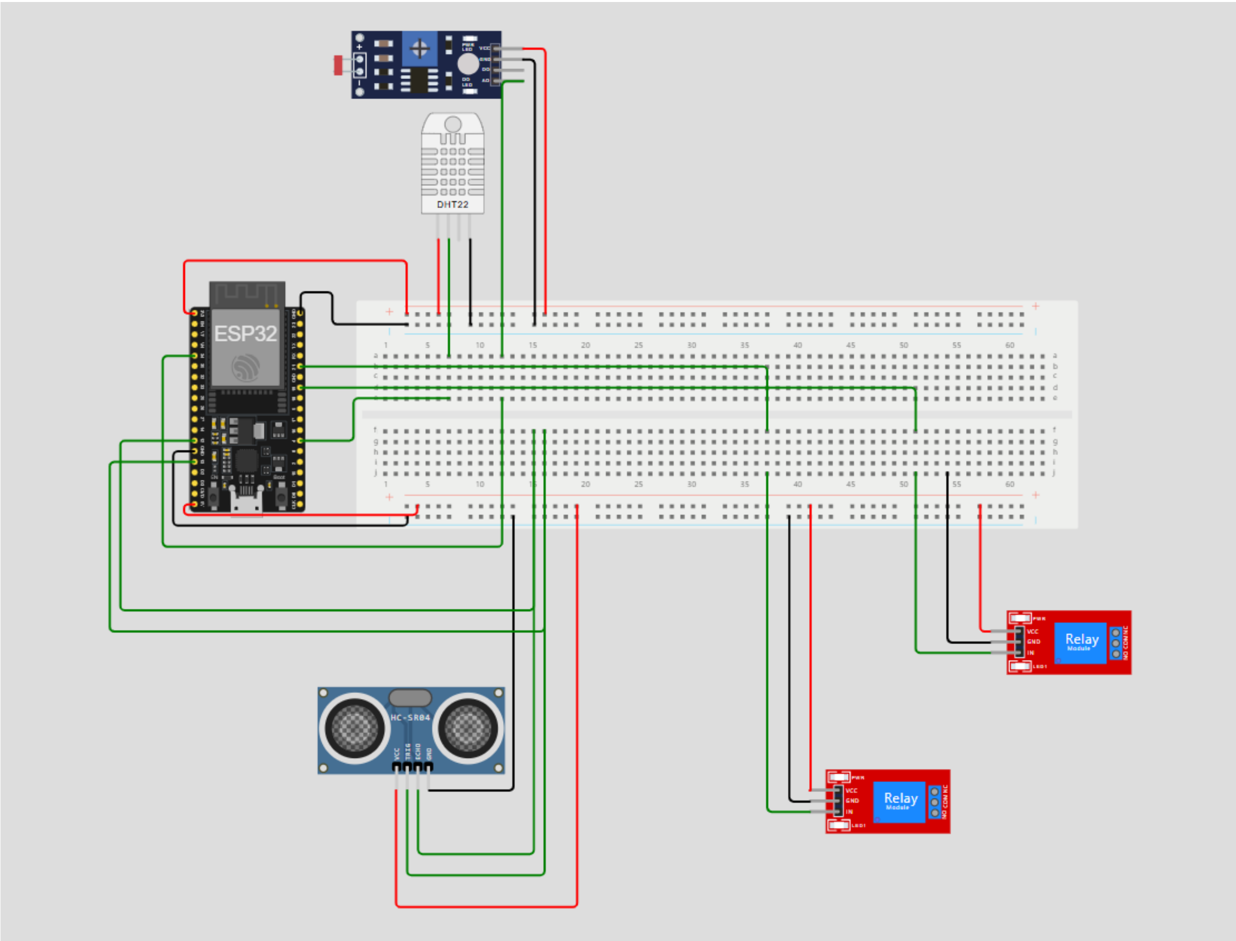


Figure 2

The figure above represents the architecture diagram of the Smart home automation system in which the ultrasonic sensor continuously look into the door .If it opens the fan and light will turn on else it will remain turn off. If LDR Sensor senses the daytime then the light will turn off else light will turn on.And then finally DHT 22 Sensor senses the room temperature and humidity if the read value is less than the threshold value fan will turn on or else fan will turn off

CIRCUIT DIAGRAM



3.4 OUTPUT

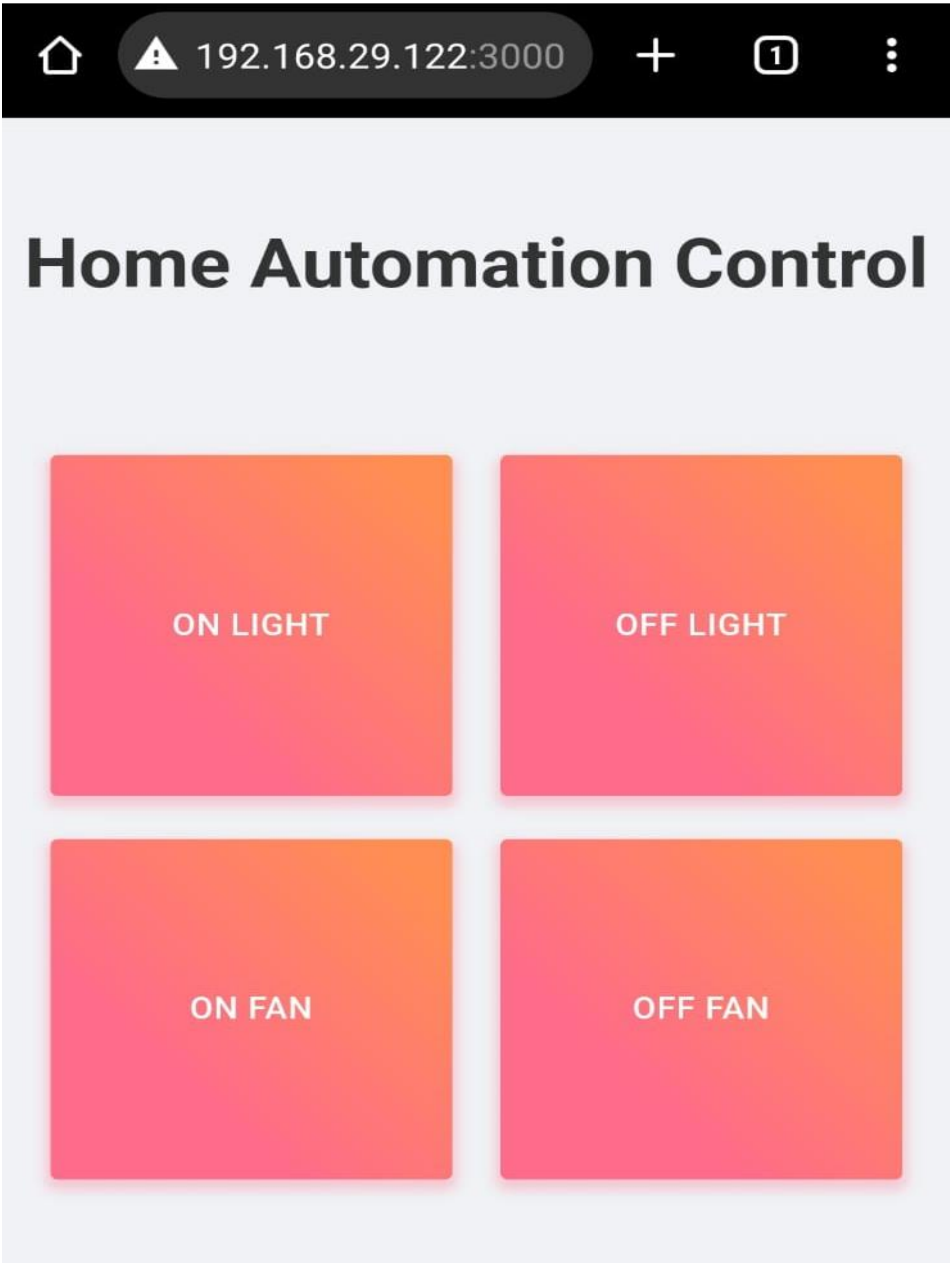


Figure 1
Home Automation User Interface that is accessible any where private within a network

CONNECTIONS:

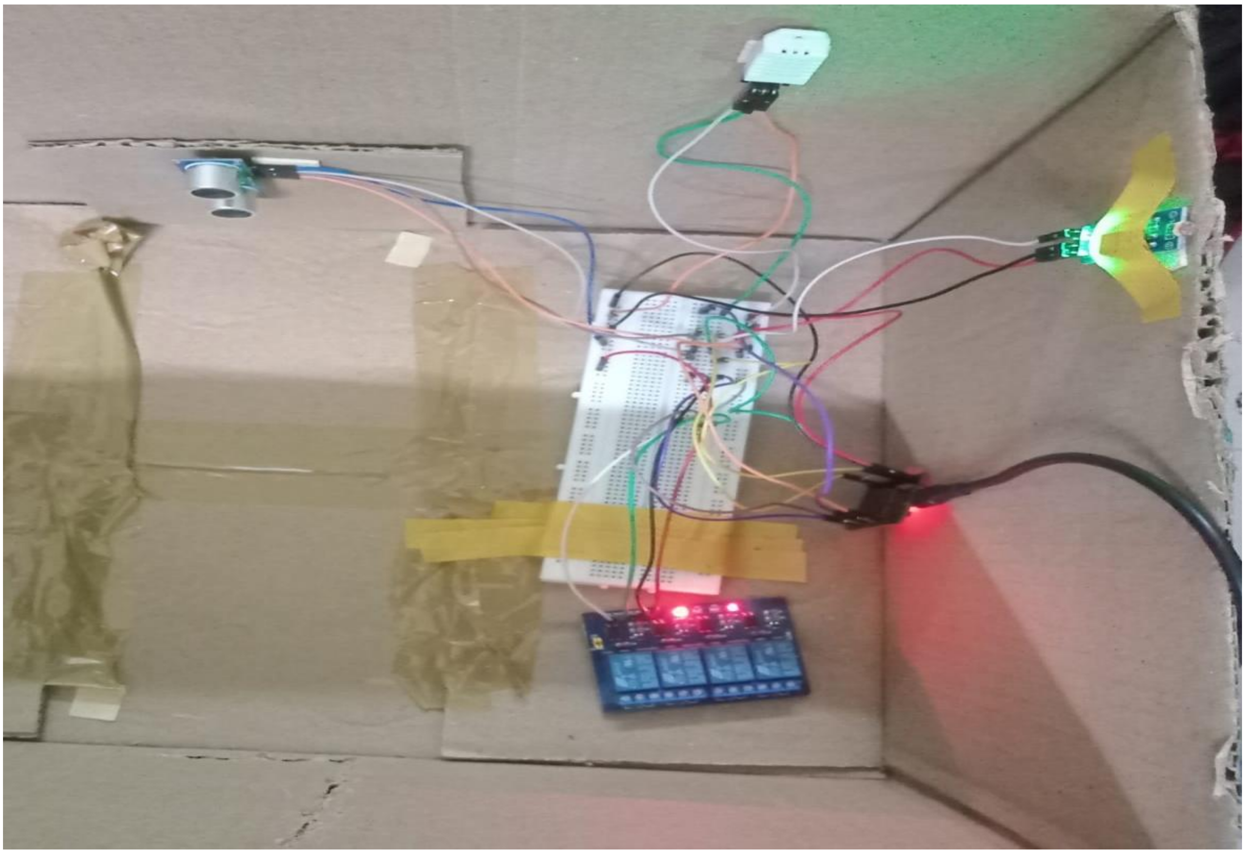


Figure 2

Figure 2 shows the connections made to the Home Automation System with the esp32. The connections are provided as specified in the architecture.

CHAPTER 4
CONCLUSION AND FUTUREWORK

In this project, a simple yet effective home automation system was developed using various components like sensors, actuators, and a microcontroller. The system allows for remote monitoring and control of devices such as LEDs, fans, and bulbs through a web interface. Additionally, environmental parameters like temperature, humidity, light intensity, and presence detection were integrated for enhanced automation.

The implementation demonstrated the feasibility of using basic hardware components along with networking capabilities to create a smart home system. The system's ability to react to environmental changes and human presence adds convenience and energy efficiency to home management.

Future Work:

1. Platform Expansion: Extend the compatibility of the system to iOS devices to cater to a wider user base.
2. Speech Interaction: Integrate a speech-to-text module to enable verbal interaction, enhancing user experience and accessibility.
3. Voice Recognition: Implement a voice recognition system for hands-free operation, improving usability further.
4. Security Enhancement: Incorporate low-cost cameras for features like face recognition to enhance security measures within the system.

These future enhancements aim to make the home automation system more user-friendly, secure, and feature-rich, thereby improving the overall experience and utility for users.

APPENDIX I

boot.py

```
try:
  import usocket as socket
except:
  import socket

from machine import Pin
import network

import esp
esp.osdebug(None)

import gc
gc.collect()

ssid = 'Ragnarok'
password = 'Vikram@567'

station = network.WLAN(network.STA_IF)

station.active(True)
station.connect(ssid, password)

while station.isconnected() == False:
  pass

print('Connection successful')
print(station.ifconfig())

led = Pin(2, Pin.OUT)
```

hcsr04.py

```
from machine import Pin, time_pulse_us
from utime import sleep_us

__version__ = '0.2.1'
__author__ = 'Roberto Sánchez'
__license__ = "Apache License 2.0. https://www.apache.org/licenses/LICENSE-2.0"

class HCSR04:
    """
    Driver to use the untrasonic sensor HC-SR04.
    The sensor range is between 2cm and 4m.
```

```
    The timeouts received listening to echo pin are converted to OSError('Out of range')

    """
    # echo_timeout_us is based in chip range limit (400cm)
    def __init__(self, trigger_pin, echo_pin, echo_timeout_us=500*2*30):
        """
        trigger_pin: Output pin to send pulses
        echo_pin: Readonly pin to measure the distance. The pin should be protected with 1k
resistor
        echo_timeout_us: Timeout in microseconds to listen to echo pin.
        By default is based in sensor limit range (4m)
        """
        self.echo_timeout_us = echo_timeout_us
        # Init trigger pin (out)
        self.trigger = Pin(trigger_pin, mode=Pin.OUT, pull=None)
        self.trigger.value(0)

        # Init echo pin (in)
        self.echo = Pin(echo_pin, mode=Pin.IN, pull=None)

    def _send_pulse_and_wait(self):
        """
        Send the pulse to trigger and listen on echo pin.
        We use the method `machine.time_pulse_us()` to get the microseconds until the echo is
received.
        """
        self.trigger.value(0) # Stabilize the sensor
        sleep_us(5)
        self.trigger.value(1)
        # Send a 10us pulse.
        sleep_us(10)
        self.trigger.value(0)
        try:
            pulse_time = time_pulse_us(self.echo, 1, self.echo_timeout_us)
            # time_pulse_us returns -2 if there was timeout waiting for condition; and -1 if there was
timeout during the main measurement. It DOES NOT raise an exception
            # ...as of MicroPython 1.17:
http://docs.micropython.org/en/v1.17/library/machine.html#machine.time_pulse_us
            if pulse_time < 0:
                MAX_RANGE_IN_CM = const(500) # it's really ~400 but I've read people say they
see it working up to ~460
                pulse_time = int(MAX_RANGE_IN_CM * 29.1) # 1cm each 29.1us
            return pulse_time
        except OSError as ex:
            if ex.args[0] == 110: # 110 = ETIMEDOUT
                raise OSError('Out of range')
            raise ex

    def distance_mm(self):
        """
        Get the distance in milimeters without floating point operations.
```

```
        """
        pulse_time = self._send_pulse_and_wait()

        # To calculate the distance we get the pulse_time and divide it by 2
        # (the pulse walk the distance twice) and by 29.1 becasue
        # the sound speed on air (343.2 m/s), that It's equivalent to
        # 0.34320 mm/us that is 1mm each 2.91us
        # pulse_time // 2 // 2.91 -> pulse_time // 5.82 -> pulse_time * 100 // 582
        mm = pulse_time * 100 // 582
        return mm

    def distance_cm(self):
        """
        Get the distance in centimeters with floating point operations.
        It returns a float
        """
        pulse_time = self._send_pulse_and_wait()

        # To calculate the distance we get the pulse_time and divide it by 2
        # (the pulse walk the distance twice) and by 29.1 becasue
        # the sound speed on air (343.2 m/s), that It's equivalent to
        # 0.034320 cm/us that is 1cm each 29.1us
        cms = (pulse_time / 2) / 29.1
        return cms
```

main.py

```
import socket
import random
import json
from machine import Pin, ADC
import _thread
import dht
import time
import hcsr04

# Define Pins for LED, Fan, and Bulb
led = Pin(2, Pin.OUT)
fan = Pin(21, Pin.OUT)  # GPIO21 for fan
bulb = Pin(19, Pin.OUT)  # GPIO19 for bulb

# Define DHT22 pin
DHT_PIN = 4  # GPIO4

# Initialize DHT sensor
```

```
dht_sensor = dht.DHT22(Pin(DHT_PIN))

# Define LDR pin
LDR_PIN = 34  # GPIO34

class LDR:
    def __init__(self, pin, min_value=0, max_value=100):
        if min_value >= max_value:
            raise Exception('Min value is greater or equal to max value')

        self.adc = ADC(Pin(pin))
        self.adc.atten(ADC.ATTN_11DB)
        self.min_value = min_value
        self.max_value = max_value

    def read(self):
        return self.adc.read()

    def value(self):
        return (self.max_value - self.min_value) * self.read() / 4095

# Initialize an LDR
ldr = LDR(LDR_PIN)

# Initialize ultrasonic sensor
ultrasonic = hcsr04.HCSR04(trigger_pin=13, echo_pin=12, echo_timeout_us=1000000)
PRESENCE_THRESHOLD = 100  # Distance in cm to detect presence

TEMP_THRESHOLD = 25.0  # in Celsius
HUMIDITY_THRESHOLD = 60.0  # in percentage

def web_page(gpio_states):
    return json.dumps(gpio_states)

def handle_client(conn, addr):
    print('Got a connection from %s' % str(addr))
    request = conn.recv(1024).decode()  # Decode bytes to string
    print('Content = %s' % request)
```

```
led_on = request.find('/?led=on')
led_off = request.find('/?led=off')
fan_on = request.find('/?fan=on')
fan_off = request.find('/?fan=off')

if led_on != -1:
    print('LED ON')
    led.value(1)
elif led_off != -1:
    print('LED OFF')
    led.value(0)

if fan_on != -1:
    print('FAN ON')
    fan.value(1)
elif fan_off != -1:
    print('FAN OFF')
    fan.value(0)

gpio_states = {
    'LED_State': 'ON' if led.value() == 1 else 'OFF',
    'Fan_State': 'ON' if fan.value() == 1 else 'OFF',
    'Bulb_State': 'ON' if bulb.value() == 1 else 'OFF',
    'Temperature': None,
    'Humidity': None,
    'Light_Value': None,
    'Presence': None
}

# Measure DHT22 sensor data
dht_sensor.measure()
temperature = dht_sensor.temperature()
humidity = dht_sensor.humidity()
gpio_states['Temperature'] = temperature
gpio_states['Humidity'] = humidity

# Measure LDR value
```

```
    light_value = ldr.value()
    gpio_states['Light_Value'] = light_value

    # Measure distance to detect presence
    distance = ultrasonic.distance_cm()
    presence = distance < PRESENCE_THRESHOLD
    gpio_states['Presence'] = 'Person detected' if presence else 'No person detected'

    response = web_page(gpio_states)

    conn.send(b'HTTP/1.1 200 OK\n')
    conn.send(b'Content-Type: application/json\n')
    conn.send(b'Access-Control-Allow-Origin: *\n')  # Allow requests from any origin
    conn.send(b'Connection: close\n\n')
    conn.sendall(response.encode('utf-8'))
    conn.close()

def sensor_control_loop():
    while True:
        distance = ultrasonic.distance_cm()
        print(f'distance is {distance} cm')

        if distance < PRESENCE_THRESHOLD:
            print('Person detected')

            dht_sensor.measure()
            temperature = dht_sensor.temperature()
            humidity = dht_sensor.humidity()

            if temperature is not None and humidity is not None:
                print('Temperature: {0:0.1f}°C, Humidity: {1:0.1f}%'.format(temperature,
humidity))

                if temperature > TEMP_THRESHOLD or humidity > HUMIDITY_THRESHOLD:
                    fan.on()
                    print('Fan turned on')
                else:
                    fan.off()
                    print('Fan turned off')
```

```
            else:
                print('Failed to read data from DHT22 sensor. Retrying...')

            light_value = ldr.value()
            print('Light value: {}'.format(light_value))

            if light_value > 50:
                bulb.on()
                print('Bulb turned on')
            else:
                bulb.off()
                print('Bulb turned off')

        else:
            print('No person detected, turning off all devices')
            fan.off()
            bulb.off()

        time.sleep(5)

def start_server():
    s = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
    s.bind(('', 80))
    s.listen(5)

    while True:
        conn, addr = s.accept()
        _thread.start_new_thread(handle_client, (conn, addr))

_thread.start_new_thread(sensor_control_loop, ())
start_server()
```

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