AUTOMATED SWITCH ON-OFF

A PROJECT REPORT

Submitted by

SUJAL SINGH [RA2112704010001]

AADITHYA RAM[RA2112704010002]

MEGHAVI RATHOD [RA2112704010012]

BADIGI SATHWIKA [RA2112704010032]

KHADEEJA NADA [RA2112704010027]

Under the Guidance of

Dr. J SHANTHINI

Associate Professor, Department of Data Science and Business Systems

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BONAFIDE CERTIFICATE

Register no. RA2112704010001, RA2112704010002, RA2112704010012, RA2112704010032, RA2112704010027 Certified to be the bonafide work done by **Sujal Singh, Aadithya Ram, Meghavi Rathod, Badigi Sathwika and Khadeeja Nada** of III year/VI sem M.Tech (Integrated) Degree Course in the subject – **21CSE429T – Data Science for Internet of Things** in **SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**, Kattankulathur for the academic year 2024-2025.

Date:

Faculty in Charge
Dr. J Shanthini
Associate Professor
Data Science and Business Systems
SRMSIT -KTR

HEAD OF THE DEPARTMENT
Dr. V.Kavitha
Professor
Data Science and Business Systems
SRMIST - KTR

ABSTRACT

The Automated Switch On/Off System is an innovative IoT solution designed to enhance convenience, energy efficiency, and security in managing electrical appliances. Utilizing a Passive Infrared (PIR) sensor, an Arduino microcontroller, and a relay circuit, the system automates the control of appliances based on human presence. When motion is detected, the PIR sensor sends a signal to the Arduino, which processes the input and activates or deactivates the relay, switching the appliance on or off accordingly. This project demonstrates the potential of IoT to simplify daily life and promote energy-saving practices, paving the way for smarter, more sustainable living environments.

TABLE OF CONTENTS

CHAPTER 1
INTRODUCTION

1.1 Introduction

The Automated Switch On/Off System is an IoT-based project developed to enhance the control and management of electrical appliances through automation. By integrating key IoT components such as a Passive Infrared (PIR) sensor, an Arduino microcontroller, and a relay circuit, this system enables automatic switching of appliances based on human presence. When the PIR sensor detects motion, it sends a signal to the Arduino, which processes the data and activates the relay circuit to turn connected devices on or off. This setup simplifies the management of electrical appliances, making it ideal for both residential and commercial applications, where convenience and energy efficiency are crucial.

1.2 Significance

This Automated Switch On/Off System offers an effective solution for energy-saving and automated appliance control. Traditional manual switching can result in energy wastage and inconvenience, especially when appliances are left on unintentionally. By automating this process, the system ensures appliances operate only when needed, reducing electricity consumption and promoting energy conservation. This project not only simplifies day-to-day tasks but also aligns with the goals of sustainable living, minimizing unnecessary energy use and providing a convenient, responsive environment.

1.3 Problem Statement

Managing appliance usage efficiently is often a challenge, especially in settings where devices are frequently left running without supervision. This issue contributes to energy waste, higher utility costs, and increased environmental impact. The Automated Switch On/Off System addresses this by providing an automated control solution that activates appliances based on human presence, reducing reliance on manual operation. This need for an intelligent, self-operating system highlights the importance of IoT in creating energy-efficient, user-friendly environments that adapt to user behavior.

1.4 Technologies Used

The Automated Switch On/Off System utilizes the following components and technologies:

- **Microcontroller: Arduino UNO –** Serves as the system's processing unit, executing the logic to control the relay based on PIR sensor input.
- **Sensor: PIR (Passive Infrared) Sensor –** Detects human presence by sensing infrared radiation from moving objects and sends the data to the Arduino.
- **Relay Circuit:** Operates as an electronically controlled switch that toggles connected appliances on or off, managed by signals from the Arduino.
- **Simulation Software: Wokwi (IDE) –** A simulation platform for testing the circuit, enabling virtual trial runs of the system’s functionality.

CHAPTER 2
PROJECT OBJECTIVES

2.1 Problem Statement

The primary issue this project aims to address is the inefficient use and management of electrical appliances, often left running unnecessarily, leading to energy wastage and higher utility costs. Traditional manual control of appliances requires constant human intervention, which is inconvenient and prone to oversight, especially in busy or unattended environments. This inefficiency not only impacts energy consumption but also contributes to increased costs and environmental strain. The Automated Switch On/Off System offers a solution by using IoT to automate appliance control, reducing the need for manual operation and ensuring appliances are only active when needed.

2.2 Goal

The goal of this project is to design and implement an Automated Switch On/Off System that uses motion detection to control electrical appliances in a convenient, energy-efficient manner. By employing a PIR sensor, Arduino microcontroller, and relay circuit, this system will automatically activate or deactivate appliances based on human presence, minimizing unnecessary energy use. This IoT-driven solution aims to create a responsive, low-maintenance setup for managing appliances, fostering a smart environment that adapts to user activity and promotes sustainable living.

2.3 Desired Outcomes

- **Automated Appliance Control:** The system will autonomously manage appliance switching, detecting human presence and turning devices on or off accordingly, eliminating the need for manual interaction.
- **Energy Efficiency:** By ensuring appliances are only active when necessary, the system will reduce energy wastage, contributing to lower electricity bills and a more sustainable environment.
- **Enhanced User Convenience:** The automated control allows for seamless integration into daily life, making it easy for users to manage appliances without

manual switches or remote controls.

- **Integration with IoT Ecosystem:** The system is designed to be compatible with other IoT devices, enabling future expansion to work with smart thermostats, security systems, and additional smart home technologies.
- **Simulation and Testing Support:** Using the Wokwi simulation IDE, developers can test and refine the system virtually, ensuring its functionality and robustness before full-scale deployment.
- **Future Scalability:** The system is built to support potential enhancements, such as remote control via mobile apps or data analytics, providing flexibility for future improvements and integration.

CHAPTER 3
TECHNOLOGIES USED

3.1 Microcontroller

The Arduino UNO microcontroller is the core processing unit of the Automated Switch On/Off System. It receives signals from the Passive Infrared (PIR) sensor, interprets the data, and triggers the relay circuit to control connected appliances. Arduino is selected for its simplicity, compatibility with various sensors, and ease of programming, making it ideal for rapid prototyping and IoT applications. The microcontroller is programmed to respond to motion detection in real-time, ensuring quick and reliable automation.

3.2 Sensor

The PIR (Passive Infrared) Sensor is used to detect human presence by sensing changes in infrared radiation in the environment. When motion is detected within its range, the PIR sensor sends a signal to the Arduino, initiating the automated switching process. This sensor was chosen for its low power consumption and effectiveness in detecting human movement, making it a cost-efficient and responsive option for motion-based automation.

3.3 Relay Circuit

The relay circuit acts as an electrically operated switch that toggles appliances on or off based on the signal received from the Arduino. When the Arduino processes a motion detection event, it activates the relay to control the power supply to the connected device. This ensures that appliances operate only when necessary, reducing energy usage and contributing to a more sustainable setup. The relay circuit allows for seamless integration with household appliances, making it essential for the automation process.

3.4 Simulation Platform

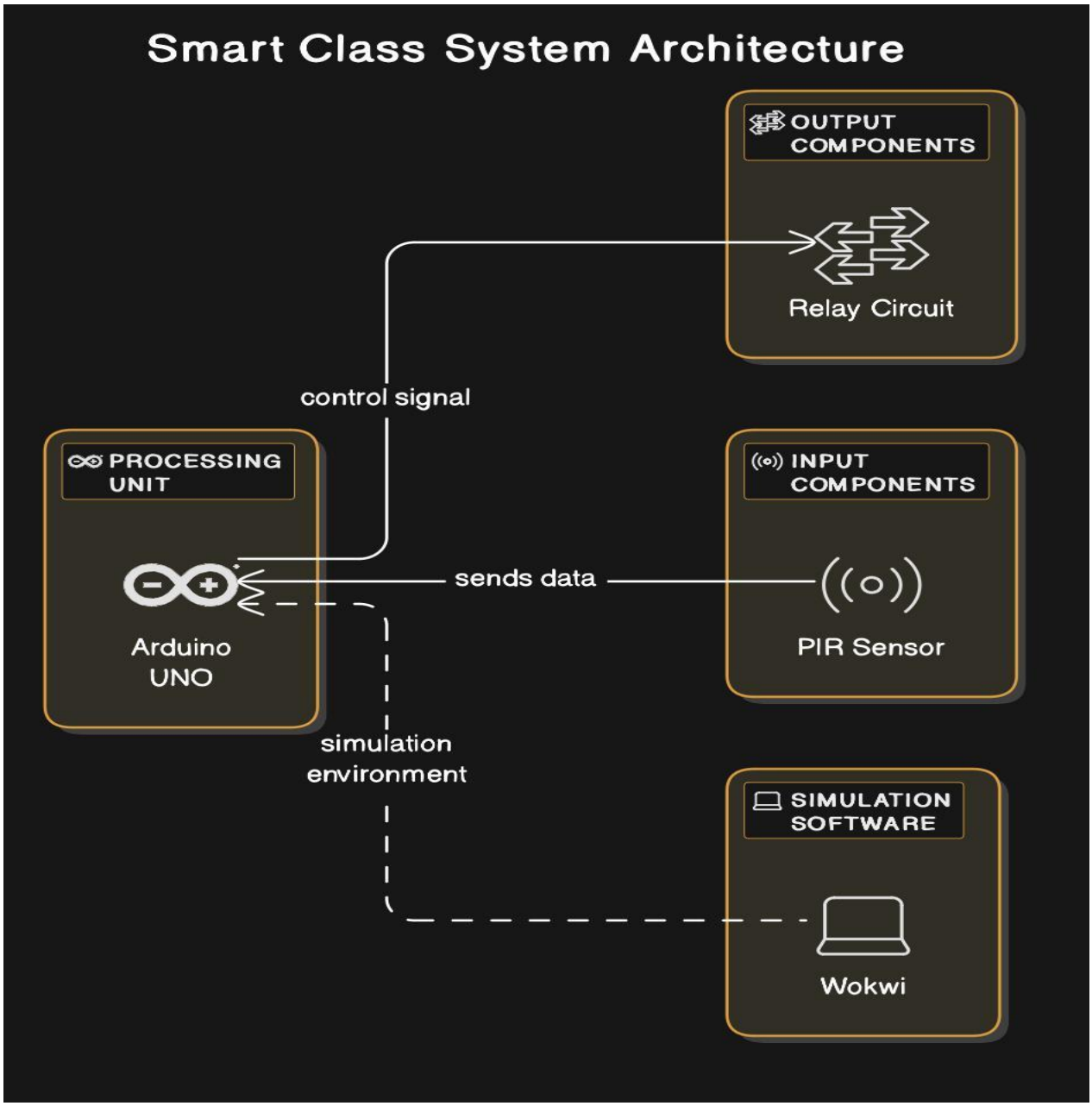
Wokwi simulation IDE is used for virtual testing and prototyping, allowing developers to simulate the Arduino, PIR sensor, and relay circuit without physical hardware. This

platform helps validate the system’s functionality, enables troubleshooting, and ensures that the code and circuit design work as expected before actual deployment. Wokwi's intuitive interface and real-time feedback make it an excellent choice for development and testing in the early stages of the project.

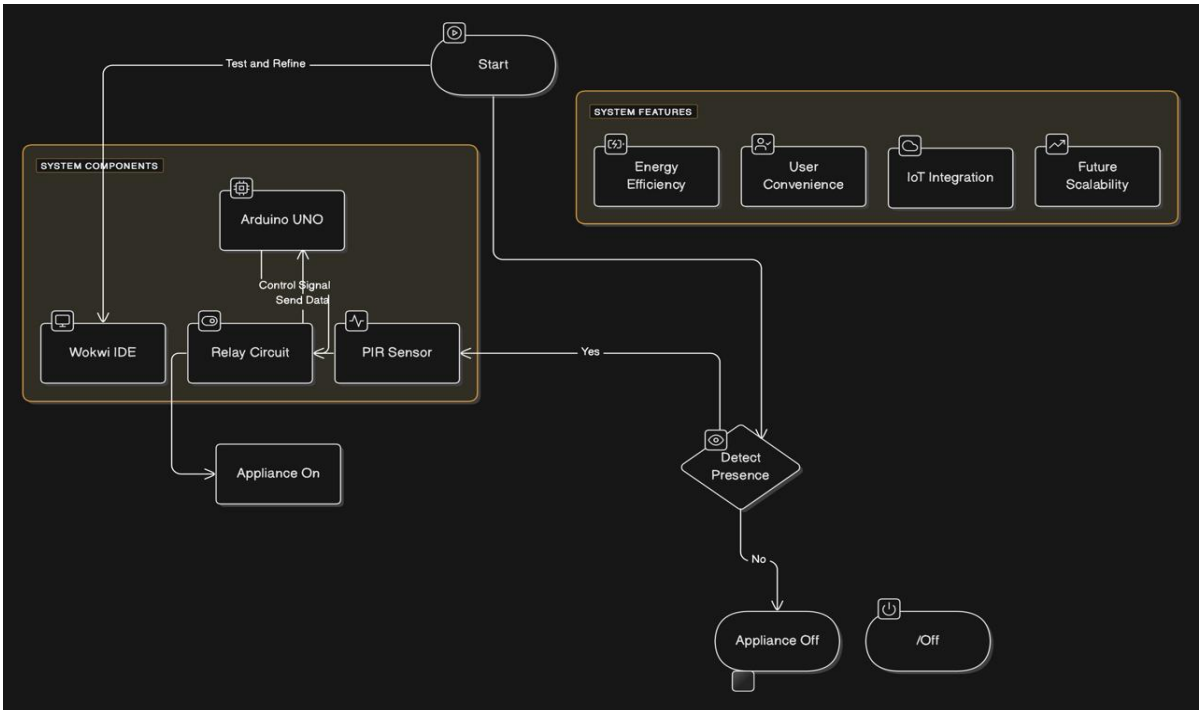
CHAPTER 4

SYSTEM ARCHITECTURE

1. System Architecture Diagram:



2. Process Flow Diagram:



CHAPTER 5
FEATURES

5.1 Motion Detection and Control

The Automated Switch On/Off System is equipped with a PIR sensor that continuously monitors its surroundings for movement. When the sensor detects infrared radiation changes, indicating human presence, it sends a signal to the Arduino microcontroller, which processes the data and triggers the relay to turn appliances on. In the absence of motion, the relay deactivates the appliances, ensuring they only operate when needed. This feature provides hands-free control, making it ideal for high-traffic areas or spaces where users might forget to turn off appliances manually, such as hallways or conference rooms.

5.2 Energy Efficiency

Energy conservation is central to this system's design. By limiting appliance operation to periods of detected activity, the system actively reduces unnecessary power consumption. This functionality not only lowers electricity costs but also supports environmental sustainability by cutting down on energy waste. The automated control reduces the need for user interaction, offering peace of mind and encouraging responsible energy use in homes, offices, and commercial spaces. Over time, the system's energy efficiency can contribute to significant savings and a reduced carbon footprint.

5.3 Automated Appliance Management

The system automates appliance control based on real-time occupancy data. For instance, it can control multiple devices such as lights, fans, or air conditioning units, which switch on upon entering a room and turn off when the room is vacated. This feature is particularly valuable in large homes or commercial spaces, where managing multiple appliances can be tedious. By centralizing control and automating responses, the system streamlines appliance management, making it both user-friendly and highly effective for optimizing resource use across various environments.

5.4 System Simulation and Testing

Wokwi simulation IDE is used to prototype, test, and validate the system's hardware and software interactions virtually. This simulation feature enables developers to verify the functionality of the PIR sensor, Arduino microcontroller, and relay circuit without needing physical components. The simulation environment supports iterative testing, allowing developers to troubleshoot code and refine hardware configurations before deploying the system in real-world settings. This reduces development time, minimizes errors, and ensures a reliable and robust end product.

5.5 Expandability with IoT Devices

The system's architecture allows it to integrate smoothly with other IoT devices, enhancing its utility and future-proofing it for more complex smart home or smart building setups. Future enhancements might include compatibility with smart thermostats, security cameras, or environmental sensors, enabling centralized control through mobile apps or web interfaces. This feature ensures that users can expand the system over time to include additional devices and functionalities, adapting it to evolving technology trends and personal needs, creating a cohesive, fully connected smart environment.

CHAPTER 6
IMPLEMENTATION DETAILS

6.1 Circuit Design and Hardware Setup

The circuit for the Automated Switch On/Off System is designed to interconnect the PIR sensor, Arduino UNO microcontroller, and relay circuit to facilitate automated appliance control. The PIR sensor is connected to the Arduino's input pins, where it detects infrared signals indicating human presence. When motion is detected, the Arduino processes the signal and sends a command to the relay circuit through its output pins. The relay, acting as a switch, either activates or deactivates the connected appliance based on the input from the Arduino. This setup ensures efficient communication among components, enabling seamless automation of electrical devices.

6.2 Arduino Programming and Logic Flow

The Arduino microcontroller is programmed in C++ to control the system's operation based on input from the PIR sensor. The code includes setup and loop functions that initialize sensor input and continuously monitor for changes in motion. When the PIR sensor detects motion, the Arduino logic triggers the relay to switch the appliance on. A timer is also implemented to turn off the appliance after a set period if no further motion is detected, conserving energy. The logic flow ensures responsive, real-time control of devices while minimizing unnecessary power usage.

6.3 Sensor Integration and Calibration

The PIR sensor is configured to detect movement within a specified range, making it suitable for various spaces such as rooms or corridors. During setup, the sensor's sensitivity and delay time are calibrated to balance responsiveness and avoid false triggers. Proper calibration is essential to ensure that the system only activates in the presence of actual motion, preventing unwanted appliance switching. The sensor's integration with the Arduino is achieved through digital input pins, allowing it to send reliable signals to the microcontroller for processing.

6.4 System Simulation Using Wokwi

The Wokwi simulation platform is used to validate the system design and functionality before deploying the physical components. Within Wokwi, the Arduino, PIR sensor, and relay are virtually connected, allowing developers to test the motion detection and relay activation in a safe, virtual environment. The simulation enables iterative testing and debugging of both the circuit and the Arduino code, ensuring that the components work harmoniously and meet the project requirements. This step minimizes errors and saves time during hardware assembly, providing a reliable foundation for the final implementation.

6.5 Code

```
#include <Wire.h>
#include <Servo.h>
#include <Adafruit_NeoPixel.h>
#include <LiquidCrystal_I2C.h>

// Define pins
const int pirPin = 2;
const int ledPin = 13;
const int buzzerPin = 6;
const int ringPin = 9;
const int servoPin = 5;

// Initialize I2C LCD (Address: 0x27, 16 columns, 2 rows)
LiquidCrystal_I2C lcd(0x27, 16, 2);
Adafruit_NeoPixel ring = Adafruit_NeoPixel(12, ringPin, NEO_GRB +
NEO_KHZ800);
Servo myServo;

unsigned long lastMotionTime = 0;
const unsigned long timeout = 5000;
```

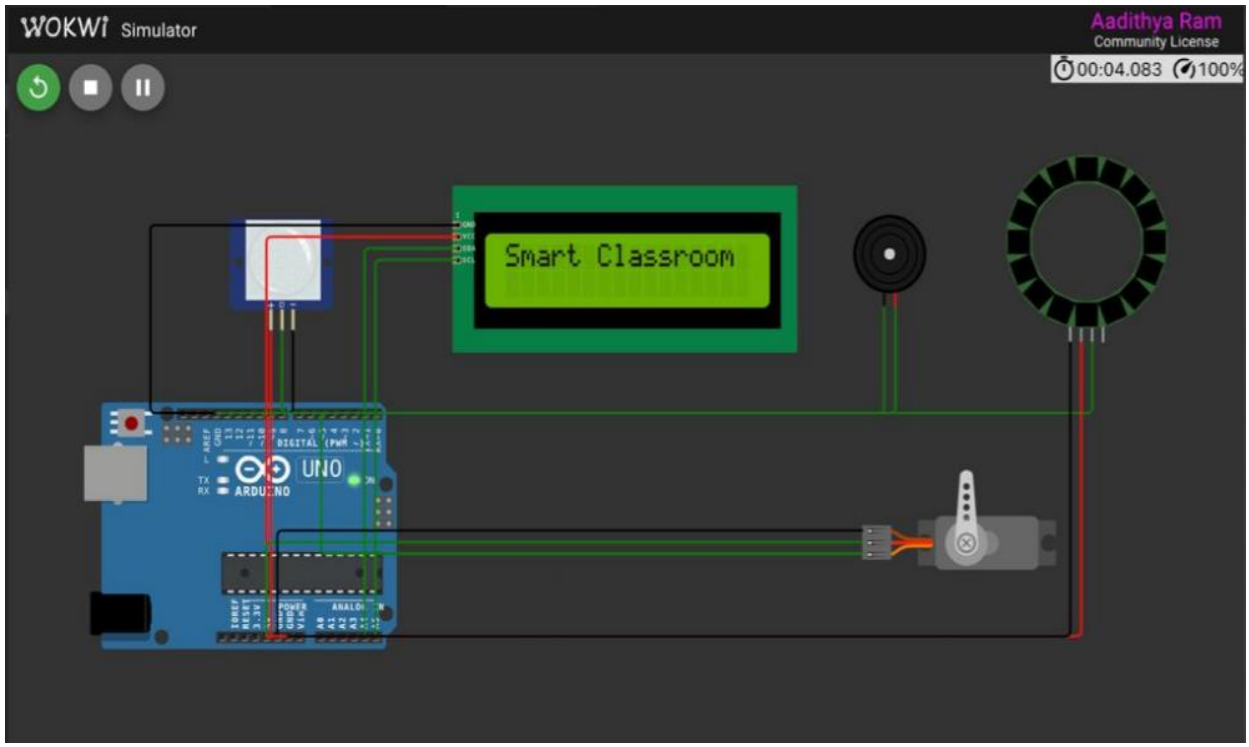
```
void setup() {
  pinMode(pirPin, INPUT);
  pinMode(ledPin, OUTPUT);
  pinMode(buzzerPin, OUTPUT);

  myServo.attach(servoPin);
  myServo.write(0); // Start with the servo at 0 degrees

  ring.begin();
  ring.show();

  lcd.init();       // Initialize the LCD
  lcd.backlight();  // Turn on the backlight
  lcd.print("Smart Class Ready");

  Serial.begin(9600);
}

void loop() {
  int motionState = digitalRead(pirPin);

  if (motionState == HIGH) {
    // Motion detected
    Serial.println("Motion detected! Turning on devices.");
    lcd.clear();
    lcd.print("Motion Detected!");

    digitalWrite(ledPin, HIGH);
    digitalWrite(buzzerPin, HIGH); // Turn on buzzer

    // Turn on NeoPixel Ring (White color)
    for (size_t i = 0; i < ring.numPixels(); i++) {
      ring.setPixelColor(i, ring.Color(255, 255, 255));
```

```
    }
    ring.show();

    // Move the servo motor
    myServo.write(90); // Rotate to 90 degrees

    lastMotionTime = millis();
  }

  // Turn off devices after timeout
  if (millis() - lastMotionTime > timeout) {
    Serial.println("No motion. Turning off devices.");
    lcd.clear();
    lcd.print("No Motion");

    digitalWrite(ledPin, LOW);
    digitalWrite(buzzerPin, LOW); // Turn off buzzer

    for (size_t i = 0; i < ring.numPixels(); i++) {
      ring.setPixelColor(i, ring.Color(0, 0, 0));
    }
    ring.show();

    // Reset the servo motor
    myServo.write(0); // Rotate back to 0 degrees
  }

  delay(100);
}
```

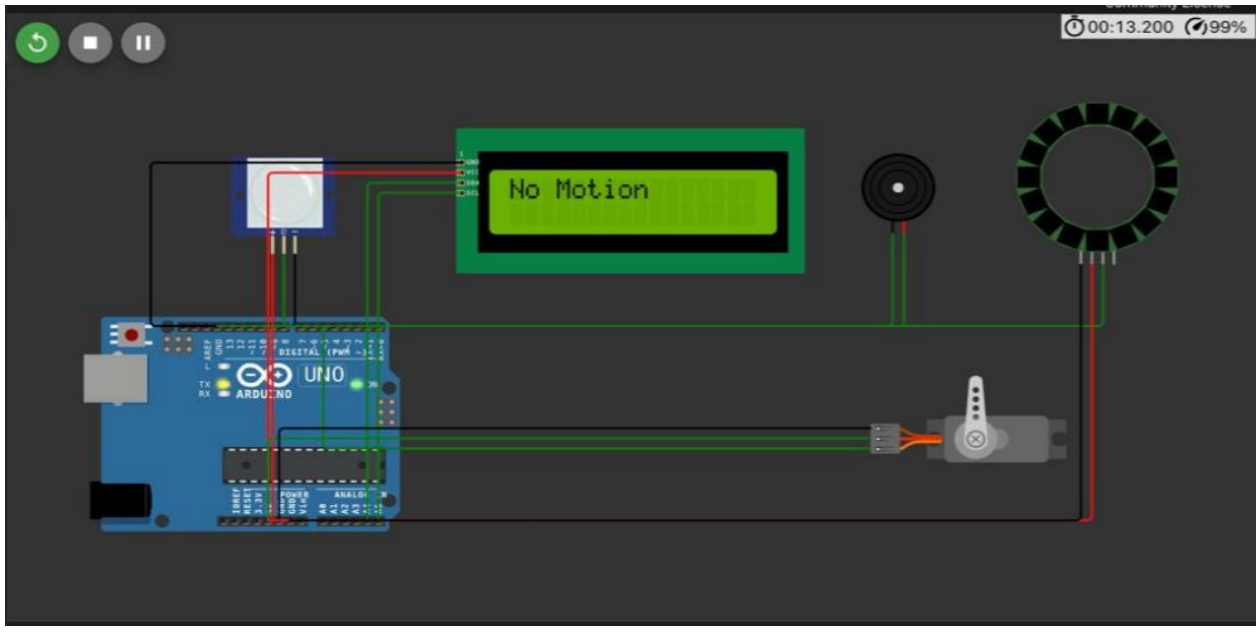
CHAPTER 7

RESULT AND OUTPUT

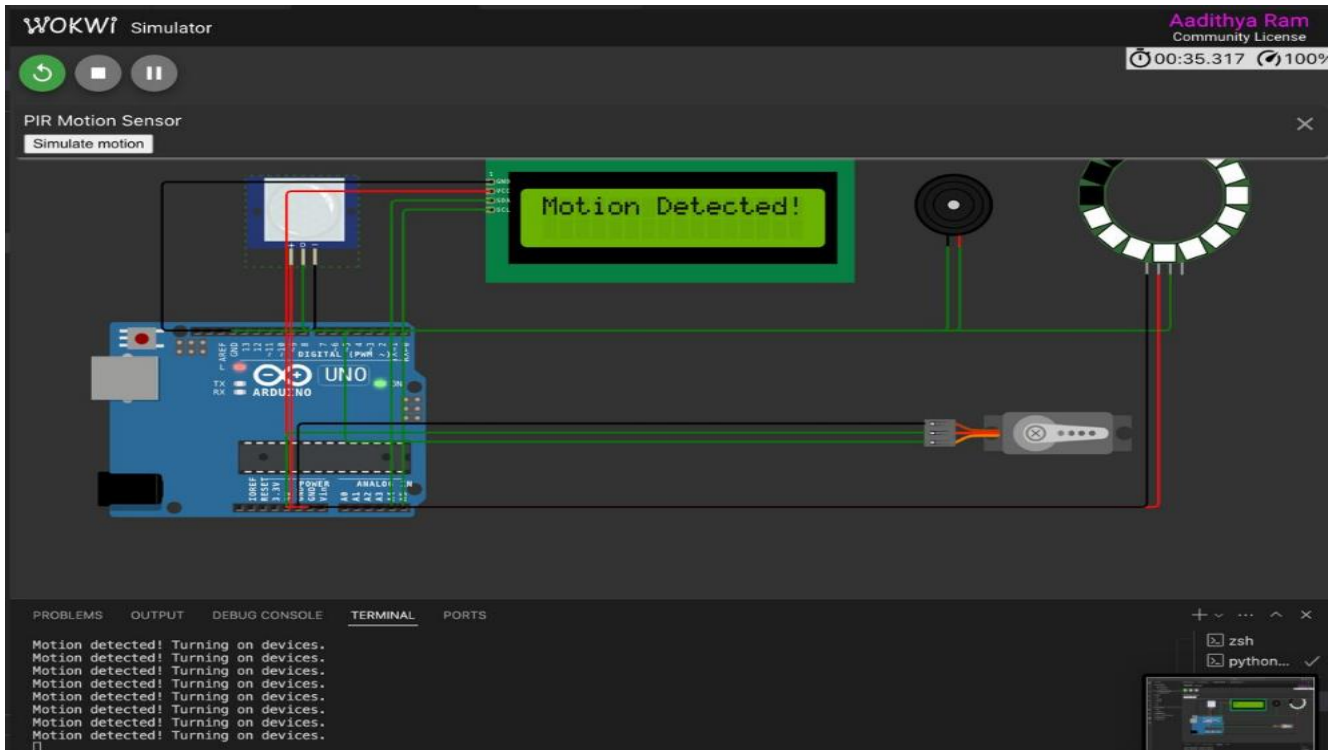
1. Simulation Start



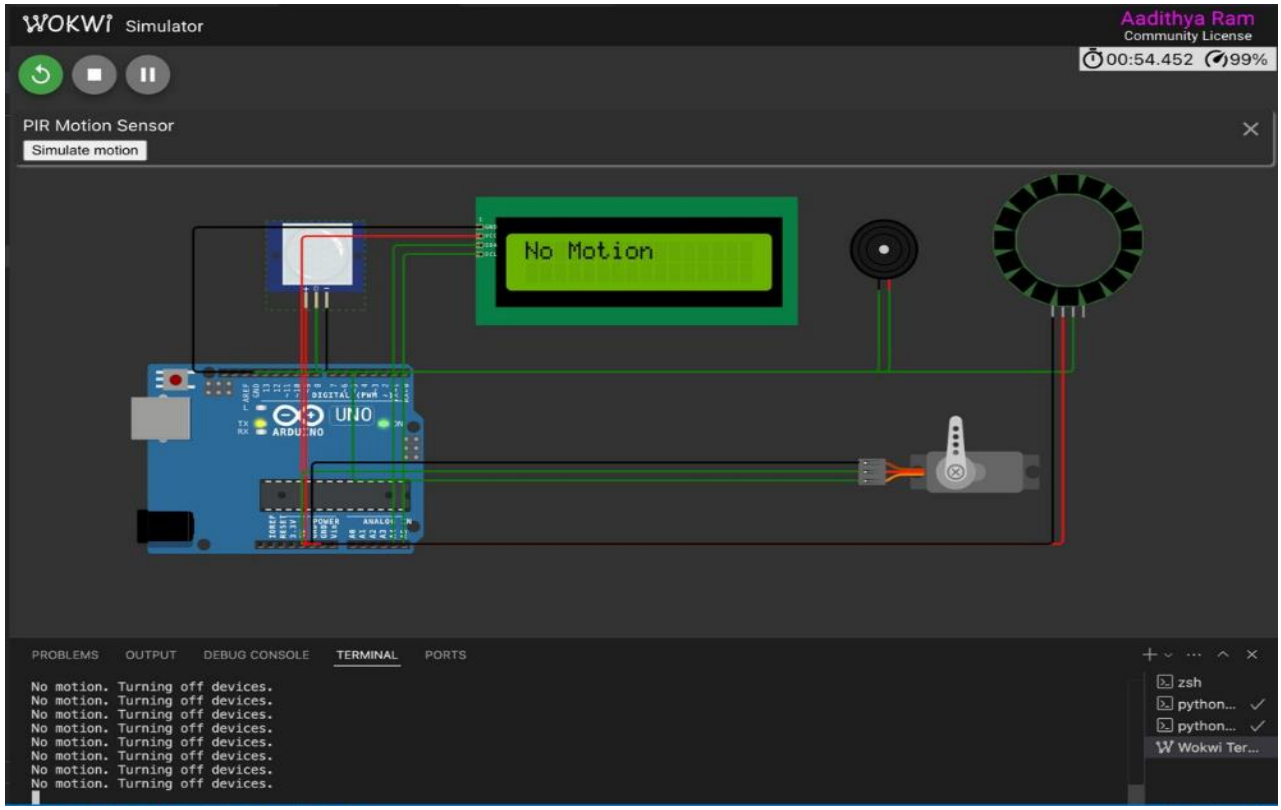
2. Continuous Monitoring of Motion



3. **Devices turned on once motion is detected**



4. **Devices turned off if no motion detected for 100ms or 10secs**



CHAPTER 8
CONCLUSION

The Automated Switch On/Off System illustrates the impact of IoT in transforming how we interact with and manage electrical appliances, making day-to-day life more convenient and energy-efficient. By leveraging a PIR sensor, Arduino microcontroller, and relay circuit, the system automates appliance control based on human presence, reducing the need for manual switches and minimizing energy wastage. This project emphasizes the benefits of automation in creating responsive, low-maintenance environments that adapt to user activity, contributing to both energy conservation and a smarter, more sustainable lifestyle. With future enhancements, the system could incorporate remote access through mobile applications, enabling users to control appliances from anywhere. Additionally, integrating data analytics could provide insights into energy usage patterns, allowing for further optimization and cost savings. Expanding compatibility with other IoT devices, such as smart thermostats, lighting systems, and security cameras, would pave the way for a fully interconnected smart home or office environment, amplifying the system's convenience, efficiency, and versatility in the evolving landscape of IoT technology.