INTELLIGENT ELECTRICAL DEVICE HANDLER IN CLASSROOM USING INTERNET OF THINGS

MINI PROJECT - II

Submitted by

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In partial fulfillment of the requirement

for the award of the degree

Of

MASTER OF COMPUTER APPLICATIONS

Dr. MAHALINGAM COLLEGE OF

ENGINEERING AND TECHNOLOGY

POLLACHI - 642 003

(Approved by AICTE, Affiliated to Anna University and

Accredited by NBA & NAAC with "A++" Grade)

JUNE 2023

Dr. MAHALINGAM COLLEGE OF ENGINEERING AND TECHNOLOGY
POLLACHI – 642 003

DEPARTMENT OF COMPUTER APPLICATIONS

MINI PROJECT - II REPORT

JUNE 2023

This is to certify that the project entitled

INTELLIGENT ELECTRICAL DEVICE HANDLER

IN CLASSROOM USING INTERNET OF THINGS

Is the bona-fide record of project work done by

A.THIRISHA

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Of Master of Computer Applications during the year **2022-2023**

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Submitted for the Project Viva-Voce examination held on ________________________________

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Internal Examiner External Examiner

DECLARATION

I affirm that the project work titled **"INTELLIGENT ELECTRICAL DEVICE HANDLER IN CLASSROOM USING INTERNET OF THINGS"** being submitted in partial fulfillment for the award of **Master of Computer Applications** is the original work carried out by me. It has not formed the part of any other project work submitted for award of any degree or diploma, either in this or any other University.

(Signature of the Candidate)

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I certify that the declaration made above by the candidate is true.

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ABSTRACT

ABSTRACT

The main objective of this initiative is to reduce the energy waste. Monitoring the electrical components is the purpose of this research (Lights and fans).This light and fan will be automatically down when no one is in the room to save energy and the main objective is to automatically control the fan and lights. An example would be having temperature sensors around the class room that would detect the temperature and respond to any change by altering the fan speed. For light control, there will be proximity sensors that would detect student's presence and cause the lights to turn on if students are near that area.

TABLE OF CONTENT

LIST OF FIGURES

INTRODUCTION

CHAPTER-1

INTRODUCTION

1.1 OBJECTIVES OF THE STUDY:

As we enter the 21st century, the interaction between humans and computer is breaking the old barriers and entering a new realm. Today’s homes require sophistication control in its different gadgets which are basically electronic appliances. This has revolutionized the area of home automation with respect to an increased level of affordability and simplicity through the integration of home appliances with smart phone and tablet connectivity. In the highly technology driven world of today’s computer and cell phones have become a part of our lifestyles. The Internet of Things (IoT) can be defined as a network of physical objects or people called "things" that are embedded with software, electronics, network, and sensors which allows these objects to collect and exchange data. The goal of IoT is to extend to internet connectivity from standard devices like computer, mobile, tablet to relatively dumb devices like a toaster. IoT makes virtually everything "smart," by improving aspects of our life with the power of data collection, AI algorithm, and networks. The thing in IoT can also be a person with a diabetes monitor implant, an animal with tracking devices, etc. Connecting up all these different objects and adding sensors to them adds a level of digital intelligence to devices that would be otherwise dumb, enabling them to communicate real-time data without involving a human being. The Internet of Things is making the fabric of the world around us smarter and more responsive, merging the digital and physical universes.

SYSTEM ANALYSIS

CHAPTER-2

SYSTEM ANALYSIS

2.1 EXSISTING SYSTEM:

Manual Operation: Without automation, the operation of fans and lights relied on manual control. Teachers or staff had to physically turn on/off lights and adjust fan speeds, which was time-consuming and inefficient. It also led to instances of lights being left on when not needed, resulting in energy waste.

Energy Waste: In the absence of automated controls, lights and fans often remained turned on even when the classroom was unoccupied. This led to unnecessary energy consumption, contributing to higher utility costs and environmental impact.

2.2 PROPOSED SYSTEM:

The main objective is to automatically control the fan, lights and projector. The idea is to plant several sensors around the classroom and give a calculated feedback to the response these sensors receive. An example would be having PIR sensors around the class room that would detect the presence of human and turns the fan ON or OFF.

ADVANTAGES OF PROPOSED SYSTEM:

Energy Efficiency: By using a PIR sensor to detect motion, the system can automatically turn on the lights and fan only when someone is present in the classroom. This helps to save energy by avoiding unnecessary usage when the room is unoccupied.

Cost Savings: With the automated control of lights and fans, there is a potential for cost savings in terms of reduced electricity bills. The system ensures that energy is not wasted when the room is vacant, leading to lower electricity consumption and cost.

Convenience and Ease of Use: The automation system eliminates the need for manual control of lights and fans. Teachers or students do not have to remember to turn them on or off, as the system handles it automatically based on motion detection. This adds convenience and simplifies the classroom management process.

SYSTEM SPECIFICATION

CHAPTER -3

SYSTEM SPECIFICATION

3.1 HARDWARE SPECIFICATION:

3.1.1 SYSTEM COMPONENTS:

- Processor : Intel i3 & Above (3.5 GHz Speed)
- Hard Disk : 40 GB.(Needed)
- RAM : 4 GB.

3.1.2 REQUIRED COMPONENTS:

The following are the required hardware components:

- Chip :Arduino UNO
- Sensor :PIR Sensor (Passive Infrared Sensor)
- Exhaustive fan
- Lamp
- Relay Module
- Resistor
- Capacitor
- Dot Matrix Board
- 9v Battery
- Jumper Cables

3.2 SOFTWARE SPECIFICATION:

- Operating System : Windows 7/8/10
- Tool : Arduino IDE 2.0
- Programming language : C

SOFTWARE DESCRIPTION

CHAPTER-4

SOFTWARE DESCRIPTION

4.1 DEVELOPMENT TOOLS AND TECHNOLOGIES:

ARDUINO IDE:

The Arduino IDE 2.0 is an updated version of the Arduino Integrated Development Environment (IDE), which is a software platform used for programming and developing projects with Arduino boards. The Arduino IDE 2.0 introduces several improvements and new features to enhance the user experience and streamline the development process. Arduino is mainly used to build electronic projects for everyone – electricians, tinkerers, hobbyists, makers, and beginners. You can feed an Arduino board a set of instructions for it to carry out certain tasks. It is able to read the inputs and turn them into an output, for example, it will read a finger on a button and turn on an LED.

Here is a detailed description of the Arduino IDE 2.0:

4.1.1 MODERN USER INTERFACE: The IDE 2.0 features a redesigned user interface that provides a more intuitive and modern experience. It includes a new dark theme and a modular interface that allows users to customize the layout based on their preferences.

4.1.2 MULTIPLE TABS AND DOCKABLE PANELS: With the IDE 2.0, users can work with multiple tabs within a single window, making it easier to switch between different sketches or project files. The panels in the IDE are also dock-able, allowing users to arrange and organize them according to their needs.

4.1.3 IMPROVED EDITOR: The code editor in the IDE 2.0 has been enhanced with features like auto-completion, syntax highlighting, and code navigation. It provides a more efficient coding experience by assisting developers with suggestions and highlighting errors or warnings in the code.

4.1.4 LIBRARY MANAGER: The IDE 2.0 includes an integrated Library Manager, which simplifies the process of installing and managing libraries for Arduino projects. Users can browse the vast library repository, search for specific libraries, and install them directly from within the IDE.

4.1.5 BUILT-IN BOARD MANAGER: The new Board Manager in IDE 2.0 enables users to install and manage different Arduino board platforms and their associated libraries. It provides a streamlined way to add support for various Arduino-compatible boards, including official Arduino boards and third-party platforms.

4.1.6 DEBUGGER INTEGRATION: The IDE 2.0 offers integration with a debugger, allowing users to debug their Arduino sketches. Debugging features include breakpoints, variable inspection, stepping through code, and real-time monitoring of variables and memory usage.

4.1.7 PROJECT STRUCTURE AND MANAGEMENT: The IDE 2.0 introduces a project-based approach, allowing users to organize their sketches and related files into projects. This simplifies project management and enables users to have a better overview of their work.

4.1.8 IMPROVED SERIAL MONITOR: The Serial Monitor tool, used for communicating with the Arduino board, has been enhanced with features like configurable baud rates, line ending options, and data visualization. It provides an improved interface for monitoring and debugging serial communication between the board and the computer.

4.1.9 PLATFORM INTEGRATION: The IDE 2.0 is built on the Eclipse Theia framework, which allows it to run as a desktop application or as a web-based IDE. This platform integration provides flexibility and cross-platform compatibility for Arduino development.

The Arduino IDE 2.0 brings several advancements and features that aim to simplify and enhance the Arduino development process. It provides an improved user interface, better code editing capabilities, integrated library and board management, debugging support, and other tools that facilitate the creation of Arduino projects.

Fig 4.1 Arduino IDE 2.0

PROJECT DESCRIPTION

CHAPTER-5

PROJECT DESCRIPTION

5.1.1 PROBLEM STATEMENT:

Class automation systems are quickly emerging and becoming popular nowadays in the world. Which help in keeping electricity usage at minimal but other than minimizing electricity it can also perform other tasks. Nowadays motion sensor is only used to control the switches activity. But motion sensor can also work for security purpose for detecting motion in environment and sending notification to authorities.

5.2 OVERVIEW OF THE PROJECT:

The project aims to implement a classroom automation system using IoT (Internet of Things) technology. The system focuses on controlling the fans and lights in a classroom using a PIR (Passive Infrared) sensor for motion detection. It utilizes an Arduino board and various components to automate the process of turning on and off the lights and fans based on occupancy.

The core idea of the project is to improve energy efficiency, convenience, and comfort in classrooms by automating the control of essential elements such as lighting and ventilation. The PIR sensor detects motion within the classroom, and when motion is detected, the system activates the lights and fans. When the room becomes unoccupied, the system automatically turns off the lights and fans to conserve energy.

By implementing this automation system, several benefits can be achieved. It reduces energy consumption and costs by ensuring that lights and fans are only active when needed. It enhances convenience by eliminating the need for manual control of these devices. It creates a comfortable environment for teaching and learning by maintaining appropriate lighting and ventilation levels. Additionally, the project showcases the integration of IoT technology in the educational setting and promotes sustainability by encouraging responsible energy usage.

Overall, the project offers a practical and efficient solution to automate classroom control systems, making them more energy-efficient, convenient, and conducive to learning. It demonstrates the potential of IoT technology in optimizing educational environments and contributes to the ongoing efforts for sustainable and smart classrooms.

5.3COMPONENT DESCRIPTION:

5.3.1 ARDUINO:

The Arduino is one of the main components of the automated fan system. It is a single-board microcontroller that uses electronics to make projects more accessible. The hardware has an "open-source" hardware board which is made with an 8-bit Atmel AVR microcontroller. The Arduino uses a programming language called the "Integrated Development Environment" or in short "IDE". The IDE, which this system will use, is a program written in C and it allows users to create instructions for the microcontroller. These instructions are then sent using a boot loader which would execute the given commands to the microcontroller and then coordinate the fan on how fast it would rotate.

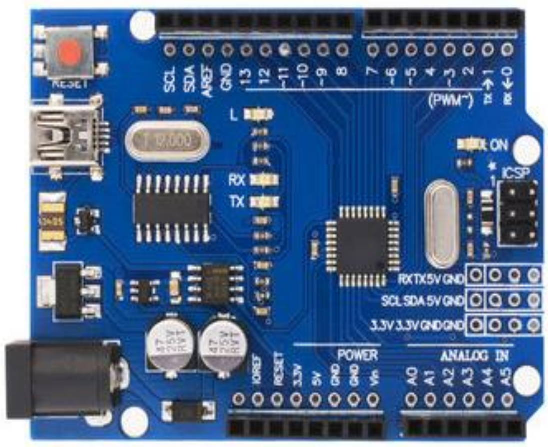

Fig 5.1 Arduino Board

5.3.2 RELAY:

Relays are switches that open and close circuits electromechanically or electronically. It controls one electrical circuit by opening and closing contacts in another circuit. When a relay contact is 30 normally open (NO), there is an open contact when the relay is not energized. When a relay contact is Normally Closed (NC), there is a closed contact when the relay is not energized. Relays are generally used to switch smaller currents in a control circuit and do not usually control power consuming devices except for small motors and Solenoids that draw low amps. Moreover, relays can "control" larger voltages and amperes by having an amplifying effect. Protective relays can prevent equipment damage by detecting electrical abnormalities, including over current, undercurrent, overloads and reverse currents. In addition, relays are also widely used to switch starting coils, heating elements, pilot lights and audible alarms.

Fig 5.2 Relay Board

5.3.3 NPN TRANSISTOR:

Transistors are used to control the coiled current of the relay. For the fan, we are using an NPN transistor because when NPN transistor is used then the relay will be energized and would turn on, when control voltage VIN is equal to +12. The relay would turn off if the VIN is 0V. The opposite would occur if the PNP used.

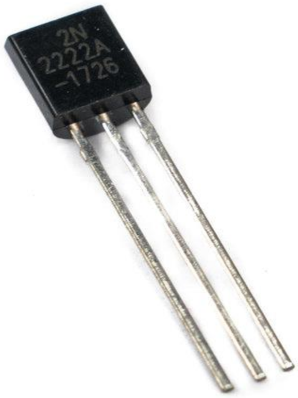

Fig 5.3 NPN Transistor

5.3.4 PIR SENSOR:

PIR sensors are more complicated than many of the other sensors (like photocells, FSRs and tilt switches) because there are multiple variables that affect the sensors input and output. The PIR sensor itself has two slots in it; each slot is made of a special material that is sensitive to IR. The lens used here is not doing much and so it can be seen that the two slots can 'see' out past some distance (basically the sensitivity of the sensor).

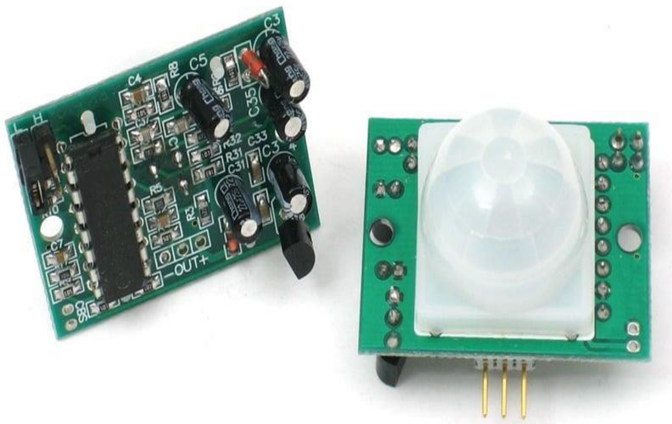

Fig 5.4 PIR Sensor

5.3.5 JUMPER CABLES:

Jumper cables, also known as jumper wires, are widely used in electronics and prototyping projects. They are short wires with male or female connectors on each end, typically with a solid-core or flexible wire construction. Jumper cables serve several purposes and have various applications, including:

Circuit Connections: Jumper cables are used to establish electrical connections between different components on a breadboard or prototype board. They allow you to connect components such as microcontrollers, sensors, resistors, LEDs, and other electronic elements without the need for soldering.

Prototyping: Jumper cables are commonly used in prototyping and experimentation. They enable you to quickly and easily make temporary connections between components, test circuits, and modify the circuit layout as needed. This flexibility is especially beneficial when developing and troubleshooting projects.

Bread boarding: Jumper cables are essential for bread boarding, which is a common technique for designing and testing electronic circuits. They enable you to connect components and create circuit paths on a breadboard, making it easier to visualize and assemble circuits before permanent soldering.

Fig 5.5 Jumper cables

5.3.6 EXHAUSTIVE FAN:

An "exhaustive fan" in the context of IoT (Internet of Things) could refer to a smart fan or ventilation system that operates based on various input factors or conditions. Instead of a traditional fan that runs at a fixed speed or with manual controls, an exhaustive fan utilizes IoT capabilities to enhance its functionality and efficiency.

Fig 5.6 Exhaustive Fan

5.3.7 LED – LIGHT EMITTING DIODE:

LED bulbs can be integrated with IoT devices and controlled remotely through a central management system. This allows for dynamic lighting scenarios in the classroom, such as adjusting brightness levels, color temperature, or creating different lighting scenes for specific activities or moods.

Fig 5.7 LED

5.3.8 RESISTOR:

A resistor is a passive electronic component designed to impede the flow of electric current within an electrical circuit. It is primarily used to create a specific resistance value, which is measured in ohms (Ω). The resistor's main function is to restrict the flow of current and control the amount of voltage across a circuit. Resistors are typically made from materials with high resistivity, such as carbon, metal, or metal oxide films. They come in various physical forms, including axial lead resistors (with wire leads on both ends), surface mount resistors (small rectangular components for PCB assembly), and variable resistors (potentiometers or rheostats that allow manual adjustment of resistance).

Fig 5.8 RESISTOR

5.3.9 CAPACITOR:

A capacitor is an electronic component that stores and releases electrical energy. It consists of two conductive plates separated by an insulating material known as a dielectric. The plates and the dielectric together form a capacitor. When a voltage is applied across the plates, an electric field is created in the dielectric, causing the capacitor to store electrical charge. Capacitors are characterized by their capacitance, which represents the ability to store charge and is measured in farads (F). However, capacitors in practical electronic circuits often have capacitance values in smaller units such as microfarads (µF), Nano farads (mph), or Pico farads (pF).

Fig 5.9 Capacitor

5.3.10 DOT MATRIX BOARD:

A dot matrix board, also known as a dot matrix display or dot matrix panel, is an electronic device that consists of an array of small LEDs (Light Emitting Diodes) or pixels arranged in a matrix pattern. It is used to display alphanumeric characters, symbols, and graphics by selectively activating or deactivating the individual LEDs. Each LED in a dot matrix display can be considered as a single "dot" or "pixel." The dots are arranged in a rectangular grid, typically in rows and columns. The size of the matrix determines the resolution and the number of characters or symbols that can be displayed.

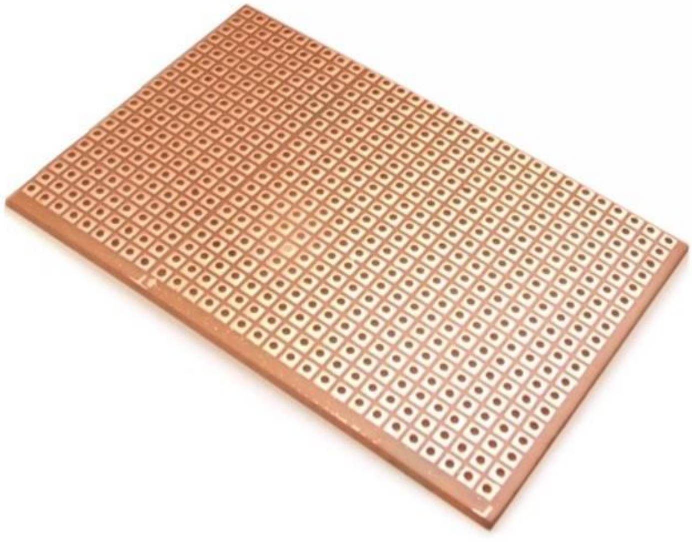

Fig 5.10 Dot Matrix Board

5.3.11 9v BATTERY:

A 9V battery is a compact and portable power source commonly used in various electronic devices, including IoT (Internet of Things) applications. It is a small rectangular-shaped battery that provides a nominal voltage of 9 volts.9V batteries are typically used in low-power devices where compactness and ease of replacement are important factors. They are often found in smoke detectors, remote controls, handheld devices, toys, and small electronic gadgets. In the context of IoT, 9V batteries can be employed in IoT devices that require a relatively low power supply.

Fig 5.10 9v Battery

5.4 SYSTEM DESIGN:

5.4.1 BLOCK DIAGRAM:

A block diagram is a graphical representation of a system or process that uses blocks to represent different components or stages and arrows to indicate the flow of information or signals between them. Each block represents a specific function or operation within the system, and the arrows indicate the direction of data flow or signal transmission.

The purpose of a block diagram is to provide a visual overview and understanding of the system's structure and operation, making it easier to comprehend complex systems and analyze their functionality. Block diagrams are commonly used in engineering, electronics, computer science, and various other fields to describe and design systems.

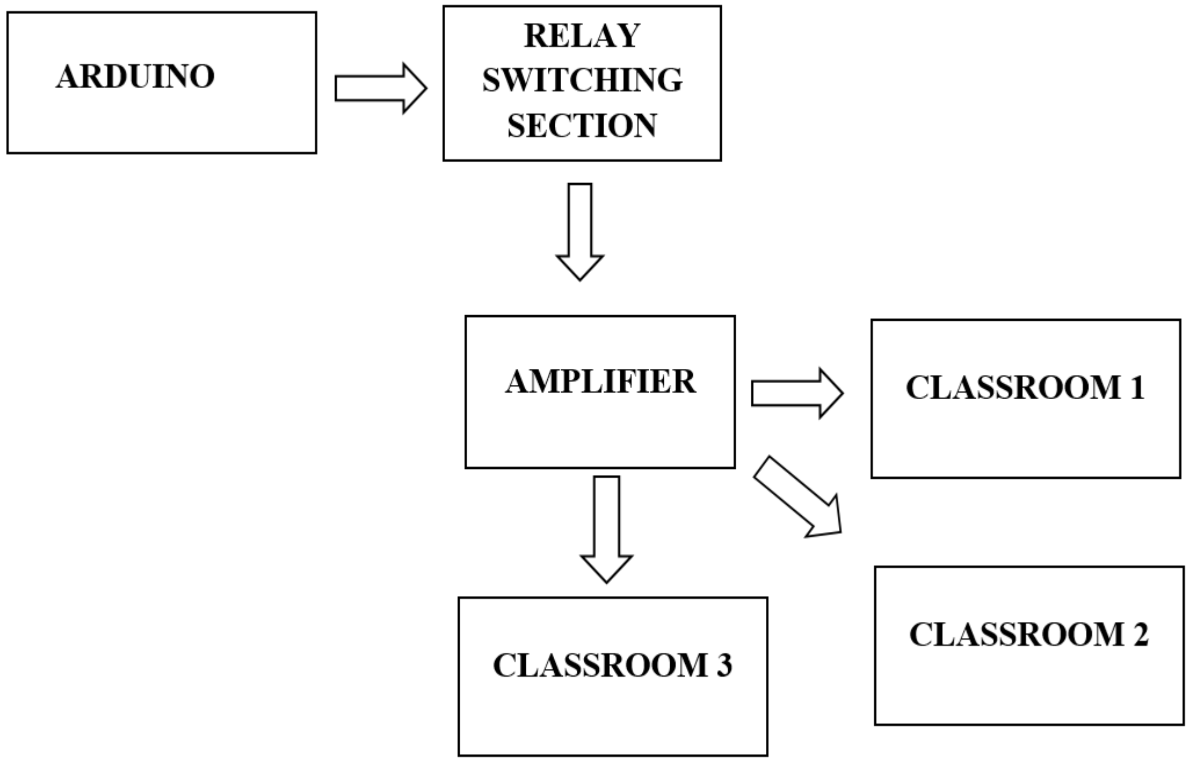

Fig 5.4.1 Block Diagram

5.4.2 WORKING OF PIR SENSOR:

A Passive Infrared (PIR) sensor is an electronic device that detects the presence of humans or animals by sensing changes in infrared radiation emitted by their bodies. PIR sensors are commonly used in security systems, motion-activated lighting, and other applications where detecting human presence is required.

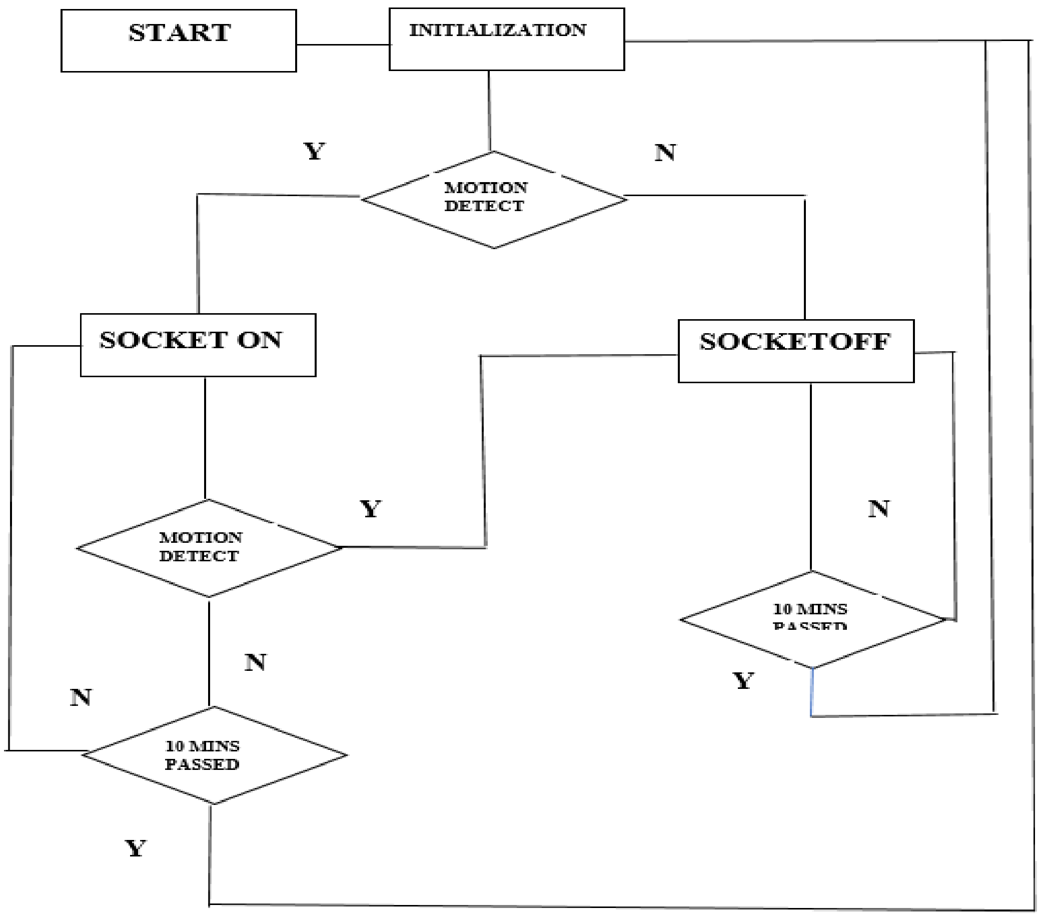

Fig 5.4.2 WORKING OF PIR SENSOR

5.4.3 FLOW CHART DIAGRAM:

The following are the steps followed in flowchart diagram:

1. Start
2. Mount the PIR sensor in a suitable location
3. Connect the power supply to the PIR sensor
4. Wire the fan and light to the appropriate power source
5. Connect the positive terminals of the fan and light to the output pin of the PIR sensor
6. Connect the negative terminals of the fan and light to the common ground or negative terminal of the power supply
7. Configure the output of the PIR sensor
    a. Set the time delay according to the desired duration
    b. Adjust the sensitivity to ensure accurate motion detection within the desired range
8. Test the setup by moving within the detection range of the PIR sensor
9. If motion is detected, activate the fan and light
10. If no motion is detected, turn off the fan and light
11. Repeat steps 8 to 10 as necessary
12. End

The exact sequence of steps and decision points may vary depending on the specific PIR sensor and fan/light setup.

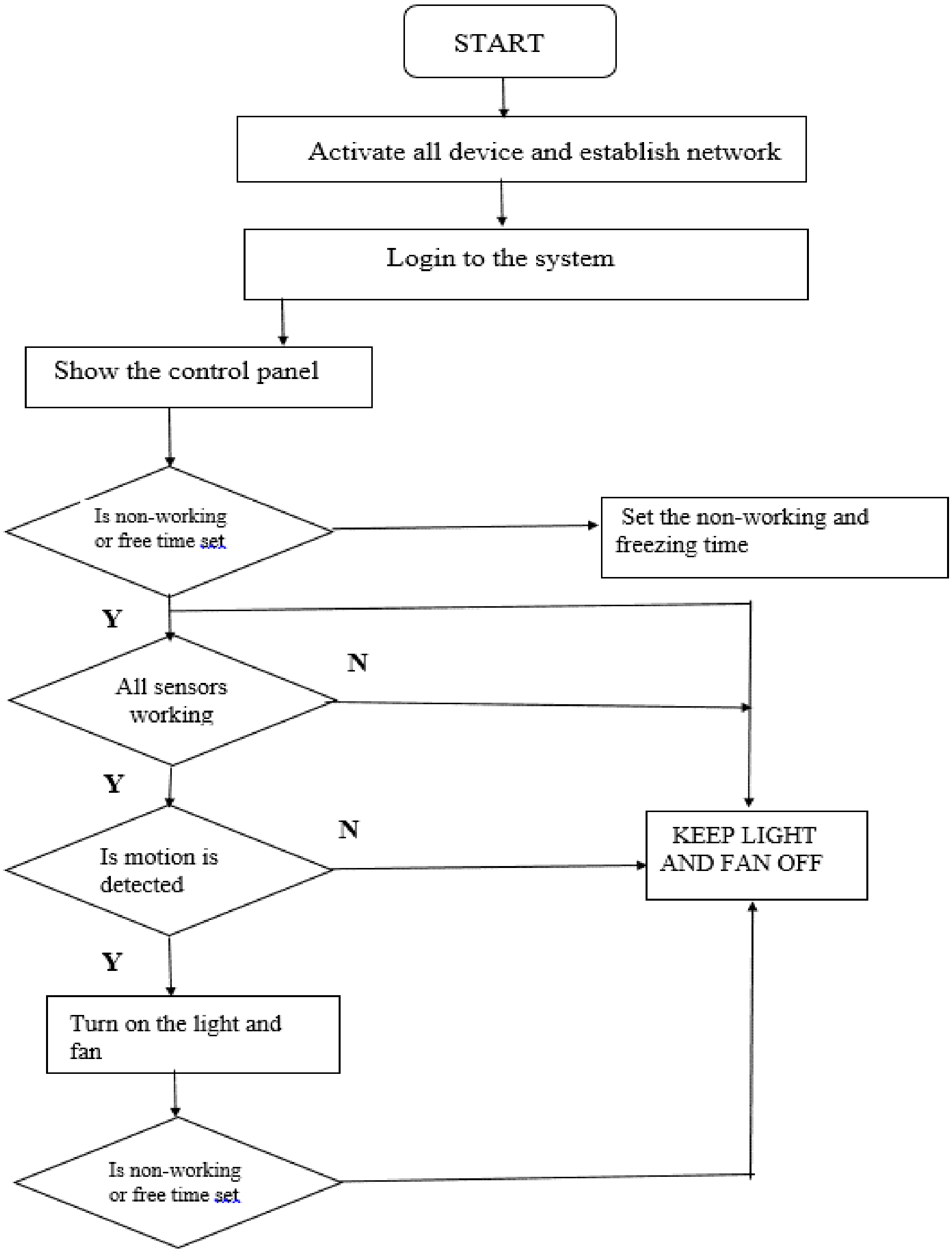

Fig 5.4.3 Flow Chart Diagram

5.4.4 CIRCUIT DIAGRAM:

A circuit diagram, also known as a schematic diagram or electrical diagram, is a graphical representation of an electrical circuit. It uses symbols to illustrate the components and connections within the circuit. The circuit diagram provides a visual representation of how the circuit is constructed and how the components are interconnected.

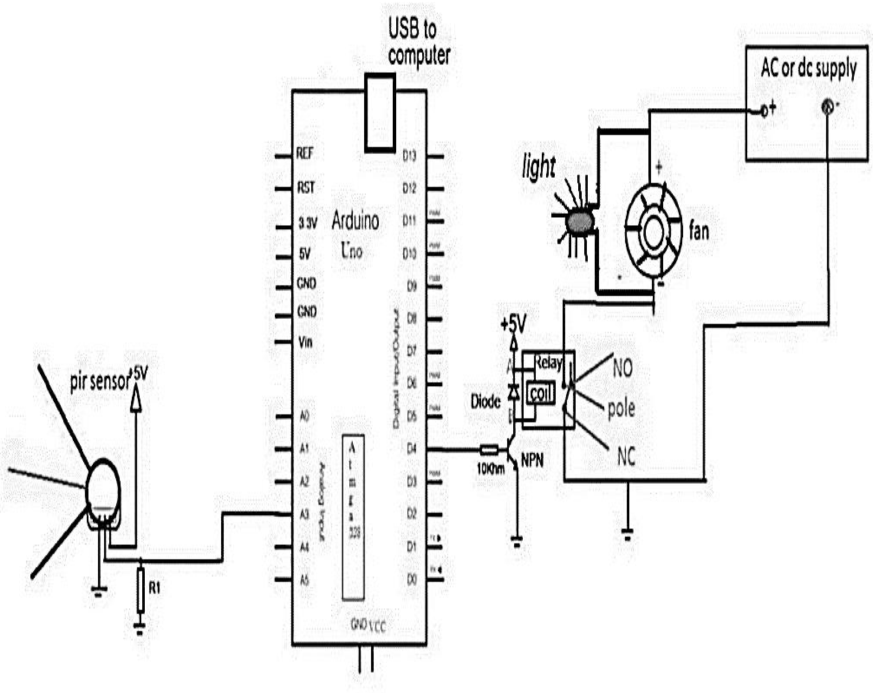

Fig 5.4.4 Circuit Diagram

IMPLEMENTATION

CHAPTER- 6
IMPLEMENTATION

6.1 DESCRIPTION OF MODULES:

In the context of a classroom automation system using IoT for controlling fans and lights using a PIR sensor, the project can be divided into several modules, each performing specific functions. Here is a description of the key modules involved:

PIR Sensor Module: This module consists of a PIR (Passive Infrared) sensor that detects motion within the classroom. The PIR sensor module is responsible for capturing infrared radiation emitted by humans or objects in motion. It provides a digital output signal indicating the presence or absence of motion in the classroom.

Microcontroller Module (e.g., Arduino): The microcontroller module acts as the brain of the system, receiving input from the PIR sensor and controlling the output devices (lights and fans) based on the detected motion. It processes the signals received from the PIR sensor and triggers the appropriate actions. The microcontroller module can be implemented using platforms such as Arduino, which provide an easy-to-use development environment and interface with other components.

Relay Module: The relay module serves as a switch that controls the power supply to the lights and fans. It receives signals from the microcontroller and activates or deactivates the relay switch accordingly. The relay module allows low-voltage control signals from the microcontroller to control higher voltage and current devices like lights and fans.

Lighting Module: The lighting module consists of LED lights that illuminate the classroom. The module is connected to the relay module and can be controlled by the microcontroller to turn on or off based on the presence of motion detected by the PIR sensor.

Fan Control Module: The fan control module controls the operation of the DC fan in the classroom. It is connected to the relay module and can be activated or deactivated by the microcontroller based on the motion detected by the PIR sensor.

Power Supply Module: The power supply module provides the necessary electrical power to operate the entire system. It ensures a stable and regulated power supply to the microcontroller, PIR sensor, relay module, LED lights, and fan control module. The power supply module can be implemented using a suitable DC power source or by integrating a power regulator circuit.

User Interface Module (optional): This module provides a user interface for manual control or monitoring of the system.It may include elements such as buttons, switches, or an LCD display to allow users to override the automated control or view the system status.

These modules work together to create an integrated system that automates the control of fans and lights in the classroom based on motion detection. The PIR sensor detects motion, which triggers the microcontroller to activate or deactivate the relay module. The relay module, in turn, controls the lighting module and fan control module to turn on or off the lights and fans as required. The power supply module ensures the availability of power for the entire system, and the optional user interface module provides manual control or monitoring capabilities.

6.2 PROJECT DEMONSTARTION:

The following are the steps which clearly demonstrates the project:

STEP 1: Connect the PIR sensor to the Arduino: Connect the VCC pin of the PIR sensor to the 5V pin on the Arduino. Connect the GND pin of the PIR sensor to the GND pin on the Arduino. Connect the OUT pin of the PIR sensor to a digital input pin on the Arduino (e.g., pin 2).
STEP 2: Connect the relay module to the Arduino: Connect the VCC pin of the relay module to the 5V pin on the Arduino. Connect the GND pin of the relay module to the GND pin on the Arduino. Connect the IN pin of the relay module to a digital output pin on the Arduino (e.g., pin 3).
STEP 3: Connect the LED lights to the relay module: Connect the positive terminal of the LED lights to the COM (common) pin of the relay module. Connect the negative terminal of the LED lights to the NO (normally open) pin of the relay module.
STEP 4: Connect the DC fan to the relay module: Connect the positive terminal of the DC fan to the NO (normally open) pin of the relay module. Connect the negative terminal of the DC fan to the GND pin on the Arduino.
STEP 5: Upload the Arduino code: Open the Arduino IDE and create a new sketch. Upload the code.

6.3 EXECUTION SNAPSHOT:

6.3.1 SCREENSHOTS:

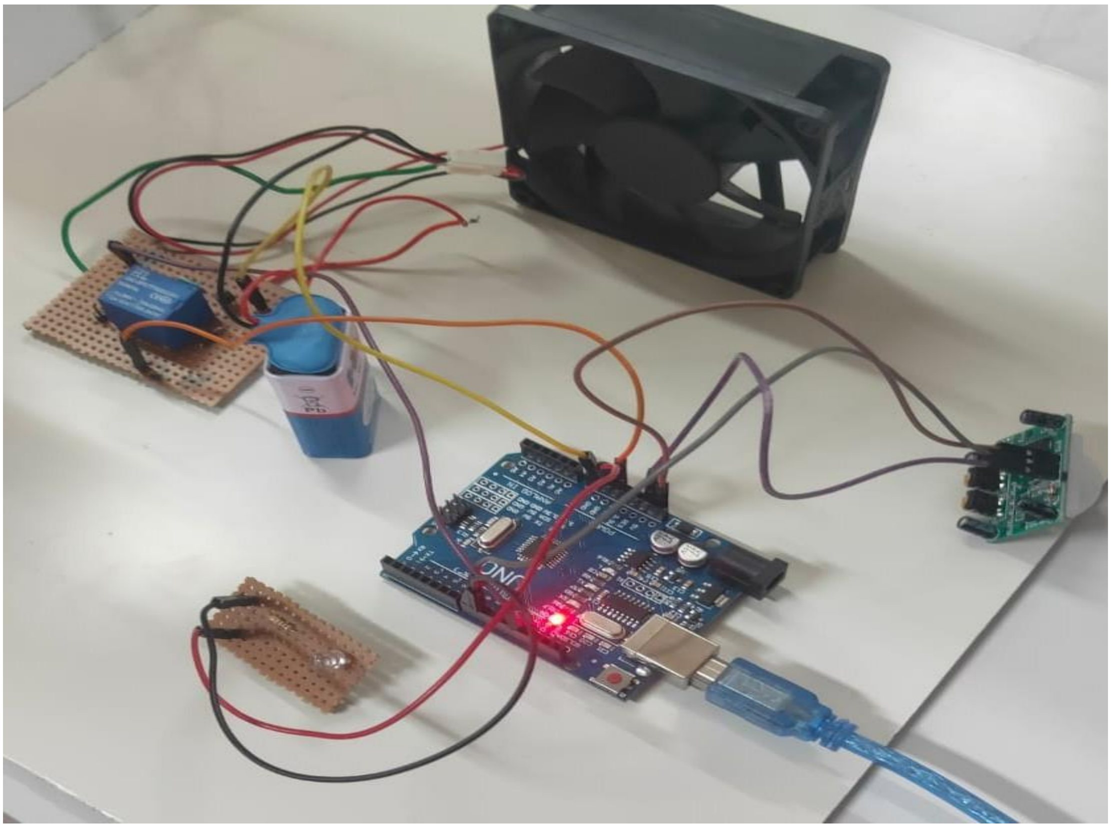

Fig 6.3.1 General Setup – Setting up all the connection such as pir sensor, LED, Battery, Relay, Exhaustive fan, Arduino UNO

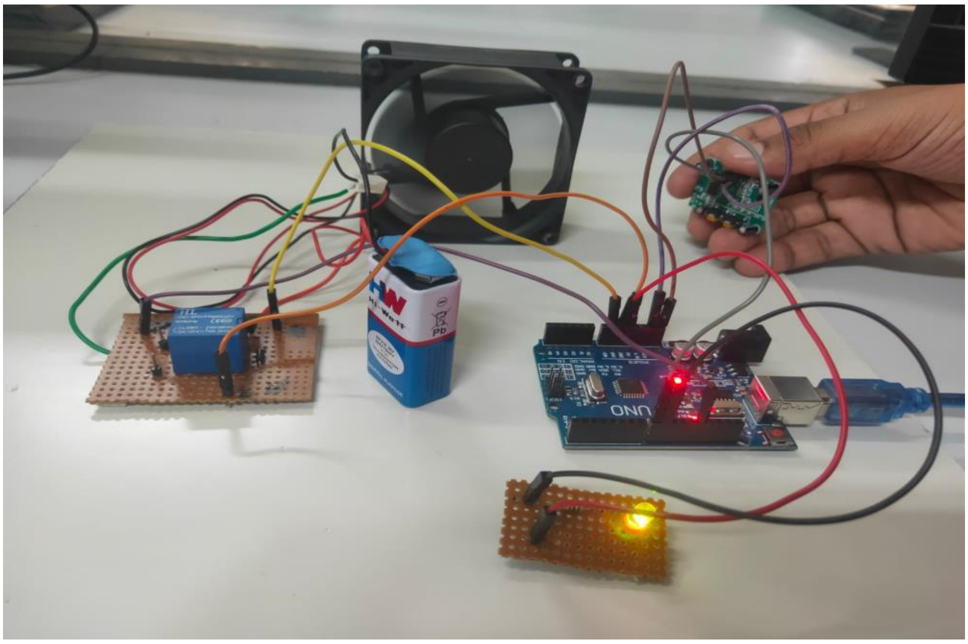

Fig 6.3.2 Fan and Light enables when the motion is detected.

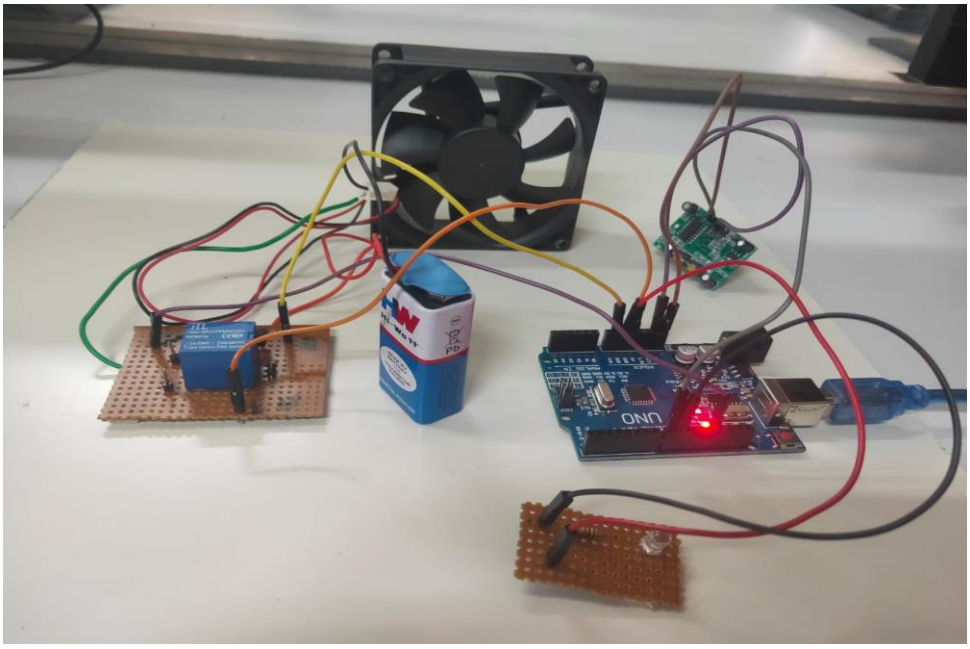

Fig 6.3.3 Fan and Light disables when the motion is not detected.

CONCLUSION

CHAPTER- 7

CONCLUSION & FUTURE ENHANCEMENT

7.1 CONCLUSION:

It significantly enhances energy efficiency by allowing precise control and automation of lighting and fan systems. IoT-based sensors and devices can monitor occupancy levels in the classroom and adjust the lighting and fan settings accordingly. This ensures that energy is not wasted when the classroom is unoccupied, leading to substantial energy savings and reduced utility costs.

However, it is important to consider certain challenges and considerations when implementing classroom automation for lights and fans using IoT. These include ensuring proper network security, data privacy, and system reliability. Adequate measures must be in place to protect sensitive information and prevent unauthorized access to the IoT devices and infrastructure.

Overall, the adoption of IoT technology for classroom automation provides a range of benefits, including energy efficiency, convenience, remote accessibility, and data-driven insights. By leveraging these advancements, educational institutions can create a more sustainable, comfortable, and intelligent learning environment.

7.2 FUTURE ENHANCEMENT:

For future enhancements in classroom automation for lights and fans in IoT, consider the following possibilities:

Occupancy Sensing: Implement more advanced occupancy sensing using technologies such as computer vision or depth sensors to accurately detect the presence of students in the classroom. This can provide more granular control over lighting and fan operation based on real-time occupancy.

Environmental Monitoring: Integrate environmental sensors to monitor factors like temperature, humidity, and air quality in the classroom. This data can be used to automatically adjust the fan speed or activate additional ventilation systems when needed to maintain a comfortable and healthy learning environment.

Energy Efficiency Optimization: Develop algorithms or machine learning models to optimize energy usage by dynamically adjusting the lighting and fan settings based on factors like natural lighting, time of day, and occupancy patterns. This can help reduce energy consumption and promote sustainability in the classroom.

Personalized Comfort Settings: Provide students and teachers with the ability to personalize their lighting and fan preferences through a mobile app or a centralized control system. This can allow individuals to adjust the settings according to their comfort levels, promoting a more productive and comfortable learning environment.

Integration with Other Systems: Explore integration with other classroom automation systems, such as audio/video equipment, projector screens, and interactive whiteboards. This integration can enable synchronized control and automation of multiple classroom devices for seamless teaching and learning experiences.

Data Analytics and Insights: Collect and analyze data from the IoT system to gain insights into classroom usage patterns, energy consumption trends, and comfort levels. These insights can be used for optimization, maintenance planning, and decision-making to improve the overall efficiency and effectiveness of the classroom automation system.

Voice and Gesture Control: Implement voice or gesture recognition capabilities to allow users to control the lights and fans using natural language commands or hand gestures. This can provide a hands-free and intuitive interaction experience for students and teachers.

Integration with Smart Building Systems: Explore integration with broader smart building systems to create synergies and enable coordinated actions across multiple classrooms or building areas. This can lead to enhanced energy management, centralized control, and better resource allocation within educational facilities.

Remember, when considering future enhancements for classroom automation, it's important to assess the specific needs and requirements of the educational institution, prioritize functionality, consider scalability, and ensure compliance with applicable regulations and safety standards.

CHAPTER- 9

APPENDIX

9.1 SOURCE CODE:

```
 void setup() {
 Serial.begin(9600);
 pinMode(8,INPUT);
 pinMode(9,OUTPUT);
 pinMode(13,OUTPUT);
}
void loop() {
 int data = digitalRead(8);
 Serial.println(data);
 if(data == 0)
 {
  digitalWrite(9,HIGH);
  digitalWrite(13,HIGH);
 }
 else
 {
  digitalWrite(9, LOW);
  digitalWrite(13, LOW);
 }
 delay (1000);
}
```

CHAPTER- 10

BIBLIOGRAPHY

10.1 JOURNAL REFERENCE:

1. Journal Title: "IEEE Internet of Things Journal"
   Publisher: IEEE
   Website: https://www.comsoc.org/publications/journals/ieee-iot-journal
2. Journal Title: "Sensors"
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   Website: https://www.mdpi.com/journal/sensors
3. Journal Title: "Journal of Ambient Intelligence and Humanized Computing"
   Publisher: Springer
   Website: https://www.springer.com/journal/12652

10.2 BOOK REFERENCE:

1. Author: Charles Bell
   Book Title: "Building Arduino Projects for the Internet of Things: Experiments with Real-World Applications"
   Publisher: Apress
2. This book provides hands-on guidance for building IoT projects using Arduino. It covers various IoT concepts, protocols, and technologies, and demonstrates how to apply them to create practical IoT solutions for classroom automation.
3. Author: Peter Dalmaris
   Book Title: "IoT: Building Arduino-Based Projects"
   Publisher: Packt Publishing