M.KUMARASAMY
COLLEGE OF ENGINEERING
NAAC Accredited Autonomous Institution
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Thalavapalayam, Karur – 639 113.

A Minor Project Report on

SMART PLUG WITH ANDROID INTERFACE

BHOOPESH T (20BEE4006)

DHARUNISH AP (20BEE4015)

DEENADHAYALAN M (20BEE4304)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

M.KUMARASAMY COLLEGE OF ENGINEERING

(An Autonomous Institution - Affiliated to Anna University, Chennai)

Karur - 639 113

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BONAFIDE CERTIFICATE

Certified that this Report titled "**SMART PLUG WITH ANDROID INTERFACE** " is the bonafide work of **BHOOPESH T (20BEE4006), DHARUNISH AP (20BEE4015), DEENADHAYALAN M (20BEE4304)**, who carried out the work during the academic year (2022-2023).

SUPERVISOR

Dr C Kumar
Professor and Head
Department of Electrical and Electronics Engineering
M Kumarasamy College of Engineering, Karur

HEAD OF THE DEPARTMENT

Dr C Kumar
Professor and Head
Department of Electrical and Electronics Engineering
M Kumarasamy College of Engineering, Karur

Submitted for Minor Project III (18EEP301L) viva-voce Examination held on _____.

DECLARATION

We affirm that the Minor Project report titled " **SMART PLUG WITH ANDROID INTERFACE** "being submitted in partial fulfillment for the award of **Bachelor of Engineering in Electrical and Electronics Engineering** , is the original work carried out by us.

STUDENT NAME

BHOOPESH T _____

DHARUNISH AP _____

DENNADHAYALAN M _____

VISION AND MISSION OF THE INSTITUTION

VISION

- ✓ To emerge as a leader among the top institutions in the field of technical education

MISSION

- ✓ Produce smart technocrats with empirical knowledge who can surmount the global Challenges.
- ✓ Create a diverse, fully-engaged, learner - centric campus environment to provide Quality education to the students.
- ✓ Maintain mutually beneficial partnerships with our alumni, industry and Professional associations.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION

To produce smart and dynamic professionals with profound theoretical and practical knowledge comparable with the best in the field.

MISSION

- ✓ Produce hi-tech professionals in the field of Electrical and Electronics Engineering by inculcating core knowledge.
- ✓ Produce highly competent professionals with thrust on research.
- ✓ Provide personalized training to the students for enriching their skills.

PROGRAMME EDUCATIONAL OBJECTIVES(PEOs)

- ✓ Graduates will have flourishing career in the core areas of Electrical Engineering and also allied disciplines.
- ✓ Graduates will pursue higher studies in leading higher learning institutions.
- ✓ Graduates will provide suitable electrical engineering solutions to resolve energy related issues.
- ✓ Graduates will practice ethics and have habit of continuous learning for their success in the chosen career.

PROGRAMME OUTCOMES(POs)

After the successful completion of the B.E. Electrical and Electronics Engineering degree program, the students will be able to:

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/Development of solutions: Design solutions for Complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal and environmental considerations.

PO4: Conduct Investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The Engineer and Society: Apply reasoning in formed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and Team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES(PSOs)

The following are the Program Specific Outcomes of Engineering Students:

PSO1: Product Development and Management: To keep abreast of new developments by applying knowledge on the theory and practices in the field of electrical power engineering

PSO2: Scientific quality product: To adapt and apply relevant techniques, resources and emerging Engineering and IT tools for developing quality products in scientific and business applications.

PSO3: Research oriented innovative ideas and methods: To apply the knowledge acquired from research and research methods including design of experiments, analysis and interpretation of data and synthesis of information for arriving significant conclusion.

Abstract (Key Words)	Mapping of POs and PSOs
Smart Plug, Android phone interface, Measure Temperature LM35 temperature sensor Cut off power supply Energy Consumption	PO1, PO2, PO3, PO4, PO9, PO11, PSO1, PSO2, PSO3

ACKNOWLEDGEMENT

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We offer our wholehearted thanks to our Minor project coordinator **Mr.M.Ramesh M.E., Assistant Professor**, **Department of Electrical and Electronics Engineering,** for his constant encouragement, kind co-operation and valuable suggestions for making our project a success.

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We glad to thank all the **Faculty Members of Department of Electrical and Electronics Engineering** for extending a warm helping hand and valuable suggestions throughout the project.

Words are boundless to thank Our Parents and Friends for their constant encouragement to complete this Minor project successfully

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ABSTRACT

This project implements a Smart Plug project which can measure the Power, Current, Voltage of any load connected to it. The Android phone interface can be used to read the values from the plug and also controls its ON/OFF. The values are also regularly sent to the Android device for monitoring. Due to rising value of energy supplies, the need for managing electrical energy sources becomes prominent. In this paper, a smart plug device is presented; which provides features to measure energy consumption and recognizes the type of attached electrical devices not only that but also it is used to measure the temperature using LM35 temperature sensor. When the temperature cross over the certain range, it will cut off the power supply and gives the supply back automatically. Smart plug technology currently for user providing one plug module that is able to monitor and control the state of electrical appliance. The addition of plug number gives some deficiencies such as from cost point of view. By looking at the disadvantage made the tool which is able to monitor and control electrical appliance so that smart plug more than one integrated plug module. The manufacture of plug modules includes system design, sensor type selection in module, data delivery process, comparison of measurement module with measuring instrument and system test. From the results of the design is known that the module can perform data transmission, display the monitoring page and do the control and obtained percent accuracy of current readings obtained between 91.50% to 99.61% and the percent accuracy of the voltage readings obtained are ranged between 98.95% to 99.90%.

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LIST OF ABBREVIATION

S No	ABBREVIATION	EXPANSION
1.	APL	Arduino Programming Language
2.	AREF	Analog Reference Pin
3.	LM35	Linear Monolithic
4.	NO	Normally Open
5.	NC	Normally Close
6.	EEPROM	Electrically Erasable Programmable Read-Only Memory

CHAPTER 1
INTRODUCTION

1.1 Introduction

The system is designed such that smart sockets wirelessly provide the necessary data to a central controller. Then, the system analyses the data to generate control commands to turn the devices attached to the smart socket on or off. Experimental results show that the proposed smart socket can correctly read the power consumption of wirelessly connected devices from up to without loss of data. The central controller can effectively control multiple sockets on the basis of a scheduled user program code. Thus, the proposed smart socket system can be fully utilized in a home energy management system with a proper scheduling algorithm.

1.2 Necessity

Turn appliances on and off remotely. Using the plug's app, you can turn appliances on and off remotely and even check to see if you left an appliance running after you've left your home. Manage your energy use with easy scheduling. By creating scenes for your appliances, you can schedule when devices should shut down or startup. For example, you can use a scene as a smart home routine for children by only letting them use gaming consoles and televisions at certain times of the day. Eliminate vampire draw from your house. One of the best things to use smart plugs for is controlling "vampire draw" Vampire draw, or phantom load, is the energy your devices suck up even when they're not in use. Smart plugs can help you identify devices guilty of a phantom load so you can save on your energy usage.

1.3 Scope of the work

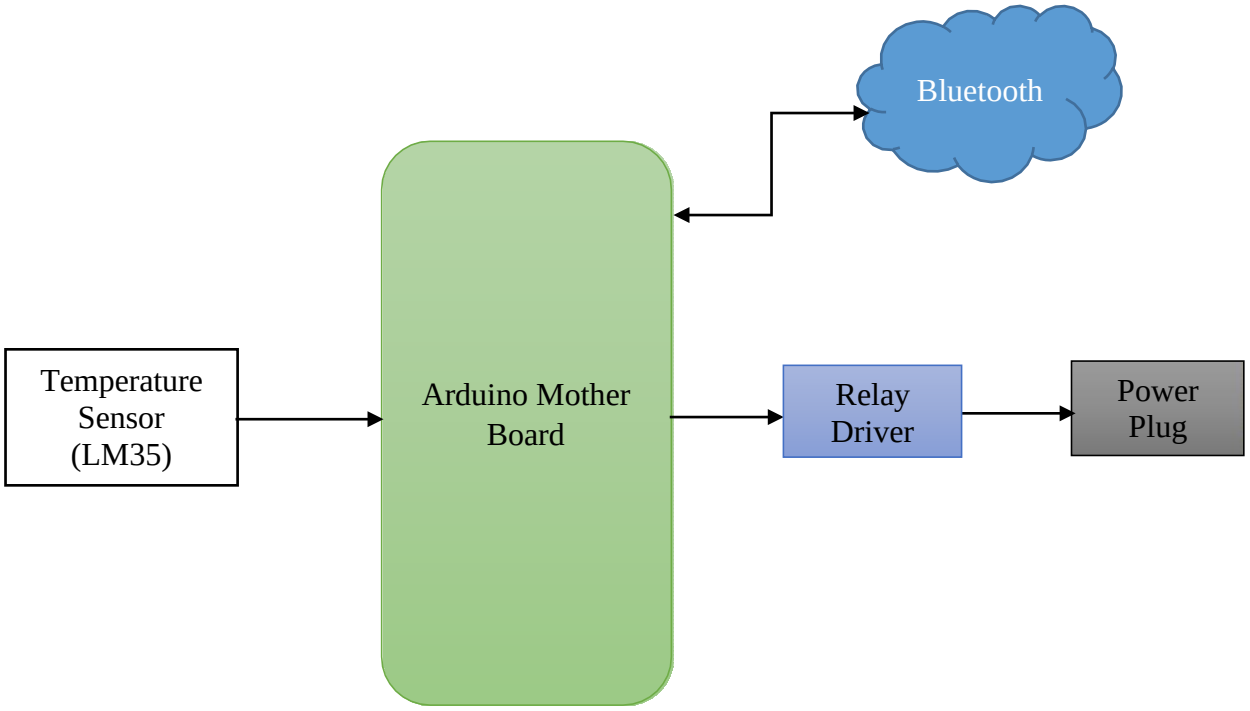
The smart-home ecosystem is continuing its accelerated expansion, but market growth rates are directly connected to the speed of 5G implementation. Recent IoT investments by Apple, Amazon, Google, and Alibaba have transformed the landscape noticeably, giving opportunities for all sorts of companies, but have also forced market strengthening. Acknowledging the contemporary moderate user penetration, long product replacement cycles, and rising device connectivity, the adoption of smart plugs will improve in the future. The concept of smart cities marked a great prospect with the Internet of Things in the energy, waste, and infrastructure sectors. Smart home, a significant trend in the smart city, offers several benefits. Several smart city projects and initiatives are ongoing, and by 2025, around 30 global smart cities are expected, with 50% of them likely to be in North America and Europe.In the residential sector, the smart-home ecosystem continues its accelerated expansion, but market growth rates are directly connected to the speed of 5G implementation. Recent IoT investments by Google, Apple, Amazon, and Alibaba transformed the landscape noticeably, giving opportunities for all sorts of companies, but have also forced market strengthening. Acknowledging contemporary moderate user penetration, long product replacement cycles, and rising device connectivity, the adoption of smart plugs will improve in the future. The key players in the market are focusing on improving their product lines by introducing new products into the market. For instance, in November 2021, Kasa introduced TP-Link Kasa EP10, a capable smart plug that can be controlled via phone or voice. Advances in wireless technology have also empowered our ability to respond to theCOVID-19 pandemic.

CHAPTER 2
SYSTEM MODEL

2.1 Introduction

The system is designed such that smart sockets wirelessly provide the necessary data to a central controller. Then, the system analyses the data to generate control commands to turn the devices attached to the smart socket on or off. Experimental results show that the proposed smart socket can correctly read the power consumption of wirelessly connected devices from up to without loss of data. The central controller can effectively control multiple sockets on the basis of a scheduled user program code. Thus, the proposed smart socket system can be fully utilized in a home energy management system with a proper scheduling algorithm.

2.2 BLOCK DIAGRAM



2.3 Description of various blocks

Arduino Mother Board

- Arduino is an open source electronics platform accompanied with a hardware and software to design, develop and test complex electronics prototypes and products.
- The hardware consists of a microcontroller with other electronic components which can be programmed using the software to do almost any task.
- The simplicity of the Arduino language makes it very easy for almost everyone who has an interest in electronics to write programs without the understanding of complex algorithms or codes.

LM35 Temperature Sensor

- LM35 is a temperature measuring device having an analog output voltage proportional to the temperature.
- It provides output voltage in Centigrade (Celsius). It does not require any external calibration circuitry.
- The sensitivity of LM35 is 10 mV/degree Celsius. As temperature increases, output voltage also increases. Example: 250 mV means 25°C.
- It is a 3-terminal sensor used to measure surrounding temperature ranging from -55 °C to 150°C.
- LM35 gives temperature output which is more precise than thermistor output.

Relay Driver

- The Relay Driver is a logic module which provides high level system control functions such as high/low voltage alarms, load control and generator start. The product controls four independent relay driver outputs by reading digital data inputs from Morningstar's TriStar controller or by reading battery voltage when used in systems with other controllers.
- A relay **allows circuits to be switched by electrical equipment**: for example, a timer circuit with a relay could switch power at a preset time. For many years relays were the standard method of controlling industrial electronic systems.

Power Plug

- AC power plugs and sockets connect electric equipment to the alternating current (AC) mains electricity power supply in buildings and at other sites.
- Electrical plugs and sockets differ from one another in voltage and current rating, shape, size, and connector type.

Bluetooth

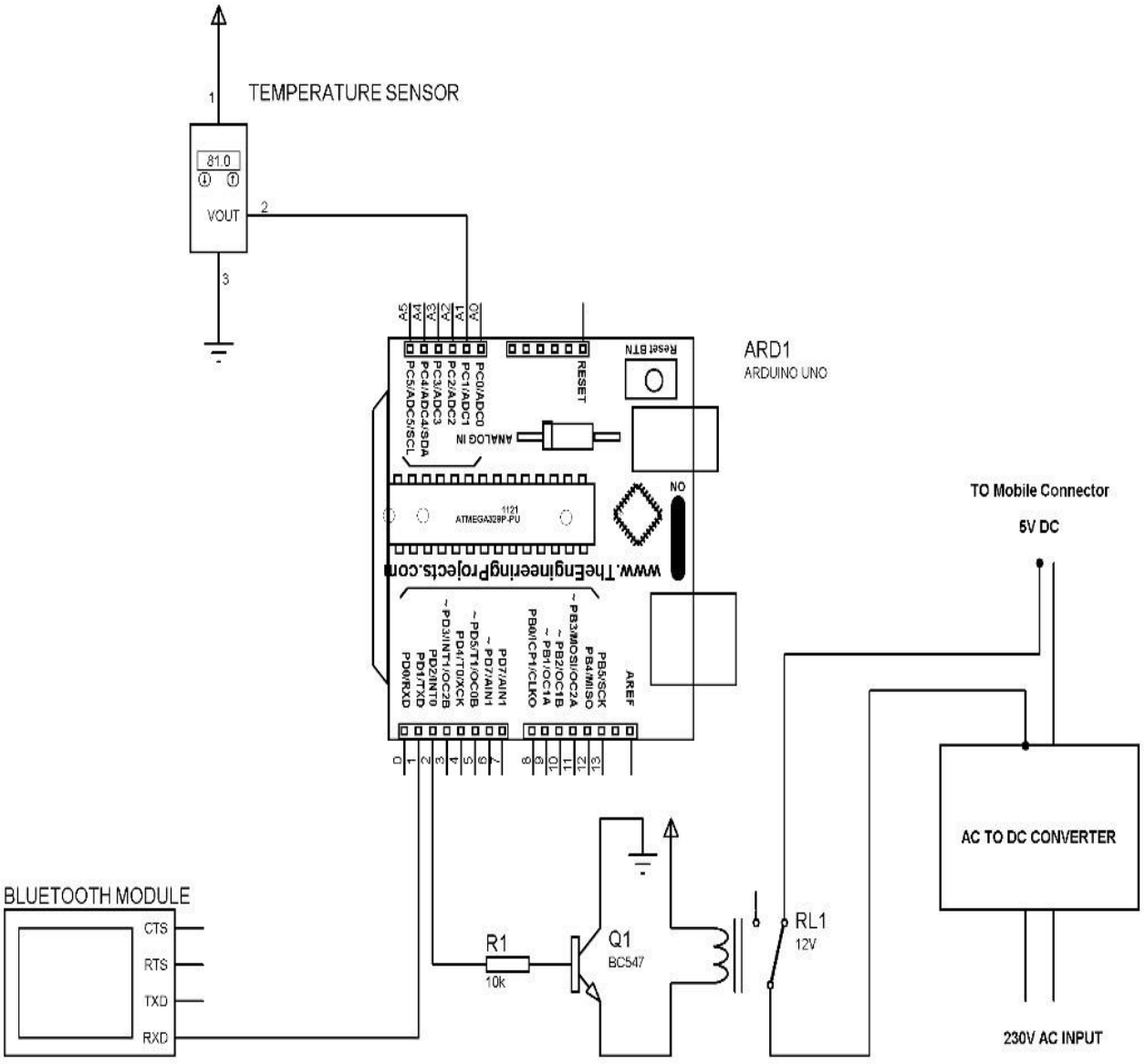
- Bluetooth is a short-range wireless technology standard that is used for exchanging data between fixed and mobile devices over short distances and building personal area networks (PANs).
- It employs UHF radio waves in the ISM bands, from 2.402 GHz to 2.48 GHz.[3] It is mainly used as an alternative to wire connections, to exchange files between nearby portable devices and connect cell phones and music players with wireless headphones.
- In the most widely used mode, transmission power is limited to 2.5 milliwatts, giving it a very short range of up to 10 metres .

CHAPTER 3
HARDWARE DESCRIPTION

3.1 Introduction

Smart Plug project which can measure the Power, Current, Voltage of any load connected to it. The Android phone interface can be used to read the values from the plug and also controls its ON/OFF. The values are also regularly sent to the Android device for monitoring. Due to rising value of energy supplies, the need for managing electrical energy sources becomes prominent. In this paper, a smart plug device is presented; which provides features to measure energy consumption and recognizes the type of attached electrical devices. Smart plug technology currently for user providing one plug module that is able to monitor and control the state of electrical appliance. The addition of plug number gives some deficiencies such as from cost point of view. By looking at the disadvantage made the tool which is able to monitor and control electrical appliance so that smart plug more than one integrated plug module. The manufacture of plug modules includes system design, sensor type selection in module, data delivery process, comparison of measurement module with measuring instrument and system test.

3.2 Circuit Diagram



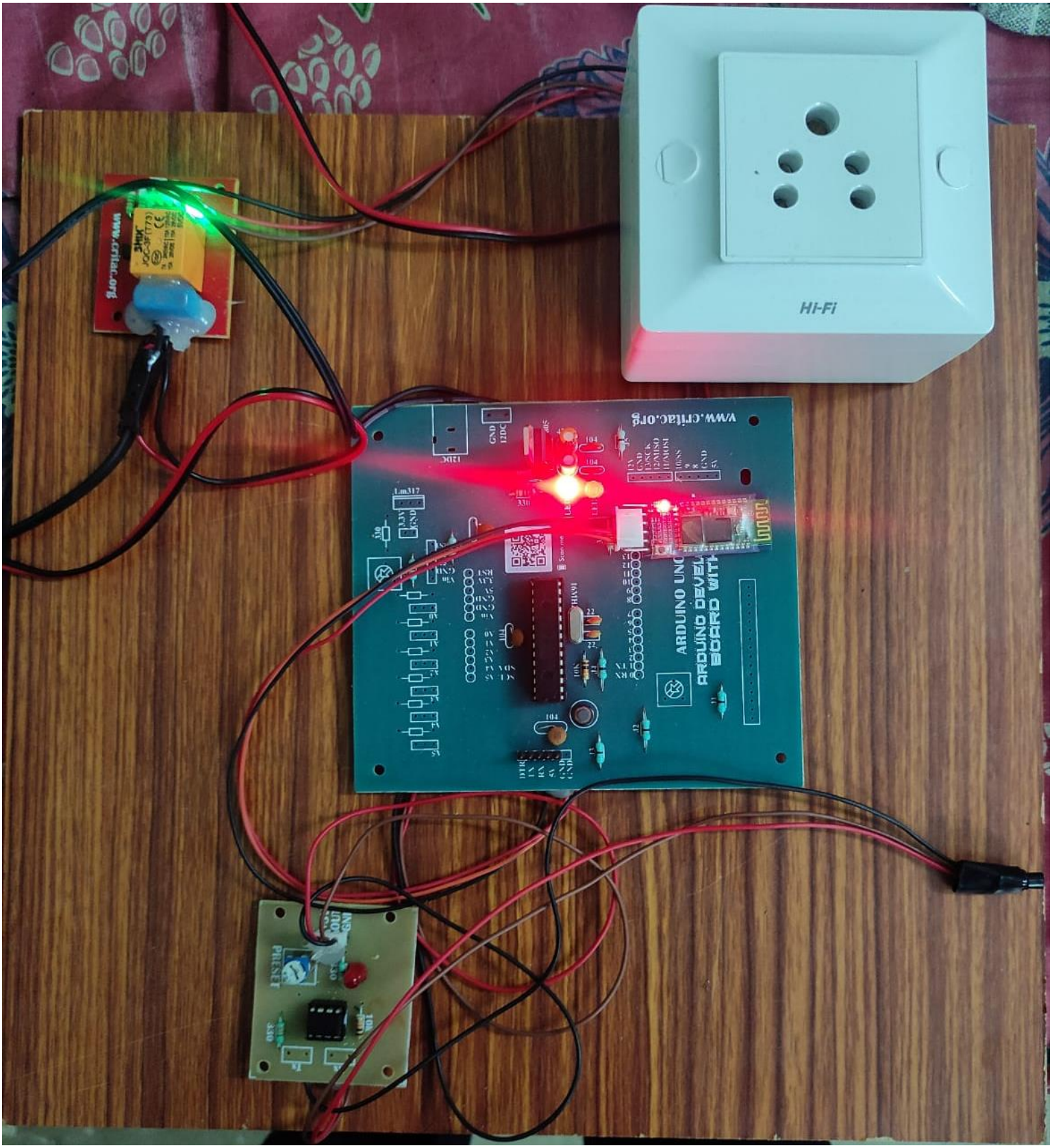
Hardware Components

S. No	Components Used	Quantity	Cost in Rs.
1	Arduino Board	1	400
2	Temperature sensor	2	120
3	Relay Driver	1	80
4	Bluetooth	1	200
5	Connecting Wires	10	50
6	Plug Power	1	150
		TOTAL	1000

3.3 Hardware Components and its Cost

CHAPTER 4

RESULT AND DISCUSSION



HARDWARE REQUIREMENTS

- Arduino Board
- Temperature sensor
- Relay driver
- Power plug
- Bluetooth

ARDUINO BOARD

Arduino

I was surprised to see a twelve-year-old boy giving life to his electronic gadgets. He was trying his hands on building his own creative toys which involved hard electronics and software skills. My zeal was on its peak to know the magical power inside the young chap. How did he understand the concepts of electronics so early? How did he develop the software? Anxiously I went down and asked him about the magic he was doing. The answer was "ARDUINO".

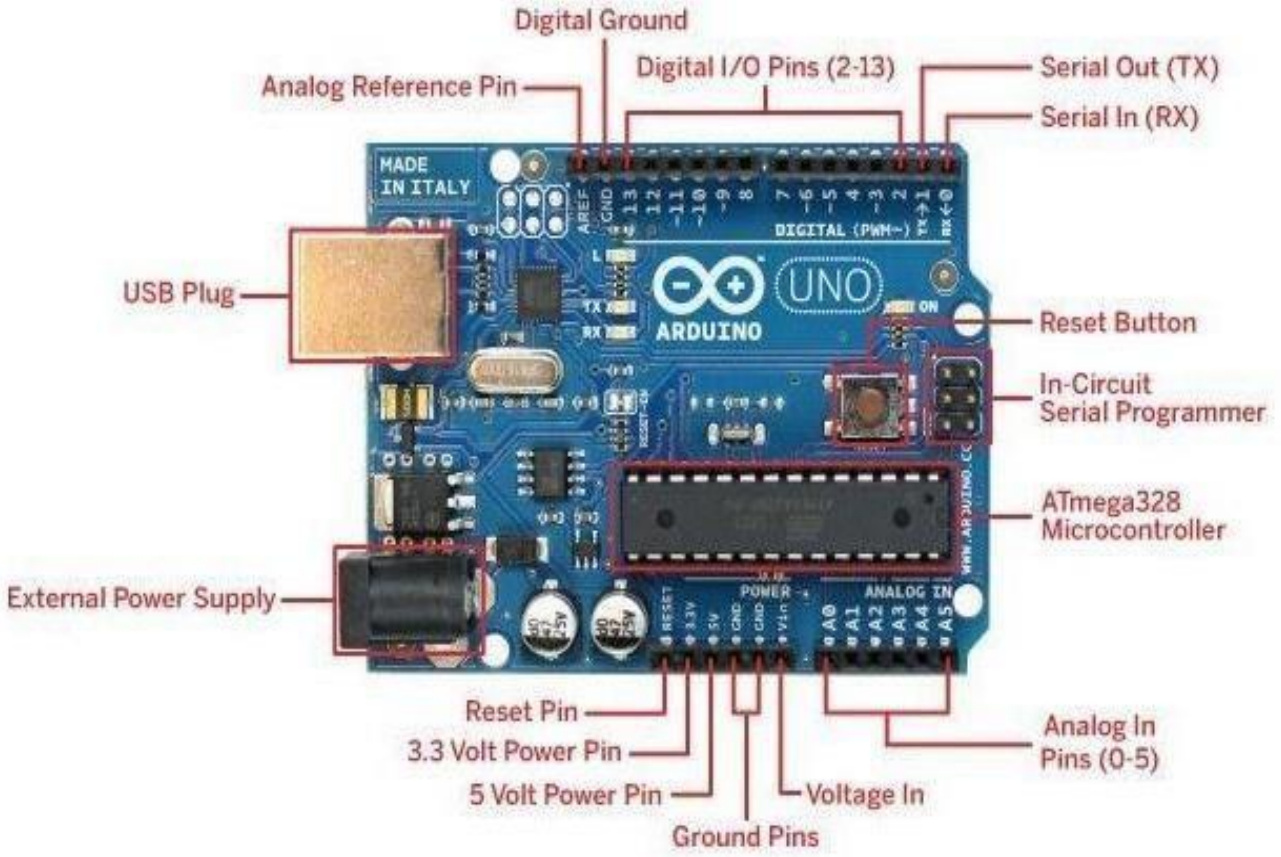
What is Arduino

Arduino is an open source electronics platform accompanied with a hardware and software to design, develop and test complex electronics prototypes and products. The hardware consists of a microcontroller with other electronic components which can be programmed using the software to do almost any task. The simplicity of the Arduino language makes it very easy for almost everyone who has an interest in electronics to write programs without the

understanding of complex algorithms or codes. Arduino is intended for an artist, tinker, designer or anyone, interested in playing with electronics without the knowhow of complex electronics and programming skills. Arduino is an excellent designed open source platform. It has specially designed boards which can be programmed using the Arduino Programming Language (APL). The presence of Arduino is not only spreading between hobbyists, but it has also expanded its roots in industries and used by experts for making prototypes of commercial products. Arduino takes off the efforts required in complex coding and designing hardware. The open source nature of Arduino has been the main reason for its rapid horizontal growth. Since it is an Open Source project, all the files related to hardware and software is available for personal or commercial use. The development cost of the hardware is very small as against the costly similar proprietary products by the industrial giants. The open source nature doesn't require any licenses to develop, use, redistribute or even sell the product. But the Arduino name is trade mark protected (Arduino™) i.e., you are free to sell the Arduino board under any other name however in order to sell it under the name "Arduino" you need to take permission from the founders and follow their quality terms. The Software files which includes all the source code library are also open sourced. A user can modify them to make the project more versatile and improve its capabilities. This provides a strong online community sup

Hardware

This board is designed around the ATmega328 AVR microcontroller. It is an 8 bit microcontroller with 32KB of flash, 2KB of SRAM, 1KB of EEPROM, timers, ADC, I2C, SPI, and UART peripherals. Arduino Uno is based on ATmega328P Atmel AVR family microcontroller (MCU). This MCU has 32KB of flash, 2KB of SRAM and 1 KB of EEPROM. It has 14 digital IO pins (PORTD – 8pins, PORTC – 6 pins, PORTB – 5pins), 6 Analogue input pins, which can be sampled using on-chip ADC. It also has 6 PWM outputs multiplexed on to the digital IO pins. A 16 MHz crystal is installed on the board.



Arduino Uno Pinout

External Power Supply - allows the Arduino to run when its not connected plugged into a USB port for power. It accepts between 7V- 12V of voltage.

USB Plug - This powers the Arduino without needing to use an external power supply and is what you use to upload sketches (program) to the microcontroller, and to communicate with your Arduino sketch (via Serial, println(), etc).

Pin Functions:

Power Pins (3.3 V, 5 V, GND) - Use these pins to connect to circuitry at 3.3 V, 5V, or GND. Make sure that whatever you power doesn't draw more than a few milliamps.

Serial Out (TX) and Serial In (RX) - Pins (0-1) are RX and TX respectively and used for sending and receiving serial data. This port can be used to send and receive data from a GPS module, Bluetooth modules, WIFI modules, etc.

Digital I/O Pins (2-13) - Accept 0 to 5 V input or output. Utilizing tristate logic Arduino makes it easy to change between inputs and outputs in software. You can use this pin as an output where it spits out 5V for a digital 1, or 0 V for a digital 0. You can also configure it to expect a voltage on the pin and that voltage could be interpreted as a 1 or a 0. These pins are used with digitalRead(), digitalWrite (). Analog Write() works only on pins with PWM symbol.

External Interrupts - Pins 2 and 3 can be configured to trigger an interrupt on low value, a rising or falling edge, or a change in value.

PWM Pins - any pins with ~ in front of them can be used to generate pulse modulated square waves. Pins 3, 5, 6, 9, 10, and 11 provide 8-bit PWM output with the analog Write() function.

Pin 13 - drives the built in LED, that is used by Arduino to receive power and useful for debugging. When pin is HIGH value, the LED is on, when pin is LOW value, it's off.

Analog In Pins - Pins A0 through A5 provide 10 bits of resolution. Accepts 0 to 5 V inputs and is used to measure continuous voltages anywhere from 0 V to 5 V. It is possible to change the upper end of their range using the AREF pin and the analog Ref ()function.

Reset Pin - bring this line low to reset the microcontroller. Typically used to add a reset button to shields that block the one on the board.

Analog Reference Pin (AREF) - input pin used optionally if you want external voltage reference for ADC rather than internal Vref. You can configure using an internal register.

Memory - The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written withthe EEPROM library).

Communication

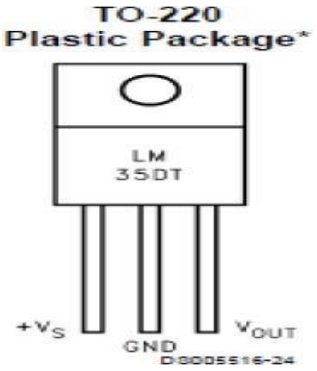
The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega8U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '8U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required.

Microcontroller	**ATmega328**
Operating Voltage	5V
Input Voltage (recommended)	7-9V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA

TEMPERATURE SENSOR (LM35):

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in ^{o}C). The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified.

Pin Diagram:



Description

✓ It has an output voltage that is proportional to the Celsius temperature.

✓ The scale factor is .01V/^{o}C

✓ The LM35 does not require any external calibration or trimming and maintains an accuracy of +/-0.4 ^{o}C at room temperature and +/- 0.8 ^{o}C over a range of 0^{o}C to +100 ^{o}C.

✓ Another important characteristic of the LM35DZ is that it draws only 60 micro amps from its supply and possesses a low self-heating capability. The sensor self-heating causes less than 0.1 ^{o}C temperature rise in still air. The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full -55 to+150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than

0.1°C in still air. The LM35 is rated to operate over a -55° to +150°C temperature range, while the LM35C is rated for a -40° to +110°C range (-10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

Features:

- Calibrated directly in ° Celsius (Centigrade)
- Linear + 10.0 mV/°C scale factor
- 0.5°C accuracy guarantee able (at +25°C)
- Rated for full −55° to +150°C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Less than 60 μA current drain
- Low self-heating, 0.08°C in still air
- Nonlinearity only ±1⁄4°C typical
- Low impedance output, 0.1 W for 1 mA load.

Temperature sensor working

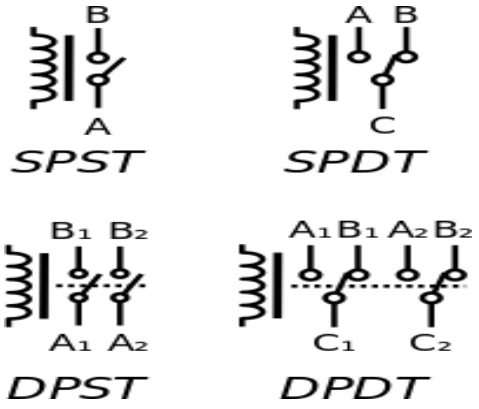
They are devices to measure temperature readings through electrical signals. The sensor is made up of two metals, which generate electrical voltage or resistance once it notices a change in temperature. The temperature sensor plays a critical role in maintaining a specific temperature within any equipment used to make anything from medicine to beer. To produce these types of content, the accuracy and responsiveness of the temperature and temperature control are critical to ensuring the end product is perfect. Temperature is the most common physical measurement type in industrial applications. Accurate measurements are vital in ensuring the success of these processes. There are many applications that are not-so-obvious, which use temperature sensors. Melting chocolate, using a blast furnace, controlling a hot air balloon, freezing substances in a lab, running a motor vehicle, and firing a kiln. Temperature sensors come in different forms, which are used for different methods of temperature management. There are two categories of temperature sensors which are contact and non-contact. Contact sensors are used mainly in hazardous areas.

Relay

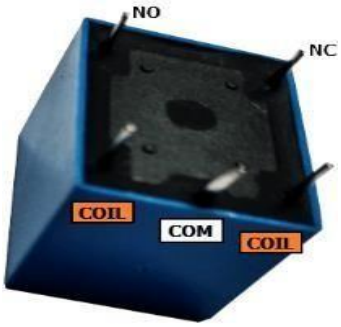
Relays control circuits by opening and closing contacts in another circuit. It takes a relatively small amount of power to operate the coil, but this itself can be used to control motors, heaters, lamps or AC circuits which themselves can draw a lot more electrical power. These switches are used to open and close circuits electromechanically or electronically. When the contact is open, it is not energized. When it is closed, there is a closed contact when it is not energized.

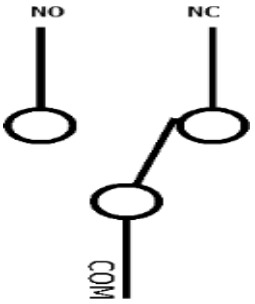
Circuit Symbols of Relays

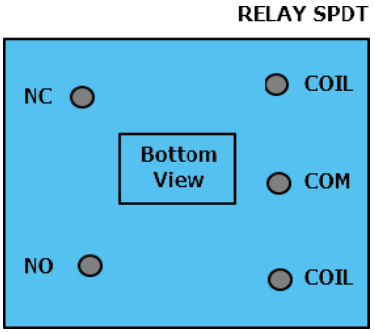
They are generally used to switch smaller currents in a control circuit and do not usually control power consuming devices except for small motors and Solenoids that draw low amps. Nonetheless, it can "control" larger voltages and amperes by having an amplifying effect because a small voltage applied to a coil can result in a large voltage being switched by the contacts.



A relay is an electromagnetic switch used to isolate and control high power devices from a low power device like Microcontrollers. It can also be used with IC555 to make different DIY Projects. There are different types of relay used according to the application needs. In our electronic circuits, the most commonly used relay is an SPDT Relay. SPDT Stands for Single Pole Double Through, which means a common terminal that connects to either of two other terminals (either NO/NC). There is another type of relay that is used in High power devices like 3 Phase motors and it is called Contactors. But we are not going to cover this topic here. We will see how to use the SPDT Relays used in our small electronic projects.

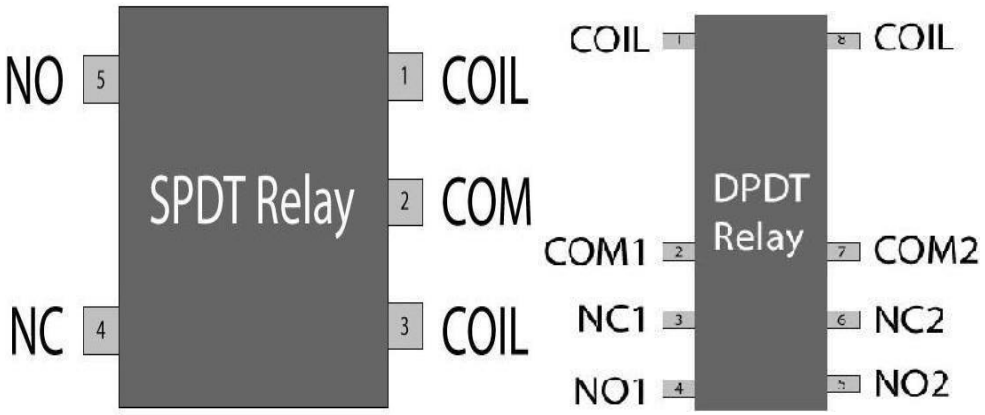






As you look at the symbol, you might have understood what is Normally Open and Normally Closed. A Normally Closed terminal always contacted with COM Terminal. Only if you give supply to the coil it latches towards 'Normally Open' terminal. If the power supply to the coil is removed then it latches back to the NC Terminal. The SPDT Relay has 5 Terminals. Two for controlling the coil (input) and other three for controlling high voltage devices (an external device like fan, light, etc), The output terminals are NO, COM and NC. COIL (T1) – Coil 1 terminal (input low voltage) COIL (T2) – Coil 2 Terminal (input low voltage) COM – Common terminal for output. NO – Normally Open Terminal NC – Normally Closed Terminal. The Coil T1 and Coil T2 are input terminals for the relay. In a 5V Relay, you need to supply 5V to the coil terminals that will energize the coil. At the output terminal COM, NO, NC. We will be connecting High power devices like AC Light, Fan, DC Motor, etc.

Pin Diagram



SPDT Relay **DPDT Relay**

Protective relays can prevent equipment damage by detecting electrical abnormalities, including overcurrent, undercurrent, overloads and reverse currents. In addition, these are also widely used to switch starting coils, heating elements, pilot lights and audible alarms.

Single Relay Board

Relays are simple switches which are operated both electrically and mechanically. Relays consist of a n electromagnet and also a set of contacts. The switching mechanism is carried out with the help of the electromagnet. The main operation of a relay comes in places where only a low-power signal can be used to control a circuit. It is also used in places where only one signal can be used to control a lot of circuits. They were used to switch the signal coming from one source to another destination. The high-end applications of relays require high power to be driven by electric motors and so on. Such relays are called contactors.

Product Description

A relay is an electromechanical switch which is activated by an electric current. A single relay board arrangement contains driver circuit, power supply circuit and isolationcircuit. A relay is assembled with that circuit. The driver circuit contains transistors for switching operations. The transistor is use for switching the relay.

Single Relay Board

An isolation circuit prevents reverse voltage from the relay which protects the controller and transistor from damage. The input pulse for switching the transistor is given from the microcontroller unit. It is used for switching of a single device.

Features

- Input voltage: 12VDC
- Driver unit: ULN2003A
- Isolation unit: In4007
- Fast switching

Applications

- Ac load Switching applications
- Dc load Switching applications
- Motor switching applications

Basic Design and Operation

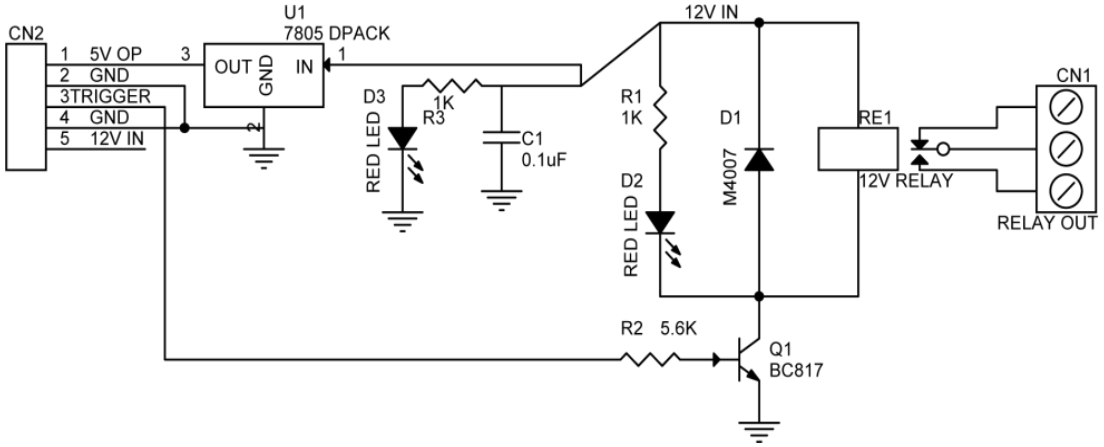
A simple electromagnetic relay consists of a coil of wire wrapped around a soft iron core (a solenoid), an iron yoke which provides a low reluctance path for magnetic flux, a movable iron armature, and one or more sets of contacts (there are two contacts in the relay pictured). The armature is hinged to the yoke and mechanically linked to one or more sets of moving contacts. The armature is held in place by a spring so that when the relay is de-energized there is an air gap in the magnetic circuit. In this condition, one of the two sets of contacts in the relay pictured is closed, and the other set is open. Other relays may have more or fewer sets of contacts depending on their function. The relay in the picture also has a wire connecting the armature to the yoke. This ensures continuity of the circuit between the moving contacts on the armature, and the circuit track on the printed circuit board (PCB) via the yoke, which is soldered to the PCB. When an electric current is passed through the coil it generates a magnetic field that activates the armature, and the consequent movement of the movable contact(s) either makes or breaks (depending upon construction) a connection with a fixedcontact. If the set of contacts was closed when the relay was de-energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open. When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position. Usually this force is provided by a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low-voltage application this reduces noise; in a high voltage or current application it reduces arcing. When the coil is energized with direct current, a diode or resistor is often placed across the coil to dissipate the energy from the collapsing magnetic field at deactivation,

which would otherwise generate a voltage spike dangerous to semiconductor circuit components. Such diodes were not widely used before the application of transistors as relay drivers, but soon became ubiquitous as early germanium transistors were easily destroyed by this surge. Some automotive relays include a diode inside the relay case. Resistors, while more durable than diodes, are less efficient at eliminating voltage spikes generated by relays and therefore not as commonly used. If the relay is driving a large, or especially a reactive load, there may be a similar problem of surge currents around the relay output contacts. In this case a snubber circuit (a capacitor and resistor in series) across the contacts may absorb the surge. Suitably rated capacitors and the associated resistor are sold as a single packaged component for this commonplace use. If the coil is designed to be energized with alternating current (AC), some method is used to split the flux into two out-of-phase components which add together, increasing the minimum pull on the armature during the AC cycle. Typically, this is done with a small copper "shading ring" crimped around a portion of the core that creates the delayed, out-of-phase component, which holds the contacts during the zero crossings of the control voltage. Contact materials for relays vary by application. Materials with low contact resistance may be oxidized by the air, or may tend to "stick" instead of cleanly parting when opening. Contact material may be optimized for low electrical resistance, high strength to withstand repeated operations, or high capacity to withstand the heat of an arc. Where very low resistance is required, or low thermally-induced voltages aredesired, gold-plated contacts may be used, along with palladium and other non-oxidizing, semi- precious metals. Silver or silver-plated contacts are used for signal switching. Mercury- wetted relays make and break circuits using a thin, self-renewing film of liquid mercury. For higher-power relays switching many amperes, such as motor circuit contactors, contacts are made with a mixture of silver and cadmium oxide, providing low contact resistance and high resistance to the heat of arcing. Contacts used in circuits carrying scores or hundreds of amperes may include additional structures for heat dissipation and management of the arc produced when interrupting the circuit. Some relays have field-replaceable contacts, such as certain machine tool relays; these may be replaced when worn out, or changed between normally open and normally closed state, to allow for changes in the controlled circuit. SPST-NO (Single-Pole Single-Throw, Normally-Open) relays have a single Form A contact or make contact. These have two terminals which can be connected or disconnected. Including two for the coil, such a relay has four terminals in total. SPST-NC (Single-Pole Single-Throw, Normally-Closed) relays have a single Form B or break contact. As with an SPST-NO relay, such a relay has four terminals in total. SPDT (Single-Pole Double-Throw) relays have a single set of Form C, break before make or transfer contacts. That is, a

common terminal connects to either of two others, never connecting to both at the same time. Including two for the coil, such a relay has a total of five terminals. DPST – Double-Pole Single-Throw relays are equivalent to a pair of SPST switches or relays actuated by a single coil. Including two for the coil, such a relay has a total of six terminals. The poles may be Form A or Form B (or one of each; the designations NO and NC should be used to resolve the ambiguity). DPDT – Double-Pole Double-Throw relays have two sets of Form C contacts.

These are equivalent to two SPDT switches or relays actuated by a single coil.

SCHEMATIC DIAGRAM



- ✓ Insight - How Relay Switch works
- ✓ Contact Mechanism
- ✓ DC Coil & Spring

Relay is one of the most important electromechanical devices highly used in industrial applications specifically in automation. A relay is used for electronic to electrical interfacing i.e. it is used to switch on or off electrical circuits operating at high AC voltage using a low DC control voltage. A relay generally has two parts, a coil which operates at the rated DC voltage and a mechanically movable switch. The electronic and electrical circuits are electrically isolated but magnetically connected to each other, hence any fault on either side does not affects the other side. Relay switch shown in the image above consists of five terminals. Two terminals are used to give the input DC voltage also known as the operating voltage of the relay. Relays are available in different operating voltages like 6V, 12V, 24V etc. The rest of the three terminals are used to connect the high voltage AC circuit. The terminals are called Common, Normally Open (NO) and Normally Closed (NC). Relays are available in various types & categories and in order to identify the correct configuration of the output terminals, it is best to

see the data sheet or manual. You can also identify the terminals using a multi-meter and at times it is printed on the relay itself. The internal structure of the relay is shown in the image above which is embedded inside the plastic covering. You can see a mechanically movable lever also called the common terminal. By default, it remains in touch with one of the fixed terminals which is called the Normally Closed (NC) terminal. The other terminal which is not connected to the common point is called the Normally Open (NO) terminal. When we give the operating voltage to the relay coil, current starts flowing and it behaves as an electromagnet. The common terminal which is made up of iron gets pulled down by the electromagnetic force and gets connected to the Normally Open (NO) terminal as shown in the figure above.

Relay Driver

- Insight - How Relay Switch works
- Contact Mechanism
- DC Coil & Spring

Relay is one of the most important electromechanical devices highly used in industrial applications specifically in automation. A relay is used for electronic to electrical interfacing i.e. it is used to switch on or off electrical circuits operating at high AC voltage using a low DC control voltage. A relay generally has two parts, a coil which operates at the rated DC voltage and a mechanically movable switch. The electronic and electrical circuitsare electrically isolated but magnetically connected to each other, hence any fault on either side does not affects the other side. In a low power circuit or an output from a Microprocessor is very low. It is sufficient for a LED to glow but to drive a high load you will need a Relay (Electromagnet Switch), and to give proper voltage or current to a relay you will need a relay driver.

Many times, one transistor with a resistance is enough to make a Relay Driver. In this type of circuit Transistor is use as current amplifier and Relay does two things (a) they isolate current (flow of electron) this is important because high load appliances run at different voltage (potential difference) thus Relay protects your sensitive electronics parts. (b) Relay is

an electromagnetic switch. It is a type of mechanical Switch which is pulled by an electro-magnet so its resistance is very low and thus it can control large power appliances. Now days in market Relay Driver Module is available which is generally combination of relay and a transistor. In many modules LED's is also placed to indicate status of a Relay Switch. In Market Relay module can purchased bytelling how many Channel Relay is Required and operating voltage. **Relay switch** shown in the image above consists of five terminals. Twoterminals are used to give the input DC voltage also known as the operating voltage of the relay. Relays are available in different operating voltages like 6V, 12V, 24V etc. The rest of the three terminals are used to connect the high voltage AC circuit. The terminals are called Common, Normally Open (NO) and Normally Closed (NC). Relays are available in various types & categories and in order to identify the correct configuration of the output terminals, it is best to see the data sheet or manual. You can also identify the terminals using a multimeter and at times it is printed on the relay itself. You can see a mechanically movable lever also called the common terminal. By default it remains in touch with one of the fixed terminal which is called the Normally Closed (NC) terminal. The other terminal which is not connected to the common point is called the Normally Open (NO) terminal. When we give the operating voltage to the relay coil, current starts flowing and it behaves as an electromagnet. The common terminal which is made up of iron gets pulled down by the electromagnetic force and gets connected to the Normally Open (NO) terminal as shown in the figure above.

Advantage

You will be able to control various appliances, and other equipment's with large current. It can be controlled directly by Microcontroller.

Power Plug

Power plugs are male electrical connectors that fit into female electrical sockets. They have contacts that are pins or blades which connect mechanically and electrically to holes or slots in the socket. Plugs usually have a live or hot contact, a neutral contact, and an optional earth or ground contact. Electrical outlets (also known as outlets, electrical sockets, plugs, and wall plugs) allow electrical equipment to connect to the electrical grid.

AC power plugs and sockets connect electric equipment to the alternating current (AC) mains electricity power supply in buildings and at other sites. Electrical plugs and sockets differ from one another in voltage and current rating, shape, size, and connector type. Different standard systems of plugs and sockets are used around the world.

Plugs and sockets for portable appliances became available in the 1880s, to replace connections to light sockets with wall-mounted outlets. A proliferation of types developed for both convenience and protection from electrical injury. Today[when?] there are about 20 types in common use around the world, and many obsolete socket types are found in older buildings. Coordination of technical standards has allowed some types of plug to be used across large regions to facilitate trade in electrical appliances, and for the convenience of travelers and consumers of imported electrical goods. Some multi-standard sockets allow use of several types of plug; improvised or unapproved adaptors between incompatible sockets and plugs may not provide the full safety and performance of an approved socket-plug combination. Domestic AC power plugs and sockets are devices that connect the home appliances and portable light fixtures commonly used in homes to the commercial power supply so that AC electric power can flow to them. Power plugs are male electrical connectors that fit into female electrical sockets. They have contacts that are pins or blades which connect mechanically and electrically to holes or slots in the socket. Plugs usually have a live or hot contact, a neutral contact, and an optional earth or ground contact. Many plugs make no distinction between the live and neutral contacts, and in some cases they have two live contacts. The contacts may be brass, tin or nickel plated. Power sockets are female electrical connectors that have slots or holes which accept the pins or blades of power plugs inserted into them and deliver electricity to the plugs. Sockets are usually designed to reject any plug which is not built to the same electrical standard. Some sockets have one or more pins that connect to holes in the plug. The three contacts most countries, household

power is single-phase electric power, in which a single live conductor brings alternating current into a house, and a neutral returns it to the power supply. Many plugs and sockets include a third contact used for a protective earth ground, which only carries current in case of a fault in the connected equipment.

Live or Phase

The live contact (also known as phase, hot or active) carries alternating current from the power source to the equipment. The voltage varies by country, as set by national standards. In some installations, there may be two live conductors, either being two phases from a three-phase system or being both phases from a split phase system. Some plug/socket combinations are designed in a way that a plug can be inserted only one possible way — this is referred to as a polarized plug (not to be confused with positive and negative polarity). Others allow the plug to be inserted with live and neutral either way round — this is referred to as an unpolarized plug. Furthermore even if live and neutral can only connect one way, in some countries it is common to wire them without regard for which is which. This can be hazardous with some equipment in which the neutral is connected directly to the chassis.

Neutral

The neutral contact returns current from the equipment back to the power source or distribution panel. It is in most (but not all) cases referenced to the earth. Except under fault conditions it does not pose a danger because the voltage between the neutral contact and the earth is close to zero, but is nevertheless treated as live in most installation practices because it can develop a high voltage under fault conditions. The main danger posed by the neutral is the voltage can rise as high as the voltage on the live conductor if a broken neutral cable in the wiring disconnects the neutral but leaves the live conductor connected. Another possibility is that the live and neutral may be reversed or crossed by improper installation. Neutral and earth (ground) are closely related and are usually connected at some point. However extra connections between the neutral and the earth should be avoided unless the relevant jurisdiction's regulations allow it. Connecting neutral and earth at more than one point can sometimes create a dangerous ground loop in the system.

Earth/Ground

The earth contact (known as ground in American English) is only intended to carry electric current when connected to equipment that has developed an insulation fault (except for EMI/RFI filters which do cause a small current down the earth). The earth connection was added to modern plugs because, if a live wire or other component in a device touches the metal casing, anybody touching the device may receive a dangerous electric shock. In many countries

devices with metal cases must have the case connected to the earth contact. This reduces but does not eliminate the possibility of the case developing a high voltage relative to the earth and grounded metalwork. It is a common misconception that the purpose of the earth connection is to take fault currents safely to earth. The primary purpose of the earthing system is to cause a fuse to blow or a breaker or a residual-current device (RCD) to trip to automatically disconnect the power supply to any device or cable which develops a wiring fault. The secondary purpose is to hold all touchable metal in a house to the same voltage to prevent electrical shocks when touching two metal objects at the same time. There are two main approaches to the problem of how to disconnect power when a live wire comes into contact with metalwork attached to the earthing system. One way is to get the resistance through the fault path and back to the supply very low by having a metallic connection from the earth back to the supply transformer (a TN system). Then when a fault happens a very high current will flow rapidly blowing a fuse (or tripping a MCB). Where such a direct connection is not used (a TT system) the resistance of the faultpath back to the supply is almost invariably far higher and as a result the fault current is generally too low to reliably blow fuses (or trip MCBs). Therefore an RCD must normally be used to disconnect the fault. The neutral core could in theory be used as a ground, but this would be dangerous if the core broke, so this is not normally used in building wiring or portable appliances. It is, however, used in some other situations with special precautions. For instance, in Switzerland, sockets in houses with the old two wire installation have the ground and neutral contacts connected together, probably supposing, that the professionally maintained house installation is much more reliable than plugged-in device. Also using the neutral as a ground prevents the use of RCDs.

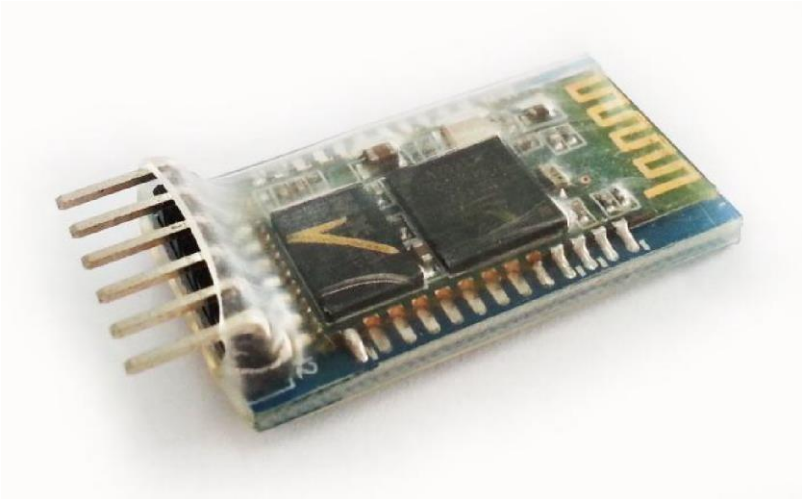
How does a power plug work?

The hot hole is connected to the wire that supplies the electrical current. The neutral hole is connected to the wire that brings the electrical current back to the breaker box. When you plug in a lamp and turn it on, the hot part of the outlet allows electricity to flow into the lamp, turning on the light bulb.

BLUETOOTH

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue core 04-External single chip Bluetooth system with CMOS technology and with AFH(Adaptive Frequency Hopping Feature). It has the footprint

as small as 12.7mmx27mm. Hope it will simplify your overall design/development cycle. HC-05 embedded Bluetooth serial communication module (can be short for module) has two work modes: order-response work mode and automatic connection work mode. And there are three work roles (Master, Slave and Loopback) at the automatic connection work mode. When the module is at the automatic connection work mode, it will follow the default way set lastly to transmit the data automatically. When the module is at the order-response work mode, user can send the AT command to the module to set the control parameters and sent control order. The work mode of module can be switched by controlling the module PIN (PIO11) input level.



Serial module PINs:

- PIO8 connects with LED. When the module is power on, LED will flicker. And the flicker style will indicate which work mode is in using since different mode has different flicker time interval.
- PIO9 connects with LED. It indicates whether the connection is built or not. When the Bluetooth serial is paired, the LED will be turned on. It means the connection is built successfully.
- PIO11 is the work mode switch. When this PIN port is input high level, the work mode will become order-response work mode. While this PIN port is input low level or suspended in air, the work mode will become automatic connection work mode.
- The module can be reset if it is re-powered since there is a reset circuit at themodule.

Software Features:

- Default Baud rate: 38400, Data bits:8, Stop bit:1, Parity: No parity, Data control: has. Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.
- Given a rising pulse in PIO0, device will be disconnected.
- Status instruction port PIO1: low-disconnected, high-connected; ë
- PIO10 and PIO11 can be connected to red and blue led separately. When master and slave are paired, red and blue led blinks 1time/2s in interval, while disconnected only blue led blinks 2times/s.
- Auto-connect to the last device on power as default.
- Permit pairing device to connect as default.
- Auto-pairing PINCODE:”0000” as default
- Auto-reconnect in 30 min when disconnected as a result of beyond the range of connection

CHAPTER 5
CONCLUSION AND FUTURE SCOPE

Conclusion

The simple algorithm is implemented for monitoring and controlling the energy consumption. In this work, it is possible to use the temperature sensor to implement the wireless communication between the smart plugs and the embedded base server for monitoring and controlling the electrical power energy usage. The basic idea behind this program is to use the many capabilities of the Mobile devices like Color display, Bluetooth, Wi-Fi etc. to act as an interface to collect data from external devices and manipulate them. In this case the external device is connected to the Android Device running the Application manipulates and displays the data. This project also introduced the use of App Inventor to write simple programs for Android devices using blocks.

Future Scope

The concept of smart cities marked a great prospect with the Internet of Things in the energy, waste, and infrastructure sectors. Smart home, a significant trend in the smart city, offers several benefits. Several smart city projects and initiatives are ongoing, and by 2025, around 30 global smart cities are expected, with 50% of them likely to be in North America and Europe.In the residential sector, the smart-home ecosystem continues its accelerated expansion, but market growth rates are directly connected to the speed of 5G implementation. Recent IoT investments by Google, Apple, Amazon, and Alibaba transformed the landscape noticeably, giving opportunities for all sorts of companies, but have also forced market strengthening. Acknowledging contemporary moderate user penetration, long product replacement cycles, and rising device connectivity, the adoption of smart plugs will improve in the future. The key players in the market are focusing on improving their product lines by introducing new products into the market. For instance, in November 2021, Kasa introduced TP-Link Kasa EP10, a capable smart plug that can be controlled via phone or voice.

APPLICATIONS

- Smart plugs or Power Strips
- Metering
- Home Appliances
- Home Monitoring

REFERENCES

[1].Vishwajeet Hari Bhide, Dr, Sanjeev Wagh “iLearning loT: An Intelligent Self Learning System for Home Automation Using loT” International Conference on Communication and Signal Processing, April 2-4, 2015, India

[2].Ravi Kishore Kodali and SreeRamya Soratkal “MQTT based Home Automation System Using ESP8266” 2016 IEEE Region 10 Humanitarian Technology Conference (R10-HTC)

[3].V.L.K. Bharadwaj Manda, Voona Kushal, and N. Ramasubramanian “An elegant home automation system using GSM and ARM-based architecture” IEEE Potentials (Volume: 37 , Issue: 5 , Sept.-Oct. 2018)

[4].Noel Nuo Wi Tay, János Botzheim , Member, IEEE and Naoyuki Kubota “Human-Centric Automation and Optimization for Smart Homes” IEEE Transactions on Automation Science and Engineering (Volume: 15 , Issue: 4 , Oct. 2018)

[5].Ahmed S. Musleh1 , Mahdi Debouza1 , Mohamed Farook2 “Design and Implementation of Smart Plug: An Internet of Things (IoT) Approach” 2017. International Conference on Electrical and Computing Technologies and Applications (ICECTA)

[6].Yaowaluk Thongkhao,Wanchalerm Pora “A Lowcost Wi-Fi Smart Plug with On-off and Energy Metering Functions” 2016 13th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON)

[7].Rung-Shiang Cheng, Chia-Peng Lin, Jiun-Yu Jhou “A Location-Aware Home Appliance Control System” 2014 Tenth International Conference on Intelligent Information Hiding and Multimedia Signal Processing.