

ADVANCED METERING SYSTEM WITH HOME AUTOMATION USING SENSORS

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering Degree in
Electrical and Electronics Engineering

by

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SCHOOL OF ELECTRICAL AND ELECTRONICS**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

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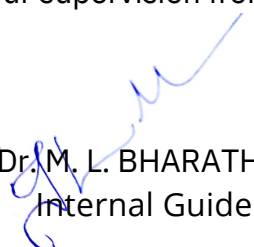
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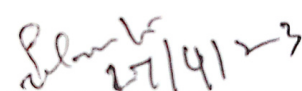
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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of Sujoy Halder (Reg. No. 39140058), Venkata Sai Vashista V (Reg. No. 39140062) who carried out the project entitled "ADVANCED METERING SYSTEM WITH HOME AUTOMATION USING SENSORS" under my / our supervision from Jan 2023 to April 2023.


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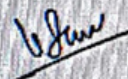
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DECLARATION

We Sujoy Halder (Reg. No. 39140058), Venkata Sai Vashista V (Reg. No. 39140062) hereby declare that the Project Report entitled “ADVANCED METERING SYSTEM WITH HOME AUTOMATION USING SENSORS”

Dr. M. L. BHARATHI

done by us under the

guidance of is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electrical and Electronics Engineering.

DATE: 26/04/2023

PLACE: CHENNAI

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SIGNATURE OF THE CANDIDATES

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ABSTRACT

The aim of this project is to develop an effective approach for measuring electricity consumption in energy meters with the use of modern electronic devices. This involves creating a communication link between the user and the energy meter to regularly update consumption data. To accomplish this, the microcontroller is connected to the unit data received from the energy meter. Various research works have been conducted on designing different home sensor networks and topologies for smart home applications. In a heterogeneous communication environment, maintaining the power supply of the home sensor network is crucial for ensuring the system's functioning. One of the key functions of smart homes is fire detection, which plays a vital role in preventing fire outbreaks and safeguarding lives and property. To this end, this study proposes a novel system for fire detection that employs gas leak concentration to predict the likelihood of a fire or explosion. The system comprises a fire predictor and a fire appearance detector, and the fire predictor notifies the user of gas leak concentrations by producing a buzzer sound.

Keywords—electricity consumption, microcontroller, smart home, fire detection, gas leak concentration.

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LIST OF ABBREVIATIONS

No.	Abbreviation	Definition
1.	ω_0	Resonant Angular Frequency
2.	Cr	Resonant Capacitor
3.	Cs	Series Resonant Capacitor
4.	Lr	Resonant Inductor
5.	Ls	Series Resonant Inductor
6.	Ir	Resistance Current
7.	R	Resistor
8.	Vc	Capacitor Voltage
9.	Vds	Drain to Source Voltage
10.	Vin	Input Voltage
11.	Vout	Output Voltage
12.	Xc	Capacitive Reactance
13.	Xl	Inductive Reactance
14.	Z	Impedance
15.	AC	Alternating Current
16.	API	Application Program Interface
17.	CCM	Continuous Conduction Mode
18.	DCM	Discontinuous Conduction Mode
19.	CISC	Complex Instruction Set Computer
20.	CPU	Central Processing Unit
21.	CTR	Current Transfer Ratio
22.	DC	Direct Current
23.	AMI	Advanced Metering Infrastructure
24.	AMR	Automated Meter Reading
25.	ARRA	American Recovery and Reinvestment Act

CHAPTER 1

INTRODUCTION

The management of energy consumption has become increasingly important in recent years due to the rise in the use of various household appliances. This surge in demand for electricity has created a need for more efficient use of energy resources, both in developed and developing nations. Traditional meters have been a drawback as they do not provide essential data to consumers. However, Smart Meters have the ability to provide this data, enabling consumers to monitor their power usage for different appliances in their homes. Through a case study on various households, this research aims to measure and analyze power consumption using Smart Meter data, providing insights into ways to save electricity and understand consumption patterns. As power consumption continues to increase, it is essential to focus on measuring and analyzing consumption over time to ensure efficient use of energy resources. The study will be conducted using a range of households in Sweden, where energy resources are scarce during the day. The study will analyze the data collected through Smart Meters to determine how much electricity is being used by various appliances in the households. The aim is to identify the appliances that consume the most energy and provide consumers with ways to reduce their power consumption. By doing this, households can save money on their electricity bills while also reducing their carbon footprint. The data collected from Smart Meters will be used to develop a model that can be used to predict energy consumption patterns. This model can be used by consumers to plan their energy usage and reduce their energy consumption during peak periods when energy resources are scarce. By doing this, consumers can save money on their electricity bills while also reducing the load on the power grid, thus ensuring a reliable and stable supply of electricity. In conclusion, the study aims to provide consumers with the necessary tools and knowledge to manage their energy consumption effectively. The use of Smart Meters and data analytics will enable consumers to monitor their energy usage, identify areas where energy consumption can be reduced, and plan their energy usage accordingly. By doing this, households can reduce their electricity bills and reduce their carbon footprint, thus contributing to a sustainable future.

CHAPTER 2

LITERATURE SURVEY

C Komathi, "Smart Energy Metering for Cost and Power Reduction in Household Applications" C Komathi's paper discusses the implementation of smart energy metering systems in households to reduce energy consumption and cost. The paper proposes the use of sensors and wireless communication technology to monitor energy consumption and provide feedback to users. The smart energy metering system can help households to save energy and reduce their electricity bills, as well as contribute to the overall energy efficiency of the power grid [1].

Gee Thika Kalari, "Automatic Light Intensity Control using Arduino UNO and LDR" Gee Thika is concentrating on automating light intensity control using an Arduino UNO and LDR sensor. The LDR sensor is responsible for identifying the existing amount of light in the surroundings and transmitting a signal to the Arduino UNO, which regulates the light's intensity based on this input. The project is useful for conserving energy and establishing a more pleasant atmosphere in residential and commercial settings [2].

Ezhilarasi.P, "Review on Smart Energy Meter for low-cost design" Ezhilarasi. P examines the progress made in creating low-cost smart energy meters that can track energy usage and transmit data to either the user or utility company. Several methods for developing such devices are discussed, such as implementing microcontrollers, wireless communication technologies, and power-efficient sensors. The author emphasizes how important smart energy meters are in encouraging energy efficiency and lowering electricity expenses. Ultimately, they conclude that these low-cost smart energy meters can be valuable for both consumers and utilities in managing energy consumption [3].

Muhammad Javeed Iqbal, "Smart Home Automation Using Intelligent Electricity Dispatch" Muhammad Javeed Iqbal suggested a system for home automation that employs smart electricity dispatch to regulate energy usage and prevent wastage. The system relies on AI algorithms and IoT devices to supervise and manipulate energy consumption, resulting in a more effective distribution of energy and decreased

electricity expenses. If implemented, this system could enhance energy efficiency and decrease energy usage in households, as well as empower users to manage their energy consumption and expenses more effectively [4].

Wahab A. Jabbar, "Design and Fabrication of Smart Home with Internet of Things Enabled Automation System" The task they are undertaking entails creating a smart home that features an automation system powered by the Internet of Things (IoT). The system is intended to enable the centralized management of different aspects of the home, including security, temperature, and lighting, for the purpose of facilitating convenient and efficient control [5].

P. Siva Nagendra Reddy, "An IoT based Home Automation Using Android Application" The project uses IoT technology to automate various functions in a home, such as controlling lights, fans, and air conditioning, through an Android application. The system includes a central control unit that communicates with different sensors and devices using Wi-Fi or Bluetooth. The Android application serves as an interface for users to interact with the system and control the devices remotely [6].

Lei Yang, "Cost-Effective and Privacy-Preserving Energy Management for Smart Meters" Lei Yang's study centres on creating an energy management system for smart meters that is both cost-effective and protects privacy. The approach involves using secure aggregation and homomorphic encryption methods to keep energy usage data private while still enabling efficient energy management. The findings show that this solution is efficient in lowering energy expenses and preserving user privacy, indicating its potential for future use in smart grid applications [7].

M.Abdul Kader Riyaz, "Graphene Coated LED based Automatic Street Lighting System using Arduino Microcontroller" They proposed a street lighting system that uses an LED light source coated with graphene, a material known for its high thermal conductivity and low resistivity. The system is automated using an Arduino microcontroller, which can sense changes in ambient light levels and adjust the brightness of the LED, accordingly, providing energy efficiency. The graphene-coated LED also reduces the need for frequent maintenance, as it is more durable and has a longer lifespan compared to traditional LED lights [8].

Vinod Namboodiri, "Toward a Secure Wireless-Based Home Area Network for Metering in Smart Grids" In this paper, a communication protocol is put forward to safeguard wireless-based home area networks from a range of security risks like message tampering, replay, and interception. The protocol employs authentication and encryption techniques to establish secure communication between the home gateway, smart meters, and the utility company's server. The research showcases the efficiency of the proposed protocol in deterring security attacks through simulation results. Additionally, it stresses the significance of securing wireless-based home area networks in smart grids [9].

Andi Adrianna, "Design of Small Smart Home System Based on Arduino" Andi Adrianna centres on the development and execution of a compact smart home system employing Arduino as the primary controller in their paper. The system comprises a range of sensors and actuators to supervise and manage the living conditions, including temperature, humidity, lighting, and security. Through successful testing, the system proved the possibility of utilizing inexpensive microcontrollers like Arduino to produce a modest and reasonably priced smart home remedy [10].

CHAPTER 3

REQUIREMENT ANALYSIS

3.1. HARDWARE REQUIREMENTS

- ARDUINO MICRO CONTROLLER
- NodeMCU
- TEMPERATURE SENSOR
- GAS SENSOR [MQ2]
- FLAME SENSOR
- 2 LDR SENSOR
- LCD DISPLAY
- 3 CHANNEL RELAY
- L298N MOTOR DRIVER
- LOAD
- CONNECTING WIRE
- POWER SUPPLY UNIT

3.1.1. ARDUINO

➤ **DESCRIPTION:**

Arduino is an open source, computer hardware and software company, project, and user community that designs and manufactures Single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world.

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger

on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online.

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.



Fig 3.1 ARDUINO UNO

Arduino is an open-source project that created microcontroller-based kits for building digital devices and interactive objects that can sense and control physical devices. The project is based on microcontroller board designs, produced by several vendors, using various microcontrollers. These systems provide sets of digital and analog input/output (I/O) pins that can interface to various expansion boards (termed shields) and other circuits. The boards feature serial communication interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) based on a programming language named Processing, which also supports the languages C and C++.

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP

header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter. Arduino Uno has a number of facilities for communicating with a computer, another Arduino board, or other microcontrollers.

➤ **FEATURES:**

- Microcontroller: ATmega328P
- Operating voltage: 5V
- Input voltage: 7-12V
- Flash memory: 32KB
- SRAM: 2KB
- EEPROM: 1KB

➤ **APPLICATIONS:**

- Real time biometrics
- Robotic applications
- Academic applications

3.1.2. ATMEGA328 IC

➤ **DESCRIPTION:**

The ATmega328 is a microcontroller developed by Atmel within the mega AVR family. This 8-bit AVR RISC-based microcontroller features 32 kB ISPflash memory with read-while-write capabilities, 1 kB EEPROM, 2 kB SRAM, 23 general purpose I/O lines, and 32 general purpose working registers. Additionally, it comes with three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, and an SPI serial port. It also features a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five

software-selectable power-saving modes. The device can operate between 1.8-5.5 volts and can achieve throughput approaching 1 MIPS per MHz.



Fig 3.2 ATmega328P IC

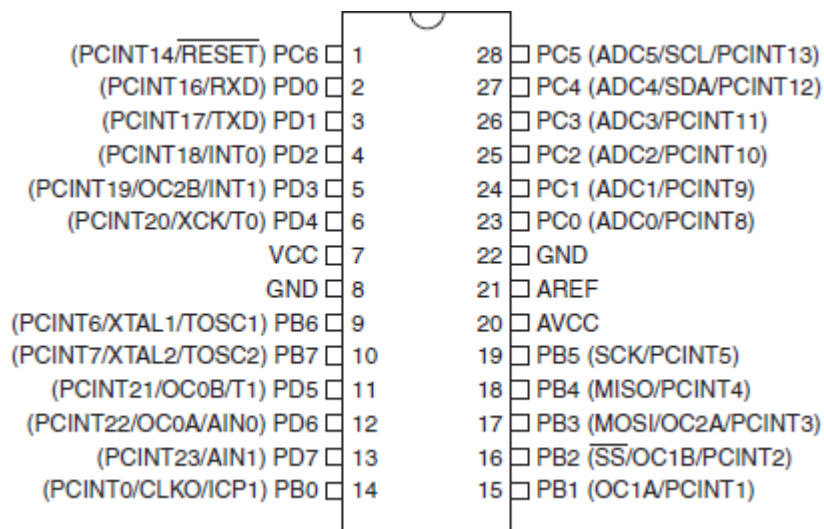


Fig 3.3 PIN DIAGRAM of ATmega328P IC

➤ **FEATURES:**

- High Performance, Low Power Atmel®AVR® 8-Bit Microcontroller Family
- Advanced RISC Architecture
 - ✓ 131 Powerful Instructions
 - ✓ Most Single Clock Cycle Execution
 - ✓ 32 x 8 General Purpose Working Registers
 - ✓ Fully Static Operation

- ✓ Up to 20 MIPS Throughput at 20MHz
- ✓ On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory Segments
 - ✓ 4/8/16/32KBytes of In-System Self-Programmable Flash program memory
 - ✓ 256/512/1KBytes EEPROM
 - ✓ 512/1K/1K/2KBytes Internal SRAM
 - ✓ Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
C(1) □ C/100 years at 25 □ Data retention: 20 years at 85
 - ✓ Optional Boot Code Section with Independent Lock Bits In-System Programming by On-chip Boot Program
 - ✓ True Read-While-Write Operation
 - ✓ Programming Lock for Software Security Atmel® QTouch® library support
 - ✓ Capacitive touch buttons, sliders, and wheels-QTouch and QMatrix® acquisition
 - ✓ Up to 64 sense channels
- Peripheral Features
 - ✓ Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
 - ✓ One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
 - ✓ Real Time Counter with Separate Oscillator
 - ✓ Six PWM Channels
 - ✓ 8-channel 10-bit ADC in TQFP and QFN/MLF package

- ✓ Temperature Measurement
- ✓ 6-channel 10-bit ADC in PDIP Package
- ✓ Temperature Measurement
- ✓ Programmable Serial USART- Master/Slave SPI Serial Interface
- ✓ Byte-oriented 2-wire Serial Interface (Philips I2 C compatible)
- ✓ Programmable Watchdog Timer with Separate On-chip Oscillator
- ✓ On-chip Analog Comparator
- ✓ Interrupt and Wake-up on Pin Change

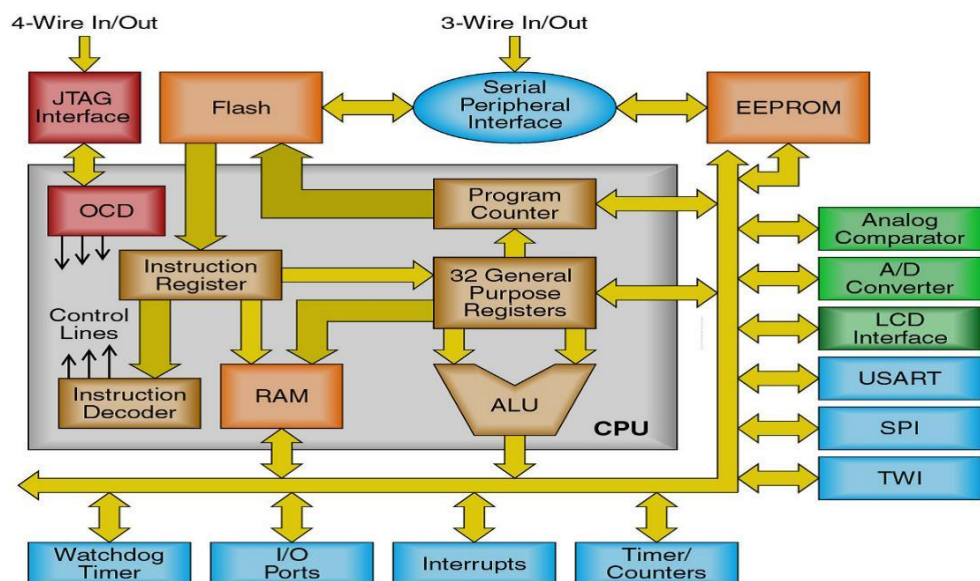


Fig 3.4 CIRCUTE DIAGRAM of ATmega328P IC

- Special Microcontroller Features
 - ✓ Power-on Reset and Programmable Brown-out Detection
 - ✓ Internal Calibrated Oscillator
 - ✓ External and Internal Interrupt Sources

- ✓ Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby
- I/O and Packages
 - ✓ 23 Programmable I/O Lines
 - ✓ 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF
- Operating Voltage: 1.8 - 5.5V
- Temperature Range: -40 °C to 85 °C
- Speed Grade: 0 - 4MHz@1.8 - 5.5V, 0 - 10MHz@2.7 - 5.5V, 0 - 20MHz @ 4.5 - 5.5V °C
- Power Consumption at 1MHz, 1.8V, 25
 - ✓ Active Mode: 0.2Ma
 - ✓ Power-down Mode: 0.1µA
 - ✓ Power-save Mode: 0.75µA (Including 32kHz RTC)

➤ **PIN DISCRIPTION:**

- **VCC** Digital supply voltage
- **GND** Ground
- **Port B (PB7:0) XTAL1/XTAL2/TOSC1/TOSC2**

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running. Depending on the clock selection fuse settings, PB6 can be used as

input to the inverting Oscillator amplifier and input to the internal clock operating circuit. Depending on the clock selection fuse settings, PB7 can be used as output from the inverting Oscillator amplifier. If the Internal Calibrated RC Oscillator is used as chip clock source, PB7..6 is used as TOSC2..1 input for the Asynchronous Timer/Counter2 if the AS2bit in ASSR is set.

- **Port C (PC5:0)**

Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC5 0 output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.

- **PC6/RESET**

If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C. If the RSTDISBL Fuse is unprogrammed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running. The minimum pulse length is given in Table 28-3 on page 308. Shorter pulses are not guaranteed to generate a Reset.

- **Port D (PD7:0)**

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

- **AVCC**

AVCC is the supply voltage pin for the A/D Converter, PC3:0, and ADC7:6. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter. Note that PC6..4 use digital supply voltage, VCC.

- **AREF**

AREF is the analog reference pin for the A/D Converter.

- **ADC7:6 (TQFP and QFN/MLF Package Only)**

In the TQFP and QFN/MLF package, ADC7:6 serve as analog inputs to the A/D converter. These pins are powered from the analog supply and serve as 10-bit ADC channels.

- **DESCRIPTION OF ANALOG PORTS**

An analog-to-digital converter (ADC) is a device used in electronics to convert analog signals into digital signals. Examples of analog signals include sound captured by a microphone or light detected by a digital camera. The ADC system can also provide an isolated measurement by converting an input analog voltage or current into a digital number that is proportional to the magnitude of the voltage or current. In embedded systems, A/D conversion is critical because these systems primarily deal with digital values, while their surroundings typically consist of various analog signals. Therefore, analog signals must be converted into digital signals before they can be processed by the microcontroller. Currently, it is possible to read an external analog signal using a PIC microcontroller and display the digital output conversion on an LCD screen. The input signal can be a varying voltage between 0 and 5 volts.

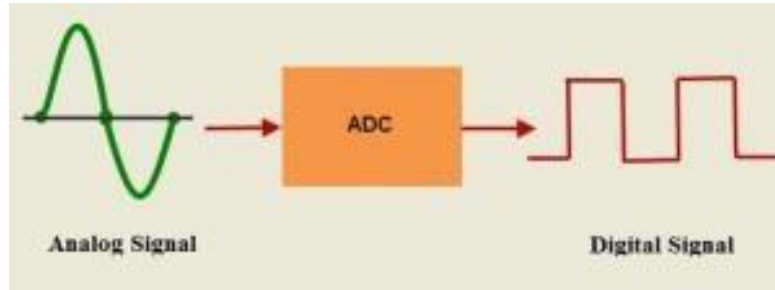


Fig 3.5 ADC Conversion of ATmega328P IC

The Arduino UNO board has five analog input pins A0 through A5. These pins can read the signal from an analog sensor like the humidity sensor or temperature sensor and convert it into a digital value that can be read by the microprocessor.

In the world of Arduino an Analog signal is simply a signal that can be HIGH (on), LOW (off) or anything in between these two states. This means an Analog signal has a voltage value that can be anything between 0V and 5V (unless you mess with the Analog Reference pin). Analog allows you to send output or receive input about devices that run at percentages as well as on and off. The Arduino does this by sampling the voltage signal sent to these pins and comparing it to a voltage reference signal (5V). Depending on the voltage of the Analog signal when compared to the Analog Reference signal the Arduino then assigns a numerical value to the signal somewhere between 0 (0%) and 1023 (100%). The digital system of the Arduino can then use this number in calculations and sketches.

To receive Analog Input the Arduino uses Analog pins # 0 - # 5. These pins are designed for use with components that output Analog information and can be used for Analog Input. There is no setup necessary, and to read them use the command: `analogRead(pinNumber);` where `pinNumber` is the Analog In pin to which the Analog component is connected. The `analogRead` command will return a number including or between 0 and 1023.

3.1.3. CRYSTAL OSCILLATOR

➤ **DESCRIPTION:**

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a precise frequency. An electronic oscillator is an electronic circuit that produces a periodic, oscillating electronic signal, often a sine wave or a square wave. Oscillators convert direct current (DC) from a power supply to an alternating current (AC) signal. They are widely used in many electronic devices. Inside a quartz clock or watch, the battery sends electricity to the quartz crystal through an electronic circuit. The quartz crystal oscillates (vibrates back and forth) at a precise frequency: exactly 32768 times each second.



Fig 3.6 CRYSTAL OSCILLATOR

An oscillator is a device that can give you a clock at a certain frequency given a constant voltage. One part of the oscillator is a crystal that is basically a very good filter. Most microcontrollers only require a crystal because they contain all other parts of an oscillator already.

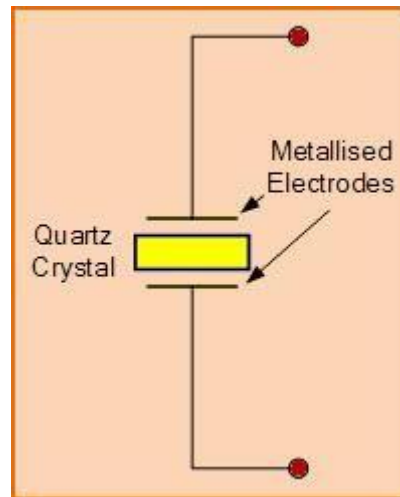


Fig 3.7 CIRCUIT DIAGRAM

In general, we know that crystal oscillators are used in the microprocessors and microcontrollers for providing the clock signals. Let us consider 8051 microcontroller for which an external crystal oscillator circuit of 12MHz is essential, even though (based on model) 8051 microcontroller is capable to run at 40 MHz (max). 8051 requires 12 clock cycles for one machine cycle, such that to give effective cycle rate at 1MHz (considering 12MHz clock) to 3.33MHz (considering maximum 40MHz clock). This crystal oscillator is used to generate clock pulses required for the synchronization of all the internal operations.

Application of Crystal Oscillator in Military and Aerospace

The use of crystal oscillator in military and aerospace, is to establish an efficient communication system, for the navigation purpose, electronic warfare, in the guidance systems, and so on.

Use of Crystal Oscillator in Research and Measurement

The crystal oscillator is used in research and measurement for celestial navigation, space tracking purpose, in the measuring instruments and medical devices, and so on.

Industrial Applications of Crystal Oscillator

There are a huge number of industrial applications of crystal oscillator such as in computers, digital systems, instrumentation, phase locked loop systems, marine, modems, sensors, telecommunications, disk drives, and so on.

Use of Crystal Oscillator in Automotive

Crystal oscillator is used for engine controlling, stereo, clock and to trip computer, and in GPS system.

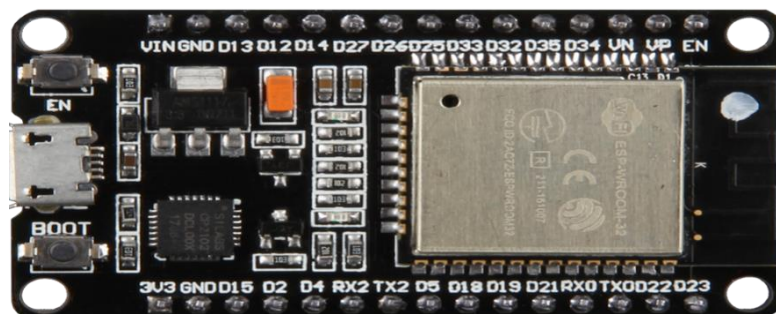
Consumer Applications of Crystal Oscillator

Crystal oscillators are used in many consumer goods such as cable television systems, personal computers, video cameras, toys and video games, radio systems, cellular phones, and so on.

3.1.4. NODE MCU ESP8266

➤ **DESCRIPTION:**

ESP8266 is a single 2.4 GHz Wi-Fi-and-Bluetooth combo chip designed with the TSMC ultra-low-power 40 nm technology. It is designed to achieve the best power and RF performance, showing robustness, versatility and reliability in a wide variety of applications and power scenarios. The ESP8266 series of chips includes ESP8266-D0WD-V3, ESP8266-D0WDQ6-V3, ESP8266-D0WD, ESP8266-D0WDQ6, ESP8266-D2WD, ESP8266-S0WD, and ESP8266-U4WDH, among which, ESP8266-D0WD-V3, ESP8266-D0WDQ6-V3, and ESP8266-U4WDH are based on ECO V3 wafer.



➤ **FEATURED SOLUTIONS:**

- Ultra-Low-Power Solution

ESP8266 is designed for mobile, wearable electronics, and Internet-of-Things (IoT) applications. It features all the state-of-the-art characteristics of low-power chips, including fine-grained clock gating, multiple power modes, and dynamic power scaling. For instance, in a low-power IoT sensor hub application scenario, ESP8266 is woken up periodically and only when a specified condition is detected. Low-duty cycle is used to minimize the amount of energy that the chip expends. The output of the power amplifier is also adjustable, thus contributing to an optimal trade-off between communication range, data rate and powerconsumption.

- Complete Integration Solution

ESP8266 is a highly-integrated solution for Wi-Fi-and-Bluetooth IoT applications, with around 20 external components. ESP8266 integrates an antenna switch, RF balun, power amplifier, low-noise receive amplifier, filters, and power management modules. As such, the entire solution occupies minimal Printed Circuit Board (PCB) area. ESP8266 uses CMOS for single-chip fully-integrated radio andbaseband, while also integrating advanced calibration circuitries that allow the solution to remove external circuit imperfections or adjust to changes in external conditions. As such, the mass production of ESP8266 solutions does not require expensive and specialized Wi-Fi testing equipment.

- Wi-Fi Key Features:

- ✓ 802.11 b/g/n
- ✓ 802.11 n (2.4 GHz), up to 150 Mbps
- ✓ WMM
- ✓ TX/RX A-MPDU, RX A-MSDU
- ✓ Immediate Block ACK

- ✓ Defragmentation
 - ✓ Automatic Beacon monitoring (hardware TSF)
 - ✓ 4 × virtual Wi-Fi interfaces
 - ✓ Simultaneous support for Infrastructure Station, SoftAP, and Promiscuous modes Note that when ESP8266 is in Station mode, performing a scan, the SoftAP channel will be changed.
 - ✓ Antenna diversity
- BT Key Features:
 - ✓ Compliant with Bluetooth v4.2 BR/EDR and BLE specifications
 - ✓ Class-1, class-2 and class-3 transmitter without external power amplifier
 - ✓ Enhanced Power Control
 - ✓ +12 dBm transmitting power
 - ✓ NZIF receiver with −94 dBm BLE sensitivity
 - ✓ Adaptive Frequency Hopping (AFH)
 - ✓ Standard HCI based on SDIO/SPI/UART
 - ✓ High-speed UART HCI, up to 4 Mbps
 - ✓ Bluetooth 4.2 BR/EDR BLE dual mode controller
 - ✓ Synchronous Connection-Oriented/Extended (SCO/eSCO)
 - ✓ CVSD and SBC for audio codec
 - ✓ Bluetooth Piconet and Scatternet
 - ✓ Multi-connections in Classic BT and BLE
 - ✓ Simultaneous advertising and scanning
 - MCU and Advanced Features:
 - ❖ CPU and Memory:
 - ✓ Xtensa® single-/dual-core 32-bit LX6 microprocessor(s), up to 600 MIPS (200 MIPS for ESP8266-S0WD/ESP8266-U4WDH, 400 MIPS for ESP8266-D2WD)
 - ✓ 448 KB ROM
 - ✓ 520 KB SRAM
 - ✓ 16 KB SRAM in RTC
 - ✓ QSPI supports multiple flash/SRAM chips
 - ❖ Clocks and Timers:
 - ✓ Internal 8 MHz oscillator with calibration
 - ✓ Internal RC oscillator with calibration
 - ✓ External 2 MHz ~ 60 MHz crystal oscillator (40 MHz only for Wi-Fi/BT functionality)
 - ✓ External 32 kHz crystal oscillator for RTC with calibration

- ✓ Two timer groups, including 2 × 64-bit timers and 1 × main watchdog in each group
- ✓ One RTC timer
- ✓ RTC watchdog

➤ **ADVANCED PERIPHERAL INTERFACES:**

- 34 × programmable GPIOs
- 12-bit SAR ADC up to 18 channels
- 2 × 8-bit DAC
- 10 × touch sensors
- 4 × SPI
- 2 × I²S
- 2 × I²C
- 3 × UART
- 1 host (SD/eMMC/SDIO)
- 1 slave (SDIO/SPI)
- Ethernet MAC interface with dedicated DMA and IEEE 1588 support
- Two-Wire Automotive Interface (TWAI®, compatible with ISO11898-1)
- IR (TX/RX)
- Motor PWM
- LED PWM up to 16 channels
- Hall sensor
- Security
 - ✓ Secure boot
 - ✓ Flash encryption
 - ✓ 1024-bit OTP, up to 768-bit for customers
 - ✓ Cryptographic hardware acceleration: – AES – Hash (SHA-2)
 - ✓ RSA – ECC – Random Number Generator (RNG)

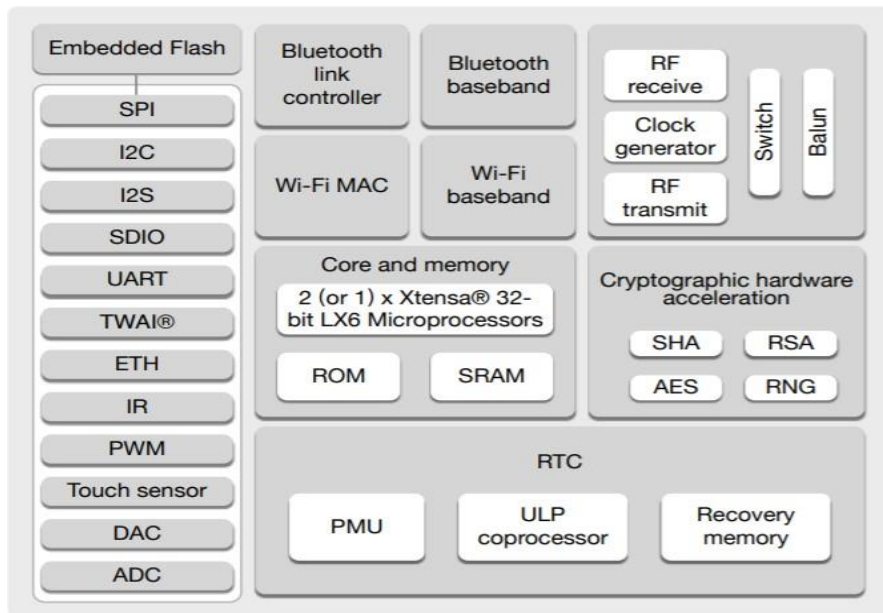


Fig 3.9 BLOCK DIAGRAM of NodeMCU

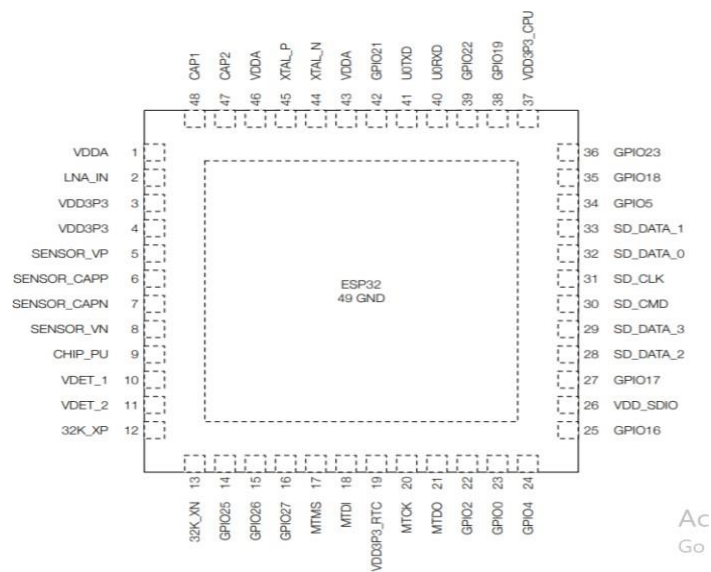


Fig 3.10 PIN LAYOUT of NodeMCU

➤ **CPU and MEMORY:**

○ **CPU**

ESP8266 contains one or two low-power Xtensa® 32-bit LX6 microprocessor(s) with the following features:

- ✓ 7-stage pipeline to support the clock frequency of up to 240 MHz (160 MHz for ESP8266-S0WD, ESP8266-D2WD, and ESP8266-U4WDH)
- ✓ 16/24-bit Instruction Set provides high code-density
- ✓ Support for Floating Point Unit
- ✓ Support for DSP instructions, such as a 32-bit multiplier, a 32-bit divider, and a 40-bit MAC
- ✓ Support for 32 interrupt vectors from about 70 interrupt sources The single-/dual-CPU interfaces include:
 - ✓ Xtensa RAM/ROM Interface for instructions and data
 - ✓ Xtensa Local Memory Interface for fast peripheral register access
- ✓ External and internal interrupt sources
- ✓ JTAG for debugging

○ **INTERNAL MEMORY**

ESP8266's internal memory includes:

- ✓ 448 KB of ROM for booting and core functions
- ✓ 520 KB of on-chip SRAM for data and instructions
- ✓ 8 KB of SRAM in RTC, which is called RTC FAST Memory and can be used for data storage; it is accessed by the main CPU during RTC Boot from the Deep-sleep mode.
- ✓ 8 KB of SRAM in RTC, which is called RTC SLOW Memory and can be accessed by the co-processor during the Deep-

sleep mode.

- ✓ 1 Kbit of eFuse: 256 bits are used for the system (MAC address and chip configuration) and the remaining 768 bits are reserved for customer applications, including flash-encryption and chip-ID.
- ✓ Embedded flash.

➤ **EXTERNAL FLASH and SRAM:**

ESP8266 supports multiple external QSPI flash and SRAM chips. More details can be found in Chapter SPI in the ESP8266 Technical Reference Manual. ESP8266 also supports hardware encryption/decryption based on AES to protect developers' programs and data in flash. ESP8266 can access the external QSPI flash and SRAM through high-speed caches.

- ✓ Up to 16 MB of external flash can be mapped into CPU instruction memory space and read-only memory space simultaneously.
- ✓ When external flash is mapped into CPU instruction memory space, up to 11 MB + 248 KB can be mapped at a time. Note that if more than 3 MB + 248 KB are mapped, cache performance will be reduced due to speculative reads by the CPU.
- ✓ When external flash is mapped into read-only data memory space, up to 4 MB can be mapped at a time. 8-bit, 16-bit and 32-bit reads are supported.
- ✓ External SRAM can be mapped into CPU data memory space. SRAM up to 8 MB is supported and up to 4 MB can be mapped at a time. 8-bit, 16-bit and 32-bit reads and writes are supported.

3.1.5. CRYSTAL OSCILLATOR

➤ **DESCRIPTION:**

LCD (liquid crystal display) is the technology used for displays in notebook and other smaller computers. Like light-emitting diode (LED) and gas-

plasma technologies, LCDs allow displays to be much thinner than cathode ray tube (CRT) technology.

Flat screen LCD and plasma screens work in a completely different way. In a plasma screen, each pixel is a tiny fluorescent lamp switched on or off electronically. In an LCD television, the pixels are switched on or off electronically using liquid crystals to rotate polarized light.



Fig 3.11 16X2 LCD DISPLAY

LCD stands for liquid crystal display. They come in many sizes 8x1, 8x2 , 10x2 , 16x1 , 16x2 , 16x4 , 20x2 , 20x4 ,24x2 , 30x2 , 32x2 , 40x2 etc . Many multinational companies like Philips Hitachi Panasonic make their own special kind of LCD'S to be used in their products. All the LCD'S performs the same functions (display characters numbers special characters ASCII characters etc). Their programming is also same and they all have same 14pins (0-13) or 16 pins (0 to 15). Alphanumeric displays are used in a wide range of applications, including palmtop computers, word processors, photocopiers, point of sale terminals, medical instruments, cellular phones,etc.

This is an LCD Display designed for E-blocks. It is a 16 character, 2-line alphanumeric LCD display connected to a single 9-way D-type connector. This allows the device to be connected to most E-Block I/O ports. The LCDdisplay requires data in a serial format, which is detailed in the user guide below. The display also requires a 24V power supply. Please take care notto exceed 5V, as this will cause damage to the device. The 24V is best

generated from the E-blocks Multi programmer or a 24V fixed regulated power supply.

The 24 x 8-inch intelligent alphanumeric dot matrix displays is capable of displaying 224 different characters and symbols. A full list of the characters and symbols is printed on pages 7/8 (note these symbols can vary between brand of LCD used). This booklet provides all the technical specifications for connecting the unit, which requires a single power supply (+24V).

➤ **FEATURES:**

- ✓ Input voltage: 24v
- ✓ E-blocks compatible
- ✓ Low cost
- ✓ Compatible with most I/O ports in the E-Block range
- ✓ Ease to develop programming code using Flow code icons

➤ **APPLICATIONS:**

- ✓ *Monitoring*

3.1.6. DHT 11 SENSOR

➤ **DESCRIPTION:**

A DHT11 SENSOR (or hygrometer) senses, measures and reports the relative DHT11 in the air. It therefore measures both moisture and air temperature. Relative DHT11 is the ratio of actual moisture in the air to the highest amount of moisture that can be held at that air temperature.



Fig 3.12 DHT 11 SENSOR

A DHT11 SENSOR senses, measures both moisture and air temperature. The sensor is composed of two metal plates and contains a non-conductive polymer film between them. This film collects moisture from the air, which causes the voltage between the two plates to change. These voltage changes are converted into digital readings showing the level of moisture in the air.

DHT11 measurement can be done using electronic hygrometers. Electronic type hygrometers or DHT11 SENSORS can be broadly divided into two categories namely capacitive sensing effects and resistive sensing effects. Resistive type DHT11 SENSORS pick up changes in the resistance value of the sensor element in response to the change in the humidity. Thick film conductor of precious metals like gold, ruthenium oxide is printed and culminated in the shape of the comb to form an electrode. Then a polymeric film is applied on the electrode; the film acts as a DHT11 sensing film due to the existence of movable ions. Change in impedance occurs due to the change in the number of movable ions.

➤ **FEATURES:**

- ✓ Input Voltage: 5v
- ✓ Output: Analog (0-5v)
- ✓ High Performance
- ✓ Long Term Stability
- ✓ Close tolerances
- ✓ Low cost

➤ **APPLICATIONS:**

- ✓ Air conditioners
- ✓ Climate control for green houses
- ✓ Storage and warehouses
- ✓ Meteorological applications

3.1.7. FIRE SENSOR

➤ **DESCRIPTION:**

A flame detector is a sensor designed to detect and respond to the presence of a flame or fire. Responses to a detected flame depend on the installation, but can include sounding an alarm, deactivating a fuel line (such as a propane or a natural gas line), and activating a fire suppression system.

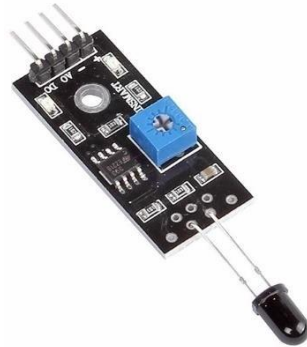


Fig 3.13 DHT 11 SENSOR

A flame detector is a sensor designed to detect and respond to the presence of a flame or fire. It also can detect ordinary light source in the range of a wavelength 760nm-1100 nm. The detection distance is up to 100 cm. The Flame sensor can output digital or analog signal. It can be used as a flame alarm or in firefighting robots. The flame sensor is most sensitive to ordinary light. In this, a small panel output interface can be directly connected with the microcontroller IO port. The sensor and the flame have to maintain a certain distance of 80cm, so as not to damage the sensor temperature of the test flame lighters. As the flame increases, the distance also increases. It also has small plate analog output mode, and the A/D conversion process is possible to get a higher accuracy. It has a black LED which indicates the power and the output signal.

➤ **FEATURES:**

- ✓ Operating Current: 15 mA
- ✓ Operating Voltage: 3.3V to 5V DC
- ✓ Output Digital: 0V to 5V, Adjustable trigger level from preset
- ✓ Output Analog: 0V to 5V based on infrared radiation from fire
- ✓ Flame falling on the sensor

- ✓ Detection angle about 60 degrees, it is sensitive to the flame spectrum.
- ✓ Comparator chip LM393 makes module readings stable.

➤ **APPLICATIONS:**

- ✓ Industrial heating and drying systems
- ✓ Domestic heating systems
- ✓ Industrial gas turbines
- ✓ Gas-fueled cookers

3.1.8. PIR SENSOR

➤ **DESCRIPTION:**

A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors. A PIR sensor is generally known to the world as motion sensor or motion detector. We can build motion sensors or motion sensing lights we get on market with the help of Arduino and PIR sensors. So, this tutorial is also a beginning guide to build motion sensor, or a motion detector based on Arduino.



Fig 3.14 PIR SENSOR

PIR is a PYROELECTRIC (“Passive”) INFRARED SENSOR. It is based on infrared technology, automatic control module, high sensitivity, high reliability, ultra-low-voltage operating mode, widely used in various auto- sensing electrical equipment, especially for battery-powered automatic controlled products. In a practical aspect, all objects emit heat energy in the

form of radiation. The theory behind this concept is that all objects with a temperature above absolute zero (absolute zero is -273.15 degree Celsius or zero Kelvin) emit heat energy in the form of radiation at infra-red wavelengths (invisible to human eyes). These emitted infra-red radiations can be detected with the help of electronics and this principle is employed in the design of a PIR sensor. A PIR sensor does not emit Any kind of radiation for detection purposes, but they just measure the infra-red radiation emitted by other objects inside its field or range of measurement

➤ **FEATURES:**

- ✓ Sensing range: less than 120 degree, within 7 meters.
- ✓ Temperature: – 15 ~ +70
- ✓ Lock time: 0.2 sec
- ✓ Voltage: 5V
- ✓ Power Consumption: 65mA

➤ **APPLICATIONS:**

- ✓ Automatically sensing light for floor, bathroom, basement, porch, warehouse, garage, etc, ventilator, alarm, etc.

3.1.9. LDR SENSOR

➤ **DESCRIPTION:**

A photoresistor (or light-dependent resistor, LDR, or photoconductive cell) is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity.

A light dependent resistor works on the principle of photo conductivity. Photo conductivity is an optical phenomenon in which the materials conductivity is increased when light is absorbed by the material. When light falls i.e., when the photons fall on the device, the electrons in the valence band of the semiconductor material are excited to the conduction band. These photons

in the incident light should have energy greater than the band gap of the semiconductor material to make the electrons jump from the valence band to the conduction band. Hence when light having enough energy strikes on the device, more and more electrons are excited to the conduction band which results in large number of charge carriers. The result of this process is more and more current starts flowing through the device when the circuit is closed and hence it is said that the resistance of the device has been decreased.



Fig 3.15 LDR SENSOR

A Light Dependent Resistor (LDR) or a photo resistor is a device whose resistivity is a function of the incident electromagnetic radiation. Hence, they are light sensitive devices. They are also called as photo conductors, photoconductive cells or simply photocells. They are made up of semiconductor materials having high resistance. There are many different symbols used to indicate a LDR, one of the most commonly used symbol is shown in the figure below. The arrow indicates light falling on it.

➤ **FEATURES:**

- ✓ Input voltage: 5v
- ✓ Output: analog
- ✓ Highly sensitivity to light
- ✓ Output voltage: 5v



APPLICATIONS:

- ✓ No need to detect absences or presences of light like in a camera light meter.
- ✓ Used in streetlamps, alarm clock, burglar alarm circuits, light intensity meters.

3.1.10. MOTOR DRIVER

➤ DESCRIPTION:

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. Dual H-bridge Motor Driver integrated circuit (IC) L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.



Fig 3.16 L298 MOTOR DRIVER

Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.

➤ **FEATURES:**

- ✓ Easily compatible with any of the system
- ✓ Easy interfacing through FRC (Flat Ribbon Cable)
- ✓ External Power supply pin for Motors supported
- ✓ Onboard PWM (Pulse Width Modulation) selection switch
- ✓ 2pin Terminal Block (Phoenix Connectors) for easy Motors Connection
- ✓ Onboard H-Bridge base Motor Driver IC (L293D)

➤ **APPLICATIONS:**

- ✓ Power Supply: Over FRC connector 5V DC
- ✓ External Power: 9V to 24V DC
- ✓ Dimensional Size: 44mm x 37mm x 14mm (l x b x h)
- ✓ Temperature Range: 0°C to +70 °C

3.1.11. DC FAN

➤ **DESCRIPTION:**

DC Brushless cooling fans have a long history of being an effective method of cooling electronic circuits. Today, DC brushless cooling fans are found in new applications and are being evaluated by engineers that may not have

previously used fans in their products. These engineers may not be familiar with all the “undocumented features” that are inherent to these types of fans.



Fig 3.17 12V DC FAN

If the engineer is not familiar with all the characteristics of air moving devices, they could be in for a nasty surprise. Fan manufacturers typically specify the nominal speed of the fan, as well as an operating voltage range.

A DC fan is a device used for cooling purpose in many systems. when a supply is given to a device it starts rotating. The direction of the fan can be changed by reversing the supply. DC or direct current fan works on the principal, when a current carrying conductor is placed in a magnetic field, it experiences a torque and has a tendency to move.

The fan has a DC brushless motor, with an operating voltage of 5V, and is rated at 360mA. Keeping the temperature down in your project can often be a necessity, and this fan can definitely help. When designing the electronics that interface to a DC brushless cooling fan, it is critically important to be aware of this behavior. The fan has a DC brushless motor, with an operating voltage of 5V, and is rated at 360mA. Keeping the temperature down in your project can often be a necessity, and this fan can help. When designing the electronics that interface to a DC brushless cooling fan.

➤ **FEATURES:**

- ✓ Supply current: 10Ma
- ✓ Supply Voltage: 12VDC
- ✓ Filter guard assembly
- ✓ Finger guard
- ✓ Mounting clip

➤ **APPLICATIONS:**

- ✓ Electronic system cooling applications.
- ✓ Industrial/Commercial Fans and Blowers.
- ✓ Computer peripherals.
- ✓ Broadcasting equipment.

3.1.12. TRANSFORMER

➤ **DESCRIPTION:**

A Transformer is a device which transfers electric current from one circuit to another, usually by the principle of mutual induction. During this process, the frequency remains constant whereas the voltage can be increased or decreased according to the need.

This transfer of electricity occurs with the help of two coils. One of which is known as the Primary Coil, which is connected to a source of alternating current. The other is known as the Secondary Coil, and it is connected to an external circuit. It is a general-purpose chassis mounting mains transformer. Transformer has 240V primary windings and centre tapped secondary winding. The transformer has flying cooled insulated connecting leads (Approx 100 mm long). The Transformer act as step down transformer

reducing AC - 240V to AC - 12V. Power supplies for all kinds of project & circuit boards.



Fig 3.18.1 TRANSFORMER

Step down 230 V AC to 12V with a maximum of 1Amp current. In AC circuits, AC voltage, current and waveform can be transformed with the help of Transformers. Transformer plays an important role in electronic equipment. AC and DC voltage in Power supply equipment are almost achieved by transformer's transformation and commutation.

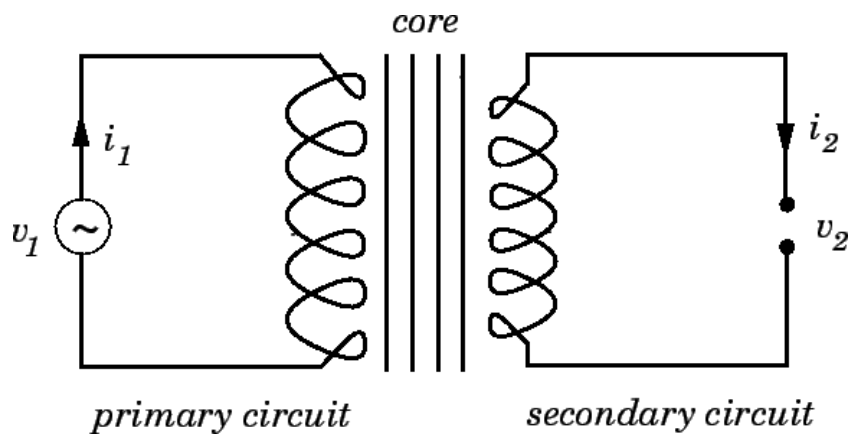


Fig 3.18.2 CIRCUIT DIAGRAM OF TRANSFORMER

A transformer is an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. Electromagnetic induction produces an electromotive force within a conductor which is exposed to time varying magnetic fields. Transformers are used to increase or decrease the alternating voltages in electric power applications. It is a step-down transformer in which the secondary winding is more than primary winding. Due to this winding, it can be able to step down the voltage. A

Transformer changes electricity from high to low voltage or low to high voltage using two properties of electricity.

➤ **FEATURES:**

- ✓ Output current:1A
- ✓ Supply voltage: 220-230VAC
- ✓ Output voltage: 12VAC
- ✓ Soft Iron Core
- ✓ 1Amp Current Drain

➤ **APPLICATIONS:**

- ✓ DIY projects Requiring In-Application High current drain
- ✓ On chassis AC/AC converter
- ✓ Designing a battery charger
- ✓ Electronic applications
- ✓ Step down applications (Power transmission)

3.1.13. FULL-WAVE BRIDGE RECTIFIER

➤ **DESCRIPTION:**

This is such a full wave rectifier circuit which utilizes four diodes connected in bridge form so as not only to produce the output during the full cycle of input, but also to eliminate the disadvantages of the center-tapped full wave rectifier circuit. There is no need of any center-tapping of the transformer in this circuit. Four diodes called D1D1, D2D2, D3D3 and D4D4 are used in constructing a bridge type network so that two of the diodes conduct for one half cycle and two conduct for the other half cycle of the input supply. The

circuit of a bridge full wave rectifier is as shown in the following figure.

➤ **WORKING BRIDGE FULL-WAVE RECTIFIER:**

The full wave rectifier with four diodes connected in bridge circuit is employed to get a better full wave output response. When the positive half cycle of the input supply is given, point P becomes positive with respect to the point Q. This makes the diode D1D1 and D3D3 forward biased while D2D2 and D4D4 reverse biased. These two diodes will now be in series with the load resistor.

The following figure indicates this along with the conventional current flow in the circuit:

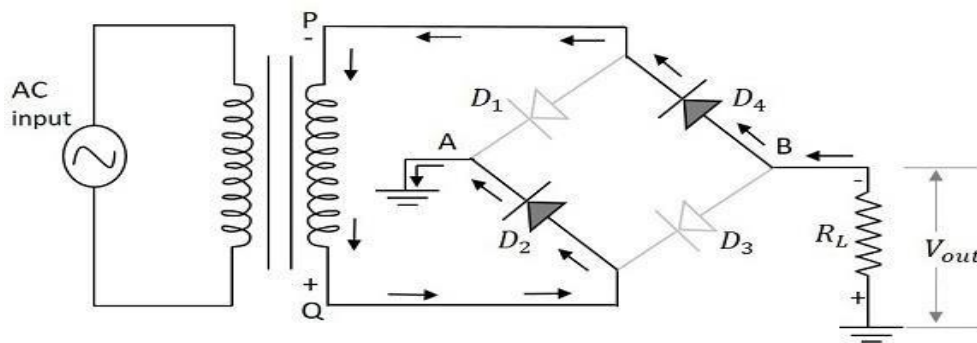


Fig 3.19 CONVENTIONAL CURRENT FLOW IN THE FULL-WAVE BRIDGE RECTIFIER

Hence the diodes D1D1 and D3D3 conduct during the positive half cycle of the input supply to produce the output along the load resistor. As two diodes work in order to produce the output, the voltage will be twice the output voltage of the center tapped full wave rectifier.

When the negative half cycle of the input supply is given, point P becomes negative with respect to the point Q. This makes the diode D1D1 and D3D3 reverse biased while D2D2 and D4D4 forward biased. These two diodes will now be in series with the load resistor.

➤ **WAVEFORMS:**

The input and output waveforms of the centre-tapped full wave rectifier are as follows.

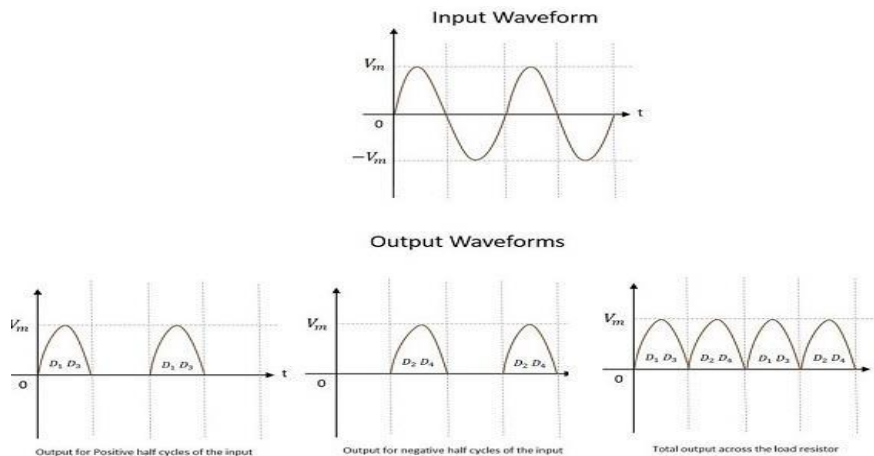


Fig 3.20 WAVEFORM OF THE FULL-WAVE BRIDGE RECTIFIER

From the above figure, it is evident that the output is obtained for both the positive and negative half cycles. It is also observed that the output across the load resistor is in the same direction for both the half cycles.

➤ **PEAK INVERSE VOLTAGE:**

Whenever two of the diodes are being in parallel to the secondary of the transformer, the maximum secondary voltage across the transformer appears at the non-conducting diodes which makes the PIV of the rectifier circuit. Hence the **peak inverse voltage** is the maximum voltage across the secondary winding, i.e.

$$PIV = V_m$$

➤ **ADVANTAGES:**

- ✓ No need of center-tapping.
- ✓ The dc output voltage is twice that of the center-tapper FWR.
- ✓ PIV of the diodes is of the half value that of the center-tapper FWR.

- ✓ The design of the circuit is easier with better output.

3.1.14. POWER SUPPLY UNIT

➤ **DESCRIPTION:**

A power supply unit (or PSU) converts mains AC to low voltage regulated DC power for the internal components of a computer. Modern personal computers universally use switched-mode power supplies. Some power supplies have a manual switch for selecting input voltage, while others automatically adapt to the mains voltage. A power supply is used to reduce the mains electricity at 240 volts AC down to something more useable, say 12 volts DC. There are two types of power supply, linear and switch mode. A linear power supply uses a transformer to reduce the voltage. The AC signal is rectified and regulated to produce a high DC voltage.

An AC adapter, AC/DC adapter, or AC/DC converter is a type of external power supply, often enclosed in a case similar to an AC plug. Adapters for battery-powered equipment may be described as chargers or rechargers (see also battery charger). AC adapters are used with electrical devices that require power but do not contain internal components to derive the required voltage and power from main power. The internal circuitry of an external power supply is very similar to the design that would be used for a built-in or internal supply.



Fig 3.21 ADAPTER (12V 1AMP)

An adapter is a device that converts attributes of one electrical device or system to those of an otherwise incompatible device or system. Some

modify power or signal attributes, while others merely adapt the physical form of one electrical connector to another. In a computer, an adapter is often built into a card that can be inserted into a slot on the computer's motherboard. The card adapts information that is exchanged between the computer's microprocessor and the devices that the card supports.

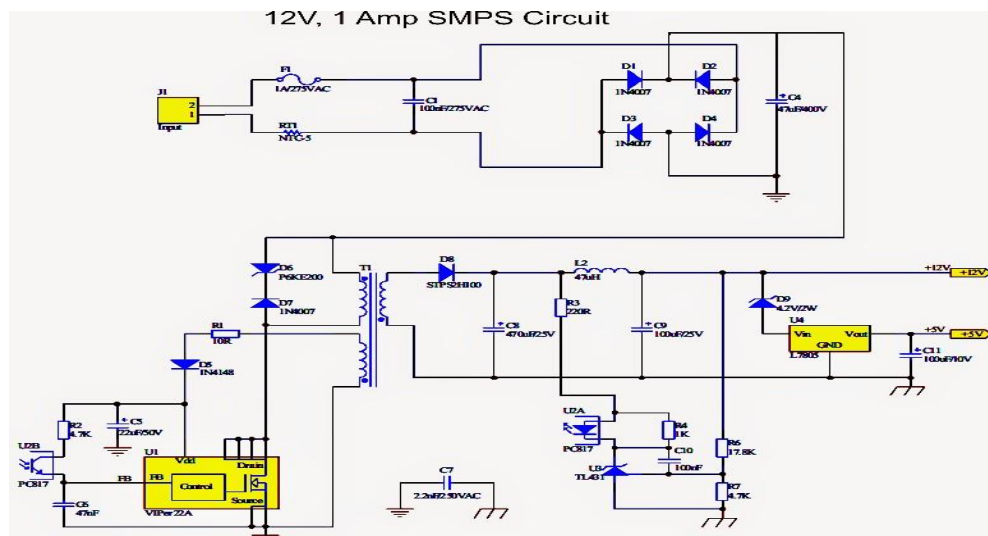


Fig 3.22 CIRCUIT DIAGRAM OF ADAPTER

An electric power adapter may enable connection of a power plug, sometimes called, used in one region to a AC power socket used in another, by offering connections for the disparate contact arrangements, while not changing the voltage. An AC adapter, also called a "recharger", is a small power supply that changes household electric current from distribution voltage) to low voltage DC suitable for consumer electronics. Some modify power or signal attributes, while others merely adapt the physical form of one electrical connector to another. For computers and related items, one kind of serial port adapter enables connections between 25-contact and nine-contact connectors but does not affect electrical power- and signalling-related attributes.

➤ **FEATURES:**

- ✓ Output current:1A
- ✓ Supply voltage: 220-230VAC
- ✓ Output voltage: 12VDC
- ✓ Reduced costs
- ✓ Increased value across front-office and back-office functions
- ✓ Access to current, accurate, and consistent data
- ✓ It generates adapter metadata as WSDL files with J2CA extension.

➤ **APPLICATIONS:**

- ✓ Back-end systems which need to send purchase order data to oracle applications send it to the integration service via a integration server client.
- ✓ SMPS applications.

3.2. SOFTWARE REQUIREMENTS

- ARDUINO IDE
- MYSQL

3.2.1. ARDUINO IDE

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuine hardware to upload programs and communicate with them.

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino.

The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

Before uploading your sketch, you need to select the correct items from the Tools

> Board and Tools > Port menus. The boards are described below. On the Mac, the serial port is probably something like `/dev/tty.usbmodem241` (for an Uno or Mega2560 or Leonardo) or `/dev/tty.usbserial-1B1` (for a Demilune or earlier USB board), or `/dev/tty.USA19QW1b1P1.1` (for a serial board connected with a Key span USB-to-Serial adapter). On Windows, it's probably COM1 or COM2 (for a serial board) or COM4, COM5, COM7, or higher (for a USB board) - to find out, you look for USB serial device in the ports section of the Windows Device Manager. On Linux, it should be `/dev/ttyACMx`, `/dev/ttyUSBx` or similar. Once you've selected the correct serial port and board, press the upload button in the toolbar or select the Upload item from the Sketch menu. Current Arduino boards will reset automatically and begin the upload. With older boards (pre-Diecimila) that lack auto-reset, you'll need to press the reset button on the board just before starting the upload. On most boards, you'll see the RX and TX LEDs blink as the sketch is uploaded. The Arduino Software (IDE) will display a message when the upload is complete or show an error.

When we upload a sketch, you're using the Arduino bootloader, a small program that has been loaded on to the microcontroller on your board. It allows you to upload code without using any additional hardware. The bootloader is active for a few seconds when the board resets; then it starts whichever sketch was most recently uploaded to the microcontroller. The bootloader will blink the on-board (pin 13) LED when it starts (i.e., when the board resets).

3.2.2. MYSQL

MySQL is a popular open-source relational database management system (RDBMS) that is widely used for web applications and other software systems. It is a client-server database system that runs on various platforms, including Windows, Linux, and macOS. MySQL uses Structured Query Language (SQL) to manage and manipulate data in the database. MySQL is known for its high performance, scalability, and reliability. It supports multiple storage engines, including InnoDB, MyISAM, and Memory, which provide different features and capabilities. InnoDB is the default storage engine, which supports transactions and foreign keys, and is recommended for most applications. MySQL can handle large volumes of data and supports a wide range of data types, including integer, string, date, time, and more. It also provides features such as indexing, partitioning, and replication, which allow for efficient data management and distribution.

MySQL is widely used in various industries, including e-commerce, social media, finance, and more. It is also used by popular web applications, such as WordPress, Facebook, and Twitter. Additionally, MySQL is easy to use and has a large community of developers who provide support and contribute to its development.

CHAPTER 4

DESCRIPTION OF PROPOSED SYSTEM

4.1. AIM OF THE PROJECT

This project aims to develop a smart energy management system that can efficiently monitor and manage energy consumption in households. The system will incorporate advanced metering technology and home automation using sensors to provide accurate and real-time information on energy consumption. The primary objective of this project is to reduce energy wastage and promote energy conservation by enabling households to make informed decisions about their energy usage. To design and develop a system that can provide energy consumption data for individual appliances, which can help identify energy-intensive appliances and optimize their usage. The advanced metering system will also integrate with home automation using sensors to provide energy-saving suggestions, such as turning off lights and appliances when not in use and regulating heating and cooling systems based on occupancy and ambient temperature.

The project will also focus on developing an easy-to-use interface for homeowners to access and analyze their energy consumption data. The system will also have a mobile application to provide remote access and control to homeowners. Overall, the project aims to provide a comprehensive solution for smart energy management, promoting energy conservation, and reducing energy wastage.

Three key considerations involved in the feasibility analysis are

- Economical feasibility
- Technical feasibility
- Operational feasibility

4.1.1 ECONOMICAL FEASIBILITY

The implementation of an Advanced Metering System with Home Automation using sensors has several economic benefits. The system aims to distribute electricity smartly and efficiently while helping consumers understand their power consumption patterns. This will result in reduced

electricity bills for households, as they will be able to monitor and manage their energy usage better.

Furthermore, the system will enable the prediction of energy consumption patterns, allowing consumers to plan their energy usage and reduce their consumption during peak periods. This will reduce the load on the power grid, ensuring a reliable and stable supply of electricity.

The implementation of this system will also benefit electricity companies by reducing the need for manual meter readings, which can be costly and time-consuming. Additionally, it will help reduce energy wastage, leading to a more sustainable use of energy resources.

Overall, the implementation of an Advanced Metering System with Home Automation using sensors has the potential to provide significant economic benefits for both households and electricity companies, making it a feasible and worthwhile investment.

4.1.2 TECHNICAL FEASIBILITY

The project involves the use of advanced metering systems, which are widely used in the utility industry. The sensors used in this project are readily available and can be easily integrated into the existing infrastructure. The home automation system can be developed using existing technologies such as wireless communication protocols and cloud computing.

The project requires the use of advanced metering systems, which can accurately measure and record energy consumption. The sensors used in this project can be used to detect motion, temperature, humidity, and light. These sensors can be used to automate various tasks such as turning on lights and adjusting the thermostat.

The home automation system can be developed using wireless communication protocols such as Wi-Fi and Bluetooth. The data collected by the sensors can be stored in the cloud, allowing users to access and control their home automation system from anywhere.

In conclusion, the technical feasibility of the project is high, and the required technologies are readily available. The project can be implemented using existing technologies, making it cost-effective and easy to maintain.

4.1.3 OPERATIONAL FEASIBILITY

The project proposes the use of advanced metering systems equipped with sensors to monitor energy consumption in households. The system will be integrated with home automation technology to control energy usage based on real-time energy consumption data.

The use of advanced metering systems and home automation technology will require a high level of technical expertise to develop and install the system. However, once the system is installed, it will be easy to operate, as it will automate many of the energy consumption control tasks.

The use of sensors will require careful calibration to ensure that they accurately detect energy consumption. This calibration will require specialized expertise but can be achieved with proper testing and quality assurance measures.

Overall, the project's operational feasibility is high, and with the proper expertise, resources, and testing, the system can be successfully developed, installed, and operated to help households manage their energy consumption effectively.

4.2. SCOPE OF THE PROJECT

This paragraph discusses the use of Wi-Fi as a key access technology for enabling the Internet of Things (IoT) due to its cost coverage and bandwidth capabilities, which can overcome the challenges posed by mobile cellular networks. The focus is on controlling the motion of things using sensors, which is considered an easy means of implementing IoT technology. The paragraph highlights the potential of this system to be used in power-saving applications by detecting changes in the outside environment. Additionally, the size of the project can be maximized depending on

specific applications.

The proposed work has been simulated using ARDUINO software, which is a popular platform for developing IoT applications. The simulation results have been validated with experimental values, which indicates that the proposed system can be implemented successfully in real-world settings.

Overall, the paragraph emphasizes the importance of Wi-Fi technology in enabling IoT applications and highlights the potential of using sensors to control the motion of things. It also provides insights into the potential uses of this technology in power-saving applications and highlights the importance of simulation and validation in the development process.

4.3. PRESENT INVESTIGATION OF THE PROJECT

The present investigation focuses on the development of an advanced metering system with home automation using sensors. The project aims to provide an efficient and reliable energy monitoring system that can help consumers manage their energy consumption better. The system is designed to monitor the energy consumption of individual appliances and provide real-time feedback to the user. The system is equipped with sensors that can detect the usage of various appliances, and the data is transmitted to a central hub. The hub then analyzes the data and provides feedback to the user. The home automation feature allows users to remotely control appliances and devices in their home. This feature enables users to turn on or off appliances and devices, adjust temperature, and control lighting. The system is designed to be user-friendly and can be accessed through a mobile app or web interface.

The investigation aims to evaluate the performance of the advanced metering system and assess its effectiveness in reducing energy consumption. The investigation will include testing the system in various scenarios and measuring its accuracy and reliability. The data collected from the investigation will be analyzed to determine the system's energy-saving potential and to identify areas where improvements can be made.

- Conducting experiments in different household environments to test the system's accuracy in detecting energy usage.

- Analyzing the collected data to identify the energy usage patterns and suggest ways to optimize energy consumption.
- Assessing the system's effectiveness in reducing energy consumption and the potential cost savings for the consumers.

Overall, the investigation aims to provide a comprehensive analysis of the advanced metering system with home automation using sensors and its potential to help consumers manage their energy consumption effectively.

4.4. BLOCK DIAGRAM OF EXISTING SYSTEM

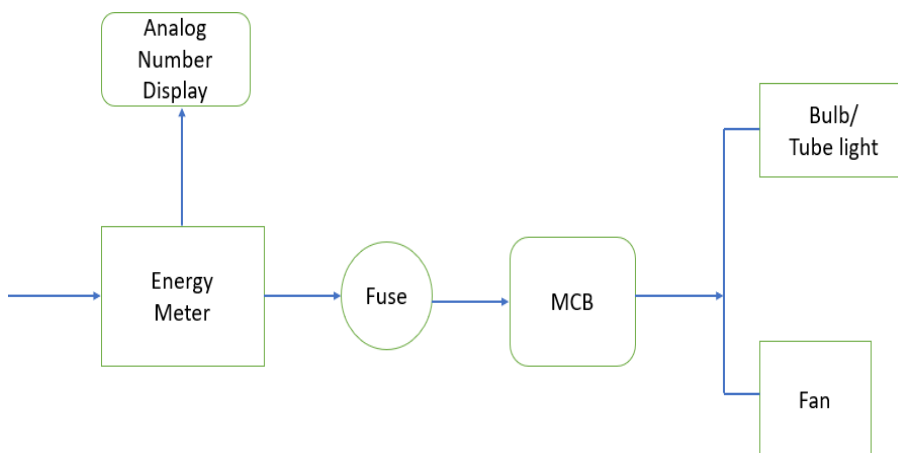


Fig 4.1 Block diagram of Existing System

4.5. BLOCK DIAGRAM OF PROPOSED SYSTEM

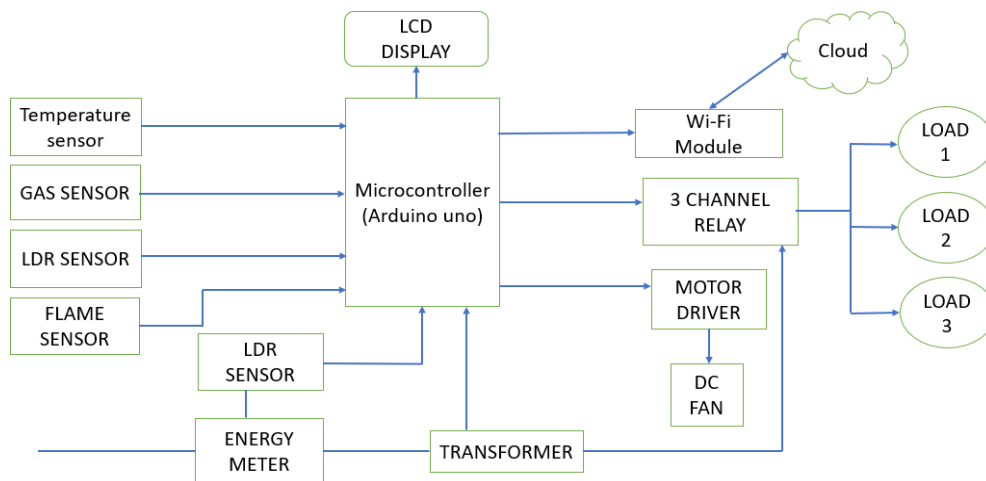


Fig 4.2 Block diagram of Proposed System Using Arduino

4.6. CONCEPT EXPLANATION

Advanced Metering System with Home Automation using Sensors including Android Application for Live and Past Billing is a project that aims to improve energy management and provide more control over energy consumption in households. The system uses advanced metering technology that allows for real-time monitoring and management of energy usage. The system also utilizes various sensors such as temperature, humidity, and light sensors to automate home appliances based on user preferences and environmental conditions.

The Android application provides users with live and past billing information, allowing them to make informed decisions about their energy consumption and manage their bills effectively. The application also provides users with real-time alerts and notifications when there is a sudden increase in energy consumption, allowing users to take necessary actions to prevent energy waste. Overall, this project aims to promote energy efficiency and provide users with more control over their energy consumption, resulting in reduced energy costs and a more sustainable lifestyle.

4.6.1. EXISTING SYSTEM

There is no system in place for cross-checking or rechecking energy utilization readings by human readers. This lack of oversight creates a potential for energymeter readings to be altered through the use of software tools when taking photos of them. Secondly, consumers are not provided with regular updates on their energy usage, which limits their ability to manage their energy consumption effectively.

Additionally, the power consumption of fans and light bulbs is significantly high without human intervention, potentially leading to wasted energy and increased costs. Lastly, it is highlighted that electrical appliances can be affected by fire or gas leakage without any detection. This emphasizes the importance of implementing measures to ensure the safe and efficient utilization of energy in households.

4.6.2. PROPOSED SYSTEM

The proposed system is equipped with multiple sensors such as temperature, LDR (Light Dependent Resistor), flame, and gas sensors. These sensors are capable of detecting abnormal values or situations, such as a sudden increase in temperature or gas leakage. If such an abnormality is detected, the system automatically triggers a relay that is connected to home appliances. This means that if the system senses, for example, a gas leak, it can turn off the gas supply to prevent any potential hazard.

In addition, the system is also connected to an IoT server, which allows for remote control and monitoring of the connected appliances. The system can receive commands from the IoT server, allowing users to control their home appliances from a mobile device or computer. This provides an added level of convenience and control over home automation.

CHAPTER 5

IMPLEMENTATION DETAILS

5.1. IMPLEMENTATION PROCESS

First, the system's hardware components, including the Smart Meters and sensors, must be installed in the households. These devices will collect data on energy consumption and home automation activities such as lighting, temperature, and security.

Next, the data collected by the sensors and Smart Meters will be transmitted to a central server using wireless communication protocols. The server will store and process the data, providing consumers with real-time feedback on their energy consumption and home automation activities.

To enable home automation, the system will be integrated with various devices, such as smart thermostats, smart locks, and smart lighting. These devices can be controlled remotely using a mobile application or a web interface, enabling consumers to manage their homes from anywhere.

Finally, the system's analytics capabilities will be leveraged to provide insights into energy consumption patterns and suggest ways to optimize energy usage. Consumers can use this information to make informed decisions about their energy consumption and reduce their electricity bills.

Overall, the implementation process for the advanced metering system with home automation using sensors involves a combination of hardware installation, wireless communication, data processing, device integration, and analytics. By implementing this system, consumers can reduce their energy consumption, save money, and contribute to a more sustainable future.

5.1.1. HARDWARE IMPLEMENTATION

- Sensors - The primary objective of this project is to use sensors to monitor different parameters in a home, such as temperature, humidity, light intensity, and motion. Sensors like DHT22, LDR, PIR, etc. can be

used to detect the changes in these parameters.

- Microcontroller - A microcontroller is required to process the data collected from the sensors and control the home automation system. Arduino boards are popular for this purpose as they are affordable and easy to use.
- Communication Module - Communication modules like Wi-Fi modules or Bluetooth modules are required to transmit data from the microcontroller to the internet or mobile devices.
- Power supply - A power supply unit is needed to power the microcontroller, sensors, and other components of the system. A regulated power supply of 5V or 9V can be used.
- Relays - Relays are used to control the home automation system. They act as switches and can turn on or off the devices based on the sensor readings.
- Display - A display module such as an LCD display can be used to display the sensor readings and the status of the home automation system.
- Actuators - Actuators such as motors, pumps, or solenoids can be used to control devices such as air conditioning units, water pumps, or door locks.
- Enclosure - An enclosure can be used to house the microcontroller, sensors, and other components to protect them from environmental factors like dust and humidity.

In summary, the hardware components required for an advanced metering system with home automation using sensors include sensors, a microcontroller, communication modules, power supply, relays, displays, actuators, and an enclosure.

5.1.2. SOFTWARE IMPLEMENTATION

- **Sensor Data Collection:** The first step in implementing an advanced metering system with home automation is to collect data from various sensors. Sensors could be used to collect data on electricity consumption, water usage, temperature, humidity, etc. The data collected by these sensors will be stored in a database for future reference.
- **Data Storage:** The data collected from the sensors should be stored in a database so that it can be accessed and analyzed later. MySQL is a commonly used database system that could be used for this purpose.
- **Data Analysis:** The data collected from the sensors can be used to analyze consumption patterns and identify areas for energy or water savings. This can be achieved using machine learning algorithms or other statistical methods.
- **Automation:** The data collected from the sensors can also be used to automate home appliances based on certain conditions. For example, if the temperature in a room rises above a certain threshold, the air conditioning system could be turned on automatically. This can be achieved using Arduino or NodeMCU boards which are microcontrollers that can be programmed to interact with various sensors and home appliances.
- **User Interface:** The data collected from the sensors can be presented to the user through a graphical user interface (GUI). The GUI could be a web-based application that displays consumption data in real-time or provides suggestions for energy-saving practices.
- **Communication:** All the different components of the advanced metering system with home automation need to communicate with each other. This can be achieved using various communication protocols like Wi-Fi.

5.1.3. MODULE IMPLEMENTATION

A. SENSOR INTERFACING

Interfacing sensors involves a combination of amplification, filtering, and other signal conditioning techniques, as well as converting analog signals to digital signals. While the analog-to-digital converter (ADC) may be present within the microcontroller, it is still necessary to ensure that the sensor output is compatible with the ADC input. Therefore, the sensor must be prepared accordingly before it can be interfaced with the ADC.

B. SENSOR INTERFACING

A power supply unit, abbreviated as PSU, is an essential component of a controller that converts the high-voltage mains AC to a low-voltage DC supply, which can be utilized by the internal components of the controller. The power supply reduces the mains electricity, which is typically available at 240 volts AC, to a lower and more usable voltage, such as 12 volts DC. Two types of power supply exist, namely linear and switch mode. A linear power supply uses a transformer to reduce the voltage, rectifying and regulating the AC signal to produce a high DC voltage.

An AC adapter, also known as an AC/DC adapter or converter, is a type of external power supply that is usually encased in a structure similar to an AC plug. Adapters that charge or recharge battery-powered devices may be referred to as chargers. AC adapters are used for electrical devices that require power but do not have internal components capable of deriving the required voltage and power from the primary power source.

C. MICRO-CONTROLLER PROGRAMMING

A microcontroller is an IC (integrated circuit) that can be programmed to perform various functions based on the code it runs. The different types of microcontrollers available in the market offer a diverse set of capabilities. This flexibility and versatility of the microcontroller make it a potent tool in modern-day design. In this guide, we will cover the fundamental aspects of microcontrollers and the process of programming them.

D. READING ANALOG DATA

The board's microcontroller contains an analog-to-digital converter (ADC) circuit that measures the changing voltage and converts it into a numerical value ranging from 0 to 1023. At one end of the shaft's rotation, the pin receives 0 volts, and the input value is 0. Conversely, when the shaft is turned to the opposite end, the pin receives 5 volts, and the input value is 1023. The analog Read() function provides a value between 0 and 1023, which corresponds to the applied voltage level at any point between these two extremes. This proportional value can be used to determine the position of the shaft, enabling precise measurement and control of analog devices.

E. TEST AND DEBUG

Verification of correct behaviour is the fundamental purpose of testing. Throughout the development of a module, testing can be performed at different stages such as requirements analysis, interface design, algorithm design, implementation, and integration with other modules. This article will focus on implementation testing. It is essential to note that implementation testing encompasses more than just execution testing. Verification of an implementation can also be achieved using methods such as correctness proofs, code tracing, and peer reviews, as explained below.

Debugging is a cyclic activity involving execution testing and code correction. The testing that is done during debugging has a different aim than final module testing.

F. SUBMISSION

Submitting the prototype for the presentation to the faculty guide for review purpose.

CHAPTER 6

RESULTS & DISCUSSION

The analysis of data collected from energy meters and sensors can help identify patterns of energy consumption in a home. These patterns could include peak usage hours, energy wastage, and other factors that impact energy consumption. By identifying these patterns, homeowners can make informed decisions about when to use energy-intensive appliances and take measures to reduce their overall energy usage.

Peak usage hours can be identified by analyzing the energy consumption data collected over time. This information can help homeowners plan their energy usage around peak hours, such as running energy-intensive appliances during off-peak hours to reduce energy costs. The analysis of energy wastage can help homeowners identify areas where energy is being unnecessarily consumed, such as leaving appliances on standby or using outdated and inefficient appliances.

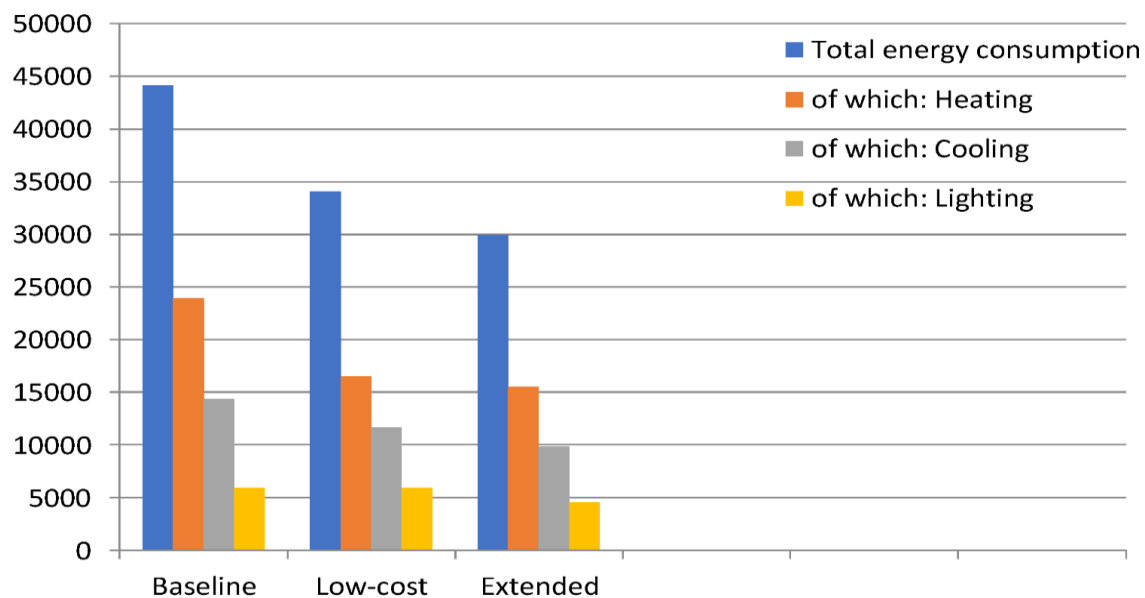


Fig 6.1 Annual energy consumption for heating, cooling, and lighting

The automation system's performance can be analyzed by examining data collected from sensors and other monitoring devices. This analysis can provide insights into how well the system is responding to user commands, controlling devices, and its overall efficiency. The performance of sensors used in the system can be analyzed to determine their accuracy, reliability, and overall performance. This analysis can help identify any issues with the sensors, such as malfunctioning or inaccurate sensors. It can also help identify areas where additional sensors may be needed to improve the system's performance.

S.no	value1	value2	value3	value4	value5	Date And Time
0	31	Gas Not Detected	Fire Not Detected	LOW	8	2023-03-30 21:30:53
1	32	Gas Not Detected	Fire Not Detected	LOW	7	2023-03-30 21:30:35
2	32	Gas Not Detected	Fire Not Detected	MEDIUM	6	2023-03-30 21:30:17
3	32	Gas Not Detected	Fire Not Detected	LOW	5	2023-03-30 21:30:02
4	33	Gas Not Detected	Fire Not Detected	LOW	4	2023-03-30 21:29:51
5	34	Gas Not Detected	Fire Not Detected	LOW	3	2023-03-30 21:29:43
6	34	Gas Not Detected	Fire Not Detected	LOW	2	2023-03-30 21:29:22
7	34	Gas Not Detected	Fire Not Detected	DARK	1	2023-03-30 21:29:09
8	34	Gas Not Detected	Fire Not Detected	MEDIUM	2	2023-03-30 21:22:11
9	31	Gas Not Detected	Fire Not Detected	MEDIUM	1	2023-03-30 21:21:45
10	29	Gas Not Detected	Fire Not Detected	LOW	57	2023-03-30 21:21:00
11	29	Gas Not Detected	Fire Not Detected	LOW	56	2023-03-30 21:20:43
12	29	Gas Not Detected	Fire Not Detected	LOW	55	2023-03-30 21:20:25
13	29	Gas Not Detected	Fire Detected	LOW	54	2023-03-30 21:20:07
14	29	Gas Not Detected	Fire Not Detected	LOW	53	2023-03-30 21:19:50

Fig 6.2 Metering Data Table

By analyzing sensor data, homeowners can gain insights into how well the sensors are functioning and identify any trends or patterns that may indicate sensor issues. For example, if a sensor consistently reports inaccurate data, it may need to be replaced or recalibrated. Overall, analyzing sensor data is crucial for ensuring that the automation system is functioning optimally and providing accurate data to homeowners.

In conclusion, analyzing the data collected from energy meters, automation systems, and sensors can provide valuable insights into energy consumption patterns, automation system performance, and sensor performance. By using this information, homeowners can make informed decisions about their energy usage, optimize their automation system's performance, and ensure that their sensors are functioning accurately and reliably.

CHAPTER 7

CONCLUSION

Improved energy management refers to the use of smart technology to monitor and manage energy consumption in homes. With this system in place, homeowners can easily monitor and control their energy usage, helping them to save money on their energy bills while also reducing their carbon footprint.

One of the primary benefits of improved energy management is that the system can monitor energy consumption in real-time. This means that homeowners can track their energy usage on a minute-by-minute basis, allowing them to identify areas where they can reduce their energy consumption. By making small adjustments to their energy usage, homeowners can significantly reduce their energy bills over time.

In addition to providing real-time monitoring of energy consumption, improved energy management also provides homeowners with the information they need to reduce their energy usage. This can include tips on how to reduce energy usage during peak hours, recommendations for more energy-efficient appliances, and other helpful information.

Another benefit of improved energy management is enhanced convenience. With home automation features, such as remote control of appliances and lighting, homeowners can easily control their home environment from anywhere. This can include turning lights on and off, adjusting the temperature, and even controlling their home security system.

Improved energy management can also increase safety in the home. The system can detect anomalies in energy consumption, such as a sudden spike, indicating a potential electrical issue. This could prevent electrical fires and other safety hazards. Additionally, many energy management systems can be integrated with home security systems, providing an additional layer of protection for homeowners.

In conclusion, improved energy management is a powerful tool that can provide homeowners with numerous benefits. From real-time monitoring of energy consumption to enhanced convenience and increased safety, this technology is transforming the way we live in our homes. As we continue to focus on sustainability and reducing our carbon footprint, improved energy management will play an

increasingly important role in achieving these goals.

7.1. FUTURE SCOPE

The integration of renewable energy sources, such as solar panels, wind turbines, and geothermal systems, is becoming increasingly important in our efforts to reduce carbon emissions and combat climate change. By enhancing the home automation system to integrate with these renewable energy sources, homeowners can track their energy usage and savings more accurately, which could encourage the adoption of renewable energy solutions.

In addition to integrating with renewable energy sources, the home automation system could also be integrated with artificial intelligence and machine learning algorithms. This would enable the system to learn the homeowner's energy usage patterns and automatically adjust home automation settings for maximum efficiency. For example, the system could adjust the thermostat to optimize heating and cooling based on the homeowner's habits, ultimately saving energy and reducing costs.

Another important feature of the enhanced home automation system is smart grid integration. This integration enables two-way communication between the energy provider and the homeowner, allowing for real-time adjustment of energy usage during peak demand periods. This feature could significantly reduce the homeowner's energy costs while also reducing strain on the electrical grid during peak periods. Security is also a major concern with home automation systems. To address this concern, the system could be enhanced with advanced security features such as biometric authentication.

Finally, the system could be expanded to include more sensors that monitor air quality, humidity, and temperature. This would provide a more comprehensive view of the home environment, allowing the homeowner to make more informed decisions about their energy usage and overall comfort. Overall, the integration of these features could result in a more efficient, sustainable, and comfortable home.

7.2. RESEARCH ISSUES

Accuracy of sensor data: One of the main challenges of home automation is the accuracy of the sensor data. The research could focus on determining how accurate the sensor data is and the steps that can be taken to improve the accuracy.

Sensor placement: The placement of sensors in a home automation system can affect the accuracy of the data collected. The research could focus on the best locations for placing sensors in different parts of the house.

Data processing: Home automation systems generate a large amount of data, and it can be challenging to process and analyze this data effectively. The research could focus on the methods and techniques that can be used to process and analyze data from the sensors effectively.

Energy consumption: Advanced metering systems are designed to help manage energy consumption in a home. The research could focus on the effectiveness of advanced metering systems in reducing energy consumption and the potential cost savings for homeowners.

User interface design: The user interface of a home automation system plays a crucial role in its usability and effectiveness. The research could focus on the design of the user interface, including the use of graphical interfaces, voice commands, and other features that can make the system easy to use and understand.

Security: Home automation systems are vulnerable to security threats, and it is essential to ensure that the system is secure. The research could focus on the security measures that can be implemented to protect the system from unauthorized access, hacking, and other security threats.

7.3. IMPLEMENTATION ISSUES

Hardware and Software Requirements:

The first step in implementing this project is to ensure that all the hardware and software requirements are available. The hardware components required for this project include sensors, microcontrollers, relays, and an energy meter. The software

requirements include the development of the code for the microcontroller and the programming language to be used.

Sensor Placement:

The placement of the sensors is critical in ensuring that the project works efficiently. The sensors need to be installed in strategic locations to enable them to capture data accurately. It is essential to consider factors such as the distance between the sensor and the source of data, the direction of the sensor.

Communication Protocols:

The communication protocols used between the different components of the system need to be well defined and tested. It is essential to ensure that the communication is reliable and efficient to avoid delays and data loss.

Power Supply:

The system requires a reliable power supply to ensure uninterrupted operation. It is necessary to have a backup power supply in case of power outages to ensure the system's continuity.

Testing and Validation:

Testing and validation of the system are essential to ensure that the system works as expected. It is necessary to conduct different tests to ensure that the system is accurate and reliable. The validation process involves comparing the results obtained by the system with the actual data obtained from other sources.

Maintenance:

Regular maintenance of the system is necessary to ensure that it continues to work efficiently. It is essential to carry out routine checks and repairs to fix any problems that may arise.

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APPENDIX

A: SOURCE CODE- ARDUINO IDE CODE

```
#include <DHT.h>
#include <LiquidCrystal.h>

const int rs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);

int gas, ldr, fire, sped, t, humidity;

void setup() {
  Serial.begin(9600);
  dht.begin ( ) ;
  lcd.begin(16, 2);
  lcd.setCursor(0, 0);
  lcd.print("HOME AUTOMATION ");
  lcd.setCursor(0, 1);
  lcd.print(" USING SENSORS ");
  pinMode(6, OUTPUT);
  pinMode(7, OUTPUT);
  pinMode(8, OUTPUT);
  pinMode(9, OUTPUT);
  pinMode(10, OUTPUT);
  pinMode(13, OUTPUT);

  digitalWrite(6, LOW);
  digitalWrite(7, LOW);
  digitalWrite(8, LOW);
  digitalWrite(9, LOW);
  digitalWrite(10, LOW);
  digitalWrite(13, LOW);

  delay(2000);
  lcd.clear();
}

void loop() {
  t = dht.readTemperature();
  humidity = dht.readHumidity ( ) ;
```

```

gas = analogRead(A0);
fire = analogRead(A2);
ldr = analogRead(A3);
int Ldr = map(ldr, 0, 1023, 100, 999);
int Fire = map(fire, 0, 1023, 100, 999);
ldr = map(ldr, 0, 1023, 1023, 0);

```

```

sped = map(t, 0, 50, 0, 255);
analogWrite(10, sped);
// analogWrite(10, 0);
int Gas = map(gas, 0, 1023, 100, 999);
gas = map(gas, 0, 1023, 0, 9);

```

```

Serial.print ( "T" ) ;
Serial.print ( t ) ;
Serial.print ( "H" ) ;
Serial.print ( humidity ) ;
Serial.print ( "L" ) ;
Serial.print ( Ldr ) ;
Serial.print ( "F" ) ;
Serial.print ( Fire ) ;
Serial.print ( "G" ) ;
Serial.print ( gas ) ;
Serial.println ( "#" ) ;

```

```

lcd.setCursor(0, 0);
lcd.print("T: ");
lcd.print(t);
lcd.print(" H: ");
lcd.print(humidity);
lcd.print(" G: ");
lcd.print(gas);
lcd.setCursor(8, 1);
lcd.print("F:");

```

```

if (Fire < 300 && gas > 6 ) {
  lcd.setCursor(10, 1);
  lcd.print("DETECT");
  digitalWrite(13, HIGH);
} else if (Fire < 300 && gas < 6 ) {
  lcd.setCursor(10, 1);
  lcd.print("DETECT");
}

```

```

    digitalWrite(13, HIGH);
}
else if (Fire > 300 && gas > 6 ) {
    lcd.setCursor(10, 1);
    lcd.print("NORMAL");
    digitalWrite(13, HIGH);
}
else if (Fire > 300 && gas < 6 ) {
    lcd.setCursor(10, 1);
    lcd.print("NORMAL");
    digitalWrite(13, LOW);
}

if (ldr < 300) {
    lcd.setCursor(0, 1);
    lcd.print(" DARK ");
    digitalWrite(6, LOW);
    digitalWrite(7, LOW);
    digitalWrite(8, LOW);
    digitalWrite(9, HIGH);
}
else if (ldr > 300 && ldr < 600) {
    lcd.setCursor(0, 1);
    lcd.print(" LOW ");
    digitalWrite(6, LOW);
    digitalWrite(7, LOW);
    digitalWrite(8, HIGH);
    digitalWrite(9, HIGH);
}
else if (ldr > 600 && ldr < 900) {
    lcd.setCursor(0, 1);
    lcd.print("MEDIUM");
    digitalWrite(6, LOW);
    digitalWrite(7, HIGH);
    digitalWrite(8, HIGH);
    digitalWrite(9, HIGH);
}
else if (ldr > 900) {
    lcd.setCursor(0, 1);
    lcd.print("BRIGHT");
    digitalWrite(6, HIGH);
    digitalWrite(7, HIGH);
    digitalWrite(8, HIGH);
}

```

```

        digitalWrite(9, HIGH);

    }
    delay(2000);
    lcd.clear();

}
Node mcu

#include <ESP8266WiFi.h>
#include <ESP8266HTTPClient.h>
#include <WiFiClient.h>
#include <ArduinoJson.h>
#include <SoftwareSerial.h>

const char* ssid    = "iot";
const char* password = "12345678";
const char* serverName =
"http://iotcloud22.in/1543_smarthome/post_value.php";

WiFiClient client;
HTTPClient http;

#define rx D7
#define tx D8
SoftwareSerial NodeSerial (rx, tx);

int flag, ldr , Temp, Hum, Fire, Ldr, Gas, nu = 0, count = 0, c = 0, a = 0;

int len;
int cnt = 0;
String inString = "";

String httpRequestData;

void setup()
{
    NodeSerial.begin(9600);
    pinMode(D8, OUTPUT);
    Serial.begin(9600);
    digitalWrite(D8, LOW);
    // digitalWrite(D6, LOW);
    WiFi.begin(ssid, password);
    Serial.println("Connecting");

```

```

while (WiFi.status() != WL_CONNECTED) {
    Serial.print(".");
    delay(500);
}
Serial.println("");
Serial.print("Connected to WiFi network with IP Address: ");
Serial.println(WiFi.localIP());
}

void loop()
{
    // ldr = analogRead(A0);
    // Serial.print("ldr "); Serial.println(ldr);

    while (c == count) {
        ldr = analogRead(A0);
        Serial.print("ldr "); Serial.println(ldr);
        if (ldr < 500)
        {
            nu = 0;
            count++;
            node();
        }
        // getdata();
    }
    c = count;
    // getdata();
}

void node() {
    while ((NodeSerial.available() > 0) && nu == 0) {
        char c = NodeSerial.read();
        Serial.print(c);
        if (c == '\n' || c == '\r') {
            if (cnt >= 2) {
                status_filter(inString);
                //Serial.println(inString);
                inString = "";
                cnt = 0;
            }
            else
            {
                inString = "";
                cnt = 0;
            }
        }
    }
}

```

```

    }
  }
  else
  {
    inString += c;
    cnt++;
  }
}
}
void status_filter(String buff)
{
  len = buff.length();
  //Serial.println(len);
  if (buff[0] == 'T')
    if (buff[3] == 'H')
      if (buff[6] == 'L')
        if (buff[10] == 'F')
          if (buff[14] == 'G')
            if (buff[16] == '#')

              //T28H64L256F999G1#
              //01234567890123456

              {
                String temp = buff.substring(1, 3);
                String hum = buff.substring(4, 6);
                String ldr1 = buff.substring(7, 10);
                String fire = buff.substring(11, 14);
                String gas = buff.substring(15, 16);

                Temp = temp.toInt();
                Hum = hum.toInt();
                Ldr = ldr1.toInt();
                Fire = fire.toInt();
                Gas = gas.toInt();

                Serial.print("Temp = "); Serial.println(Temp);
                Serial.print("Hum = "); Serial.println(Hum);
                Serial.print("Ldr = "); Serial.println(Ldr);
                Serial.print("Fire = "); Serial.println(Fire);
                Serial.print("Gas = "); Serial.println(Gas);
                nu = 1;

                sending_to_db();

```

```

    }
}

void sending_to_db()
{
    if (WiFi.status() == WL_CONNECTED)
    {
        http.begin(client, serverName);
        http.addHeader("Content-Type", "application/x-www-form-urlencoded");

        httpRequestData = "&value1=" + String(Temp) + "&value2=" + String(Gas )
+ "&value3=" + String(Fire) + "&value4=" + String(Ldr) + "&value5=" + String(
count) + "";

        // Serial.print("httpRequestData: ");
        Serial.println(httpRequestData);
        int httpResponseCode = http.POST(httpRequestData);
        if (httpResponseCode > 0) {
            Serial.print("HTTP Response code: ");
            Serial.println(httpResponseCode);
        }
        else {
            Serial.print("Error code: ");
            Serial.println(httpResponseCode);
        }
        http.end();
    }
    else {
        Serial.println("WiFi Disconnected");
    }

    delay(3000);
}

```

B: SCREENSHOTS

```
Done compiling.

Executable segment sizes:
ICACHE : 32768      - flash instruction cache
IROM : 254732      - code in flash      (default or ICACHE_FLASH_ATTR)
IRAM : 27369 / 32768 - code in IRAM      (IRAM_ATTR, ISRs...)
DATA : 1552 )      - initialized variables (global, static) in RAM/HEAP
RODATA : 1176 ) / 81920 - constants      (global, static) in RAM/HEAP
BSS : 25944 )      - zeroed variables      (global, static) in RAM/HEAP

Sketch uses 284829 bytes (27%) of program storage space. Maximum is 1044464 bytes.
Global variables use 28672 bytes (35%) of dynamic memory, leaving 53248 bytes for local variables. Maximum is 81920 bytes.

Module, 80 MHz, Flash, Disabled (new aborts on oom), Disabled, All SSL ciphers (most compatible), 32KB cache + 32KB IRAM (balanced), Use pgm_read macros for IRAM/PROGMEM, 4
```

Fig B.1 Arduino Output

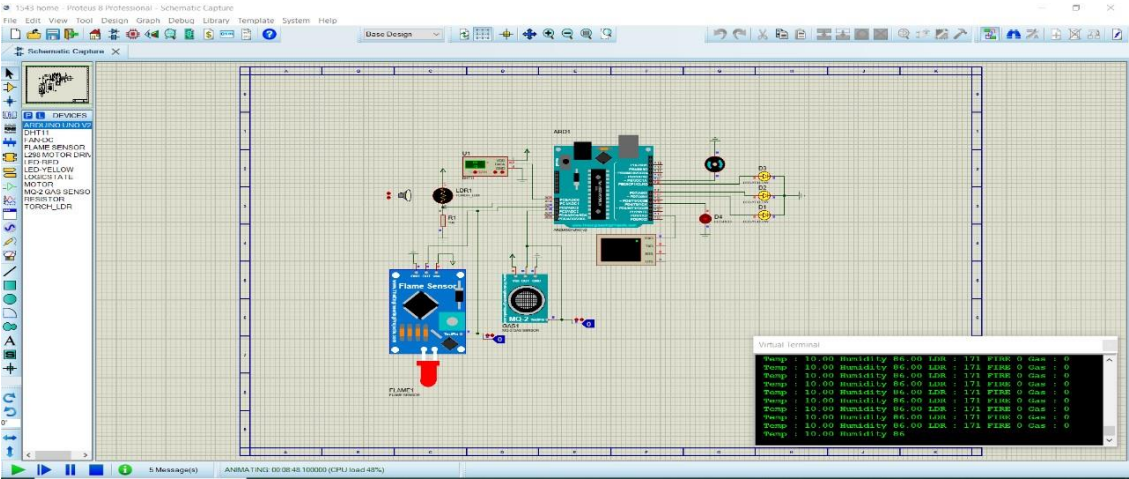


Fig B.2 Project Simulation in Proteus Software



Fig B.3 Full Hardware

ADVANCED METERING SYSTEM WITH HOME AUTOMATION USING SENSORS

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Abstract - The aim of this project is to develop an effective approach for measuring electricity consumption in energy meters with the use of modern electronic devices. This involves creating a communication link between the user and the energy meter to regularly update consumption data. To accomplish this, the microcontroller is connected to the unit data received from the energy meter. Various research works have been conducted on designing different home sensor networks and topologies for smart home applications. In a heterogeneous communication environment, maintaining the power supply of the home sensor network is crucial for ensuring the system's functioning. One of the key functions of smart homes is fire detection, which plays a vital role in preventing fire outbreaks and safeguarding lives and property. To this end, this study proposes a novel system for fire detection that employs gas leak concentration to predict the likelihood of a fire or explosion. The system comprises a fire predictor and a fire appearance detector, and the fire predictor notifies the user of gas leak concentrations by producing a buzzer sound.

1. INTRODUCTION

In recent years, there has been a noticeable increase in the utilization of household appliances, resulting in a higher requirement for electricity. This growing demand has caused apprehension in both developed and developing countries regarding the urgent necessity for additional electricity supply. To tackle this problem, it is crucial for consumers to monitor their daily power usage within their homes. In Sweden, there is a shortage of energy resources during the daytime, making it vital for individuals to conserve and regulate these resources. The purpose of this investigation is to employ Smart Meter information to allocate electricity intelligently and effectively to consumers while also aiding them in comprehending their power consumption patterns, thereby mitigating the potential energy crisis.

One of the primary limitations of conventional meters is their inability to provide consumers with information. In contrast, Smart Meters have the capability to offer this vital data, allowing users to keep track of their power consumption

for different household appliances. Through the examination of Smart Meter data across various households, this research endeavour seeks to gauge and evaluate energy usage. Furthermore, the Smart Meter data reveals consumer patterns in utilizing devices, offering valuable insights on electricity conservation. As energy usage rises, it's becoming increasingly important to grasp how people consume electricity. To achieve this, it's crucial to track and scrutinize consumption trends over time. However, in less developed countries, Smart Meters are not yet widely known among consumers and power providers. Therefore, there's a pressing need to deploy these meters to promote energy conservation. The objective of this study is to lower energy costs by exploring how consumer behaviour relates to electricity prices in the market.

The origins of home automation can be traced back to the early 1900s with the introduction of electric and gas-powered appliances such as washing machines (1904), water heaters (1889), refrigerators (1913), sewing machines, dishwashers, and clothes dryers. However, it was not until 1975 that the first general purpose home automation network technology was developed, which was called X10. X10 is a communication protocol for electronic devices that primarily uses electric power transmission wiring for signalling and control. The signals involve brief radio frequency bursts of digital data. X10 offers a variety of products including a 16-channel command console, a lamp module, an appliance module, a wall switch module, and the first X10 timer.

ABI Research stated in 2012 that approximately 1.5 million home automation systems were implemented in the United States. According to research firm Statista, over 45 million smart home devices were installed in American households by the end of 2018. The term "smart home" refers to a system that utilizes information and communication technologies (ICT) protocols.

Fire and Gas System, part of a combination system, is composed of various components and circuits that are designed to detect and signal the status of fire, gas alarms, or supervisory signal-initiating devices. Upon receiving these signals, the system initiates an appropriate response to address the situation.

II. LITERATURE SURVEY

C Komathi, "Smart Energy Metering for Cost and Power Reduction in Household Applications" C Komathi's paper discusses the implementation of smart energy metering systems in households to reduce energy consumption and cost. The paper proposes the use of sensors and wireless communication technology to monitor energy consumption and provide feedback to users. The smart energy metering system can help households to save energy and reduce their electricity bills, as well as contribute to the overall energy efficiency of the power grid [1].

Gee Thika Kalari, "Automatic Light Intensity Control using Arduino UNO and LDR" Gee Thika is concentrating on automating light intensity control using an Arduino UNO and LDR sensor. The LDR sensor is responsible for identifying the existing amount of light in the surroundings and transmitting a signal to the Arduino UNO, which regulates the light's intensity based on this input. The project is useful for conserving energy and establishing a more pleasant atmosphere in residential and commercial settings [2].

Ezhilarasi.P, "Review on Smart Energy Meter for low-cost design" Ezhilarasi. P examines the progress made in creating low-cost smart energy meters that can track energy usage and transmit data to either the user or utility company. Several methods for developing such devices are discussed, such as implementing microcontrollers, wireless communication technologies, and power-efficient sensors. The author emphasizes how important smart energy meters are in encouraging energy efficiency and lowering electricity expenses. Ultimately, they conclude that these low-cost smart energy meters can be valuable for both consumers and utilities in managing energy consumption [3].

Muhammad Javeed Iqbal, "Smart Home Automation Using Intelligent Electricity Dispatch" Muhammad Javeed Iqbal suggested a system for home automation that employs smart electricity dispatch to regulate energy usage and prevent wastage. The system relies on AI algorithms and IoT devices to supervise and manipulate energy consumption, resulting in a more effective distribution of energy and decreased electricity expenses. If implemented, this system could enhance energy efficiency and decrease energy usage in households, as well as empower users to manage their energy consumption and expenses more effectively [4].

Wahab A. Jabbar, "Design and Fabrication of Smart Home with Internet of Things Enabled Automation System" The task they are undertaking entails creating a smart home that features an automation system powered by the Internet of Things (IoT). The system is intended to enable the centralized management of different aspects of the home, including security, temperature, and lighting, for the purpose of facilitating convenient and efficient control [5].

P. Siva Nagendra Reddy, "An IoT based Home Automation Using Android Application" The project uses IoT technology to automate various functions in a home, such as controlling lights, fans, and air conditioning, through an Android application. The system includes a central control unit that communicates with different sensors and devices using Wi-Fi or Bluetooth. The Android application serves as an interface for users to interact with the system and control the devices remotely [6].

Lei Yang, "Cost-Effective and Privacy-Preserving Energy Management for Smart Meters" Lei Yang's study centres on creating an energy management system for smart meters that is both cost-effective and protects privacy. The approach involves using secure aggregation and homomorphic encryption methods to keep energy usage data private while still enabling efficient energy management. The findings show that this solution is efficient in lowering energy expenses and preserving user privacy, indicating its potential for future use in smart grid applications [7].

M.Abdul Kader Riyaz, "Graphene Coated LED based Automatic Street Lighting System using Arduino Microcontroller" They proposed a street lighting system that uses an LED light source coated with graphene, a material known for its high thermal conductivity and low resistivity. The system is automated using an Arduino microcontroller, which can sense changes in ambient light levels and adjust the brightness of the LED, accordingly, providing energy efficiency. The graphene-coated LED also reduces the need for frequent maintenance, as it is more durable and has a longer lifespan compared to traditional LED lights [8].

Vinod Namboodiri, "Toward a Secure Wireless-Based Home Area Network for Metering in Smart Grids" In this paper, a communication protocol is put forward to safeguard wireless-based home area networks from a range of security risks like message tampering, replay, and interception. The protocol employs authentication and encryption techniques to establish secure communication between the home gateway, smart meters, and the utility company's server. The research showcases the efficiency of the proposed protocol in deterring security attacks through simulation results. Additionally, it stresses the significance of securing wireless-based home area networks in smart grids [9].

Andi Adrianna, "Design of Small Smart Home System Based on Arduino" Andi Adrianna centres on the development and execution of a compact smart home system employing Arduino as the primary controller in their paper. The system comprises a range of sensors and actuators to supervise and manage the living conditions, including temperature, humidity, lighting, and security. Through successful testing, the system proved the possibility of utilizing inexpensive microcontrollers like Arduino to produce a modest and reasonably priced smart home remedy [10].

III. METHODOLOGY

The Internet of Things (IoT) is the term used to describe the network of physical objects, appliances, vehicles, and other devices that are equipped with software, sensors, and connectivity to exchange data. This allows them to interact with each other and with humans. IoT has ability to bring significant changes to various industries, such as healthcare, transportation, agriculture, and manufacturing, by enhancing productivity, reducing expenses, and providing new services. Additionally, it can improve our daily lives through smart homes and wearable technology. In conclusion, IoT is an important technology that has the potential to reshape our lifestyles and working practices.

IoT, the Internet of Things, will greatly enhance home automation by allowing for seamless communication between devices and enabling more intelligent, automated systems. With IoT technology, devices such as smart thermostats, lighting systems, security cameras, and home assistants can be integrated and controlled through a single platform. This will enable homeowners to monitor and control their home systems remotely, customize settings based on their preferences, and even automate certain tasks based on data collected by sensors. Additionally, IoT-enabled home automation can improve energy efficiency, enhance security, and provide greater convenience and comfort for residents.

a) Hardware Architecture

The overall prototype of Smart home automation is depicted in the block diagram shown in Fig.1. Firstly, the three-phase electricity will be transmitted to the smart meter. Subsequently, the power will traverse a step-down transformer before entering the Arduino microcontroller, where all sensors will be connected. The smart energy meter will then transmit all energy consumption data to the cloud server, which is linked to the web application. An Android application will be developed based on the web application to display all current and historical electricity usage data. To guarantee safety, several sensors are connected to the microcontroller. Flame sensors will be utilized to prevent danger from flames, while gas sensors will be incorporated in parallel to provide protection from gas hazards. When the sensors detect any occurrence of gas leakage or the presence of flames, the microcontroller will issue a danger alert to the Android application and trigger the buzzer for safety purposes.

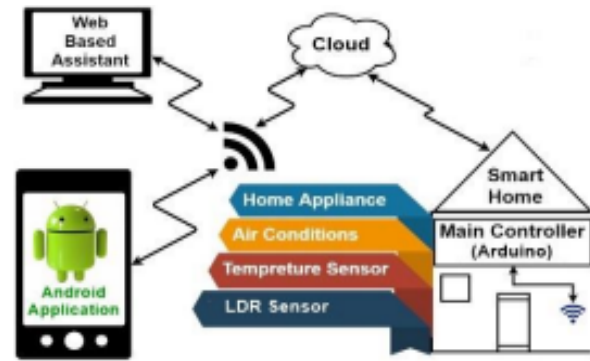


Fig 3.1 Block diagram of home automation

b) Working Principle

The entire system's input is connected to one smart meter, which is in turn connected to a three-phase input. The output of the smart meter is then passed through a step-down transformer, which reduces the power and sends it to the microcontroller, making the home smart. The household lights glow unnecessarily for extra hours. Even when sunlight is at its maximum in the morning, the household lights remain illuminated at full brightness, even when there is no one present in the room. To make energy usage more efficient, we propose a system that uses LDR sensors to control the illumination of household lights. The measurement of sunlight intensity dictates the switching on/off household lights in a manner that is determined by the input/output of sensors. The lights are arranged in circuits, with their on/off movement being controlled by this system. Light Dependent Resistors (LDRs) are utilized to detect and gauge light intensity. When the ambient light intensity is low, the LDR increases its resistance. If the environment becomes dark, the microcontroller receives an output signal from the LDR, causing it to activate the lights through relays [7]. Additionally, a temperature sensor detects the environment temperature and sends the data to the microcontroller. If the surrounding temperature is higher than normal, household applications such as fans/ACs work at their maximum efficiency until the room temperature comes back to normal. Similarly, if the surrounding temperature is lower, then fans/ACs will run with minimum cooling as output [8].

c) Flowchart

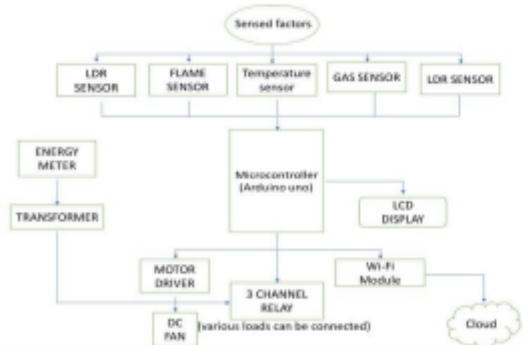


Fig 3.2 Flowchart for controlling the smart home based on sensors input

The block diagram of the proposed system includes a smart energy meter that operates on a three-phase power input, as depicted in Figure 1. This energy meter is connected to a microcontroller for data transmission and reception, and a converter is used to facilitate communication between the energy meter and the Arduino Uno microcontroller, as they operate on different protocols. To evaluate the hardware setup, three case studies were conducted with three 40-watt bulbs used for load consumption. The first case evaluated the system's performance with no load devices, while the second and third cases tested it with a single load device and both loads connected, respectively. In the third case, the system sends a notification to the user via a web browser using PHP coding when the energy consumption exceeds the threshold value. Users can monitor their past electricity usage through the Android application since all energy usage data is stored in the cloud [1].

To determine the light intensity available in a room, LDRs are strategically placed in various locations, including around the workspace and near windows, if present. For instance, if someone is in the kitchen during mid-morning with open windows, the kitchen lights will remain off if the LDRs detect light intensity greater than the average value required for vision, which is set at 5000 lumens. Different rooms have different threshold values to ensure proper vision and efficient light control. The use of these thresholds reduces energy consumption, eye strain, and promotes natural sunlight usage. The system takes an average value of the intensities measured by the four LDRs to obtain a more precise intensity value. The LDRs generate analog voltage that corresponds to the light intensities, which is then converted to digital using an ADC. The Arduino Uno serves as the central processing unit for the system, equating the obtained digital value to an equivalent light intensity, as illustrated in Figure 1 [5].

This section presents the proposed strategy for creating an automated household system, which integrates software and hardware technologies. The primary objective of the system is to address most of the energy consumption issues and includes three automated methods: web-based, app-based, and local.

The Arduino Uno board, along with sensor, switches, and relay modules, is employed in the system. The study focuses on four devices: bulb, fan, AC, and electric heater, which are observed under specific conditions and managed in three ways: local, web, and app based. In the local scenario, the Arduino Uno processes the sensor feedback and generates a result for the relay module and switches to perform their actions, such as breaking or restoring the circuit. In the web and app-based cases, the Arduino, relay, and NodeMCU are linked to the appliances, and users can access the app or web page to request turning the device on or off based on their requirements. The server processes the request, and the defined action is executed. The app and web-based modules are given priority in all cases. For instance, if a person is in the room, the light will automatically switch on based on the sensor's detection. However, if the person does not want the light to turn on, they can use the app or web page to manage it.

IV. PROPOSED SYSTEM

RESEARCH GAP OF THE EXISTING SYSTEM: There is currently no system of cross-checking or rechecking by human readers for energy utilization. There is a potential for the readings of energy meters to be altered through the use of software tools when taking photos of them. Consumers are not being provided with updates on their regular energy usage. The power consumption of fans and light bulbs is significantly high without human intervention. Electrical appliances can be affected without any detection of fire or gas leakage.

PROPOSED SYSTEM: This system will incorporate a smart metering system that will provide highly accurate reports on electricity consumption. This will be achieved through the integration of a microcontroller with light and temperature detection sensors. Our objective is to ensure safety by implementing gas and flame sensors with the proposed system, thereby providing maximum safety in the smart home. Given the ever-increasing usage of smartphones, we will develop an Android application that can be connected via Wi-Fi to the microcontroller using node-mcu. Through this application, we will be able to track our daily and past electricity usage.

ADVANTAGES: This technology facilitates convenient monitoring and tracking of energy consumption for the user. By utilizing specific equipment, power usage for fans and lights can be effectively reduced. Additionally, this technology ensures the safety of electrical appliances through the incorporation of fire and gas leakage detection mechanisms.

V. IMPLEMENTATION PROCESS

The completion of the analysis task marks the production of the software requirements specification. During this stage, the software's function and performance within the system engineering framework are carefully refined. This includes developing a detailed description of the system's behavior,

specifying its performance requirements and design constraints, and determining appropriate validation criteria.

- ARDUINO MICRO CONTROLLER
- Wi-Fi
- TEMPERATURE SENSOR
- GAS SENSOR [MQ2]
- FLAME SENSOR
- 2 LDR SENSOR
- 3 CHANNEL RELAY
- L298N MOTOR DRIVER
- LOAD
- CONNECTING WIRE
- POWER SUPPLY UNIT
- LCD DISPLAY

A. ARDUINO UNO MICROCONTROLLER:

The Arduino Uno is a popular microcontroller board used for building digital devices and interactive projects. It is based on the ATmega328P microcontroller and designed to make it easy for hobbyists, students, and professionals to create and prototype electronics projects without advanced programming knowledge. The board has 14 digital input/output pins, 6 analog inputs, a USB connection, a power jack, and a reset button. It is programmed using the Arduino Software, based on the Wiring language, which is easy to learn yet powerful enough for experienced programmers. The board allows you to connect sensors, actuators, and other components to interact with the physical world and build a wide range of projects, including robots, home automation systems, and interactive art installations.



Fig 5.1 Arduino UNO

B. TEMPERATURE SENSOR:

the DHT11 digital temperature sensor to gauge temperature and relative humidity. This sensor has a built-in chip that enables analog-to-digital conversion and produces a digital output signifying the temperature and humidity levels. As a result, it is uncomplicated to operate these sensors with any microcontroller, such as the Arduino. However, it is essential to take appropriate steps to avoid plagiarizing someone else's work while presenting information about these sensors. The temperature sensor is shown in Fig. 5.3

Communication protocol	one-wire
Power supply range	3 to 5.5 V
Temperature range	0 to 50 °C $\pm 2^{\circ}\text{C}$
Humidity range	20 to 90% $\pm 5\%$
Sampling period	1 second

Fig 5.2 The most relevant specifications of the DHT11 temperature sensor

In the Fig. 5.2, the specification of the temperature sensor is given.



Fig 5.3 DHT11 Temperature Sensor

C. GAS SENSOR [MQ2]:

The MQ2 sensor is a commonly used and favoured component in the MQ sensor series, owing to its widespread application. This MOS sensor functions by sensing alterations in resistance of the sensing material when in contact with different gases, which are also referred to as chemiresistors. The MQ2 gas sensor runs on 5V DC and consumes around 800mW of power. It can detect multiple gas concentrations, including LPG, Smoke, Alcohol, Propane, Hydrogen, Methane, and Carbon Monoxide, across a range of concentrations from 200 to 10000 ppm.



Fig 5.4 DHT11 Temperature Sensor

D. FLAME SENSOR:

A flame-sensor that can identify and react to the presence of fire or flame. It has the flexibility to incorporate different functions like a fire suppression system, alarm system, propane, natural gas line, etc. Flame-sensors are frequently utilized in industrial boilers to ensure their proper operation. Compared to smoke or heat detectors, flame-sensors possess a distinctive flame-detection mechanism that enables them to

respond more precisely and rapidly. The flame sensor is shown in Fig. 5.5.



Fig 5.5 Flame Sensor

E. 3 CHANNEL RELAY:

The following product consists of a 3-channel relay module with optocoupler isolation that is compatible with both 3.3V and 5V signal high-voltage relays. The product dimensions are 634220mm, and its power supply voltage is 5V. The module operates with a high-level trigger, and it can be controlled using CH1, CH2, and CH3 control ports. When a high-level trigger is received, the relay will connect. The module's trigger level is between 3V to 7V, with a trigger current of 5mA. The module's control voltage is AC 0-250V or DC 0-30V, and its control current ranges from 0 to 7A.



Fig 5.6 Three Channel Relay

F. L298N MOTOR DRIVER:

The L298 features two power output stages, denoted as A and B. These power output stages are configured in a bridge setup, which enables the device to drive an inductive load in either common or differential mode. The current flowing through the load is sensed and monitored at the output of the bridge, and an external resistor can be utilized to measure the current intensity accurately.



Fig 5.7 L298N Motor Driver

Demands for sophisticated and accurate measuring tools: The energy market requires more advanced and precise measuring tools to improve energy metering and promote efficient energy consumption. Multi-function electric energy meters: There is a growing trend towards using multi-function electric energy

meters that offer multiple parameters measuring, energy metering, analysis, and control capabilities. This is done to meet the demand for more sophisticated energy measurement tools.

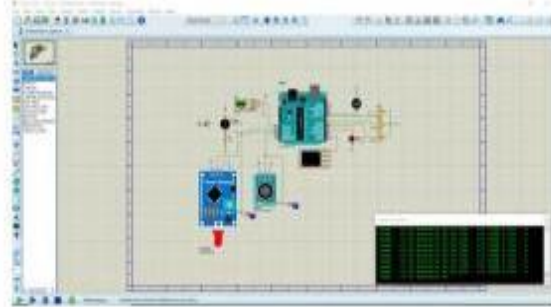


Fig 5.8 Project Simulation in the Proteas Software

Advancements in power measurement automation technology: The progress made in computer and communication technology has led to the development of automation technology for power measurement.



Fig 5.9 Project Arduino Code

1. To set up the Arduino IDE, first go to the official Arduino website and download the Arduino Integrated Development Environment (IDE) onto your computer. Once the download is complete, proceed to install it.
2. Establish a connection between your computer and the Arduino board by utilizing a USB cable to link them together.
3. Write your code: Begin by launching the Arduino Integrated Development Environment (IDE) and entering your code into the editor. You have the option of either utilizing the IDE's pre-existing examples or creating your own code from scratch.
4. Upload your code: Once your code is written, compile it by clicking on the "Verify" button. If there are no errors, click on the "Upload" button to upload the code to your Arduino board. The Arduino board will reset and begin running the code you just uploaded. It shown in Fig. 5.9.

To improve the management of line losses and promote scientific management in the power industry, it's important to develop a data application platform that utilizes power-related data. This platform would enable comprehensive statistical analysis of various aspects, including all categories, voltage divisions, sub-lines, and sub-areas of the entire network.

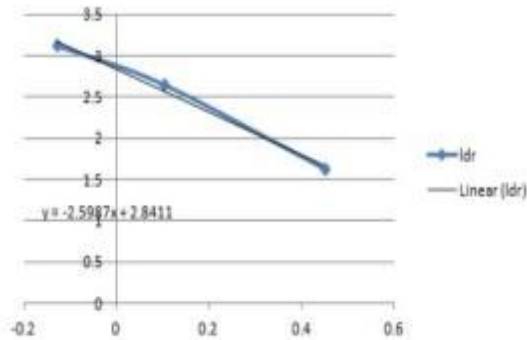


Fig 5.10 Performance Graph of LDR

The digital value is converted to light intensity value using the following code:

```
pValue = analogRead(A0);
pVoltage=(5*pValue/1023);
// print out the read value:
ldVoltage=(5-pVoltage);
ldlux=(693.58*pow(ldVoltage, -2.5987));
```

These values are obtained by ARDUINO's digital value with the light intensity value measured by the LUX meter.



Fig 5.11 Snapshot of Full Hardware

A novel electronic multi-function energy meter is required to measure conventional power parameters, energy, timing, display, alarm, and instrument self-test functions in a three-phase system. The development of such a tool will provide the energy market with an advanced and accurate device to fulfil their energy measurement needs.



Fig 5.12 Snapshot of Android Application

The home automation system has a smart meter that measures energy usage and sends data to the cloud. The cloud stores the energy usage data and provides access through an Android or web application. The Android or web application displays energy usage data in a user-friendly format, allowing users to track usage over time and save energy. The Android or web application allows users to control smart home devices, such as thermostats and lights, through the cloud. The cloud sends commands to the appropriate devices and receives data from them, allowing the Android or web application to provide real-time information on device status, shown in Fig. 5.12.

V. RESULT AND CONCLUSION

Simulated Home Automation is an innovative technology that allows users to remotely control simulated devices connected to their home PC via the internet. This system provides secure access to home appliances, without the need for direct access from a public network. To ensure security, the system uses a public mailing system that operates through Gmail SMTP/POP3/IMAP servers.

Simulated Home Automation is an efficient and cost-effective solution for remotely controlling electronic devices from any location worldwide. Future enhancements to the system could include embedding devices that notify users of power loss or device failure. Additionally, the entire system could be implemented using wireless technology, and the embedded device could be utilized as a remote controller for electronic gadgets.

VII. REFERENCES

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