International Journal of Engineering Inventions
e-ISSN: 2278-7461, p-ISSN: 2319-6491
Volume 14, Issue 6 [June. 2025] PP: 216-227

"Battery Temperature Monitoring and Control System"

M. SAI RAJESH, S. ROOBAK, SP. RIYAN RALPH, K. LAWRANCE

ABSTRACT
The growing demand for battery-powered devices and systems has led to an increased need for battery monitoring and protective systems. These systems play a critical role in ensuring the safe and reliable operation of battery-powered systems, such as electric vehicles, renewable energy systems, and mobile devices. This work emphasizes to monitor the state of charge (SOC) of the battery to ensure optimal performance and prevent premature failure. The battery is protected from damage due to overcharging, over-discharging, overheating, and short-circuiting. It also provides early warning of potential battery issues, such as low SOC or high temperature, so that corrective action can be taken to prevent damage. The charging and discharging of the battery is optimized to maximize its lifespan and efficiency. The proposed model facilitates remote monitoring and control of the battery using NODEMCU.

Date of Submission: 14-06-2025 Date of acceptance: 29-06-2025

I. INTRODUCTION

Batteries are one of the key components in our everyday lives. They are widely used as energy storage solutions in various applications, ranging from portable electronics to electric vehicles and renewable energy systems. They also help integrate renewable energy sources into the grid, and are becoming increasingly important in electric vehicle networks. Installing battery energy storage improves the use of renewable energy, offers a backup power source, less dependence on the grid, reduces carbon footprint, and offers long-term cost savings

Typically Industrial batteries are designed for performance, reliability and longevity. Different types of batteries offer different benefits and features that are taken into consideration when choosing a battery based on application. Lithium-ion Battery, Lead-acid Battery, and Nickel Cadmium Battery are very commonly used based on their affordability, weight, size and maintenance. The demand for batteries is expected to grow exponentially in the coming years.

However, batteries are prone to various issues, including voltage fluctuations, overcharging, overheating, and capacity degradation, which can lead to reduced performance, safety hazards, and even failure.

A battery monitoring system measures various battery parameters, such as temperature, voltage, current, and state of charge (SOC), in real-time to monitor the health and performance of the battery. This information is used to optimize the charging and discharging of the battery, extend its lifespan, and prevent damage due to overcharging, over-discharging, overheating, and short- circuiting [1], [2]. A battery protective system is designed to trigger protective mechanisms when the battery parameters exceed certain thresholds to prevent any further damage. It provides early warning of potential battery issues, such as low SOC or high temperature, so that corrective action can be taken to prevent any further damage.

Remote monitoring and control of the battery is another critical aspect of battery monitoring and protective systems. It enables predictive maintenance, reduces downtime, and allows the battery operator to monitor the battery's health and performance from a remote location.

Battery monitoring and protective systems play a crucial role in ensuring the safe and efficient operation of battery-powered devices and systems. Batteries are widely used as energy storage solutions in various applications, ranging from portable electronics to electric vehicles and renewable energy systems. However, batteries are prone to various issues, including voltage fluctuations, overcharging, overheating, and capacity degradation, which can lead to reduced performance, safety hazards, and even failure.

In this work, the battery monitoring and protective systems is designed to continuously monitor the vital parameters of batteries, such as voltage, current, temperature, and state of charge with the help of Arduino. This system makes use of sensors, control circuits, and intelligent algorithms to collect real-time data and analyze the battery's condition using the BLYNK app. Thus, based on the information obtained, appropriate actions are triggered to protect the battery and the associated equipment.

II. LITERATURE SURVEY

TITLE: TEMPERATURE BASED SPEED CONTROL OF FAN USING ARDUINO

AUTHOR: Shwetha S Baligar , Srinidhi S Joshi , Sujay Mudhole , Spoorti S Jadhav , Chaitanya K Jambotkar
ABSTRACT:
In present scenario, availability of electricity is found to reach crucial stage. To protect and safeguard one's future we need to save the energy. As a slogan suggest "One unit saved is one unit generated". The project is a standalone automatic fan speed controller that controls the speed of an electric fan according to our requirement. Use of embedded technology makes this closed loop feedback control system efficient and reliable. Arduino microcontroller allows dynamic and faster control. Liquid crystal display (LCD) makes the system user friendly. The sensed temperature and fan speed level values are simultaneously displayed on the LCD panel. It is very compact as it is constructed by using few components and can be interfaced for several applications including air-conditioners, water-heaters, snow-melters, ovens, heat-exchangers, mixers, furnaces, incubators, thermal baths and veterinary operating tables. Arduino micro controller is the heart of the circuit as it controls all the functions. The temperature sensor LM35 senses the temperature and converts it into an electrical signal, which is forwarded to the microcontroller. The sensed and set values of the temperature are displayed on the 16x2-line LCD. The microcontroller drives Transistor to control the fan speed. This project uses regulated 12V, 2A power supply. This project is useful in process industries for maintenance and controlling of Boilers temperature.

TITLE: AUTOMATIC TEMPERATURE BASED FAN SPEED CONTROLLER USING ARDUINO
AUTHOR: Shivshankar Adsule1 , Shivani Mohite2 , Rahul Patil3 , Prof. Namrata R. Dhawas4

ABSTRACT:
This project is a independent automatic fan speed controller that controls the speed of an electric fan according to the requirement by using electronic circuit consists of an Arduino board. Use of embedded technology makes this closed-loop feedback-control system efficient and reliable. Arduino board is very progressive among all controller circuits, thus we employed Arduino board for fan speed control. The proposed framework is intended to determine the temperature of the room and send that data to the Arduino board. At that point the Arduino board executes the difference of current temperature and set temperature dependent on the inbuilt program of the Arduino.
TITLE: AUTOMATIC LIGHT SWITCHING AND TEMPERATURE BASED FAN SPEED CONTROL USING MICROWAVE, TEMPERATURE AND LDR SENSOR
AUTHOR: Siddharth Remane, Radhika Sutar, Pranav Joshi, Digambar Patil, Yogesh Naik

ABSTRACT:
Since energy is the driving force for necessities, ease and comfort the use of energy has tapered and hence most of the times we tend to disgrace its use, hence the following paper will discuss and emphasize a method for automatic switching of lighting system and temperature apparatus, by checking for the intensity of sunlight, detecting human presence and controlling fan speed depending on the temperature of the room. Our design can be categorized into human detection circuit using Microwave sensor (RCWL0516), LDR based light detection circuit to detect the sunlight and temperature sensor (DS18B20) based speed control of fans along with its switching circuits. There will be two modules associated, first will be a combination of Microwave sensor and LDR for lighting fixtures and the second module will be a combination of Microwave sensor and a temperature sensor for fans. The basic idea behind this project is to conserve the amount of power which is otherwise wasted in case of absence of an entity or human behaviors. The system will restrict the turning ON/OFF of the lights utilizing sunlight entering the room and turning ON/OFF the fan automatically based on the temperature detected. The design gives the user its flexibility to choose the modes of operation either automated that is based on sensors or just the conventional switching.
TITLE: ARDUINO UNO-BASED ROOM TEMPERATURE SENSOR FOR AUTOMATIC FAN SPEED CONTROLLER
AUTHOR: Dr.M.Pandi Maharajan *1 , Dr.R.Ramkumar 2 ,Dr. T.Sangeetha 3 , Dr.P.Kannan

ABSTRACT:
This paper introduces an ARDUINO UNO-based automatic room temperature fan speed controller. The purpose of this presentation is to provide an overview of a standalone automatic fan speed controller that regulates fan speed in accordance with our needs. The LM35 temperature sensors are intended to be detected by this system, which then transforms the data into an electrical analogue signal that can be applied to the microcontroller. On the 16*2-line LCD, the temperatures sensed and set values are shown. The system is user-friendly because to the Liquid Crystal Display (LCD). On the LCD panel, the figures for the measured temperature and fan speed level are shown

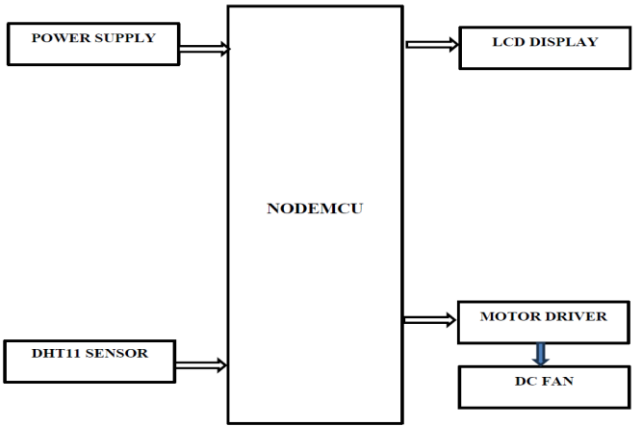
concurrently. The power supply for this project is regulated at 12V, 2A. It can be used for many different purposes, including as air conditioners, water heaters, incubators, snow-melters, heat exchangers, furnaces, and thermal pots. It is also highly compact and only requires a small number of components.

1.3 PROPOSED SYSTEM

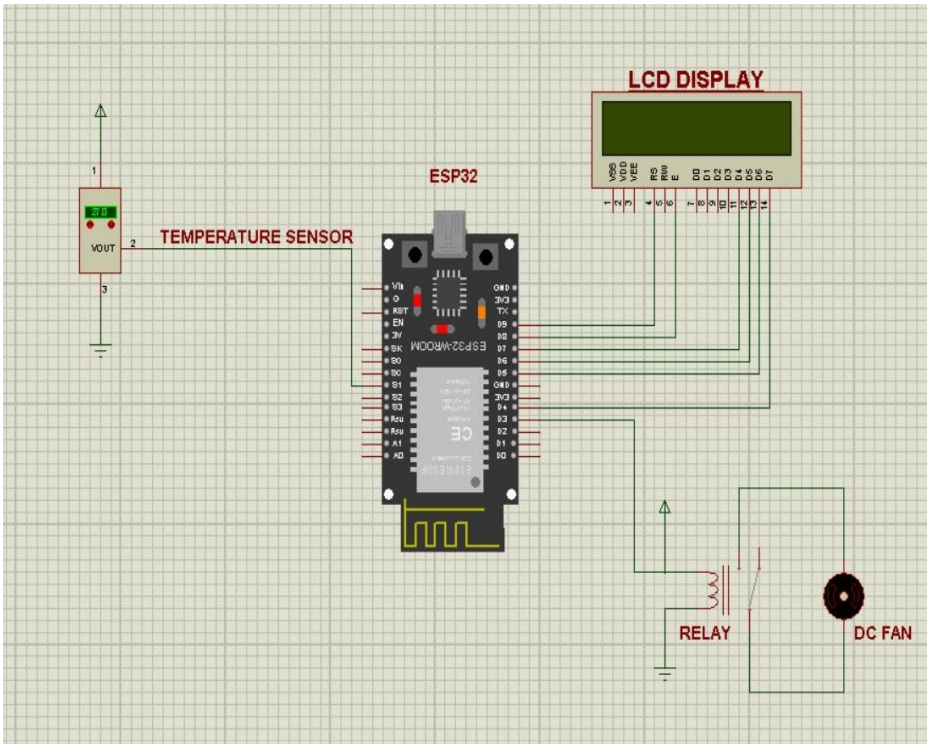
The main objective of the proposed battery monitoring and protective system includes the following aspects:

1. Monitor battery health: A battery temperature monitoring system aims to track the health and performance of the battery in real-time. It measures various battery parameters such as temperature, to ensure that the battery is operating within safe and optimal conditions.
2. Prevent damage: A battery protective system is designed to protect the battery from damage due to various factors such as overcharging, over-discharging, overheating, and short- circuiting. It triggers protective mechanisms when the battery parameters exceed certain thresholds to prevent any further damage.
3. Optimize battery performance: A battery monitoring system aims to optimize the charging and discharging of the battery to maximize its lifespan and efficiency. It ensures that the battery is charged only when necessary and discharges only when needed [5], [6].

BLOCK DIAGRAM



3.2 CIRCUIT DIAGRAM



3.3 WORKING PRINCIPLE

The block diagram of Proposed Battery Monitoring and Protection System is as shown in Fig. 1. The major components that facilitate the Battery Monitoring and Protective System are as discussed below:

The temperatureDHT11 are used to measure the temperature of the battery. The battery is connected in series with the sensors, these sensors are in turn connected in parallel with the data acquisition and battery monitoring system (LED display, Arduino, etc). The sensors are used to measure the current and voltage of the battery, and send values to the Arduino Uno for processing. Based on the instructions set, the calculated SoC is displayed on the LCD. The discharging process occurs when the battery supplies current to the DC motor, while the charging process occurs when the battery is connected to the charger.

The temperature sensor DHT11 is interfaced with nodemcu to fetch the data of temperature in the room. The data is processed if the temperature is high fan speed is more relatively if the temperature is low fan speed is low. Moreover if the temperature is below the threshold set then fan will be in off condition. The data related to temperature, fan speed is displayed on the LCD for user interaction. The fan speed is controlled relatively with the temperature using PWM pins available on the Arduino. As duty cycle of PWM signal increases the fan speed increases and the same is true conversely.

4. COMPONENTS USED

4.1 HARDWARE REQUIREMENTS

- NODEMCU
- Power supply
- Dht11 sensor
- Dc motor driver
- Dc fan
- LCD display

4.2 SOFTWARE REQUIREMENTS

- software = Arduino IDE
- language = embedded C.

4.1 NODEMCU

NodeMCU is an open-source firmware for which open-source prototyping board designs are available. The name "**NodeMCU**" combines "node" and "MCU" (micro-controller unit). The term "**NodeMCU**" strictly speaking refers to the firmware rather than the associated development kits. Both the firmware and prototyping board designs are open source. **Nodemcu ESP8266** and **Nodemcu ESP32** are becoming very popular and are almost used in more then 50% IoT based projects today.

The firmware uses the Lua scripting language. The firmware is based on the eLua project and built on the **Espressif Non-OS SDK for ESP8266**. It uses many open source projects, such as lua-cjson and SPIFFS. Due to resource constraints, users need to select the modules relevant for their project and build a firmware tailored to their needs. Support for the 32-bit **ESP32** has also been implemented.

The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards. The design was initially was based on the ESP-12 module of the ESP8266, which is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applications.

PROGRAMMING NODEMCU ESP8266 WITH ARDUINO IDE

The NodeMCU Development Board can be easily programmed with Arduino IDE since it is easy to use. Programming NodeMCU with the Arduino IDE will hardly take 5-10 minutes. All you need is the Arduino IDE, a USB cable and the NodeMCU board itself. You can check this Getting Started Tutorial for NodeMCU to prepare your Arduino IDE for NodeMCU.

UPLOADING YOUR FIRST PROGRAM

Once Arduino IDE is installed on the computer, connect the board with the computer using the USB cable. Now open the Arduino IDE and choose the correct board by selecting Tools>Boards>NodeMCU1.0 (ESP-12E Module), and choose the correct Port by selecting Tools>Port. To get it started with the NodeMCU board and blink the built-in LED, load the example code by selecting Files>Examples>Basics>Blink. Once the example code is loaded into your IDE, click on the 'upload' button given on the top bar. Once the upload is finished, you should see the built-in LED of the board blinking.

NodeMCU ESP8266 Specifications & Features

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106
- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1
- UARTs: 1
- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz
- USB-TTL based on CP2102 is included onboard, Enabling Plug n Play
- PCB Antenna
- Small Sized module to fit smartly inside your IoT projects

Applications

- Prototyping of IoT devices
- Low power battery operated applications
- Network projects
- Projects requiring multiple I/O interfaces with Wi-Fi and Bluetooth functionalities

(xiii) ARDUINO IDE

The Integrated Development Environment (IDE)is a combination of editor, linker and a compiler which helps the developer to make their Firmware for their Innovative Projects. Arduino IDE play a major role in open source platform for fast prototyping and easy to access of library. It is user friendly tool for beginners and it supports programming language like embedded C, Luna etc. Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. Its supports all the variant of Arduino boards like Arduino Uno, Nano and Mega etc. As soon as it reaches a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments

(xiv) ARDUINO IDE SOFTWARE

With this Arduino Integrated Development Environment you can edit, compile and upload Arduino sketches to the Arduino boards.

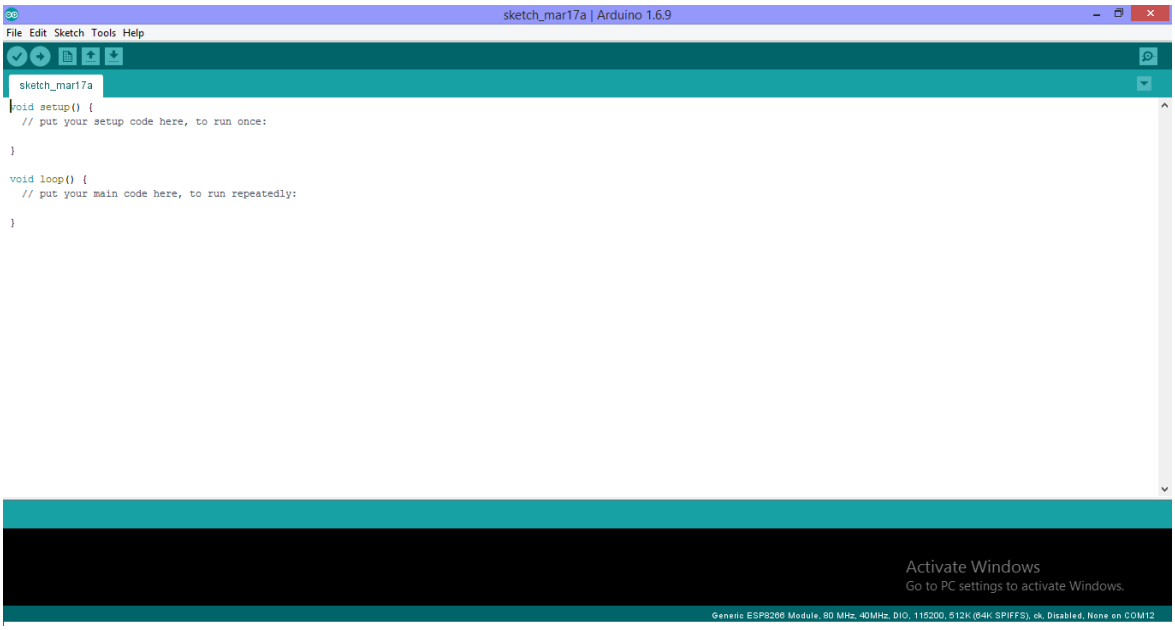
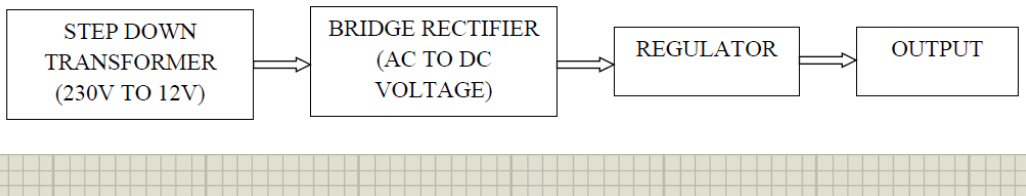


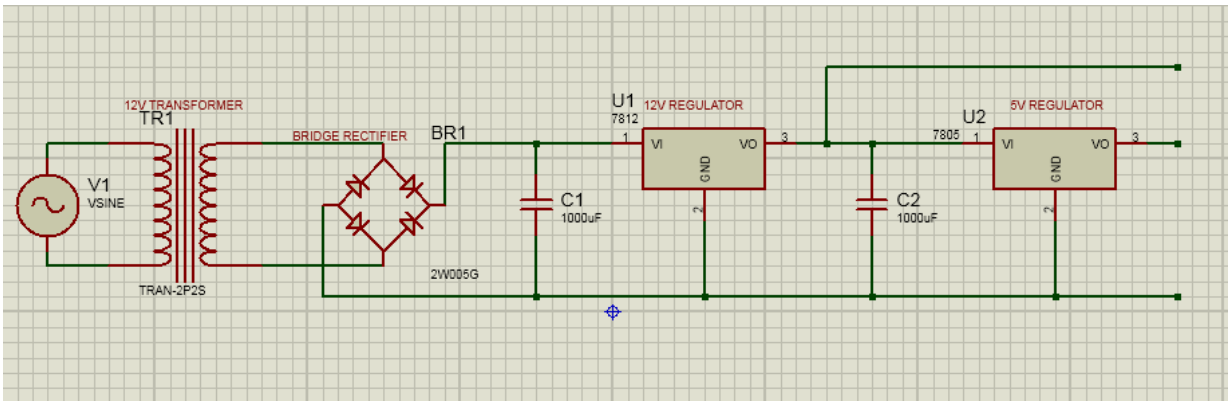
Fig.2.8 Arduino IDE software

4.2 POWER SUPPLY:

This is a simple approach to obtain a 12V and 5V DC power supply using a single circuit. The circuit uses two ICs 7812 and 7805 for obtaining the required voltages. The AC mains voltage will be stepped down by the transformer, rectified by bridge and filtered by capacitor to obtain a steady DC level .The 7812 regulates this voltage to obtain a steady 12V DC. The output of the IC1 will be regulated by the 7805 to obtain a steady 5V DC at its output. In this way both 12V and 5V DC are obtained.

BLOCK DIAGRAM





Circuit diagram

Initially small step down transformer is used to reduce the voltage level 230V AC into 12V AC. The output of the transformer is a pulsating sinusoidal AC voltage, which is converted to pulsating DC with the help of a rectifier. This output is given to a filter circuit which reduces the AC ripples, and passes the DC components. 7812 regulator is used to converts 12V DC study voltage. And 7805 regulator is converts constant 5V DC voltage.

DHT11 SENSOR

This DHT11 Temperature and Humidity Sensor features a calibrated digital signal output with the temperature and humidity sensor capability. It is integrated with a high-performance 8-bit microcontroller. Its technology ensures the high reliability and excellent long-term stability. This sensor includes a resistive element and a sensor for wet NTC temperature measuring devices. It has excellent quality, fast response, anti-interference ability and high performance.

Each DHT11 sensors features extremely accurate calibration of humidity calibration chamber. The calibration coefficients stored in the OTP program memory, internal sensors detect signals in the process, we should call these calibration coefficients. The single-wire serial interface system is integrated to become quick and easy. Small size, low power, signal transmission distance up to 20 meters, enabling a variety of applications and even the most demanding ones. The product is 4-pin single row pin package. Convenient connection, special packages can be provided according to users need.

The DHT11 sensor provides the current temperature is humidity readings. The DHT11 gives out analog output and is connected to the analog input of the Arduino micro-controller A0. The dht11 sensor has 3 pins. Along with temperature and humidity the other values that are calculated or derived from the dht11 sensor is the dew point, heat index etc. The dew point is the temperature at which air in the atmosphere freezes to become water droplets and the heat index is the heat felt by the human skin from the environment. This is important in places with high humidity. Even though the temperature maybe lowers, the body still feels warm. This is due to the high humidity in the air. Humidity is the moisture content in the air. High humidity in the air generally makes one to sweat or perspire.

DHT11 SPECIFICATIONS:

- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA (measuring) 60uA (standby)
- Output: Serial data
- Temperature Range: 0°C to 50°C
- Humidity Range: 20% to 90%
- Resolution: Temperature and Humidity both are 16-bit
- Accuracy: ±1°C and ±1%

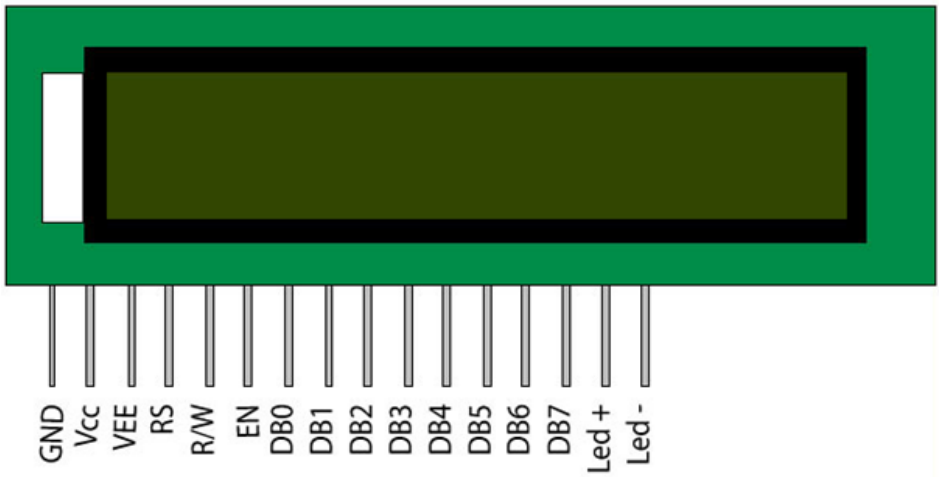
APPLICATIONS:

- Measure temperature and humidity
- Local Weather station
- Automatic climate control
- Environment monitoring

4.4 LCD DISPLAY

There are many display devices used by the hobbyists. LCD displays are one of the most sophisticated display devices used by them. Once you learn how to interface it, it will be the easiest and very reliable output device used by you! More, for micro controller based project, not every time any debugger can be used. So LCD displays can be used to test the outputs.

PIN DIAGRAM



LCD accepts two types of signals, one is data, and another is control. These signals are recognized by the LCD module from status of the RS pin. Now data can be read also from the LCD display, by pulling the R/W pin high. As soon as the E pin is pulsed, LCD display reads data at the falling edge of the pulse and executes it, same for the case of transmission. LCD display takes a time of 39-43µS to place a character or execute a command. Except for clearing display and to seek cursor to home position it takes 1.53ms to 1.64ms. Any attempt to send any data before this interval may lead to failure to read data or execution of the current data in some devices. Some devices compensate the speed by storing the incoming data to some temporary registers.

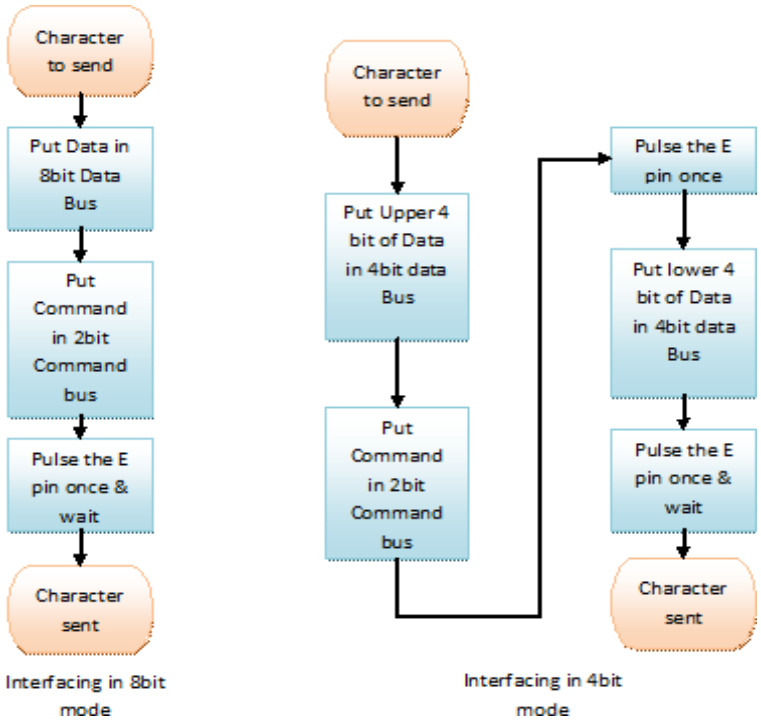
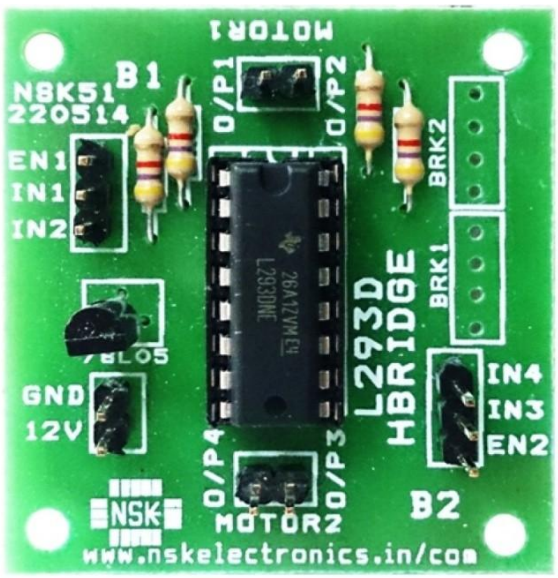


Fig.2.14 Flow chart of interfacing LCD display

LCD displays have two RAMs, naming DDRAM and CGRAM. DDRAM registers in which position which character in the ASCII chart would be displayed.

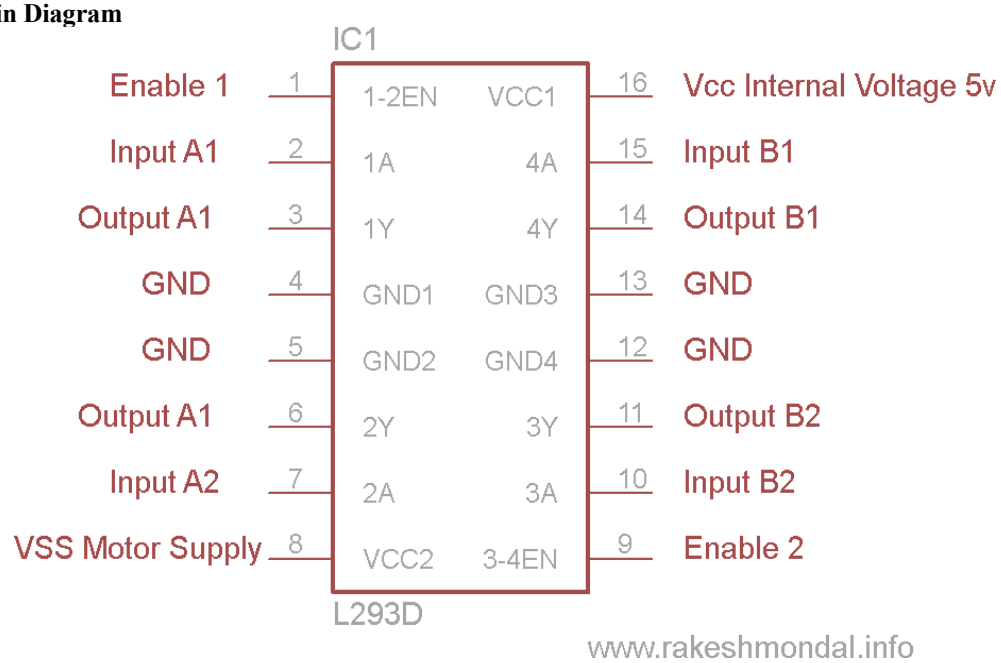
Each byte of DDRAM represents each unique position on the LCD display. The LCD controller reads the information from the DDRAM and displays it on the LCD screen. CGRAM allows user to define their custom characters. For that purpose, address space for first 16 ASCII characters are reserved for users. After CGRAM has been setup to display characters, user can easily display their custom characters on the LCD screen.

MOTOR DRIVE



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. It works on the concept of H-bridge. H-bridge is a circuit which allows the voltage to be flown in either direction. As you know voltage need to change its direction for being able to rotate the motor in clockwise or anticlockwise direction, Hence H-bridge IC are ideal for driving a DC motor. In a single L293D chip there are two h-Bridge circuit inside the IC which can rotate two dc motor independently. Due its size it is very much used in robotic application for controlling DC motors. Given below is the pin diagram of a L293D motor controller. There are two Enable pins on l293d. Pin 1 and pin 9, for being able to drive the motor, the pin 1 and 9 need to be high. For driving the motor with left H-bridge you need to enable pin 1 to high. And for right H-Bridge you need to make the pin 9 to high. If anyone of the either pin1 or pin9 goes low then the motor in the corresponding section will suspend working. It's like a switch.

L293D Pin Diagram



Working of L293D

There are 4 input pins for l293d, pin 2,7 on the left and pin 15 ,10 on the right as shown on the pin diagram. Left input pins will regulate the rotation of motor connected across left side and right input for motor on the right

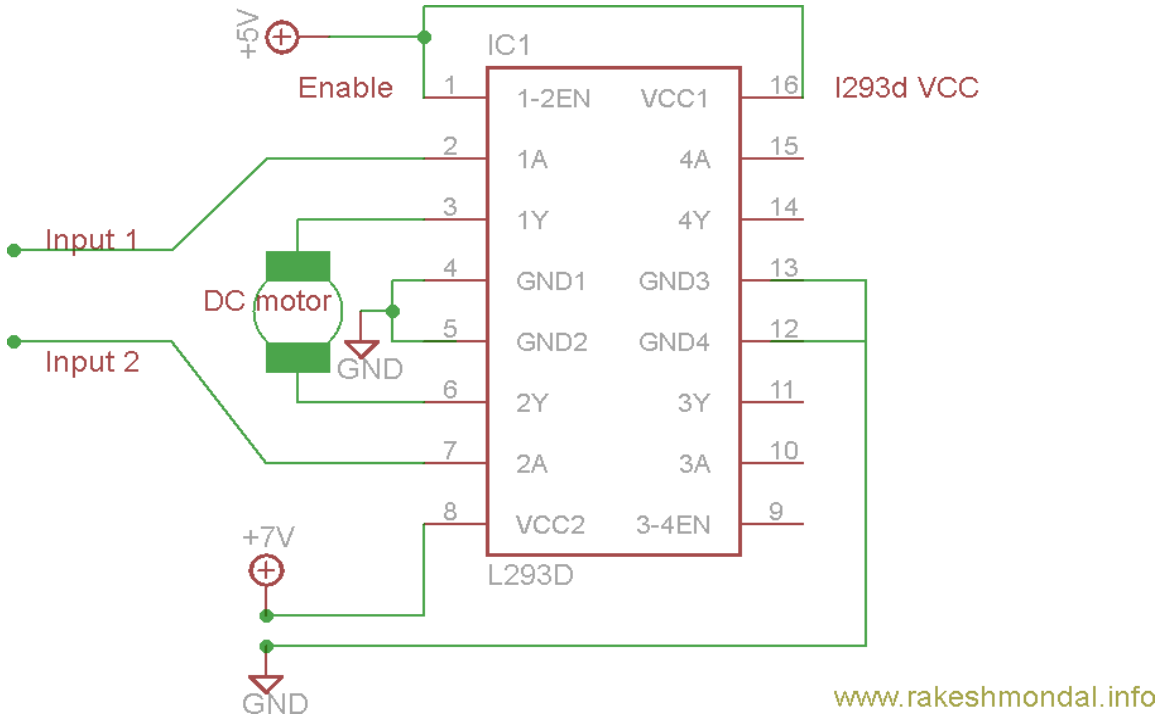
hand side. The motors are rotated on the basis of the inputs provided across the input pins as LOGIC 0 or LOGIC 1.
In simple you need to provide Logic 0 or 1 across the input pins for rotating the motor.

L293D Logic Table.

Lets consider a Motor connected on left side output pins (pin 3,6). For rotating the motor in clockwise direction the input pins has to be provided with Logic 1 and Logic 0.

- **Pin 2** = **Logic 1** and **Pin 7** = **Logic 0** | Clockwise Direction
- **Pin 2** = **Logic 0** and **Pin 7** = **Logic 1** | Anticlockwise Direction
- **Pin 2** = **Logic 0** and **Pin 7** = **Logic 0** | Idle [No rotation] [Hi-Impedance state]
- **Pin 2** = **Logic 1** and **Pin 7** = **Logic 1** | Idle [No rotation]

In a very similar way the motor can also operate across input pin 15,10 for motor on the right hand side.



Voltage Specification
VCC is the voltage that it needs for its own internal operation 5v; L293D will not use this voltage for driving the motor. For driving the motors it has a separate provision to provide motor supply VSS (V supply). L293d will use this to drive the motor. It means if you want to operate a motor at 9V then you need to provide a Supply of 9V across VSS Motor supply.
The maximum voltage for VSS motor supply is 36V. It can supply a max current of 600mA per channel.Since it can drive motors Up to 36v hence you can drive pretty big motors with this l293d VCC pin 16 is the voltage for its own internal Operation. The maximum voltage ranges from 5v and upto 36v.

12V DC FAN
When a 12 volt direct current (DC) supply is used as input, a fan will operate. By using the temperature as an input and controlling the fan's efficiency as an output, the dht11 temperature sensor regulates the fan's speed. This 12V DC fan has rotor or impeller and blades, just as other varieties of conventional model fans.

III. RESULT

The design and building of a fan speed control system to regulate room temperature are explained in this paper. To gauge the temperature of the room, a temperature sensor was carefully selected. Additionally, the Arduino was effectively coded using C/C++ Language to compare temperature and standard temperature, set fan

speed, and display their attributes on LCD. The microcontroller had been used to regulate the fan speed using the fan speed in rpm. A temperature-controlled fan is implemented using Arduino. Thus, the fan speed in this instance has been managed by an Arduino board in accordance with the temperature detected with the aid of a temperature and humidity sensor. The project's goal is automatic temperature adjustment of the fan. Additionally, if the room temperature rises, the fan speed will follow suit. In conclusion, the technology that is now being created for programmed control works fairly well for any temperature change. Future versions of the suggested system could incorporate cloud-based predictive analytics and IoET [13].

Kit image

The above figure 6 depicts the hardware implementation of the proposed concept. The motor at present is running at maximum speed as the temperature is high.

IV. CONCLUSION & FUTURE SCOPES

nodemcu based battery temperature monitoring and controlled system implemented. Thus, here fan speed has been controlled by using Pulse Width Modulation and nodemcu board according to the temperature sensed by the help of Temperature and Humidity Sensor (DHT11). The idea of the project is to change the fan temperature automatically. PWM technique is found to be the best technique for controlling the fan speed using the sensed temperature. The system is working properly. The speed of fan depends on the temperature and there is no need for regulating the fan speed manually again and again.

V. PROGRAM

```
#include "ThingSpeak.h" #include "DHT.h"
#include <ESP8266WiFi.h> #include <Wire.h>

#include <LiquidCrystal.h>
const int RS = D0, EN = D1, d4 = D2, d5 = D5, d6 = D6, d7 = D7;
LiquidCrystal lcd(RS, EN, d4, d5, d6, d7);\


#define DHTPIN D3 #define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);

int relay = 10; void setup() {


pinMode(relay,OUTPUT); lcd.begin(16, 2); lcd.setCursor(0,0);
lcd.print("BATTERY MONITORING");

lcd.setCursor(0,1); lcd.print("      SYSTEM           "); delay(5000);
lcd.clear();
dht.begin();
}
void loop() {
float h = dht.readHumidity(); float t = dht.readTemperature(); if (isnan(h) || isnan(t))
{
Serial.println("Failed to read from DHT sensor!"); return;
}
lcd.setCursor(0, 0); lcd.print("TEMP = "); lcd.setCursor(6, 0); lcd.print(t); lcd.setCursor(0, 1);
lcd.print("HUMIDITY = "); lcd.setCursor(11, 1); lcd.print(h);
delay(1000); lcd.clear(); if(t>35)

{


digitalWrite(relay,HIGH); lcd.setCursor(0,0); lcd.print("TEMPERATURE HIGH");
lcd.setCursor(0,1); lcd.print("FAN ON"); delay(10000); lcd.clear();
}
```

```
digitalWrite(relay,LOW);
}
```

8 OUTPUT IMAGES

REFERENCE

[1] National Power and Energy Conference (PECon) 2004 Procedures, Kuala Lumpur, Malaysia 121Speed Drive of Single-stage Induction Motor, Hamad S. H; S. M. Bashi, I. Aris and N. F. Marlah.

[2] Global Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 2, Issue 7, July 2013, Copyright to IJAREEIE www.ijareeie.com 3470Design, Modeling and Simulation of a Microcontroller Based Temperature Control in a Ventilation System, K.A Akpado1, C.O Ezeagwu2, A. Ejiofor3, A.O N wokeke.

[3] Investigation of Single-Phase SPWM Inverter; A Thesis Sub-mitted In incomplete fulfillment of the requirements for the level of Bachelor in Electrical Engineering By Bijoyprakash Majhi Under the supervision of Prof. Somnath Maity.

[4] Global Journal of Innovative Research in Science, Building and Technology Vol. 4, Issue 7, July 2015 Copyright to IJIRSET .Design and Fabrication of Temperature based DC Fan Speed Control System utilizing Microcontroller and Pulse Width Modulation Technique Surabhi1, Upendra Prasad2 , Vivek Kumar Jain3.

[5] Sixth Int'l Conference on Electrical, Electronics and Civil Building (ICEECE'2014) Nov. 27-28, 2014 Cape Town (South Africa) Automatic Fan Speed Control System Using Microcontroller Mustafa Saad, Hossam Abdoalgader, and Muammer Mohamed.