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Automatic Battery Health Analysis and Monitoring using with Arudino Controller to Check on IoT

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Abstract - Battery management system (BMS) forms a crucial system component in various applications like electric vehicles (EV), hybrid electric vehicles (HEV), uninterrupted power supplies (UPS), telecommunications and so on. The accuracy of these systems has always been a point of discussion as they generally give an error of maximum 10% considering all the parameters together. Batteries are the heart of the automation system, and its applications are more in all the fields, where the electrical supply requires. The periodical monitoring/observations are required for battery source to provide continuous power to the load without any interruption. Our proposed system monitors and stores parameters that provide an indication of the lead acid battery's acid level, state of charge, voltage, current, and the remaining charge capacity in a real-time scenario. Wireless local area network is used as the backbone network. The information collect from all the associated battery clients in the system is analyzed. The malfunction of the battery status are continuously monitored based on sudden Charge & discharge voltage of battery bank and battery conditions are viewed in the cloud with help of IoT module.

Key Words: Battery Bank, Arduino ATMEGA 2560, Current sensor, Voltage Sensor, Temperature Sensor, IoT Modules, Relay.

1. INTRODUCTION

The growing understanding of global warm around the world, the demand for clean fuel/energy is on the rise and as a result there is a continuous shift towards the electric vehicles and hybrid electric vehicles. Battery performance is influenced by factors such as depth of discharge (DOD), temperature and charging algorithm. This paper attempts to provide a measurement of voltage and current level of the battery using internet of things. Lead-acid batteries are very effective at powering many different applications. They are easy to obtain, relatively inexpensive, and provide a lot of power to whatever they are hooked up to. Regrettably, if there is nil monitoring the charge, the battery will eventually run out of power. In addition to determine the charge of the battery, the current voltage of the battery is needed. By depending on the output voltage of the battery, the approximate charge of the battery can be estimated.

The battery's temperature, voltage, current and state of charge (SoC) are the most common parameters that are normally monitored. Monitoring the each battery in the battery bank ensures the battery system operating levels and conditions remains optimal. And the battery should provide a power without interrupting the device operations of the system in the absence of ac input power. In order to provide the power for the systems in the absence of ac input, the battery should be in good condition to provide the sufficient amount of power to the devices without interruption.

In order to know the condition of battery, it does require monitoring the each battery in the battery bank periodically in real time. The main goal of this system is to inform the users regarding the present status or condition of individual battery in the battery bank periodically and sends the alert information to authorized person through IoT module. To know the present status of battery some important parameters of the battery should be measure in regular interval. The important parameters are terminal voltage, load current, capacity, discharge current and room temperature of each battery.

2. LITERATURE SURVEY

Previous literatures 1, 2, 3, 4, 5 and research work done by scholars in this domain have reviewed. Difficulties that were faced by them are present here.

In this Paper, briefly discuss about estimation of SoC methods. We take an Adaptive system method, this methods are self designing and can automatically adjust the soc for different discharge condition [1].

In our System, we are using LM35 Temperature sensor. This sensor connecting with ATmega 2560 Microcontroller are used to control the abnormal temperature. A particular limit values are written in the controller and battery temperature values is monitored [2].

This Paper discuss about Charging/discharging method. It occurred problem has been solved with help of

Fuzzy logic control technique. This technique was told that four methodology based prediction on non healthy battery condition such as Fuzzifier, a knowledge base, a decision making, and a defuzzification [3].

In this paper, we propose an analysis of the parameters that affect battery characteristics during discharging to estimate the SoC of the lead-acid battery. Battery behavior and characteristics during discharge or charge depend on some internal parameters. In general battery modeling is divided into three major parts, name as electrochemical model, analytical/mathematical model, and electric circuit model [4].

In this paper discuss about IC engine ignition has used to lead acid battery. This operation battery was worried situation to control. CC, CV, SoC, Electrolyte capacity is predict to sensing method. We are take this how to detect current, Voltage, Temperature level. Each compound which type sensor used will predict unhealthy battery conditions [5].

3. SYSTEM ANALYSIS

The various literature studies that were done helped in developing a new technique for controlling and monitoring the battery health.

3.1. ISSUES IN THE EXISTING

[5] As a result of this, IC engine ignition has used lead acid battery. This concept has used in single battery for ignition process on IC engine so it's very small part of operation worked.

Mainly batteries are monitoring on individual so it not sense (such as current, voltage, temperature) in operating time. It's mainly drawback of the monitoring system.

3.2. PROPOSED SYSTEM

This paper is clearly described on drawback of the monitoring (voltages) in not operating time. Due to battery bank has connected in series but this issue was minimized to analysis the voltage, current, and temperatures. An efficient energy-management system for Lead Acid Battery, using IoT and Arduino/ATMEGA 2560 is develop.

The system uses an ACS712 sensor to detect current and voltage in the circuit while LM35 Thermistor is used to detect the temperature. The LM35 is a temperature sensor which gives voltages which are proportional to the temperature in degree centigrade. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin. The data output from these sensors is stored and manipulated through Arduino (microcontroller). The State of charge (SOC) of the battery is the index which shows the amount of charge present in the battery. The SOC depends upon various parameters, such as current, voltage, temperature and pressure. In our system, the temperature, current and voltage are considered for determining the SOC.

4. SYSTEM DESCRIPTION

The proposed system is described with the help of an architecture diagram and its module description.

4.1. BLOCK DIAGRAM

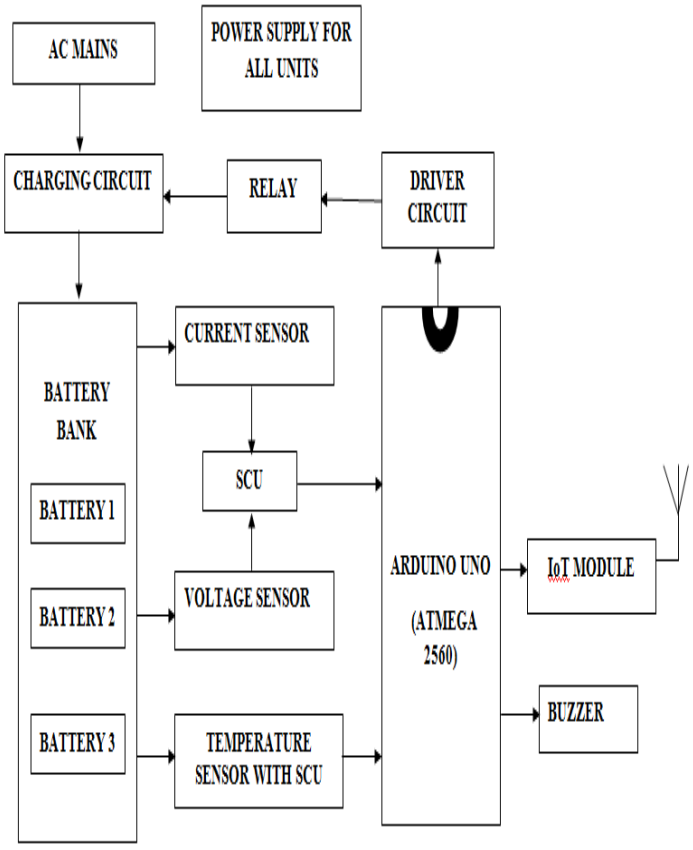

Fig -1: The Block diagram for automatic battery health analysis

A. ATMEGA 2560 (MICRO CONTROLLER)

Arduino is an open-source physical computing platform based on a simple i/o board and a development environment that implements the Processing/ Wiring language. Arduino can be used to develop stand-alone interactive objects or can be connected to software on your computer (e.g. Flash, Processing, MaxMSP). The open-source IDE can be downloaded for free (currently for Mac OS X, Windows, and Linux).

The Arduino Mega is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, 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 or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

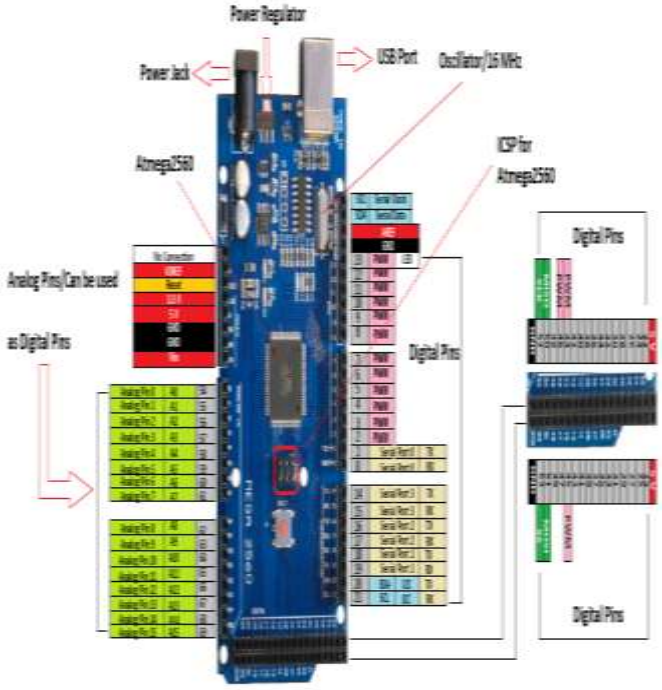

Fig -2: Arudino ATmega 2560 controller board

B. BATTERY

A lead-acid battery is an electrical storage device that uses a reversible chemical reaction to store energy. It uses a combination of lead plates or grids and an electrolyte consisting of a diluted sulphuric acid to convert electrical energy into potential chemical energy and back again. The electrolyte of lead-acid batteries is hazardous to your health and may produce burns and other permanent damage if you come into contact with it.

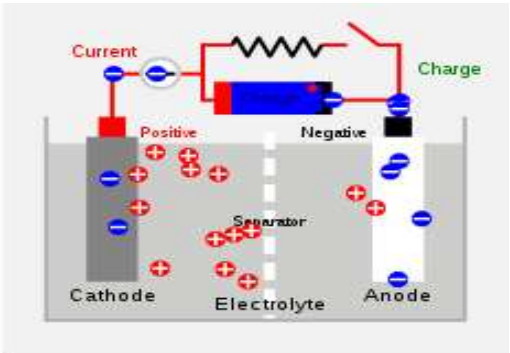

Fig -3: Lead-acid Battery

C. CURRENT SENSOR

Current sensor will be used to measure the load current and will convert this current to certain voltage level and feed that to input of Arduino. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer.

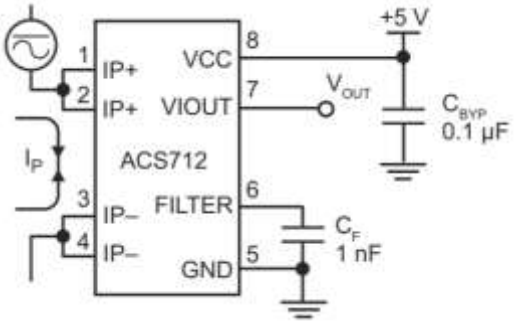

Fig -4: Functional Block diagram for Current Sensor

D. VOLTAGE SENSOR

The voltage divider rule is used to solve circuits to simplify the solution. Applying this rule can also solve simple circuits thoroughly the main concept of this voltage divider rule is **The voltage is divided between two resistors which are connected in series in direct proportion to their resistance.** Voltage divider involves of two important parts they are the circuit and the equation.

VOLTAGE DIVIDER EQUATION

The voltage divider rule equation accepts when you know the three values in the above circuit they are input voltage and the two resistor values. By using the following equation, we can find the output voltage.

$V_{out}=V_{in}. R_2/R_1+R_2$

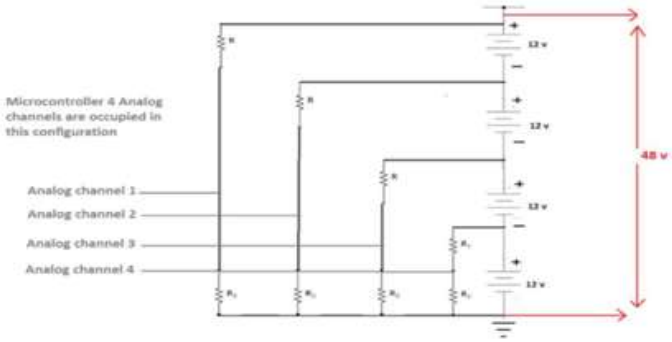

Fig -5: voltage divider method to sense the voltages

Batteries are connected in series, voltages not sense in individual battery. So we were taken common current in the battery bank. First battery sense the voltage (v1) and second battery voltage sense on add with (v1+v2) , similarly

go on another batteries. Finally arithmetic logic programming method to used determine v1, v2, v3,..... voltage values.

E. TEMPERATURE

LM35 Temperature Sensor The LM35 series are precision integrated-circuit LM35 temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The temperature is placed in surface of the skin. The temperature output is given to the RA0 pin. The LM35 sensor thus has an advantage over linear temperature sensors calibrated in ° Kelvin.

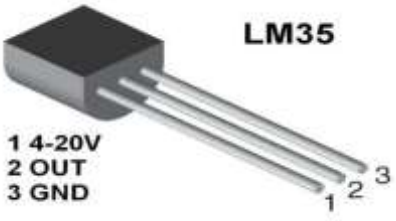

Fig -6: LM35 Temperature sensor

F. RELAY

A **relay** is an electrically activated switch. It consists of an internal coil which creates a magnetic field that attracts a movable lever and then changes switch contacts when a current flows through it.

The main operation of a **relay** comes in places where only a low-power signal can be **used** to control a circuit. It is also **used** in places where only one signal can be **used** to control a lot of circuits.

G. IOT MODULE

The *Internet of things* (IoT) is the network of everyday objects — physical things embedded with electronics, software, sensors, and connectivity enabling data exchange.

Node MCU is an open source IoT platform.It includes firmware which runs on the ESP8266 wi-Fi SoC from Espressif System, and hardware which is based on the ESP-12 module. The IoT module is powered by the 5V.

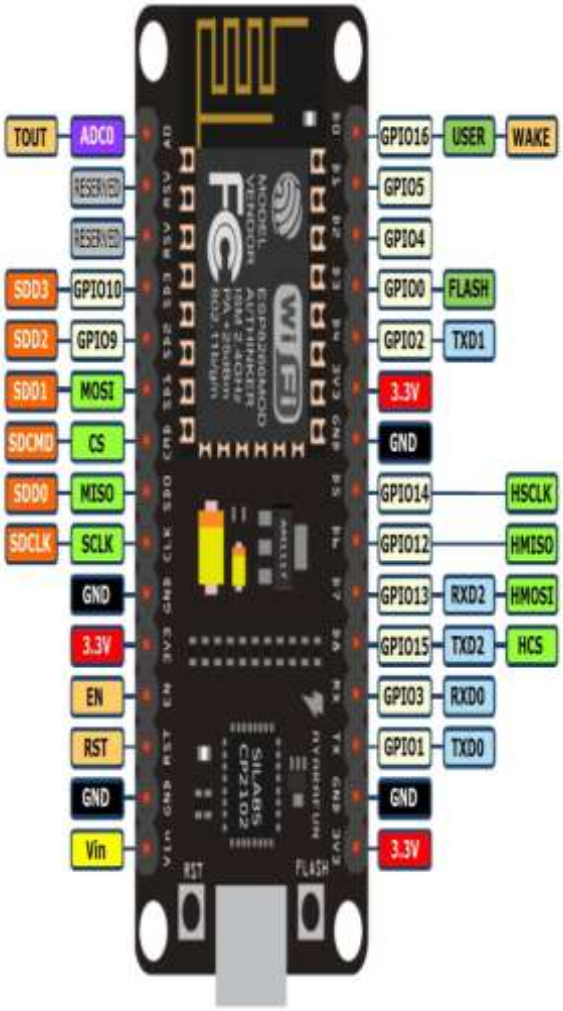

Fig -7: ESP8266 – 12E NODE MCU

4.2 CIRCUIT DIAGRAM

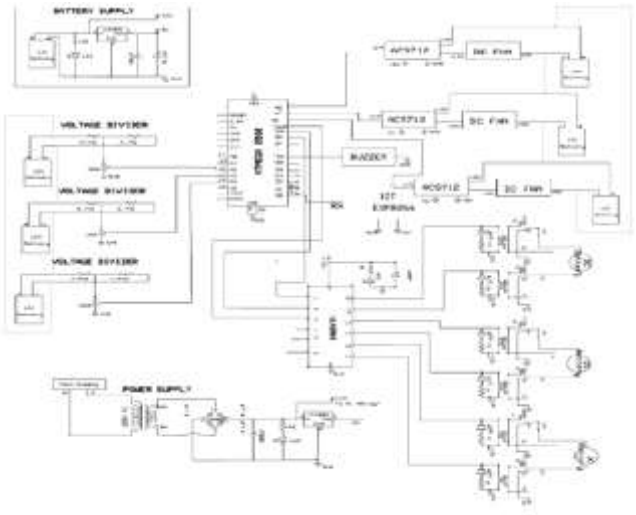

Fig -8: Circuit diagram in Automatic battery health analysis and monitoring system

5. EXPRIMENTAL RESULT AND DISCUSS

The experimental results for good battery and battery may lead to fail are shown in figure. This tells present status of each battery and displays the battery parameters. By using these results the user can know the present condition of battery and if the battery which may lead to fail tells the user that he/she has to remove that battery n the bank and replace with good battery. That removed battery internal resistance has to check manually and by this way he/she can determine the battery operating Life.

5.1. SENDING DATA TO CLOUD

Internet of Things is a very fast growing technology. Integrating the battery management system with IoT enables us to view the data obtained from the batteries anywhere with the help of our Mobile phone or it can be saved in Cloud and retrieved anytime for analysis. This feature is enabled by using a ESP 8266 node MCU module, which will collect the data from the controller and display it in cloud via any of the available bearer services. The IoT module can be checked by sending the MQTT protocol to it. We have to provide the username, client ID, password of the website in which we need to post while configuring the ESP module.

Fig -9: Notification received on user mail or mobile to predict unhealthy battery

5.2. ADVANDAGE

- 24X7 Continuous monitoring
- State of Battery bank (Charging / Discharging / Idle)
- Visual and Audible alarms in case of any failure
- Complete Isolation from Battery Bank
- Battery / Cell failure is easily identified in standalone Battery bank

6. HARDWARE IMPLEMENTATION

Batteries are connected in series voltage, current, temperature sense parallel. These values are through controller on ATmega 2560 to convert ADC and monitoring on through IoT Modules (NODEMCU-12E) has presented below the Fig -10.

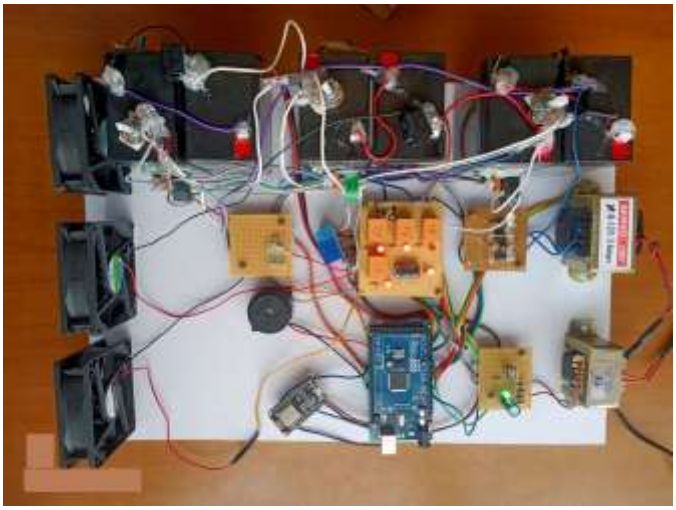

Fig -10: Hardware implementation on Automatic battery health Analysis and monitoring

7. CONCULSION

Thus, the batteries are connected in series connection and monitor the battery level using current sensor, temperature sensor and voltage sensor and also measuring sudden charging and discharging of the battery bank. When the battery level is getting low and charging circuit will be triggered automatically as well as send information to the particular person using internet of things.

APPLICATIONS

- Automotive industry
- Household application
- Industrial application

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