Ramya. 2019, 7:2
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

International Journal of Science, Engineering and Technology
An Open Access Journal

Embedded Based Estimation of State of Charge of Battery

[1]C. Premkumar, [2] E. Ramya

Abstract

Batteries are employed as the source of power in many devices and instruments. In case of supplying DC voltage, batteries are used since DC can be stored in battery. Moreover it is used in portable devices and employed in EV (electric vehicles). Nowadays, the automobiles use the battery as the source of energy. But the charge of the battery will discharge when it is used or it may get self discharge due to certain problem in it. It is essential to know the battery state at any time, so that the device works properly and efficiently. This is termed as "state of charge" referred as SoC. The health of the battery cannot be found by seeing it physically. So it is necessary to develop a method to find it. Herewith, a method is being proposed to determine the SoC of a battery by measuring the battery voltage using the microcontroller by adopting voltage division technique.

Keywords: Batteries, State of Charge, microcontroller

Introduction

It is often necessary to determine the state of charge of a battery, so that the device which is operated works without any discontinuation and check whether it works efficient. Since the battery property varies over a certain period it is necessary to monitor the battery regularly. Several researchers have proposed various mathematical models to find the SOC of the battery. But in practical it is not possible to determine the SOC of the battery accurately.

The automobile industries are recently developed a lot over a century. These industries are recently adapting electrical vehicles (EV) instead of the automobiles which run on fossil fuel. The reason for this may be the emission of harmful effluents which result in global warming. Hence the industries are interested towards the electrical vehicles. Nowadays, the electrical vehicles and hybrid electric vehicles are popular and use batteries as their power source. So it is crucial to know about the state of charge of the battery used in these vehicles.

There are many factors which make the determination of the SOC difficult. The battery may be affected by self discharge, temperature effects, aging, etc.

Since the battery output is affected by enormous factors such as temperature, humidity and loading effects, there is no accurate method for determining the state of charge of the batteries either it is rechargeable or not. However, the state of the battery can be determined by finding its maximum capacity by testing it.

State Of Charge (SoC)

State of charge is defined as the current capacity of the battery over any period of time with reference to the maximum rated capacity when it is was manufactured. It is usually expressed in percentage.

It usually provides the information about certain parameters such as maximum voltage of the battery, present battery voltage, discharge rate, maximum rechargeable level, etc. Thus the state of charge helps in monitoring the battery anytime.

Problem Statement

The output of the battery is affected by enormous factors such as temperature, ageing process, self-discharging property, etc. This varying property of the battery makes the estimation SOC of it difficult. However it is not possible to determine the state of battery just by looking it physically. Moreover it is difficult to analyze a battery which is under

operation or connected to some external source. The hybrid vehicles employ regenerative braking by which the vehicle switches to generator mode. By this process the battery is charged when brake is applied. Thus it is important to monitor the state of battery.

Objective

The main objective of the project is to design a prototype to determine the State of Charge of the battery using Arduino. The percentage of the SoC can be viewed in the hardware and also in the software. This setup provides warning to the user before the charge of the battery gets completely drained.

Proposed Methodology

The methods available to determine the SoC of the battery were experimental and it is difficult to do. Moreover they were not accurate; hence the state of battery can be determined by implementing a voltage divider circuit. The maximum capacity of the battery it could provide when a load is connected to it should be known.

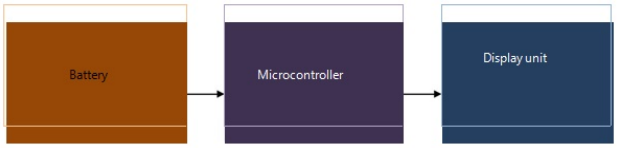


Fig 1: Block diagram

The output voltage of the voltage divider circuit is given to the microcontroller which performs the mathematical calculations and finally displays the SoC of battery in percentage. The order in which the process is done is shown in figure 1. Arduino software is used for programming the micro controller, so that it performs the mathematical calculations as mentioned in the program.

Working Principle

The battery's present voltage must be found so that the state of the battery could be found. For this process the voltage division technique is employed. The circuit consists of two resistors connected in series. The positive terminal of the battery is given to one end of the resistor, while the other end of the second resistor is connected to ground. The connection of voltage division technique is shown in figure 2.

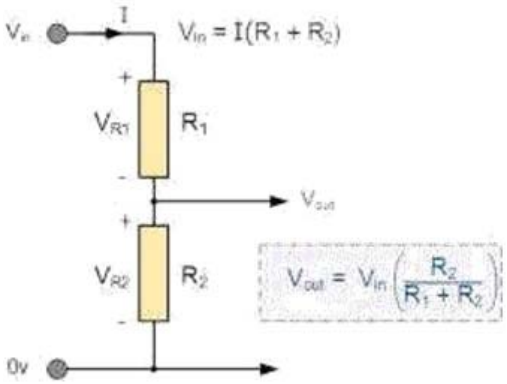


Fig 2: Voltage divider circuit

The voltage drop across the resister 2 is directly proportional to the input voltage. Hence by knowing this value, the input voltage can be determined.

Circuit Diagram

The battery to be tested is connected as the source voltage for the voltage divider circuit. Now the voltage drop across resistor 2 is given to the analog pin of arduino. The connection between the arduino and LCD module is quit complex as shown in figure 3.3. The pin vdd is given positive supply through the 10 k potentiometer, pin Vee is connected to the wiper of the potentiometer, pin Rs is given to 8 pin of arduino, pin Rw is connected to ground, pin E connected to the 9 th pin. Pins D4 to D9 connected the digital pins of arduino. After the connections are made the pot resistance value is varied until the value is displayed in LCD. And the LCD displays the SoC in terms of Percentage and the input voltage of the battery.

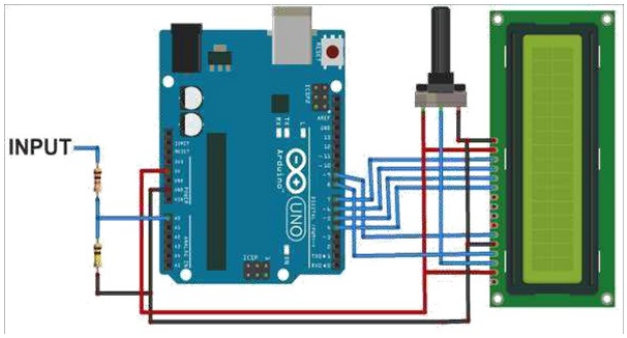


Figure 3: Circuit diagram

Flow Of Working

The battery to be tested is used as the source for a voltage divider circuit. This circuit consists of two resisters connected in series. The battery positive terminal is connected to one end of the resister,

while the negative terminal is connected to other end of the 10KΩ resistor. Thus certain amount of voltage is dropped across the 10KΩ resistor; this voltage is directly proportional to the input voltage from the battery. Hence by knowing the voltage drop across it, the input battery voltage can be calculated directly from the formula as follows

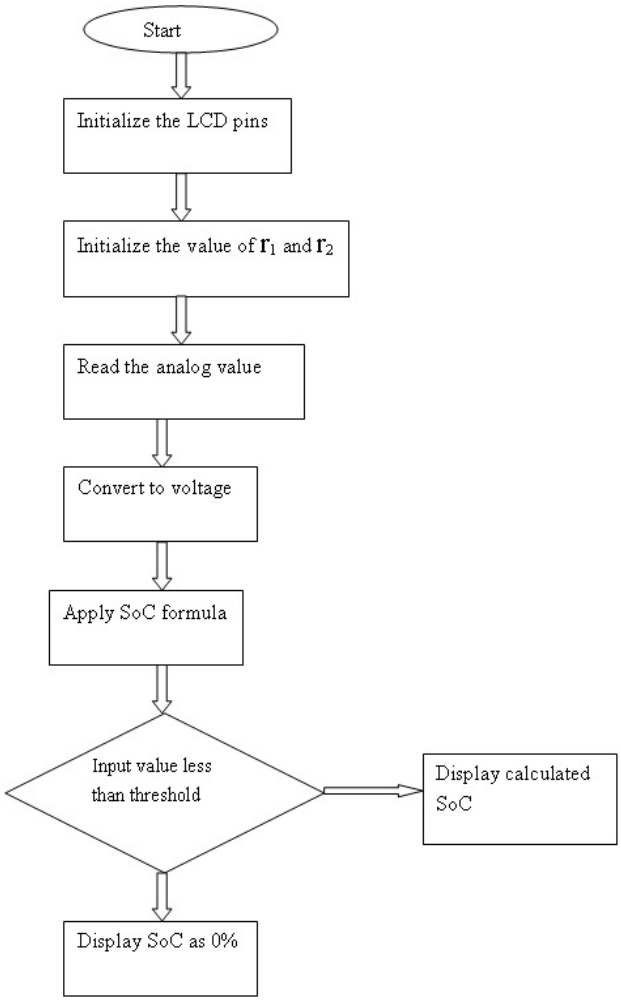
$V_{out}=V_{in}(r_2/(r_1+r_2))$ (1)

The V_{out} is the voltage drop across the resister 2 and is given as the input analog signal to the microcontroller. Thus the battery voltage is found and displayed in the LCD. The SoC is expressed in percentage. Hence it calculated as,

SoC = (input volt * 100.0) / 5.0 (2)

Where, 5 is the maximum rated voltage of the battery. This value may be varied according to battery capacity.

Flowchart



The voltage of the battery is found by mathematical calculations, which is made in arduino programming. Initially the resistor value is included and then the LCD pins are initialized. Now the analog value is converted to voltage then it is substituted in the voltage division formula. Thus the input battery voltage is found.

Result and Discussion

The project proposed is quite accurate method of calculation of SOC. This method is also known as the voltage method, in which the SOC is calculated indirectly by voltage value rather than calculating from the value of current.

Even though the battery output is affected by environment factors, the proposed method provides the real value of battery at any cause. The SOC of battery is displayed in percentage as shown in figure below.

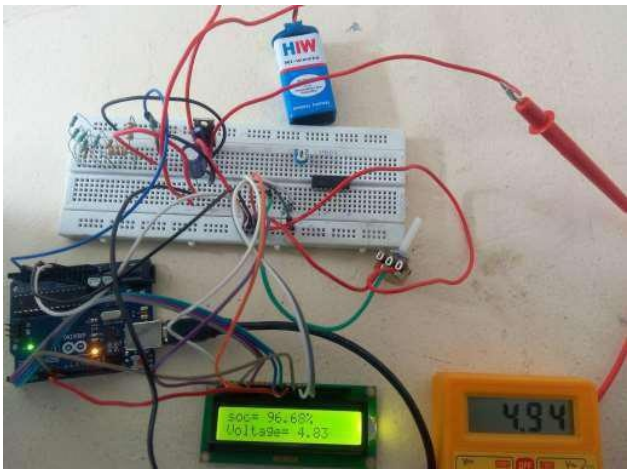


Fig 4: Hardware setup

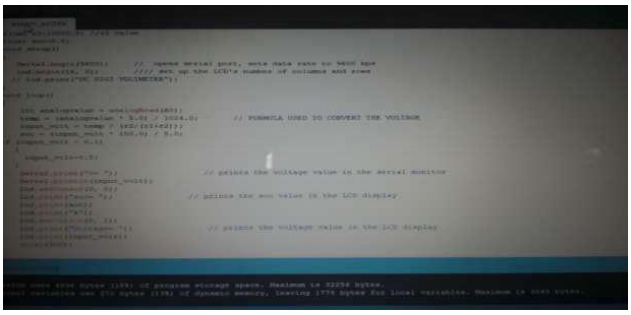


Fig 5: Program snapshot

Conclusion

✓ Prototype to determine the State of Charge of the battery using Arduino is designed successfully. The percentage of the SoC can be viewed in the

hardware and also in the software. This setup provides warning to the user before the charge of the battery gets completely drained. The total cost of this project is 1070 rupees, hence it is cost effective. The future scope of the project may include the effects of temperature and gives the corresponding response of the battery due to affecting factors.

References

[1] Liu, L.; Wang, L.Y.; Chen, Z.; Wang, C.; Lin, F.; Wang, H. Integrated system identification and state-of-charge estimation of battery systems. IEEE Trans. Energy Convers. 2013, 28, 12–23.

[2] Xing, Y.; He, W.; Pecht, M.; Tsui, K.L. State of charge estimation of lithium-ion batteries using the open-circuit voltage at various ambient temperatures. Appl. Energy 2014, 113, 106–115

[3] Omar, N.; Monem, M.A.; Firouz, Y.; Salminen, J.; Smekens, J.; Hegazy, O.; Gaulous, H.; Mulder, G.; Van den Bossche, P.; Coosemans, T.; et al. Lithium iron phosphate based battery—Assessment of the aging parameters and development of cycle life model. Appl. Energy 2014, 113, 1575–1585

[4] sepasi, s.; ghorbani, r.; liaw, b.y. improved extended kalman filter for state of charge estimation of battery pack. j. power sources 2014, 255, 368–376.

[5] mastali, m.; vazquez-arenas, j.; fraser, r.; fowler, m.; afshar, s.; stevens, m. battery state of the charge estimation using kalman filtering. j. power sources 2013, 239, 294–307.

[6] yuan, s.; wu, h.; yin, c. state of charge estimation using the extended kalman filter for battery management systems based on the arx battery model. energies 2013, 6, 444– 470.

Author's Profile

[1]UG Student, Department of Electronics and Electronics Engineering, Bannari Amman Institute of Technology, Sathyamangalam, Erode district, India.

[2]Assistant Professor, Department of Electronics and Electronics Engineering, Bannari Amman Institute of Technology, Sathyamangalam, Erode district, India.