

# Intelligent Battery Management System For Electric Vehicle

Shubhangi M Gond<sup>1</sup>, Amol D Bhoi<sup>2</sup>

P.G. Student, Department of Electronics and Telecommunication, G.H. Rasoni Institute of Engineering and Technology, Pune, India<sup>1</sup>

Professor, Department of Electronics and Telecommunication, G.H. Rasoni Institute of Engineering and Technology, Pune, India<sup>2</sup>

**ABSTRACT:** Electrical vehicle is new face of modern automotive. The reason for increase electrical vehicle demand are limited source of fossil oils and high cost of fossil oil. One more major reason is due to high emission of CO<sub>2</sub> from conventional vehicle. If we study and understand the above reason, we can understand that incising popularity battery vehicle is not only because of high demands but also it is basic need of future. The key component for conventional vehicle is engine & transmission, similarly for battery vehicle the key components are battery and battery monitoring and management system. These battery vehicle runs with the help of energy which is stored in battery. Hence those battery should have basic requirements like these battery needs to be safe, power density (high acceleration), energy density, high efficiency, low self-discharge rates and the very basic need of battery should be long lasting. In conventional vehicle it is easy to get this information with availability of fuel. However, in battery vehicle it is not too easy to get this information directly from availability of energy stored in battery, it is strongly depending on temperature and operating conditions. An efficient battery management system for Lithium-ion Battery, using Arduino and Neural network, was developed and tested. To detect the temperature LM35 sensor is used, while voltage and current value received from battery. The output from this sensor get fetch by Arduino and continuously send real time value to MATLAB. The SOC is calculated using battery parameter like voltage, current temperature. SOC calculated amount of charge present in battery.

**KEYWORDS:** Temperature, voltage, Battery Management Systems (BMS), Lithium-Ion Batteries, State of Charge (SOC).

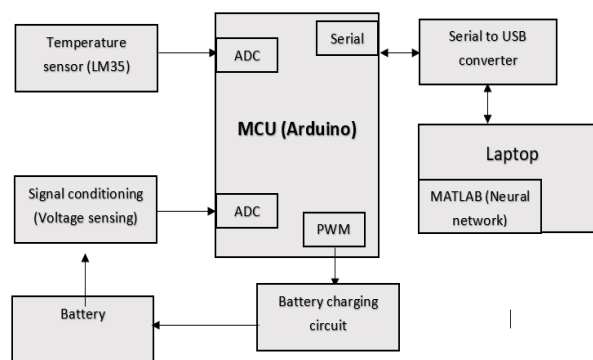
## I. INTRODUCTION

The available resource of diesel, petrol and fossil oils are decreasing rapidly. Due to more and more Burdon on it. Which is increasing day by day because of increasing demand of transportation. This transport industry plays key parameter role in development of villages, urban city, state and country. Hence, the emission of tones of CO<sub>2</sub> gas in environment is also increase, this pollute air is not only harmful for humans but also effect every alive thing on earth. The density of pollution will observe more or less for example in villages it is less compare to urban city. However, effect of pollute air is much more dangerous. Also, it contributes to greenhouse gas emission and global warming. Hence, battery vehicle is considered in list of development of every automotive manufacturer. Modern automotive spend majority of funds to developed substitute energy resource for conventional fuel vehicle, for example solar, biogas, stem, battery etc. out of all modern automotive industry convince that battery vehicle has potential to compete with conventional fuel vehicle or battery vehicle is the only vehicle that can be better substitute for convention vehicle. Hence, i.e. the reason it is observed in roadmap of every automotive manufacturer.

If everything is in favour of battery vehicle then why the picture on road which we seen is not in favour of battery vehicle. The reason is the bulky and heavy arrangement of battery, the pries of battery and the most important is need of intelligent system for battery monitoring and management. The minimum expectation of modern automotive from batteries are listed below. The battery needs to be safe. If driver drives the car and due to some reason or short circuit if battery catch the fire, then very dangerous accident can happen. Like any electrical component battery can explode if safety precautions are not in place. The second requirement of battery is power density (high acceleration) power density means the rate of transfer per unit volume. Third requirement of battery is energy density which means how battery can hold the energy. The fourth requirement is high efficiency means the total energy utilized from battery to amount energy supply to battery while charging. The last and important requirement from battery is battery should be long lasting.

## II. METHODOLOGY

To safe operation of battery different types of BMS is used. most effective BMS is which take care operational parameter such as Voltage, current, battery Temperature during charging and discharging of batteries. If any of the parameter exceed the value beyond its reference value monitoring circuit will gives notification. For making battery pack more efficient have to keep lots of factor in consideration like charging capacity, cell voltages, battery temperature, battery life, self-discharge rate, stored energy, energy density, numbers of cycles. All this mentioned parameter helps to design more effective BMS system. By keeping mentioned factor in mind user can take decision according to the requirement. Used Microcontroller (Arduino board) along with other peripherals like power supply, temperature sensor, battery, signal conditioning circuit, etc



**Fig1: BMSBlock Diagram**

Temperature sensor LM35 we are going to used which interfaced with microcontroller through ADC channel. Cost, battery life, is depend upon battery pack. Operating temperature of battery affect the performance. Battery life decreasing with increase in operating temperature. Battery gives best performance and good battery life when it is operating within optimum temperature range. Smart BMS plays vital role and consider temperature effect during charging and SOC estimation. Also, voltage of battery is monitored through readings obtained at other ADC channels. Serial port of Arduino is used for the communication between Microcontroller and PC. Sensor values are sent to PC through serial port. Values received at PC end are then put into an equation to find out state of charge (SOC) of battery using voltage and current value of battery. Neural network algorithm will be implemented on MATLAB software for the process.

## III. BATTERY CHARGING CIRCUIT

The Arduino UNO hosts an ATmega 328P microcontroller running at 16 MHz clock frequency and is used as the main processing unit for the device. The PWM-enabled digital output pin on the Arduino generates a PWM signal which drives the gate of the MOSFET Q1. The voltage divider formed by R1 and R2 ensures that the gate-source voltage of the MOSFET stays within the specified limits. The diode D2 protects the battery from a reverse polarity, it also prevents the battery from feeding power back into the Arduino in case the main power supply has been disconnected. The PWM-enabled.

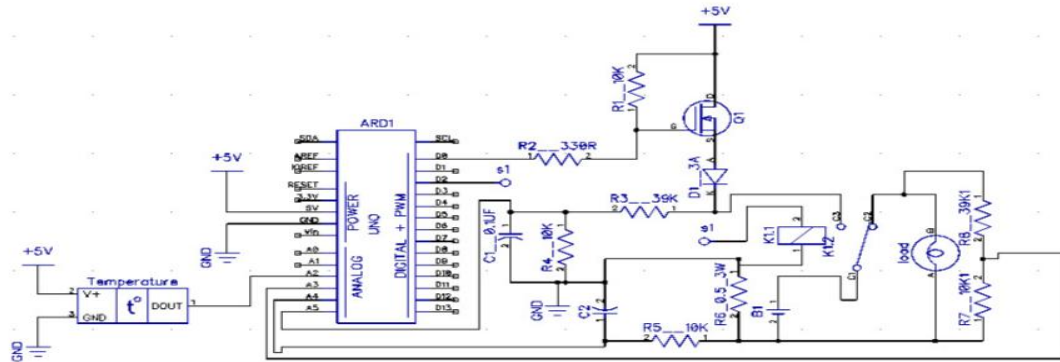


Fig 2: Battery charging circuit

digital output pin D0 on the Arduino generates a PWM signal which drives the gate of the MOSFET Q1. A current-sensing shunt resistor of 0.5 Ω is used. At a charging current of  $I = 2A$ , the voltage across the shunt will be exactly 1 V; which is slightly below the 1.1 V internal voltage reference of the Arduino thus corresponds to the full range of the Arduino's analog-to-digital converter (ADC). The analog pin A4 and A5 on the Arduino is used for measuring the voltage. a voltage divider consisting of R3 and R4, the ratio has been chosen such that the maximum battery pack voltage of 12.8 V would result in slightly less than the Arduino's internal reference voltage of 1.1 V at A5. Two 0.1uF capacitors C1 and C2 are used for blocking the high-frequency noise caused by the PWM from reaching the analog inputs, an essential measure for smooth ADC reading.

Lithium batteries charged using the (CC-CV) Constant Current Constant Voltage charging method. in (CC-CV) charging method battery start charging at constant current i.e.  $I_{chrg}$  up to reached threshold voltage  $V_{max} = VI$  4.2volt/cell once it reaches to threshold voltage current reducing charging in such manner at constant cell voltage  $V_{max}$  is not exceeded charging operation discontinued unless and until it reaches to threshold  $I_{full}$ . Along with above method EOC criteria also provided for safety concern. As per this criteria EOC can monitor battery charging by its capacity and time required to charge. When battery is connected to terminal for charging operation it estimates its state of charge SoC in %. Then this % SOC help to calculate remaining capacity of battery  $C_{max}$  and required time  $T_{max}$ . Battery charging operation stop immediately if either of these values has been reached.

#### IV. LI-ION BATTERY

The main function of battery is covert stored chemical energy into electrical energy. This electric energy is used as a source of power. When battery is connected load or source Occurs chemical reaction inside the battery which decide the performance battery the main feature of Li-Ion battery is higher energy density which have been reduce in size and cost and good electrochemical potential with lightest metal. Lithium rechargeable battery provide high voltage with excellent capacity and high energy density. Lithium Battery is most suitable to electrical vehicle among all other batteries like lead-acid and NiMH batteries because its self-discharge rate is less than half of the discharge rate of other batteries. Like other batteries lithium battery does not required maintenance. For Li-ion battery cycle scheduling is not required and no memory effect in the battery. Cathode, Anode, and electrolyte is main component of battery. A lithium-ion cell having an anode and cathode immersed in electrolyte solution and a separator. Li-ion and electron move from anode to cathode, during charging. for ion electrolyte solution is transformation medium.

During charging the cell can store electro-chemical energy and stored charge get release during discharging. At the cathode, neutral lithium is oxidized and converted to  $Li^+$ . These  $Li^+$  ions then migrate to the cathode, where they are incorporated into  $LiCoO_2$ . This results in the reduction of Co (IV) to Co (III) when the electrons from the anode reaction are received at the cathode. Because lithium is involved in the reactions at both electrodes, the battery can be recharged by running the reactions in reverse.

lithium is oxidized from  $Li$  to  $Li^+$  (0 to +1 oxidation state) in the lithium-graphite anode through the following reaction:  $C_6Li \rightarrow 6C(\text{graphite}) + Li^+ + e^-$  during discharging. Electrolyte is medium to transfer  $Li^+$  ion toward cathode, where they are incorporated into lithium cobalt oxide through the following reaction, which reduces cobalt from a +4 to a +3-oxidation state:  $Li_{1-x}CoO_2(s) + xLi^+ + xe^- \rightarrow LiCoO_2(s)$ . to recharge the cell reaction can be run in reverse.

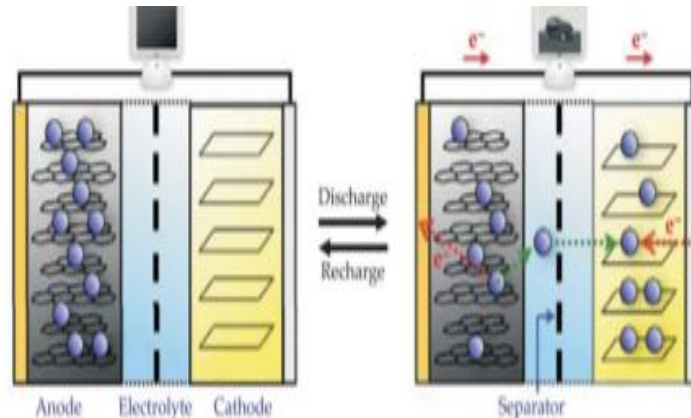


Fig 3: Li-Ion battery

**A. Application**

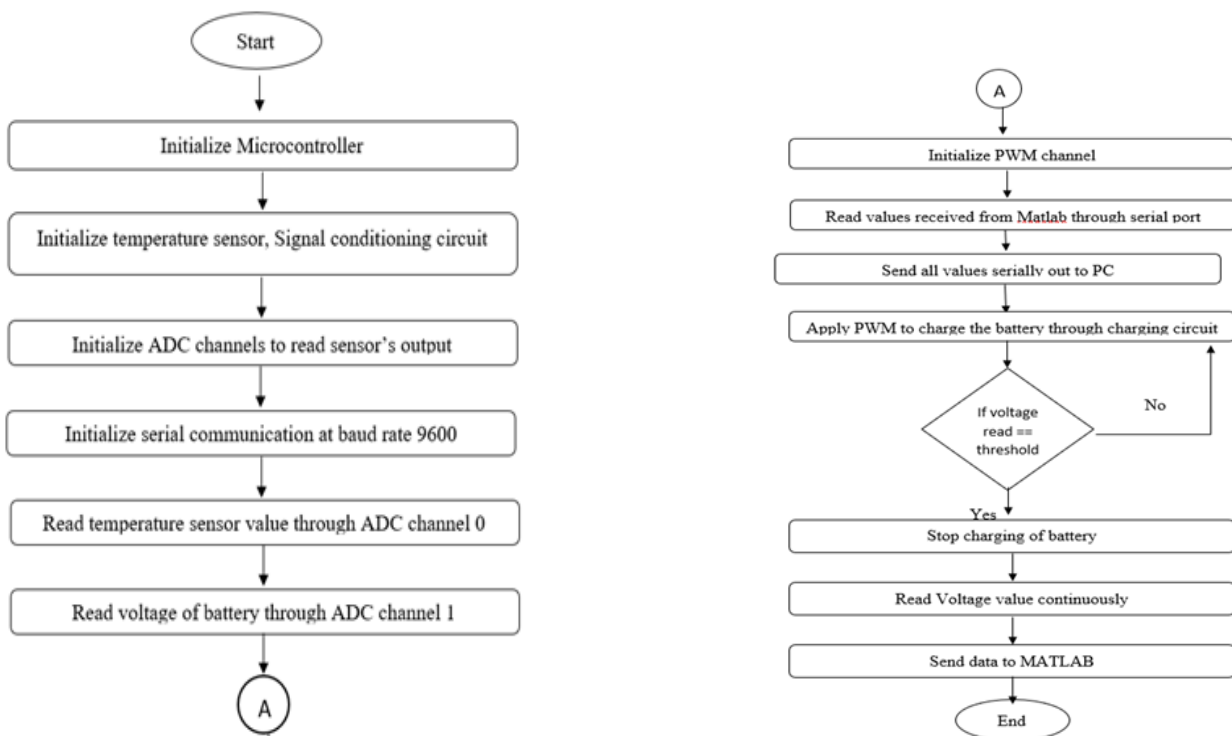
- Due to their light weight used in laptop computers, cell phones, wrist watches.
- Li-Ion battery is used wind power and solar storage.
- Used in space probes and satellites due to their light weight.

**B. Advantage of Li-Ion Battery.**

- Li-Ion battery has higher energy density, lower self-discharge rate, Voltage capacity.
- Li-ion battery is more stable and recharged hundreds of times.
- Li-ion battery is long lasting, and it gives 10 times more life compare to others.
- Li-ion battery is 50-60% lightweight compare to others.
- Li-ion battery itself required low maintenance, because of that battery didn't suffer from the memory effect

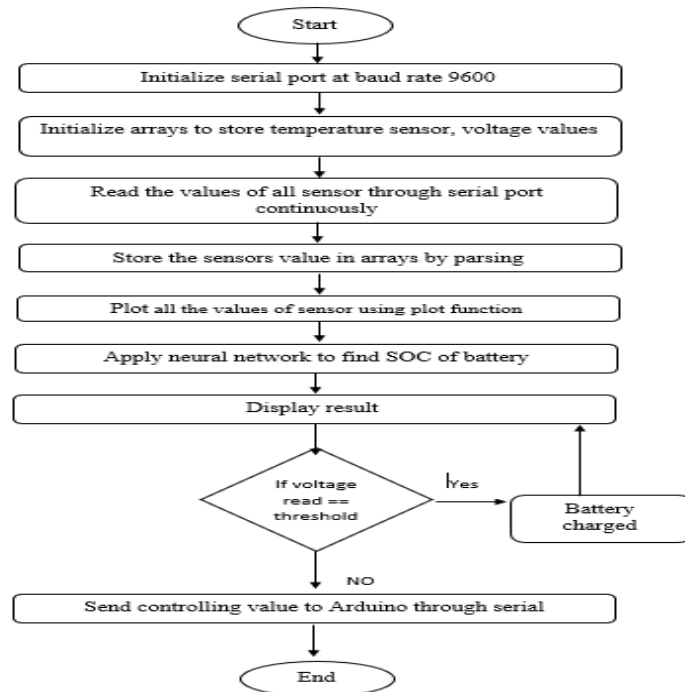
**V. PROCESS FLOW**

**A. Arduino functional Process.**



Flow chart 1:Arduino functional Process

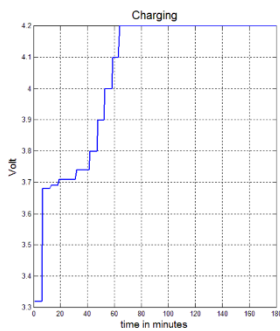
**B. MATLAB functional Process.**



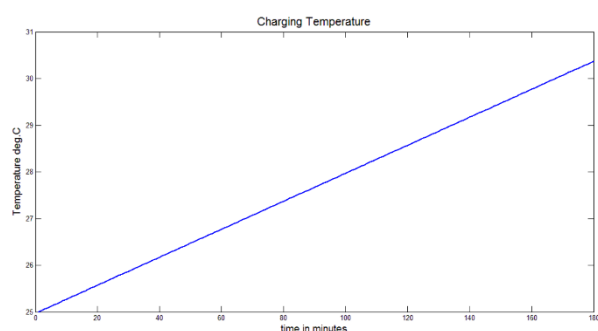
**Flow chart 2:MATLAB functional Process**

**VI. RESULT**

Fig 4. & Fig 5gives graphical representation of battery charging and discharging curve., temperature effect during charging. Fig 6 shows SOC output, Fig 7 shows output at different load.



**Fig 4: Li-Ion Charging/ Discharging Curve**



**Fig 5: Temperature effect during charging.**

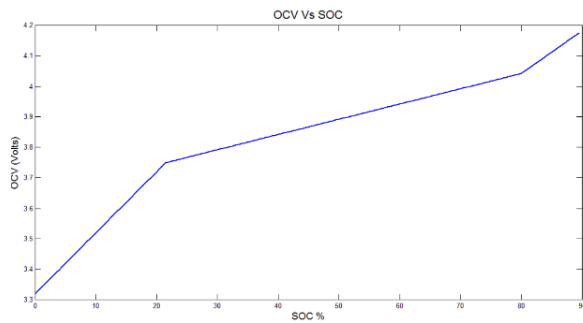


Fig 6: Li-Ion SOC Curve.

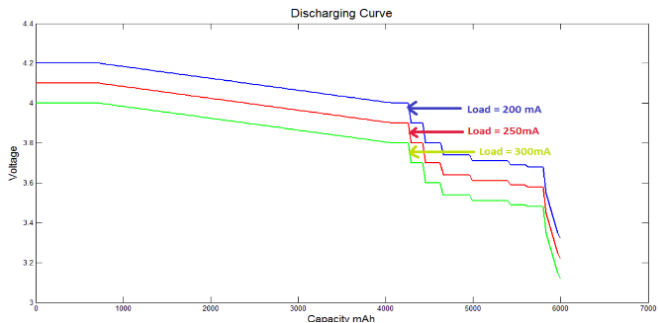


Fig 7: Discharging curve with various load

## VII. CONCLUSION

The paper presented can conclude following points

- The presented BMS system is fully operational and it provide accurate monitoring of temperature current and cell voltages.
- BMS system can significantly provide better result for EVs.
- BMS is an intelligent system of electric vehicles. that assured result for a safe, efficient and reliable battery operation.

## REFERENCES

- [1] W. Taylor, G. Krithivasan, and J. J. Nelson, "System safety and ISO compliance for automotive lithium-ion"
- [2] Banzi, M. (2011). Getting Started with Arduino 2nd Edition. Sebastopol, CA: O'Reilly & Associates
- [3] Bergveld, H. J. (2013). Battery Management System; Design and Modelling. Eindhoven, Netherlands: Royal Philips Electronics
- [4] David Linden, Thomas B. Reddy. Handbook of Batteries
- [5] Sandeep Dhameja. Electric Vehicle Battery Systems. Butterworth Heinemann
- [6] Guo-quan, X. I. N. G. (2007). Temperature Characteristics and Application of LM35 Sensor
- [7] Pavlov D. (2011) Lead-Acid Batteries: Science and Technology, Elsevier London
- [8] Chang, W. Y. (2013). The state of charge estimating methods for battery: A review. ISRN Applied Mathematics, 2013
- [9] Bergveld, H. J. (2013). Battery Management System; Design and Modelling. Eindhoven, Netherlands: Royal Philips Electronics