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Arduino based Battery Monitoring System

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ABSTRACT

Now a day's electric vehicles (EVs) are becoming very popular. They have captured a good market due its performances in last few years. Its performance in terms of distance and high acceleration with one time charging. Recent research also shows some promising benefits from integrating EVs with power grid. Thus the EV batteries can be used as distributed energy storage. This stored energy is utilized in electrical vehicles as an when required. However, compared to traditional Nickel-cadmium and lead-acid batteries, Li-ion battery operates in a narrow window, and need to be monitored, managed and protected. This becomes more severe when it is applied for large applications. Number of Li-ion are interconnected to provide sufficient voltage and current. The solution mainly relies on a robust and efficient battery management system (BMS). This paper presents a review on the different features of BMS and commercial selection of BMS from the market and designing a custom BMS for better control of functionalities. An arduino based system is designed to monitor the state of charge(SOC) and state of health (SOH) of batteries. If the battery charge goes below threshold the load is automatically switched to another battery and the load is balanced. The discharged battery is charged through charging circuit.

Index Terms: Battery Management, Arduino Uno, Battery Relay, State of charge, State of health

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I. INTRODUCTION

Batteries in electric vehicles (EVs), are widely used as an energy source in many applications. In mid ninths century the EV came into existence. As EVs reduces consumption of gasoline, the EV batteries gained attention in the market. The global market is expected to reach US $25 by 2020, as per reported by Boston Consulting Group, which is three times the size of today's entire lithium-ion battery market for consumer electronics. The U.S. Council for Automotive Research (USCAR) and the U.S. Advanced Battery Consortium (USABC) have set goals for battery characteristics for its long-term commercialization of advanced batteries in EVs and also in hybrid electric vehicles (HEVs). Reliability and safety are the concern parameters of the users, to increase he market share of EVs and HEVs. First commercial electrical was available at New York, U.S.A. was the taxi cab and using Lead acid battery in 1991. This vehicle had limited mileage hence not popular that time and also less number of vehicles sold in the market. Then in the year of 1999, the commercial market was seen fuel cell based Necar 4 fuel cell car. Mahindra Reva (2001),Toyota prius, Honda FCX (2002), Citario fuel cell powered bus (2003), Smart Electric Drive(2007), Mitsubishi I MiEV (2009), Mercedes-Benz SLS AMG coupe Electric Drive(2010), Ford Focus EV(2011), Renault Twizy (2012), Tesla Model S (2012), Mahindra e2o (2013), Chevrolet Spark EV (2013),

BMW i3(2013), Nissan Leaf (2013) and Honda Fit EV(2014) seen in the succeeding years with advanced battery technology .These electric vehicles use different capacity of the battery and different types of batteries to propel the electric motor. The BMW i3 was considered as the first complete electric car from BMW Company built electric from the ground up. This car is a part of BMW"s "born electric" i series. Its cost put it somewhat in the center of the Nissan Leaf and the Tesla Model electric cars. Despite of looking a bit bulky, the BMW i3 is the lightest electric car available in the world's car market. While the selection of hybrid power train is growing every year, it is seen that Toyota Prius as has top priority because of its low price as compare to other electric vehicles in the market. The redesigned the Fusion Hybrid is slightly larger, sportier and more upscale-looking with advance facility

than previous version. This luxurious car has a well-furnished cabin, features and high tech loads. Second low price category of hybrid electric car is the Chevrolet Volt. With four cylinder gas modelling and simulation of BPP efficiency of electric vehicles increases and can achieve an range of 60Km. The Nissan Leaf vehicle proves to be a highly superior and also affordable in comparison with all other electric cars. Nissan promises a range of 150 km in city per 210km on highway, but EPA tests has proved in the real-world at 110km, depending on conditions and driving style. The Ford C-Max is another case to be considered. The plug-in electric hybrid wagon from Ford, delivered a 750km of driving range with fill-ups between. The lithium-ion battery pack recharges from a standard 120 volt electric outlet. In 2013, Tesla Models EV came in the market with its aluminum body, for 5 passengers interior and with a powerful battery pack. This system had no competition at that time. It's only disadvantage is that as a battery-electric car it has limited range, although it goes a lot of distance than other EVs. It also offered two battery options with an range of 240 km to an EPA-certified test of 390km. In Europeans country, one of the best top end scales model is the Mercedes-Benz S400 Hybrid with its superior interior design, safety and magnificent technology features, and sleek sedan body.

In India 2013, Mahindra Company has launched e2o electric vehicle and which is advanced versions than earlier vehicles. This company has launched Reva i in 2001 and considered as first electric car on road in India. The rising prices of petrol, diesel and gases increased awareness to protest environmental issues and stress on maneuverability have made many people seriously considering this option. Even this car is not that much comparable with earlier vehicle with range, facility and battery technology. Modelling & Simulation of BPP for Efficient Electrical Vehicles. It has been observed that use of lithium ion battery pack extends range of the vehicle because energy densities of the lithium ion batteries are higher than lead acid battery. Mahindra company used Lead acid battery as well as lithium ion battery pack in their different versions of electrical cars. However, both the batteries are subject to not only the battery technology but also the management system for the battery. Therefore, in a BMS, plays and important role between battery and vehicle. Its performance is improved and the operation becomes reliable and safer. Thus it is essential to develop a comprehensive and mature BMS. Also some arrangement to be provided for the engine to display the state of the safety, usage, performance, and life of the battery. Lithium batteries get ignited if overcharged due to changes in volatility, flammability and entropy [5]. But however due to over discharge cell capacity reduces. Therefore, a BMS needs to monitor and control the battery parameter and incorporating safety circuitry within the battery packs. Thus any conditions, such as over-voltage or overheating, are detected, the BMS should notify the user and in addition it should also monitor system temperature for fulfill power requirement.

II. REVIEW OF RELATED WORK.

The authors [1] proposed (BMS) as an electronic regulator to control and monitor the charging and discharging activity of the rechargeable batteries. They developed a model that monitors operational parameters such as voltages, currents with the battery internal and ambient temperature during charging and discharging. The authors in [2] proposed that battery is a basic component of electric vehicles, which represent sustainable mobility. It also reviews the performance of battery and also discussed the requirements and standards used in systems for battery management. For state-of-charge estimation and charge balance a new architecture was proposed. [6] This paper focus on the balancing methods based on energy flow. They have also focused on comparison of the methods which are classified on the basis of nature of balancing. [5] This paper proposes a BMS architecture for light electrical vehicles using extra cells i.e. it dynamically disconnects a cell in the battery pack for optimum balancing. [8] The authors proposes a Kalaman filter based SOC method for lead acid battery. This paper also discusses on comparison between different methods based on advantages and its applications.

III. METHODOLOGY

The system is designed to monitor the battery status from the SOC and SOH of the battery. The system consists of Arduino, two 12v batteries, LCD display, a load circuit, for output 3.3V battery and zener diode protection circuit. Arduino is programmed such that it continuously monitors the battery status. Battery status consists SOC, SOH and equivalent potential remaining in the battery. Zener diode is used as protection circuit for protection from reverse voltage. The SOC, SOH and voltage is displayed on an LCD display. Two motors are used as load through relays. A 3.3v battery is used at the output for fetching the data remotely i.e using Internet of things (IoT). Figure 1 is the block diagram of the methodology implemented . Initially it is assumed that load is balanced so that load is running on a single battery, while programming the arduino a threshold is set to 8V. If the battery discharges and voltage level drops below 8V i.e. SOC is below 8V than the display will displayS a message 'Please charge your battery'. In this state i.e. if battery charge goes below threshold the load is automatically switched to another battery and the load is balanced. The discharged battery is charged through charging circuit. At remote place if the state of battery and SOH is to be monitored we have used IoT and the output can be represented and updated through graphs.

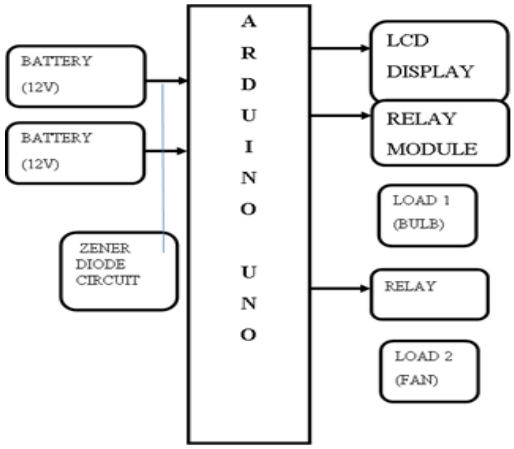

Fig.1 Proposed Methodology

Figure 2 represents the prototype of the proposed methodology. Two parameters SOC and SOH parameters are obtained.

Algorithm of the system

Step1: Initially assumed that load is balanced and load is running on single battery and threshold is set to 8V. Step2: IF Battery discharges and drops below 8V

Step3: This is state of charge and message is displayed" Charge the Battery"

Step4: load is automatically switched to another load

Step5: The discharged battery is then charged through charging circuit

A. Performance Parameters

State of Charge (SOC): State of charge is defined as capacity of battery. It is also represented as % of rated capacity. Its function is to estimate the SOC by measuring battery parameters such as voltage, current and temperature. The estimation of SOC ensures the remaining capacity of the battery when the battery is discharged. SOC can be measured and can be evaluated from direct measurement by two methods offline and online. In offline the battery has to be charged and discharged in constant rate. This gives precise estimation of battery. In our system a threshold is set to 8 volt. If battery voltage goes below 8 volt i.e SOC and amessage is displayed to charge the battery.

State of Health (SOH): State of health describes the physical state of the battery such as the losses in the capacity of battery. It reveals the healthy state of the battery and its ability to deliver specified performance compared to a new or optimum battery. It is a figure of merit of the condition of battery compared to fresh battery.

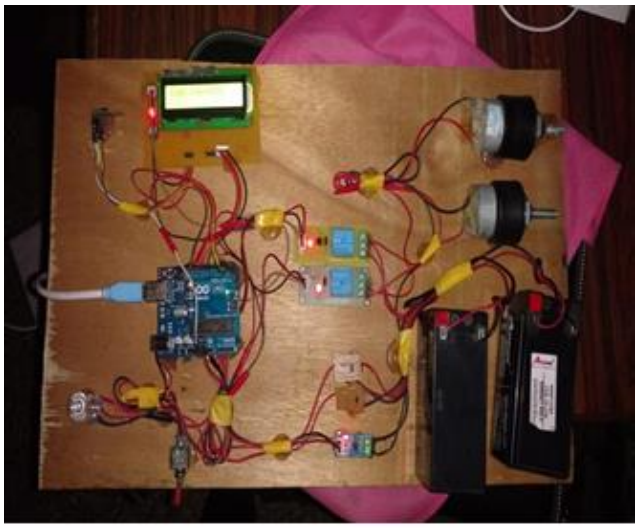

Fig.2. Prototype of proposed

Fig.3. Output displayed on LCD

Software's used for this work is Arduino software, PROTEUS and ESP FIRMWARE FLASHER. Arduino software for controlling the parameters. Proteus for simulation. The voltage and current status are transmitted to remotely placed node or user through IoT arrangement as per fig.5. The fig.4 is the voltage and current graphs which can be transmitted to a remote node. This system can be used in electric vehicles, E-rickshaws, for Power monitoring, in Communication and mobile, for Drones and robots and in Home appliances.

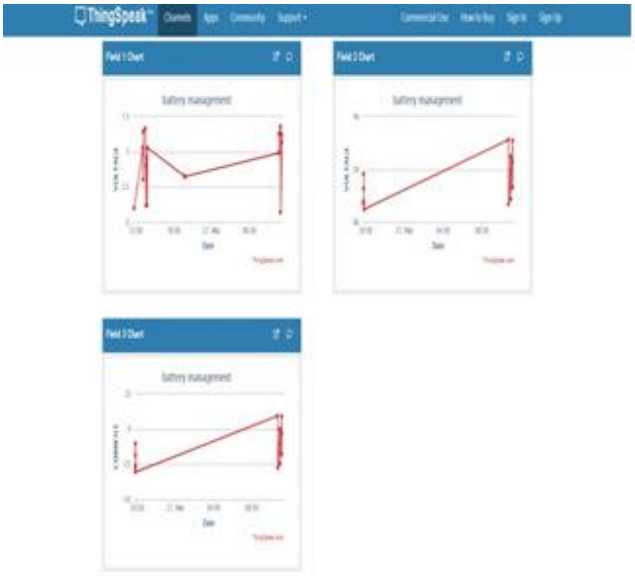

Fig.4. Remotely transmitted data of Battery Status through IoT.

Fig.5 Circuit connection for remote monitoring.

IV. CONCLUSION

The study reveals which battery monitoring system market segment or region or Country should focus in coming years. This will channelize the efforts taken and investments made to maximize growth and profitability in battery monitoring. Lead acid battery technology has been developing rapidly, so contribution of the BMS system results in switching of charging and discharging ports depending on stored potential in cells. The system results in indication of individual voltage level of each cell so as to prevent failure due to imbalance of potentials while running or on ideal state operation, this ensures increase reliability and less maintenance for end user to operate the system.

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