Battery Swapping Technique for Electric Vehicle with Auto Charging

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Abstract - *The proposed project is a battery swapping technique for electric vehicles with auto charging that allows electric vehicle (EV) owners to quickly swap out a depleted battery pack with a fully charged one. This can be a convenient option for long-distance travel or for drivers who don't have access to a charging station. Auto charging in electric vehicles (EVs) with mechanical energy involves harnessing the kinetic energy generated by the vehicle's movement to recharge the battery. This technology is known as regenerative braking, which converts the kinetic energy produced during braking into electrical energy that can be stored in the battery. This process works by using an electric motor to slow down the vehicle, which causes the motor to act as a generator and produce electrical energy. This energy is then sent to the battery to be stored for later use. In this way, we are creating a system model that shows Battery Swapping Technique for Electric Vehicle with Auto Charging, which is controlled through three key parameters: voltage, current, and temperature. To achieve this, we are utilizing an LM35 integrated-circuit temperature device, an analog-to-digital converter (ADC) is used to convert an analog signal, like voltage into a digital format. The primary purpose of the ADC is to convert an analog signal into a binary code, which can then be read and processed by a microcontroller. Our aim is to provide a cost-effective solution that allows for the development of sophisticated products.*

Key Words*: *Electric Vehicles, Battery Swapping Technique, Battery Management System, ATmega 328 Microcontroller.

1. INTRODUCTION

Electrification in a vehicle (electrified transportation) is the most successful way to achieve clean and efficient transportation that is very important to the sustainable development of the whole world. In the coming future, electric vehicles (EVs) including hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), or pure battery electric vehicles (BEVs) will dominate the clean vehicle Market. In coming years, it is expected that more than half of new vehicle sales will likely be Electric Vehicle models. The key and enabling technology to this revolutionary change is the battery. Electric vehicles are powered by a maximum number of battery cells, requiring an effective battery management system (BMS) to sustain the battery cells in an operational condition while providing the necessary power efficiently. Battery management systems (BMS) make decisions on charge or discharge rates on the basis of load demand, cell voltage, current, and temperature measurements, and calculable battery SOC, capacity, impedance, etc.

Electric vehicles (EVs) are now being widely adopted, not only to reduce the number of fossil fuels used but also out of consideration for greenhouse gas emissions and environmental protection. However, many car owners still want to buy traditional vehicles due to certain well-known drawbacks of EVs, such as long charging time, short battery life, limited travel distance per charge, and expensive EV batteries. The introduction of the BSS would reduce range anxiety and provide access to fully-charged batteries for EV owners. When a vehicle's battery is running low, an EV driver can drive to the nearest battery swapping station and swap to a recharged battery within two minutes.

As typical charging operations would take much longer than refilling the vehicle with gasoline, fast- and ultra-fast charging technologies were proposed to improve the charging efficiency. However, these fast-charging schedules require certain conditions. Firstly, the battery must be designed to be charged with a high current. Secondly, fast charging only applies to the first stage of charging, which is typically the constant-current stage. Thirdly, the high current should be reduced after the battery is around 70 percent charged, in order to protect the circuit and prolong the battery life. Lastly, fast charging can only be used in an environment in which a definite temperature can be maintained.

2. LITERATURE REVIEW

A.Hariprasad, I.Priyanka, R.Sandeep, V.Ravi & O.Shekhar. “Battery Management System in Electric Vehicles”-Hariprasad with his students in May 2020 depicts that, in Electric Vehicles, Battery Management Systems (BMS) are used to monitor and control the charging and discharging of rechargeable cells, making the operation more efficient. The Battery Management System keeps the battery safe and reliable during increasing senility without causing damage.

Author Mingyue Zhang and Xiaobin Fan in March 2020 “Review on the State of Charge Estimation Methods for Electric Vehicle Battery”, highlight the significant role of battery management research in overcoming the challenges of electric vehicle technology. One of the significant hurdles faced by electric cars is their battery technology.

Morris Brenna, Federica Foiadelii, Carola Leone, Michela Longo “Electric Vehicles Charging Technology Review and Optimal Size Estimation” - Morris Brenna, Federica Foiadelli, Carola Leone1, and Michela Longo in 2020 discuss an overview of different EV battery chargers based on power levels, the direction of power flow, and charging control strategy. It includes inductive and conductive charging methods with their merits and demerits.

3. METHODOLOGY

3.1 The Importance of Battery Management System

Battery Management System (BMS) is a major system in electric vehicles because cells or batteries used in an electric vehicle should not be overcharged or over-discharged. The system provides inputs to the safety devices so that the monitoring circuits could generate alarms and even disconnect the cell from the load or charger if any of the parameters exceed the values set by the protection zone.

For the below given reasons, a battery management system is needed.
1. Maintain battery safety and reliability.
2. Charging Status and Battery Life.
3. Controlling billing status.
4. Control the operating temperature and balance the batteries.
5. Managing renewable energy.

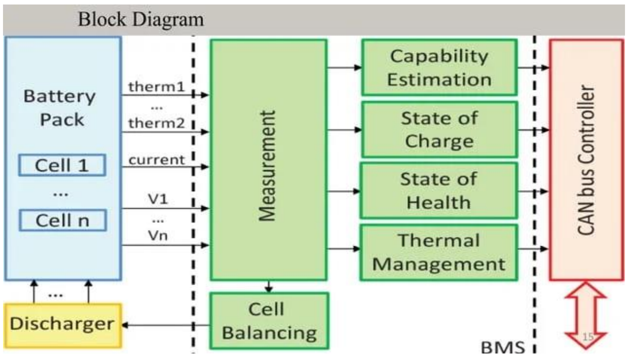

Figure 1: Battery Management System (BMS) in Electric Vehicles

3.2 System Design

Here going to see about various types of methods of system architectures and Algorithms to achieve this project’s specification. we are going to discuss the proposed system architecture its Benefits and its Algorithm for battery management system implementation with the help of a microcontroller.

Description: The external charger is connected to the battery by a contactor and it is controlled by a battery control unit. Loads like the ECU machine and regulator are connected to the battery by DC/DC converter to give sufficient supply needed by using a contactor. BMS controls the current, temperature, and voltage in each cell in the battery.

The basic electrochemical unit is used to generate electrical energy from stored chemical energy or to store electrical energy in the form of chemical energy. A cell consists of two electrodes placed in a container filled with an electrolyte.A cell, which is the fundamental electrochemical unit, is utilized to either generate electrical energy from stored chemical energy or store electrical energy in the form of chemical energy. It is comprised of two electrodes situated in a container filled with an electrolyte. To attain the necessary operating voltage and capacity for a particular load, two or more cells are connected in an appropriate series/parallel configuration. The term "battery" is often used interchangeably with single cells. In this thesis, we will adopt this terminology unless it is necessary to differentiate between cells and batteries. An excellent illustration of this concept is a battery pack, which comprises multiple cells connected in series and/or parallel.

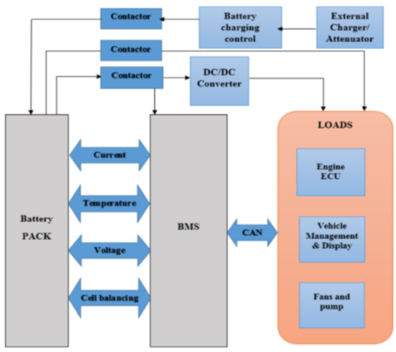

Figure 2: Basic block diagram of BMS

4. PROJECT DESCRIPTION

4.1 Microcontroller

ATmega328 is an Advanced Virtual RISC (AVR) microcontroller. It supports 8-bit data processing. ATmega-328 has 32KB internal flash memory. ATmega328 microcontroller has 1 KB EEPROM(Electrically Erasable Programmable Read-Only Memory). This property shows if the electric current supplied to the microcontroller is removed, indeed also it can store the data and can give results after furnishing it with the electric current. Also, ATmega-328 has 2 KB Static Random Access Memory (SRAM). Atmega328 is the microcontroller, exercised in introductory Arduino boards i.e Arduino UNO, Arduino Pro Mini, and Arduino Nano. It has 8 Pins for ADC operations, which all merge to form Port A(PA0 - PA7). It operates ranging from 3.3V to 5.5V but typically we use 5V as a standard. Its excellent features carry cost-effectiveness, low power dissipation, a programming cinch for security purposes, and a real-time counter with a separate oscillator.

4.2 Analog-to-Digital Converter(ADCs)

The function of Analog-to-Digital Converters (ADCs) is to enable digital logic circuits like micro-processor controlled circuits, Arduinos, Raspberry Pi, and other similar devices to interface with the physical world. Analog signals in the real world are characterized by constantly varying values, which originate from a diverse range of sources and sensors that measure phenomena such as sound, light, temperature, or motion. Many digital systems rely on ADCs to gather data from such transducers and integrate them with their surroundings.

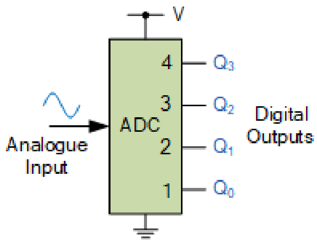

Figure 3: Analog-to-Digital Converter(ADC)

4.3 Loads on vehicle battery

Vehicles are equipped with a variety of loads, which are connected to the battery either through direct wiring or by utilizing a contactor and DC to DC converter based on their compatibility.

- ECU
- Motors
- Pumps
- Fans
- Displays

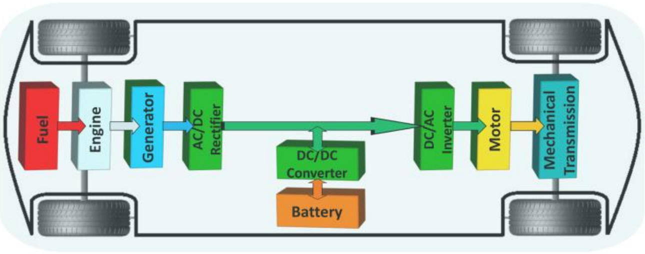

Figure 4: Typical Configuration of an Electric Vehicle

5. RESULT

The prototype hardware has been successfully developed and appropriately tested for its intended purpose. In this model, the depleted battery pack quickly swaps out with a fully charged one, and auto charging takes place with mechanical energy involves harnessing the kinetic energy generated by the vehicle's movement to recharge the battery.

Figure 5: Working Model

6. CONCLUSION

In this model, we have used two batteries. When the first battery is discharged by 70%, it automatically switches to the next battery with a load. The first battery then gets charged automatically with the mechanical energy that is converted into electrical energy. The mechanical energy is generated from moving rotor which is converted into electrical energy with the help of a generator, and this electrical energy is used to charge the discharged battery. Thus, this project demonstrates automatic battery swapping and auto-charging.

In this way, we are creating a system model that show Battery Swapping Technique for Electric Vehicle with Auto Charging, which is controlled through three key parameters: voltage, current, and temperature. To achieve this, we are using LM35 integrated-circuit temperature sensors to measure temperature. For converting the analog signal which in this case is voltage, into a digital form we are utilizing an analog-to-digital converter (ADC), this conversion allows the signal to be read and processed by a microcontroller. And battery monitoring IC with embedded processing. Our aim is to provide a cost-effective solution that allows for the development of sophisticated products.

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