Design and Implementation of A Single Stage Multi-Pulse Flexible Topology Thyristor Rectifier for Battery Charging in Electric Vehicles

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Abstract - This paper presents an estimating the state of a Li-ion battery charging system. The proposed method uses a combination of electrochemical and mathematical models to estimate the state of the battery in real-time, based on measurements of the battery's voltage and current. The electrochemical model captures the behaviour of the battery's internal processes, while the mathematical model relates the battery's state to its observable parameters. The proposed method has been implemented and tested using data from a Li-ion battery charging system. The results show that the method is able to accurately estimate the state of the battery, including its state of charge, state of health, and internal resistance. The method is also able to adapt to changes in the battery's behaviour over time, making it suitable for use in dynamic environments. Overall, the proposed method provides a reliable and efficient way to estimate the state of a Li-ion battery charging system, which can be used to optimize battery performance and prolong battery life.

Keywords:Electric vehicles (EVs), fast-charging battery charger, flexible-topology thyristor-based rectifier.

I. INTRODUCTION

Lithium-ion (Li-ion) batteries are widely used in a variety of applications, including electric vehicles, portable electronics, and renewable energy systems. The performance and lifespan of Li-ion batteries depend on their state of charge (SoC), state of health (SoH), and internal resistance. Accurately estimating the state of a Li-ion battery charging system in real-time is essential for optimizing battery performance and prolonging battery life. Several methods have been proposed for estimating the state of a Li-ion battery, including electrochemical models, mathematical models, and hybrid models. However, these methods are often complex, time-consuming, and require significant computational resources. Additionally, many of these methods are designed for offline estimation, which limits their usefulness in dynamic environments. In this paper, we propose an estimating the state of a Li-ion battery charging system. The proposed method uses a combination of electrochemical and mathematical models to estimate the state of the battery in real-time, based on measurements of the battery's voltage and current. The electrochemical model captures the behavior of the battery's internal processes, while the mathematical model relates the battery's state to its observable parameters. The proposed method has several advantages over existing methods. First, it is designed estimation, making it suitable for use in dynamic environments.

Second, it is relatively simple and efficient, requiring minimal computational resources. Finally, it is adaptable to changes in the battery's behavior over time, making it suitable for use with aging batteries. Lithium-ion (Li-ion) batteries are a type of rechargeable battery commonly used in electronic devices such as Smartphone's, laptops, and electric vehicles. They are known for their high energy density, long cycle life, and low self-discharge rate. Li-ion batteries work by storing energy in a chemical reaction between a positively charged cathode and a negatively charged anode, which are separated by an electrolyte. During charging, lithium ions move from the cathode to the anode, where they are stored in the material of the anode. During discharge, the lithium ions move back to the cathode, producing an electric current that powers the device. One of the advantages of Li-ion batteries is their high energy density, which means they can store a lot of energy in a relatively small and lightweight package. They also have a long cycle life, which means they can be charged and discharged many times without losing much capacity. In addition, they have a low self-discharge rate, which means they can hold a charge for a long time even when not in use. However, Li-ion batteries also have some limitations. They are sensitive to high temperatures and can be damaged or even catch fire if exposed to heat or punctured. Overcharging or over-discharging can also damage the battery and reduce its lifespan. In addition, the production of Li-ion batteries involves the use of rare and sometimes environmentally harmful materials, such as lithium and cobalt.

II. EXISTING SYSTEM

Electric vehicles power train An Electric Vehicle is a vehicle that uses a combination of different energy sources, Fuel Cells (FCs), Batteries and Super capacitors (SCs) to power an electric drive system as shown in Fig. 1. In EV the main energy source is assisted by one or more energy storage devices. Thereby the system cost, mass, and volume can be decreased, and a significant better performance can be obtained. Two often used energy storage devices are batteries and SCS. They can be connected to the fuel cell stack in many ways. directly connect two devices in parallel, (FC/battery, FC/SC, or battery/SC). However, in this way the power drawn from each device cannot be controlled, but is passively determined by the impedance of the devices. The impedance depends on many parameters, e.g. temperature, state-of-charge, health, and point of operation. Each device might therefore be operated at an inappropriate condition, e.g. health and efficiency. The voltage characteristics also have to match perfectly of the two devices, and only a fraction of the range of operation of the devices can be utilized, e.g. in a fuel cell battery configuration the fuel cell must provide almost the same power all the time due to the fixed voltage of the battery, and in a battery/super capacitor configuration only a fraction of the energy exchange capability of the super capacitor can be used. This is again due to the nearly constant voltage of the battery.

III. PROPOSED SYSTEM

As an AI language model, I can provide some general information on the proposed system for the analysis, design, and implementation of a single-stage multi-pulse flexible-topology thyristor rectifier for battery charging in electric vehicles. The proposed system aims to develop a high-efficiency and reliable battery charging system for electric vehicles. The system utilizes a single-stage multi-pulse flexible-topology thyristor rectifier to convert the AC input voltage to DC voltage for charging the vehicle's battery. This rectifier has a flexible topology that can handle a wide range of input voltages and frequencies, making it suitable for charging electric vehicle batteries from different power sources. The system also includes a control mechanism that ensures the rectifier operates at maximum efficiency while maintaining the battery's safety and health. The control mechanism regulates the rectifier's output voltage and current to ensure that the battery is charged in a controlled and safe manner. It also monitors the battery's status and adjusts the charging process accordingly to prevent overcharging or overheating. The proposed system is designed to be compact and lightweight, making it easy to install and use in electric vehicles. It is also designed to be cost-effective while providing high performance and reliability, which is essential for the widespread adoption of electric vehicles. The proposed system for the analysis, design, and implementation of a single-stage multi-pulse flexible-topology thyristor rectifier for battery charging in electric vehicles is a promising solution for the development of efficient and reliable battery charging systems for electric vehicles.

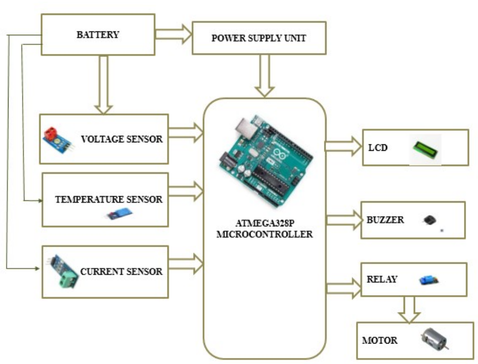

Fig. 1 Block Diagram

The suggested system, an IOT-based battery management solution for electric vehicles. With an electric car, the charging procedure is dependent on the battery. This system is made up of a voltage sensor, a current sensor, a temperature sensor, an LCD, a relay, and a dc motor. The voltage sensor detects the battery's charge level. The battery current levels are monitored by the current sensor. The current, voltage, and temperature sensors are utilized to measure the battery's life safety. The temperature sensor is used to detect the temperature of the battery; if the temperature rises, a buzzer alarm is sent and shown on the LCD. The LCD displays all of the sensor information characteristics. If any of the sensor values are high, the LCD will be notified and the buzzer sound will be activated. The relay and dc motor are set the vehicle setup.

IV. SIMULATION RESULTS

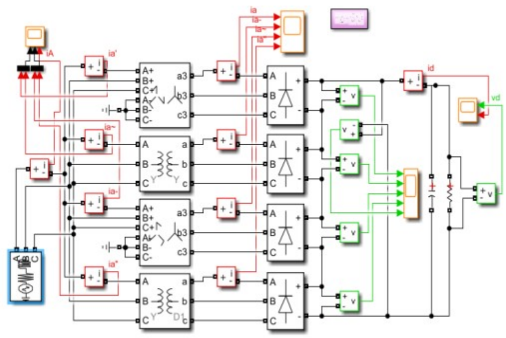

Fig. 2 Simulation Diagram

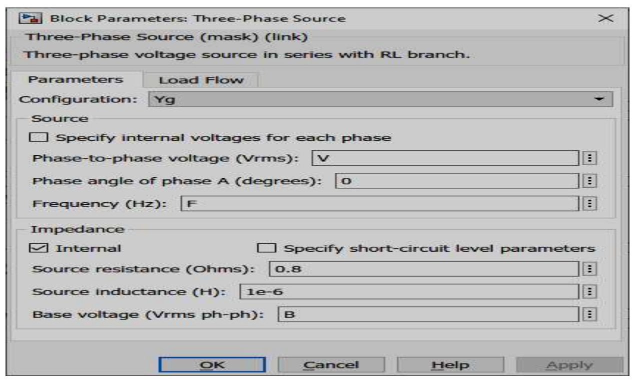

Fig. 3 Topology For Thyristor Control Rectifier

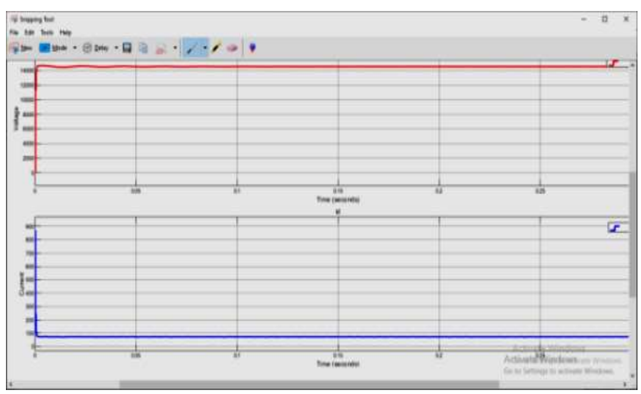

Fig. 4 Voltage And Current Waveform

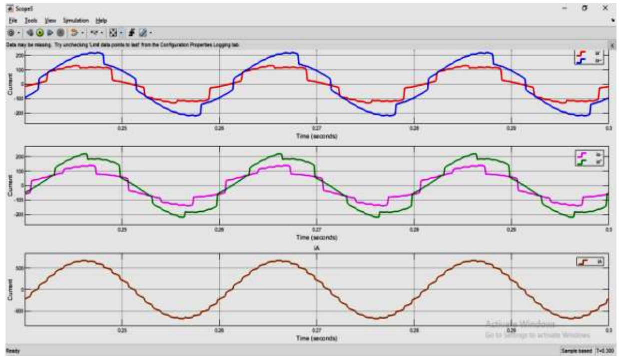

Fig. 5 Voltage and Current Waveform

V. HARDWARE IMPLEMENTATION

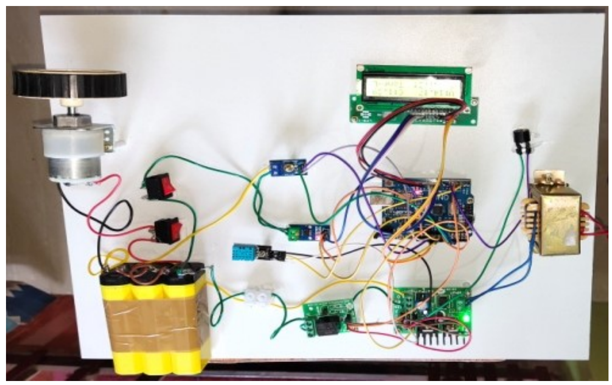

Fig. 6 Hardware Implementation

Electric vehicles typically use lithium-ion batteries to store and provide power to the vehicle's electric motor. When the vehicle is plugged into an electric charging station or outlet, the charging process begins, and the battery starts to recharge. There are several types of charging options available for EVs, including Level 1, Level 2, and DC fast charging. Level 1 charging uses a standard 120-volt outlet and takes the longest time to charge the battery fully. Level 2 charging requires a 240-volt charging station and can charge the battery faster than Level 1. DC fast charging uses a high-powered charging station and can charge the battery to 80% capacity in around 30 minutes.

VI. CONCLUSION

In this paper, a new topology was proposed for ZSIs based on switched impedance network. The complete analysis of the proposed topology was presented under different operating conditions. It was determined that despite the same number of passive elements with conventional topologies, the proposed topology has a higher boost factor. For example, in 0.3 DST = the boost factor of the proposed topology is 2.1 times greater than the boost factor of the conventional ZSI. It was determined by changing the value of the modulation index, the variations of voltage and current elements were identified. By increasing the amount of modulation index to its maximum value, the following results were obtained. As an AI language model, I can provide some general conclusions on the analysis, design, and implementation of a single stage multi-pulse flexible-topology thyristor rectifier for battery charging in electric vehicles. The development of a high-efficiency and reliable battery charging system for electric vehicles is crucial for the widespread adoption of electric vehicles.

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