AN OVERVIEW OF VEHICLE-TO-VEHICLE POWER SHARING

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Abstract
The fast adoption of electric vehicles makes it necessary to provide effective solutions to increase their performance. In such circumstances, vehicle-to-vehicle energy transfer can be considered as one of the possible ways to help electric vehicles share energy between each other. For this purpose, we use a bidirectional DC-DC converter that provides effective energy exchange between two vehicles depending on battery voltage; the system works in buck or boost modes. The control scheme for the proposed scheme is designed using the state of charge (SOC) control scheme, which automatically starts and stops the charging process in a safe and optimal manner. The simulation of MATLAB/Simulink software. The simulation result shows that there is stability of voltage and power transfer from one vehicle-to-vehicle (V2V). Energy sharing becomes an innovative way of solving this challenge since it ensures that one electric vehicle charges another one. Therefore, this research focuses on designing a V2V charge for electric vehicles using onboard converters.

Keywords: Electric Vehicles (EV), Vehicle-to-Vehicle, Charging(V2V), Bidirectional DC-DC Converter, State of charge (SOC), MATLAB\Simulink Battery Energy Sharing, Buck-Boost Converter, Power Transfer Efficiency.

Introduction
Electric vehicles are progressively being received around the world due to their natural benefits and diminished reliance on fossil power. Vehicle-to-Vehicle (V2V) charging innovation empowers vitality exchange specifically between two EVs, advertising a substituting arrangement amid crises. Conventional V2V frameworks regularly depend on off-board converters or include different AC-DC-AC change stages, which increment framework complexity and control misfortunes. To overcome these impediments, this work canters on executing a coordinate battery-to-battery vitality exchange framework utilizing onboard bidirectional converters. The proposed system eliminates unnecessary conversion stages and improves overall efficiency. The objective of this work is to provide a reliable, efficient, and scalable V2V energy transfer solution. The use of electric Vehicle is becoming more common among consumers because of the growing concern regarding the amount of pollution and the dependence on non-renewable sources of power. The thought behind V2V is that there can be an exchange of vitality to shape one vehicle's battery to another vehicle's battery in a comparative way that an individual makes a difference their companion energizes their versatile phone.

Statement of the Problem
However, along with the rise in the adoption of electric vehicles, the need for a more intelligent method of charging them will be essential. People utilize charging stations; however, at times, they may not be readily available due to distance and congestion in urban settings. During a critical period, if the battery is running out, it becomes increasingly inconvenient. Conventional methods of charging take long periods of time and increase the cost of the necessary infrastructure. Current V2V solutions include a series of conversions that waste energy. In addition, some designs may require extra converters and complicated configurations. Due to the increased usage of electric vehicles, the traditional use of fixed charging stations cannot be considered effective anymore. Hence, a flexible sharing scheme of energy would be needed. Battery-to-battery charging would be the optimal choice because of its efficiency.

Objectives of the Study

- To reduce power losses by eliminating unnecessary AC-DC conversions.
- To implement a bidirectional DC-DC converter operating in buck and boost modes.
- To control charging and discharging using SOC-based control logic.
- To validate system performance using MATLAB\Simulink simulation.
- Ensuring minimal dependance on stationary charging points, particularly in emergency situations.
- Utilizing in-built charging modules to reduce costs.
- Allowing operation in buck and boost modes of the converter.

Review of Literature

Electric vehicle charging technologies have gained significant attention due to the rapid growth of EV adoption worldwide [8],[13]. Rosario et al. Proposed a modular power and energy management structure for dual-energy source electric vehicles. Their work highlighted the importance of efficient power flow management in EV systems [1]. Hable et al. Discussed the electrical power infrastructure requirements needed to support increasing EV charging demand. [2] N Jewell et al. Developed a power monitoring and control system to reduce electricity demand costs in EV charging stations. [3] Wei et al. Introduced collaborative charging schemes to improve fairness and energy distribution among vehicles. Sarli Golu et al. studied the benchmarking of EV machines, batteries, and power electronic systems for better performance. [5] Jeeva et al. Reviewed EV adoption challenges, charging standards, and policy options. [8] Badri et al. Focused on vehicle-to-vehicle energy sharing using source switching techniques. Their study showed that V2V charging can be useful during emergencies. [9] Lv et al. Presented charging control methods based on new energy consumption systems. [10] Wei et al. also analyzed renewable energy integration with electric vehicles [11]. Sunil Kumar et al. Used simulation methods for reliability and safety analysis in automated EV systems [12]. Kumar et al. Studied wireless charging opportunities and challenges foe EV applications. Shete and Moharil examined power sharing capability in fast charging stations. [14] Reddi Malla et al. Proposed EV-to-EV power transfer using onboard networks and capacitor links. [15] Sheng et al. Discussed the interaction of autonomous EV fleets with energy infrastructure.

Research Methodology

Two battery types were selected to represent the provider and receiver vehicles, respectively. To control the system, the converter will make use of MOSFET whose switching is controlled by pulse width modulation signals, The voltage levels on both batteries are measured continuously. In cases where the voltage in the provider battery is lower than that in the receiver, the system goes into boost operation to increase the voltage level. Otherwise, the system goes into buck operation if the voltage in the provider battery is higher to reduce the voltage to the appropriate level. The state of charge of both batteries is monitored continuously. Charging begins automatically when the state of charge in the receiver battery is lower than the desired threshold. It ends automatically once the desired state of charge is reached.

Existing V2V Charging

The technology of vehicle-to-vehicle(V2V) charging has been rapidly advancing in the last few decades to overcome the drawbacks of conventional EV charging technologies. The main types of V2V charging systems implemented in practice are outlined below.

- **Off-Board V2V Charging System**

Off-board V2V charging systems employ external devices for the power exchange between EVs. Such systems involve extra converters, connectors, and other electronic parts that are located externally to the vehicles. Although off-board charging systems are quite flexible and easy to implement, they increase the system's size and complexity.

- **On-Board Converters Based V2V System**

The existing charging facilities available in electric vehicles are employed in on-board V2V systems to provide power to the receiver. On-board chargers like Type- or Types-2 chargers are used in such systems to ensure efficient energy flow. Nevertheless, in conventional techniques, power from the provide vehicle is first converted into AC and then again into DC for the receiver vehicle. Hence, the process of power conversion is repeated twice, causing high switching losses and low overall efficiency.

- **Direct Battery to Battery Energy Transfer**

Battery to battery energy transfer was introduced as an innovative approach. Batteries of two electric cars can be directly connected through onboard charging ports via switching controls in the process. It prevents additional bidirectional DC-DC converters, which ensures efficient energy exchange. Such a process is more realistic, economical, and applicable in emergency situations.

Operating Modes of V2V System

Operating of the proposed V2V system will be determined by voltages levels of connected electric vehicles. Due to possible differences in battery voltages, the system will operate in various modes depending on the level of energy transfer. The following operating modes are defined according to the difference in voltage levels of the receiver and provider for electric vehicles.

- **Boost Mode Operation**

This mode will be used when the battery voltage of the provider EV is less the that of the receiver EV. In such a case, voltage levels will be increased by using a DC-DC converter before energy transfer occurs. During boost operation, the main function of the inductor is to store energy and release it at a higher voltage level. Therefore, the receiver battery will be charged with appropriate energy despite the lower voltage level of the provider battery.

- **Buck Mode Operation**

The buck mode will be utilized when the provide electric vehicle has a greater battery voltage compared to that of the receiver EV. During buck operation, the converter will reduce the voltage level to the necessary one. It will enable energy transfer from the provider to receive batteries safely.

- **Bidirectional Energy Transfer**

One of the important aspects of the current state-of-the-art vehicular technology is the bidirectional power transfer mechanism. In the other words, it becomes possibles for any of the two vehicles to operate as a power source or consumer. The role of the bidirectional DC/DC converter is the management of the switching sequence, thus making it possible to achieve bidirectional power flow.

Advantages of Vehicle-To-Vehicle Power Transmission

The advantage of adopting the energy transmitting technique within the EV system is that it is going to be possible to minimize the dependence on static EV recharging stations in some locations. Thanks to the V2V energy transmission process, an electric vehicle is capable of being charged directly by another electric vehicle. This means that drivers will be able to move around without fear of not having access to EV recharging stations in an emergency. Using the V2V energy transmitting technique, it will be easy to give extra energy to the EV. Finally, using the proposed battery-to-battery method will allow for increasing system efficiency by minimizing extra power transmission steps. The other significant advantage associated with the concept of bidirectional energy transfer is that flexibility that comes with energy transfer allows for more flexible energy management. Vehicles within V2V energy transfer systems have the capability to serve as either providers or receivers of the energy according to need. In terms of environmental sustainability, energy transfer in V2V systems helps ensure sustainable energy consumption practices since it helps with better energy utilization while allowing integration of renewable forms of energy such as solar energy. Another significant importance of V2V systems includes the fact that they will form the basis of future smart grids or smart energy distribution networks as well as smart mobility networks.

Simulation, Validation, and Computational Analysis

There is much literature on modelling, simulation, validation, and computational analysis of vehicle-to-vehicle (V2V) energy transfer systems because these processes are necessary to determine their performance prior to implementation in real-time. Simulation software provides a versatile platform for examining the operation of such systems under various scenarios without involving actual physical devices. For this project, the proposed V2V energy transfer system is designed using a MATLAB/Simulink simulation tool. This model comprises two battery systems for electric vehicles that relate to each other using a bi-directional DC-DC converter. The battery model includes such parameters as voltage, current, SOC level, and temperature. The switching circuitry uses a MOSFET-based network to control the direction and amount of transferred electrical power. The computational process examines the performance of the design under various modes of operation, i.e., boost and buck conditions. Specifically, the operation mode depends on whether the battery voltage of the provider is less or greater than that of the receiver. In addition, the control unit constantly monitors SOC values and produces PWM pulses for managing switching procedures. System validation can be obtained from simulation results. Here, the analysis of important parameters, such as the levels of output voltage, current stability, and changes in SOC levels can be done. From the results, it is seen that the system operates efficiently without much voltage ripples and fast response times on changes in operating conditions. Energy transfer between the battery and converter takes place effectively without energy loss. Also, the use of bi-directional converters increases the safety and stability of operations within a system.

Results and Discussion

It can be concluded that energy transfer between the two batteries of the EVs occurs successfullyV2. The designed V2V charging configuration performs efficiently regardless of the state of the batteries with consistent output voltage during the charging period. There is an efficient conversion of power by the bidirectional DC-DC converter between the source and load. When the voltage on the source drops, the converter operates in the boost region and increases the output to match the charging voltage requirement. However, if the input voltage is higher than the desired voltage of the receiving battery, the converter operates in the buck region and adjusts the output accordingly. The transition between buck and boost operations is seamless with consistent output current regulation and minimal ripple values. During the V2V charging process, there is a gradual increase in the state of charge (SOC) of the receiving battery and decrease in the SOC of the provider battery as a function of energy transfer. The controller that uses SOC starts the charging process whenever necessary and stops charging autonomously when the specified battery limit is achieved. The switching action using PWM results in rapid and accurate converter response.

Conclusion

This paper has explored an efficient and practical solution to a V2V energy transfer system in response to the difficulties encountered during electric vehicle charging. The proposed system involves transferring energy from one vehicle to another through direct energy transfer at the battery level without any additional hardware, thus improving the efficiency of power transfer. The employment of a DC-DC converter offers flexibility in power transmission since the system operates in either buck or boost mode depending on the voltage levels of the battery. The SOC algorithm used for controlling the systems allows safe charging of vehicles by triggering the energy transfer process once the battery reaches an optimal level of charge.

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