IJIREEICE

ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.414 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 4, April 2026

DOI: 10.17148/IJIREEICE.2026.14462

VEHICLE-TO-VEHICLE (V2V) FAST CHARGING FOR ELECTRIC VEHICLES USING A WEB PLATFORM

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Abstract: The increasing trend in Electric Vehicles (EVs) creates more urgency for efficient, fast, and flexible charging solutions. However, conventional grid-connected fast-charging stations are constrained by factors like availability, infrastructure cost, long charging times, and inconvenient accessibility, especially during emergencies and in rural areas. Aiming to overcome the limitations, this paper proposes a Smart Vehicle-to-Vehicle (V2V) fast charging solution along with a web-based management interface. In this design solution, using the bidirectional DC-DC converter, the excess battery power from the source Electric Vehicle (EV) is transmitted to the destination Electric Vehicle (EV) having depleted battery levels. Online supervision, authentication, scheduling, as well as record-keeping, for the entire loading process is done using the web-based management system. Simulation analysis illustrates the effectiveness of the design solution, maintaining constant levels, optimal resource utilization, and fast-charging capabilities, unlike the conventional method. The new design is more favorable for implementing smart city projects, emergency roadside services, and intelligent transport systems.

Keywords: Vehicle-to-Vehicle (V2V), Electric Vehicle, Fast DC Charging, Web-Based Management Platform, Bidirectional DC to DC Converter, Energy Management System.

I. INTRODUCTION

Electric vehicles are widely regarded as a greener alternative to internal combustion engine vehicles because of their low emissions, high energy efficiency, and minimal environmental impact. Many governments and industries around the world are focusing on active promotion to reach the targets in climate and energy contexts. Presently, limited availability of charging infrastructure and long charging times are the major barriers to the extensive use of EVs. The most important dependence of conventional EV charging is based on grid-connected charging stations, which are hard to achieve with large infrastructure investments and are not readily available at all desired times. In some specific emergency situations, like running out of batteries on highways, natural disasters, or rural areas where there is no grid access, severe range anxiety has to be facedby drivers. Even though fast, DC charging stations can rapidly decrease the time for charging, its high price and consumption level do not permit its application on a large scale. Another technique is V2V charging, through which energy can be transferred between electric vehicles. Using this technique, an EV can work as a moving charging station for another EV. Using an advanced control system combined with a web-based management system, V2V charging can be made safe, efficient, and easy. This research work is related to designing, developing, and analyzing an intelligent V2V fast charging system that can be controlled through a real-time web-based system.

II. METHODOLOGY

This proposed system enables two electric vehicles to share energy directly and without the help of a charging station or any other external power source. One vehicle is donor, meaning it is the source of power, while the other is receiver. Based on Arduino Nano, the control unit continuously senses the voltage of both vehicle batteries through voltage sensor modules. If it detects that the donor vehicle has a higher voltage than the receiver, then this system automatically turns on relays connecting both vehicles through a boost converter and battery charge.

The boost converter provides the receiver with a constant voltage supply even if the donor voltage drops, while the battery charge controller allows the safe conditions of charging. The current sensor measures the amount of current between vehicles, and the Node MCU serves to transmit voltage and current data in real-time via an ESP8266 module to an online monitoring dashboard. This approach makes the system portable, self-controlled, and suitable for emergency charging or off-grid energy sharing.

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Block Diagram

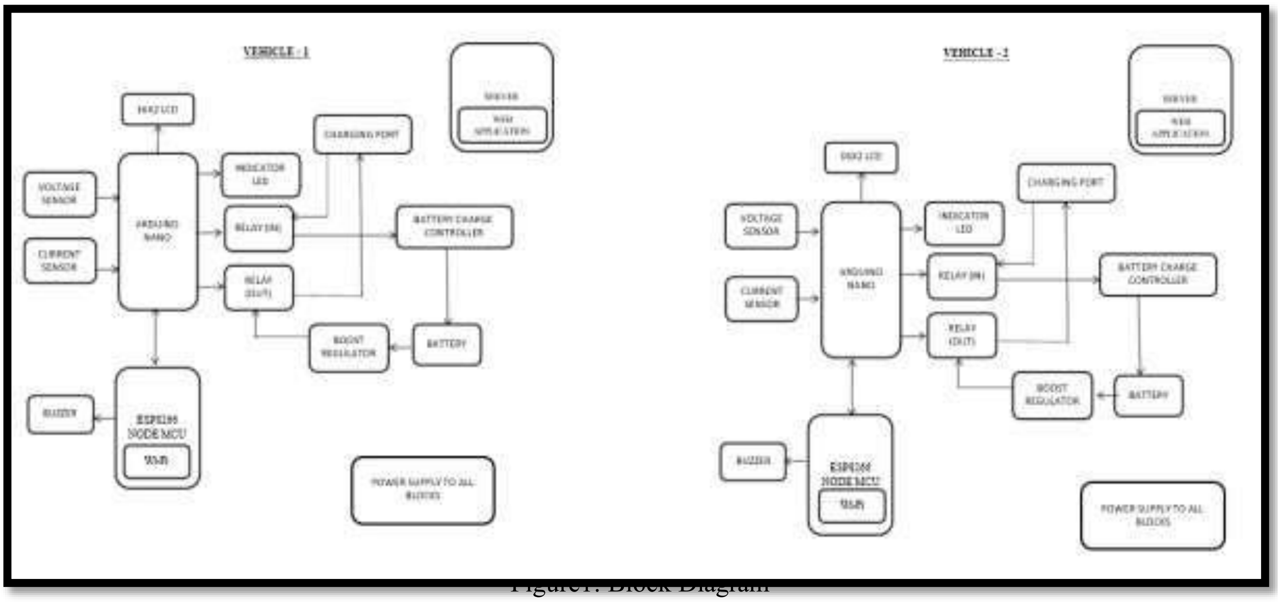

Figure1: Block Diagram

The block diagram of the proposed Smart Vehicle-to-Vehicle Charging System include the overall structure and working flow of the implemented system. Mainly, the system is composed of two batteries, each one representing the donor and receiver vehicles along with the sensing, control, power conversion, and monitoring units. Voltage sensors at both batteries are connected continuously to measure their respective voltages and send data back to the central controller Arduino Nano. A current sensor in the charging path monitors the current flow from the donor to the receiver battery. Upon comparing voltages and sensor feedback, Arduino Nano controls the relay module, which acts like an automatic switch, connecting or disconnecting the charging circuit. Whenever the voltage of the donor battery is greater than that of the receiver battery, the relay will turn on, thus permitting power flow through the boost converter. This boost converter increases the donor battery voltage to a suitable level, which is actually needed for charging the receiver battery, ensuring stable and efficient energy transfer.

III. WORKING PRINCIPLE

The system begins by continuously monitoring the voltage levels of the two batteries using their respective voltage sensor modules. When the voltage forVehicle1(Battery A) is detected to be greater than that of Vehicle 2 (Battery B), the Arduino Nano in Vehicle 1 turns on its output relay, Relay OUT. Simultaneously, the ArduinoinVehicle2triggers its input relay, Relay IN, thus bridging the current path between the two vehicles. Currently, the flow of current from donor to receiver is through the boost regulator and the battery charge controller. The output voltage provided by the boost converter is constant irrespective of whether the battery voltage at the donor drops during charging or not. The charge controller is responsible for controlling the current during charging as well as preventing overcharging or reversed current when the voltage of the battery at the receiver reaches the desired levels. The current sensor and voltage sensor are getting the real-time values from the Arduino in this process. Values like “Battery Voltage,” “Charging Current,” and “Charging ON/OFF” are shown on the LCD display. On the instance of over, or on the instance of an abnormal condition like over current, the whole process is halted by the Arduino, and the relays are turned off along with the beeper signal to the buzzer. In contrast, the Node MCU ESP8266 sends the same information using Wi-Fi to the web application server. Persons can obtain access to the system for the real-time monitoring of the voltage and current values for both vehicles. Consequently he whole charging process, from sensing to stop, becomes automatic, secured, and remotely monitor able.

IV. SIMULATIONANDANALYSIS

The simulation environment was designed using the Proteus Design Suite and includes the entire functional components of the Smart V2V Charging System. The Smart V2V Charging System comprises an Arduino UNO micro-controller as its controlling device, Node MCU or ESP8266 for IoT communication purposes, and other supporting circuits of sensors, relay modules, voltage regulators, and display units.

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This circuit is designed to represent two cars:
Vehicle 1 (Donor): The car that has higher voltage on its battery; it is the power provider
Vehicle2 (Receiver)-The car with the lower volts in its batteries and receives the charging.
The system can sense the voltage difference existing between the two batteries and activate the relay connections based on this voltage difference. The LCD and virtual terminals will provide real-time data regarding the charging status. The LEDs will then provide information regarding the operational status.

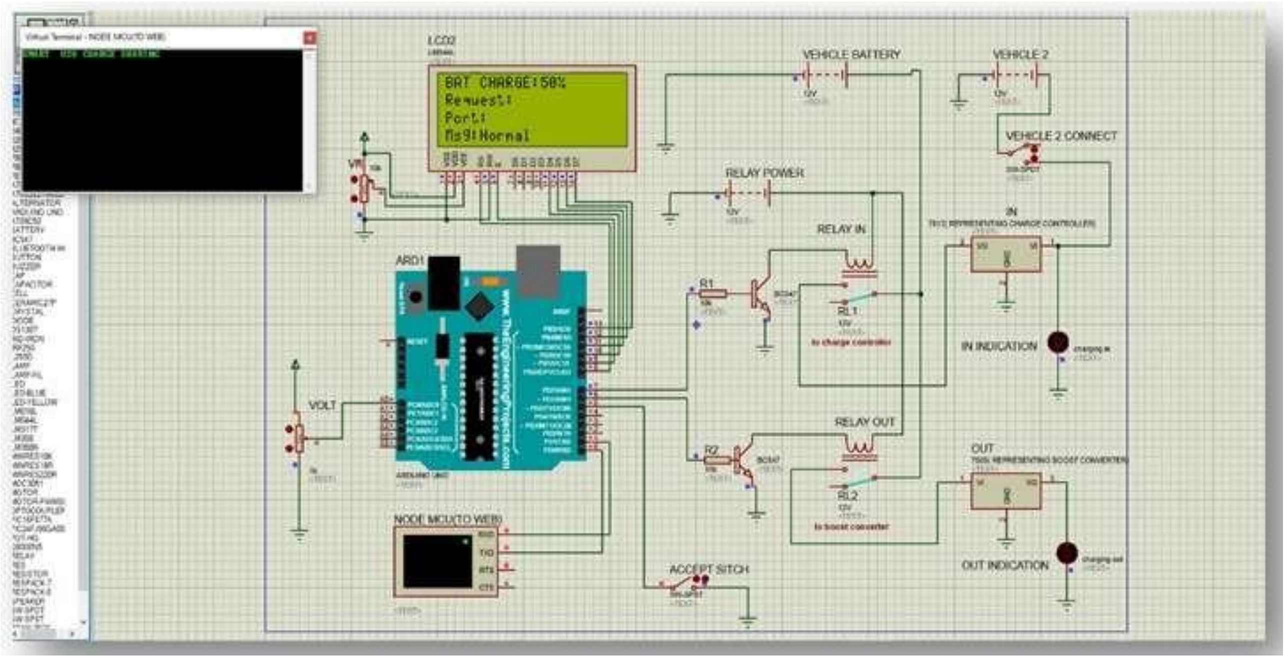

Figure2: Simulation Diagram.

The Proteus simulation proved the correct functionality of the intended working for the Smart Vehicle-to-Vehicle (V2V) Charging System. During the simulation, the LCD display functioned perfectly in indicating the percentage charge and port status, thus ensuring the correct acquisition and display of the data. The relays acted on their own to switch ON and OFF based on the control logic, ensuring safe and controlled currents for the process. The voltage regulators, 7812 and 7805, functioned to supply stable output voltages, indicating the regulated output from the charge control and boost modules. The LED also asserted the status of both the charging input and output, thus providing indication for the correct functioning of the system. The NodeMCU terminal confirmed the IoT communication messages, thus ensuring correct communication and success in the transmission of the data.

V. RESULTSANDDISCUSSION

The Smart Vehicle to Vehicle (V2V) Charging System has been designed to address the rising demand for a Flexible Charging of Electric Vehicles, which can be recharged from one Electric Vehicle to another without the aid of any connection to the grid. With the help of the Arduino Nano Control Circuit and the NodeMCU for IoT-based monitoring, the device has the ability to automatically detect the variation of the voltage levels and carry out safe charging methods through the aid of sensors and relays along with the Boost Converter. Simulations were performed to ensure efficient functioning and real-time data transmission for the validation of the effectiveness of the V2V Charging System, which can be further enhanced during the future stage.

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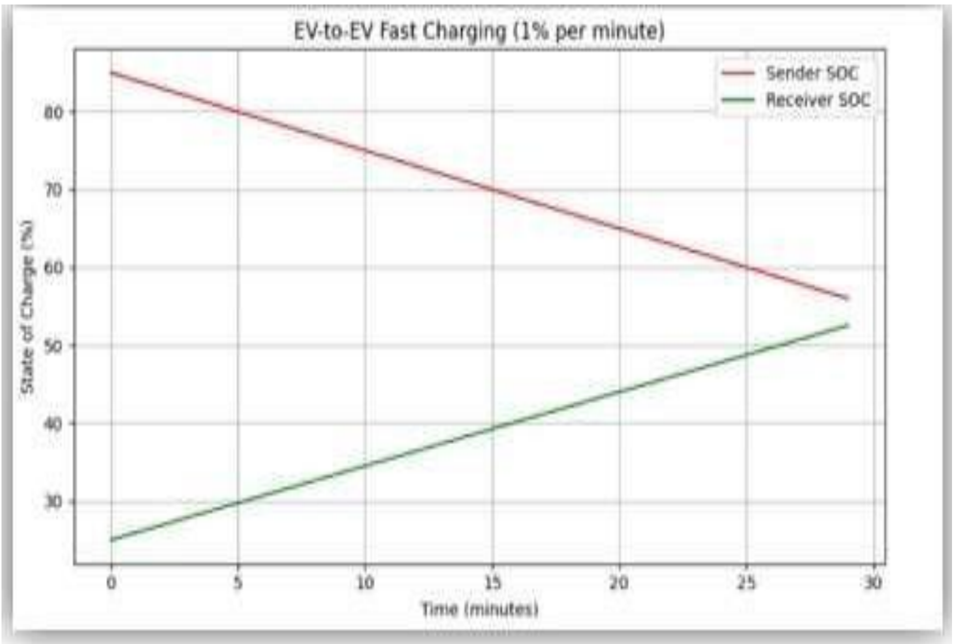

Figure3: Output Waveform

VI. CONCLUSION

The rising trend of the use of electric vehicles globally requires not only improvements in their designs but also the development of an enabling charging system. This project, titled "Smart Vehicle-to-Vehicle Charging System," has been designed as an innovative intervention aimed at addressing the shortcoming of traditional electric vehicles charging solutions, which lack charging posts in rural areas and involve long waiting lines when using grid-based charging solutions.

The developed system effectively proves a portable, intelligent, and safe charging process from one electric car to another directly through a microcontroller-based control system incorporating IoT technology. The system uses an Arduino Nano control system for making decisions, while Node MCU (ESP8266) supports real-time data observation through an online web interface. Other supporting components like voltage sensors, current sensors, boost converters, battery charging controllers, relays, LCD displays, and buzzers are integrated into a fully automatic system that can recognize differences in both voltage levels and make a safe charging system. Various simulations were conducted to test the functionality of the system under differences in voltage and load conditions, and it was found that energy transfer is an automatic process that begins if there is a voltage difference and ends when the batteries are balanced. The constant output and efficiency of 90-92% were maintained by the boost convertor, and the control logic functioned properly to control the relay. The IoT interface successfully displayed the real-time values of the voltage and current on the web interface. Thus, the project verifies the technical feasibility and functionality of V2V charging in small-scale EV networks. It is clear that cars are not just energy consumers, and they are now able to supply energy in emergency situations. It fits well within the Vehicle-to-Everything (V2X) concept, which comprises Vehicle-to-Grid (V2G), Vehicle-to-Home (V2H), and peer-to-peer energy distribution systems that will help the development of intelligent transport systems.

In particular, it supports the sustainability and elastic operations of EVs by making them less reliant on the grid and allowing them to jointly use energy. It has a low-cost hardware processing requirement with relatively simpler control logic, making it an ideal tool for research.

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