International Journal of Scientific Research and Engineering Development-– Volume 9 Issue 2, Mar-Apr 2026
Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

IOT BASED: V2X (Vehicle-to-Everything) Technology

Falgun Mahesh Saindane[1], Yogeshwar Girish Bhavsar[2], Matin Mqsood Shaikh[3], Atharv Dipak Chandak[4], Prof. S. S. More
[1234]Student, Department of Electrical Engineering, MET's Institute of Technology – Polytechnic, Adgaon, Nashik, Maharashtra, India

----------**********----------

Abstract:

The rapid growth of electric vehicles has created a need for flexible and efficient charging solutions. Conventional EV charging methods depend on fixed charging stations, which may not always be available in emergency situations. This limitation highlights the importance of intelligent energy management systems that enable energy sharing between electric vehicles.

This paper presents the design and development of a V2X (Vehicle-to-Everything) based smart energy sharing system. The system uses a NodeMCU (ESP8266) microcontroller, voltage sensor module, relay module, and lithium-ion battery pack to monitor and control energy flow. Real-time battery data such as voltage and percentage is transmitted to a mobile application using IoT technology.

The system supports Vehicle-to-Vehicle (V2V) energy sharing and Vehicle-to-Grid (V2G) operation, allowing energy transfer between vehicles and external loads during emergency conditions. The proposed system demonstrates efficient energy utilization and highlights the potential of V2X technology in future smart transportation and energy management systems.

Keywords — Vehicle-to-Everything (V2X), Electric Vehicles, Energy Sharing, NodeMCU ESP8266, Internet of Things (IoT), Reverse Charging System.

----------**********----------

I. INTRODUCTION

Electric vehicles (EVs) are rapidly gaining importance in modern transportation due to their ability to reduce environmental pollution and dependence on fossil fuels. With the increasing adoption of EVs, the demand for efficient charging infrastructure and energy management systems has also grown significantly. However, one of the major challenges faced by EV users is the limited availability of charging stations, especially in emergency situations where the battery level becomes critically low.

To overcome these limitations, Vehicle-to-Everything (V2X) technology has emerged as a promising solution. V2X enables electric vehicles to communicate and exchange energy with other vehicles, the power grid, and surrounding infrastructure [1]. This concept allows EVs not only to consume energy but also to act as mobile energy storage units capable of supplying energy when required. One important application of this technology is Vehicle-to-Vehicle (V2V) energy transfer.

In this work, a V2X-based smart energy sharing system is developed using a NodeMCU ESP8266 microcontroller, voltage sensing module, relay module, and lithium-ion battery pack. The system is designed to monitor battery parameters and enable controlled energy exchange between electric vehicles through a mobile application.

The proposed system also supports reverse charging and emergency power supply, demonstrating Vehicle-to-Grid (V2G) functionality. This approach improves energy utilization, reduces dependency on fixed charging stations, and contributes to the development of smart transportation and energy management systems.

II. LITERATURE REVIEW

Various studies have been carried out in the field of electric vehicle charging and energy management systems to improve efficiency and flexibility. Early EV charging methods primarily relied on centralized grid-based charging stations, which created challenges such as limited accessibility and increased waiting time [2]. These limitations highlighted the need for alternative and more flexible charging solutions.

Researchers later introduced advanced energy management techniques that allow electric vehicles to interact with the power grid. Vehicle-to-Grid (V2G) technology enables EVs to supply stored energy back to the grid during peak demand, thereby improving grid stability and energy distribution [3]. This concept has gained significant attention in smart grid applications.

With the rapid development of Internet of Things (IoT) technology, modern EV systems now incorporate microcontrollers, sensors, and wireless communication modules for real-time monitoring and control. Platforms based on NodeMCU and ESP8266 have been widely used to develop smart charging systems with remote accessibility and control features [4].

Recent research has also focused on Vehicle-to-Vehicle (V2V) energy sharing, where one electric vehicle can provide energy to another in emergency situations [5]. This concept is particularly useful in scenarios where charging infrastructure is not readily available. These advancements indicate that integrating V2X technology with IoT can significantly enhance the efficiency and reliability of EV energy systems.

III. METHODOLOGY

The proposed V2X system is designed to enable smart energy exchange between electric vehicles using IoT-based monitoring and control. The NodeMCU ESP8266 microcontroller acts as the central control unit, responsible for processing sensor data and managing system operations [6]. A voltage sensor module is used to continuously monitor the battery voltage, which is then used to estimate battery status.

Two electric vehicle units are connected to a mobile application through wireless communication. The application displays real-time battery parameters such as voltage, battery percentage, and system status. This allows users to monitor their vehicle condition remotely and take necessary actions when required.

The system implements Vehicle-to-Vehicle (V2V) energy sharing by allowing users to send charging requests through the mobile application. When a vehicle with low battery sends a request, nearby users receive the notification and can accept the request to provide energy. The relay module is used to control the energy transfer between vehicles.

In addition, the system supports Vehicle-to-Grid (V2G) functionality, where the battery can supply power to external loads during emergency situations such as power outages. A Battery Management System (BMS) is used to ensure safe operation of the battery by protecting it from overcharging, over-discharging, and short circuits.

IV. HARDWARE DESCRIPTION

The hardware implementation of the V2X system includes components such as NodeMCU ESP8266, voltage sensor module, relay module, lithium-ion battery pack, and Battery Management System (BMS). The NodeMCU serves as the main controller and provides Wi-Fi connectivity for communication with the mobile application [7].

The voltage sensor module is used to measure the battery voltage and provide input to the microcontroller. Based on this data, the system calculates battery percentage and determines the charging status. The relay module is used to control the flow of electrical energy between the battery and external load or another vehicle.

The Battery Management System (BMS) plays a crucial role in ensuring battery safety by protecting it from abnormal conditions such as overcharging and short circuits. The lithium-ion battery pack acts as the primary energy storage unit and supports both charging and discharging operations in the system.

V. RESULTS AND DISCUSSION

The developed V2X system was tested under different operating conditions to evaluate its performance. The voltage sensor successfully measured battery voltage and transmitted data to the

NodeMCU, which then sent real-time updates to the mobile application.

The application displayed battery parameters such as voltage, percentage, and system status accurately. It also provided alerts when the battery level dropped below a certain threshold, enabling timely action by the user.

The Vehicle-to-Vehicle (V2V) energy sharing feature was tested by sending charging requests between two vehicles. The relay module effectively controlled the energy transfer process, ensuring smooth and reliable operation.

The system also demonstrated Vehicle-to-Grid (V2G) functionality by supplying power to an external load during testing. The results indicate that the proposed system operates efficiently and provides a practical solution for smart energy sharing in electric vehicles [8].

VI. HARDWARE FIGURES

A. Circuit Diagram

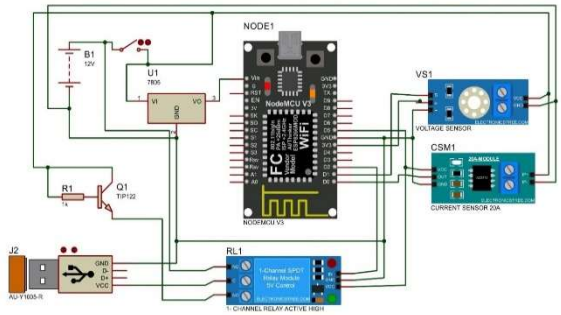

Fig. 1 Circuit Diagram

The circuit diagram shows the complete connection of the V2X system including NodeMCU, voltage sensor, relay module, battery pack, and BMS.

B. NodeMCU ESP8266

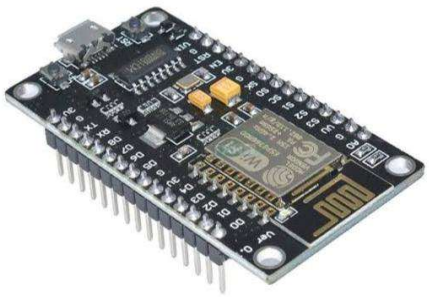

Fig. 2 NodeMCU ESP8266

The NodeMCU acts as the main controller for processing data and enabling Wi-Fi communication with the mobile application.

C. Relay Module

Fig. 3 5V Relay Module

The relay module controls the energy flow between the battery and load during charging and reverse charging operations.

D. Voltage Sensor Module

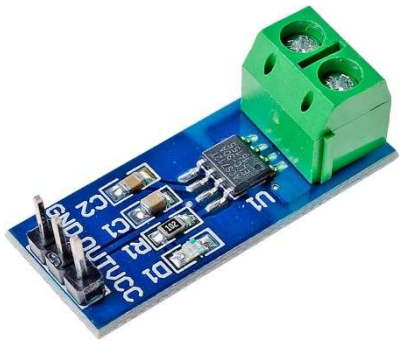

Fig. 4 Voltage Sensor Module

The voltage sensor measures battery voltage and provides input to the microcontroller for monitoring battery status.

E. Battery Management System (BMS)

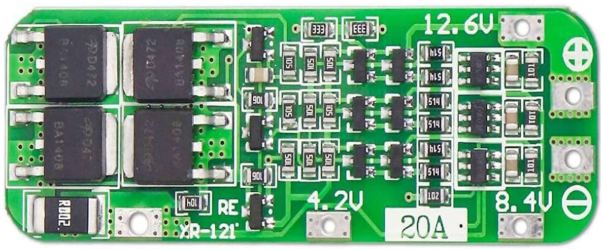

Fig. 5 Battery Management System

The BMS ensures safe operation of the battery by protecting it from overcharging, over-discharging, and short circuits.

F. Battery Pack

Fig. 6 Lithium-ion Battery Pack

The lithium-ion battery pack acts as the main energy storage unit used for charging and energy transfer.

VII. CONCLUSION

The proposed V2X (Vehicle-to-Everything) system successfully demonstrates the concept of smart energy sharing between electric vehicles using IoT-based monitoring and control. The system enables real-time tracking of battery parameters such as voltage, percentage, and operational status through a mobile application. The implementation of Vehicle-to-Vehicle (V2V) energy sharing allows one electric vehicle to provide energy to another in emergency situations, while the Vehicle-to-Grid (V2G) functionality enables the battery to supply power to external loads when required.

The developed prototype operates reliably and effectively under different conditions, demonstrating controlled energy transfer using relay-based switching and proper battery management. The integration of NodeMCU ESP8266, voltage sensing, and Battery Management System ensures safe and efficient operation. Overall, the system improves energy utilization, reduces dependency on fixed charging infrastructure, and highlights the practical feasibility of V2X technology in future smart transportation and energy management systems.

VIII. FUTURE SCOPE

The proposed system can be further enhanced by integrating GPS-based location tracking to automatically identify nearby vehicles for energy sharing. This would allow users to send and receive charging requests more efficiently without manual input. Additionally, cloud-based data storage and real-time monitoring dashboards can be implemented to improve system scalability and performance.

Further improvements can include the use of high-efficiency bidirectional converters and advanced battery technologies to increase energy transfer efficiency. Features such as automated request handling, dynamic pricing, and secure communication protocols can enhance user experience and system reliability. With these advancements, the V2X system can be expanded for large-scale deployment in smart cities and future intelligent transportation networks.

IX. REFERENCES

[1] W. Kempton and J. Tomic, “Vehicle-to-Grid Power Implementation: From Stabilizing the Grid to Supporting Large-Scale Renewable Energy,” Journal of Power Sources, 2005.

[2] T. Markel, K. Bennion, and W. Kramer, “Vehicle-to-Grid Communication and Control for Electric Vehicles,” IEEE Smart Grid Conference, 2010.

[3] A. Yilmaz and P. T. Krein, “Review of Battery Charger Topologies, Charging Power Levels, and Infrastructure for Plug-In Electric and Hybrid Vehicles,” IEEE Transactions on Power Electronics, 2013.

[4] F. Mwasilu, J. J. Justo, E. K. Kim, T. D. Do, and J. W. Jung, “Electric Vehicles and Smart Grid Interaction: A Review on Vehicle-to-Grid and Renewable Energy Integration,” Renewable and Sustainable Energy Reviews, 2014.

[5] J. Tomic and W. Kempton, “Using Fleets of Electric Vehicles to Support Power Grid Operations,” Journal of Power Sources, 2007.

[6] S. Deilami, A. S. Masoum, P. S. Moses, and M. A. S. Masoum, “Real-Time Coordination of Plug-In Electric Vehicle Charging in Smart Grids,” IEEE Transactions on Smart Grid, 2011.

[7] Espressif Systems, “ESP8266EX Datasheet,” Available: https://www.espressif.com

[8] G. A. Putrus, P. Suwanapingkarl, D. Johnston, E. C. Bentley, and M. Narayana, “Impact of Electric Vehicles on Power Distribution Networks,” IEEE Vehicle Power and Propulsion Conference, 2009.

