

An Efficient Grid Independent E-Vehicle

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ABSTRACT: Solar powered electric vehicle is environment friendly transportation means. In this project solar cells used to charge battery and supply power to drive electric motor. It is powered by energy of sun. Solar panels, rechargeable battery, charge controller and electric drive are used for efficient conversion of solar energy into mechanical energy of vehicle. It reduces the consumption of fuel, air pollution and dependency on fossil fuels. By using solar energy as fuel we can reduce our expenditure on fuel which burns and pollutes the environment. Solar electric vehicles provide lower operating costs, pollution free environment, use of clean fuels and improved efficiencies than that of conventional vehicles. Prototype prove satisfactory operation, efficient battery charging and stable performance even during variation of climatic conditions. Solar electric vehicles can be used in green Electric transportation and smart energy field in future.

I. INTRODUCTION

Vehicle (EV) refers to vehicles that are designed for transportation of people and goods from one point to another using electric motors and rechargeable batteries instead of using fossil fuels like petroleum products. They help minimize air pollution, fuel consumption, and reduce the demand for fossil fuels and conserve energy. Features implemented in new generation electric vehicles are motor drivers, sensors, Micro-controller unit and wireless controlling circuit of EV. However, charging the battery and driving range are the main problems faced by these vehicles. Charging using solar panels solves this problem, Solar-powered electric vehicle is the vehicle which can be charged by Solar power. Battery and solar panels are used in these vehicles to harness solar power and make the vehicle run efficiently by using solar renewable energy. This also leads to better energy efficiency and lesser dependency on charging stations

II. PROBLEM STATEMENT

The growing demand for fuel, the rise in environmental pollution, and our reliance on non-renewable energy sources have sparked a pressing need for sustainable transportation solutions. While traditional electric vehicles do a better job at cutting down harmful emissions compared to gas-powered cars, they still rely heavily on charging stations. The need for frequent charging, limited battery life, and energy management challenges can really impact how efficient and practical these electric vehicles are. In many rural and remote areas, the scarcity of charging stations makes them even less usable. To tackle these issues, incorporating renewable energy sources like solar power into electric vehicles is becoming a key solution for the future of transportation.

III. OBJECTIVES

The main goal of this project is to create a solar-powered electric vehicle prototype that harnesses renewable solar energy for eco-friendly and sustainable transportation. By integrating solar panels with a rechargeable battery system, we aim to cut down on our reliance on traditional energy sources, ensuring efficient power generation and storage.

Another key aspect of the project is to introduce a wireless remote-control system using RF transmitter and receiver modules, allowing for smooth navigation and real-time operation of the vehicle. Additionally, we're focusing on incorporating embedded system components like ESP32 controllers, motor drivers, rechargeable batteries, voltage regulation circuits, and DC motors into a compact and efficient vehicle model. This will help us achieve stable performance and effective power management.

The main objectives of the proposed system are

- To implement a wireless remote-control mechanism using RF transmitter and receiver modules for seamless vehicle navigation and real-time operation.
- To integrate embedded system components such as ESP32 controllers, motor drivers, voltage regulation circuits, rechargeable batteries, and DC motors into a compact and efficient vehicle model.
- To ensure stable vehicle performance, efficient power management, and reliable operation under various working conditions.
- To develop a low-cost, educational prototype that showcases the practical use of renewable energy, embedded electronics, and wireless communication technologies.
- To raise awareness about clean energy solutions and encourage the adoption of sustainable transportation systems for future applications

IV. METHODOLOGY

The proposed solar-powered electric vehicle features a system architecture that includes ESP32 controllers, RF communication modules, DC motors, rechargeable batteries, solar panels, and motor drivers. The ESP32 controller is responsible for managing wireless communication and controlling the vehicle's movement via RF-based remote control. Solar panels play a crucial role in charging the battery and enhancing energy efficiency, while the motor driver directs the vehicle's movement in various directions. This system showcases effective wireless control, the use of renewable energy, and reliable vehicle performance.

V. BLOCK DIAGRAM

The block diagram illustrates the complete architecture and workflow of the proposed solar-powered electric vehicle system. It features key components like the ESP32 controller, RF communication modules, motor driver, DC motors, rechargeable battery, and solar panel. This diagram clarifies how wireless control signals are transmitted for vehicle movement and highlights the use of solar energy for effective power management and vehicle operation.

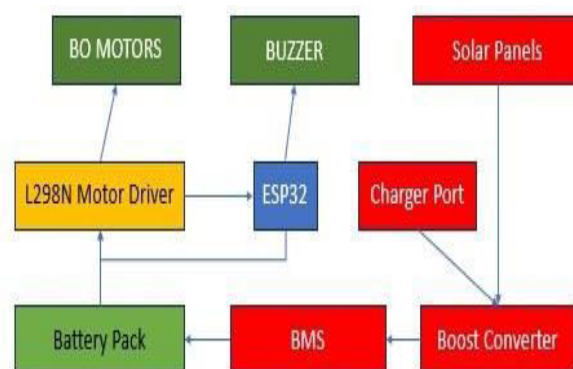


Fig 5: Block Diagram of the proposed system

VI. CIRCUIT DIAGRAM

The diagram below illustrates the circuit connections for a Solar Powered Electric Vehicle, along with a list of components used in this project. The circuit functions as depicted in the figure, fulfilling its intended purpose.

In this proposed solar-powered electric vehicle, the circuit diagram features both transmitter and receiver sections, which are built around ESP32 controllers. The transmitter unit employs joystick controls to create movement commands—like moving forward, reversing, and turning left or right—which are sent wirelessly using UDP-based Wi-Fi communication. The receiver unit picks up these commands and manages the DC motors through a motor driver circuit to facilitate vehicle movement. A rechargeable battery powers the entire system, while a solar panel helps recharge the battery using clean, renewable solar energy. Additionally, voltage regulation circuits are in place to ensure stable power distribution, enabling efficient wireless communication, motor control, and smooth overall vehicle operation.

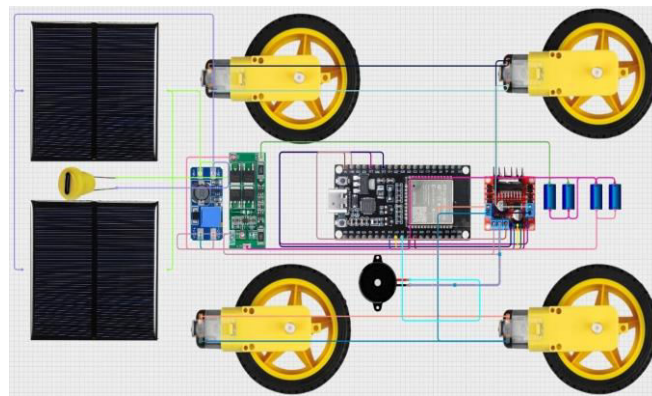


Fig 6: Circuit Diagram of the proposed system

VII. WORKING OF THE PROPOSED SYSTEM

The solar-powered electric vehicle system is an innovative blend of renewable solar energy, rechargeable batteries, wireless communication, and smart control technology. It's made up of two key parts: the transmitter unit and the receiver unit in the vehicle. The transmitter is in charge of sending movement commands, while the receiver takes those commands and directs the vehicle's actions based on the wireless signals it gets. When you turn the system on, the ESP32 controller in the transmitter picks up the joystick inputs and creates directional commands like forward, reverse, left, and right. These commands are then sent wirelessly via RF communication to the receiver unit on the vehicle. On the receiving end, the ESP32 controller processes the incoming signals and sends the right control outputs to the motor driver circuit. This motor driver manages the DC motors that are connected to the vehicle's wheels, allowing for smooth movement in various directions. The vehicle runs on a rechargeable lithium-ion battery, while a solar panel harnesses sunlight to generate electrical energy, helping to charge the battery and boost energy efficiency. Voltage regulation circuits ensure a stable power supply for the ESP32 controllers, RF modules, and motor driver circuits. This integrated system showcases effective wireless vehicle control, the use of renewable energy, smart battery management, and eco-friendly transportation through advanced embedded technology.

VIII. HARDWARE IMPLEMENTATION

The success and dependability of this project hinge on choosing and integrating the right hardware components. Every part of the system, from the ESP32 microcontroller to the BO motor and power supply, is essential for ensuring precise operation and reliable communication. By focusing on thoughtful design, thorough testing, and careful configuration, we can make sure that all components work together seamlessly and efficiently.

The hardware components needed for the proposed system include: ESP32 x2 • BMS x1 • L298N x1 • BOOST CONVERTER x1 • BUCK CONVERTER x1 • DUAL AXIS JOYSTICK MODULE x1 • LITHIUM ION BATTERY x6 • SOLAR PANELS x2 • BO MOTORS x4 • BUZZER x1 • TYPE C FEMALE PORT x1

IX. SOFTWARE IMPLEMENTATION

The development of software for the proposed solar-powered electric vehicle system is done using Platform I O alongside Visual Studio Code. This combination creates a streamlined environment for programming, compiling, debugging, and uploading firmware to the ESP32 controllers that are part of both the transmitter and receiver sections. The ESP32 controllers are programmed in Embedded C/C++ to facilitate UDP-based Wi-Fi communication, enable wireless vehicle control, and manage motor driver operations. The transmitter program captures joystick inputs and sends out directional commands, while the receiver program interprets the incoming signals to control the DC motors accordingly. Platform IO also offers features like library management, serial monitoring, debugging tools, and ESP32 board configuration, making it a great fit for embedded and IoT applications. This integrated software environment guarantees reliable wireless communication, effective motor control, and stable performance for the solar-powered electric vehicle system

X. RESULTS AND DISCUSSION

To kick things off, the user turns ON both the transmitter and receiver parts of the solar-powered electric vehicle system. The ESP32 controller in the transmitter picks up the joystick inputs and creates movement commands like forward, reverse, left, and right. These commands are then sent wirelessly via RF communication to the receiver unit that's attached to the vehicle. The receiver ESP32 is always on the lookout, receiving and processing the signals to manage the motor driver and DC motors, making the vehicle move as intended. A rechargeable lithium-ion battery powers the entire system, while a solar panel works its magic, converting sunlight into electrical energy to keep the battery charged and boost energy efficiency. Voltage regulation circuits ensure that the ESP32 controllers, RF modules, and motor driver components receive stable power for dependable operation. This setup guarantees smooth wireless control, efficient motor performance, and solid communication between the transmitter and receiver units.

The prototype has successfully showcased all the features it was designed for:

- Seamless wireless communication between the transmitter and receiver units.
- Dependable vehicle movement in all directions: forward, reverse, left, and right.
- Effective solar-assisted battery charging and power management.
- Consistent motor control and real-time vehicle responsiveness.

XI. APPLICATIONS

1. Eco-Friendly Transportation Applications:
 - Designed to create sustainable transportation systems that run on renewable solar energy.
 - Aims to cut down on air pollution and lessen our reliance on fossil fuels.
2. Educational and Research Applications:
 - Great for engineering students and researchers exploring embedded systems and electric vehicle technology.
 - Showcases the practical use of ESP32 controllers, solar charging, and wireless communication.
3. Robotic and Remote-Control Applications:
 - Can be tailored for remote-controlled robotic vehicles and surveillance systems.
 - Facilitates wireless navigation and real-time motor control tasks.
4. Smart Mobility
 - Valuable in the realm of smart transportation and autonomous vehicle research
 - Can be adapted for lightweight electric transport and campus mobility solution
5. Prototype and Industrial Applications:
 - Ideal for developing prototypes and experimenting with renewable energy systems.
 - Fits well with small-scale industrial transport and automation needs.

XII. FUTURE SCOPE

the proposed solar-powered electric vehicle system. One key enhancement could be the integration of advanced battery management systems, which would boost power efficiency and extend the vehicle's operational time. We could also take things up a notch by incorporating GPS and IoT-based monitoring, allowing for real-time vehicle tracking and smarter mobility solutions. Future iterations might even feature autonomous navigation, obstacle detection sensors, and AI-driven control systems to make vehicle operation more intelligent. Plus, we could integrate higher-capacity solar panels and more efficient energy storage systems to enhance charging performance and driving range. On top of that, this system could be adapted for practical uses in smart transportation, agricultural utility vehicles, and lightweight commercial electric mobility options.

XIII CONCLUSION

The “Solar Powered Electric Vehicle” project is a fantastic example of how we can blend renewable solar energy, wireless communication, and embedded system technology to create an eco-friendly transportation prototype. This innovative system harnesses solar panels and rechargeable lithium-ion batteries to manage power efficiently and lessen our reliance on traditional energy sources. With the help of ESP32 controllers, it ensures reliable wireless communication between the transmitter and receiver, allowing for real-time control of the vehicle. Plus, the combination of joystick controls, motor drivers, DC motors, and voltage regulation circuits guarantees smooth movement and stable performance of the system

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