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Solar Powered Hybrid Electric Vehicle (HEV)

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ABSTRACT:

This paper presents the development of a Solar Powered Hybrid Electric Vehicle (HEV) designed to use renewable solar energy and battery power to enable eco-friendly transportation. This project introduces an innovative Solar Powered Hybrid Electric Vehicle (HEV) system designed for sustainable mobility and real-time power distribution. Using a polycrystalline 12V/100mA solar panel, the system charges a 3-cell lithium-ion battery pack (11.1V total), powering four brushed DC motors via an L298N dual H-Bridge motor driver. At the heart of the project is the ESP8266 microcontroller (30-pin NodeMCU) which enables IoT capabilities via Wi-Fi. An integrated relay module serves as a digital switch to direct power from the main source to external vehicles through connecting terminals. Real-time control, battery monitoring, and switching are managed using the Blynk IoT platform, In addition to self-powered operation, the HEV is capable of transferring its stored energy to other vehicles using dedicated terminals, making it suitable for emergency support.

Keywords: Solar Vehicle, Hybrid Electric Vehicle, ESP8266, L298N Motor Driver, Renewable Energy, IoT, Power Sharing, Lithium-ion Battery.

Introduction:

The rising concerns over environmental pollution and fossil fuel depletion have led to a demand for green vehicle alternatives. This paper introduces a cost-effective, solar-powered hybrid electric vehicle system that combines solar energy harvesting with intelligent energy management to power a lightweight vehicle prototype. It highlights the hardware integration, system design, and the emergency power-sharing feature for assisting other electric vehicles.

The transportation industry is one of the largest contributors to global carbon emissions, and the rising costs and environmental impact of fossil fuels have created an urgent need for clean, renewable alternatives. Electric Vehicles (EVs) have emerged as a promising solution—but their dependence on grid-based charging limits their usefulness in remote or underdeveloped regions.

This project proposes a Solar Powered Hybrid Electric Vehicle (HEV) system that integrates solar energy, lithium-ion battery storage, and ESP8266-based IoT monitoring to create a sustainable, self-sufficient, and mobile transportation and power-sharing unit. By incorporating a polycrystalline solar panel, smart relay-based energy distribution, and real-time control via the Blynk app, the vehicle can also act as a mobile charger for other electric vehicles or devices—especially in off-grid scenarios.

This fusion of renewable energy, embedded systems, and wireless control reflects the core principles of modern green engineering and offers a practical, cost-effective model for the future of mobility.

Key Technologies and Components:

Component	Description
Solar Panel	12V, 100mA, Polycrystalline (117mm x 91mm)
Battery	3 x 3.7V Li-Ion cells in series = 11.1V
Microcontroller	ESP8266 NodeMCU (30-pin) with Wi-Fi
DC Motors	4 brushed DC motors for vehicle mobility
Motor Driver	L298N dual H-Bridge motor driver
Relay Module	5V single-channel, controls external power supply
Switch	Manual ON/OFF switch for power conservation
Blynk IoT Platform	Remote control and monitoring of battery and load

METHODOLOGY

The **Solar Powered Hybrid E-Vehicle** uses solar energy and electric charging to run. Solar panels charge the battery during the day. If sunlight is low or if the vehicle stops suddenly on the road without a charger, the stored solar energy in the battery can be used. This reduces the need for fossil fuels and makes the system eco-friendly and reliable.

1. Hardware Connections:

The Solar Powered Hybrid E-Vehicle system consists of the following hardware components, interconnected to enable effective energy management and vehicle movement:

1. *Solar Panel:* Converts sunlight into electricity and charges the battery during daytime.
2. *Electric Adapter:* Charges the battery from electricity if sunlight is not available.
3. *Battery Pack:* Stores energy from both solar panel and adapter. Supplies power to the motors when needed, especially in emergencies.
4. *ESP8266 Microcontroller:* Controls motor speed, direction, & manages system activities.
5. *L298N Motor Driver:* Receives control signals from the microcontroller & drives the motors.
6. *DC Motors (4 Motors):* Enable vehicle movement.
7. *Relay Module:* Safely switches between charging mode and motor driving mode.

Circuit Diagram:

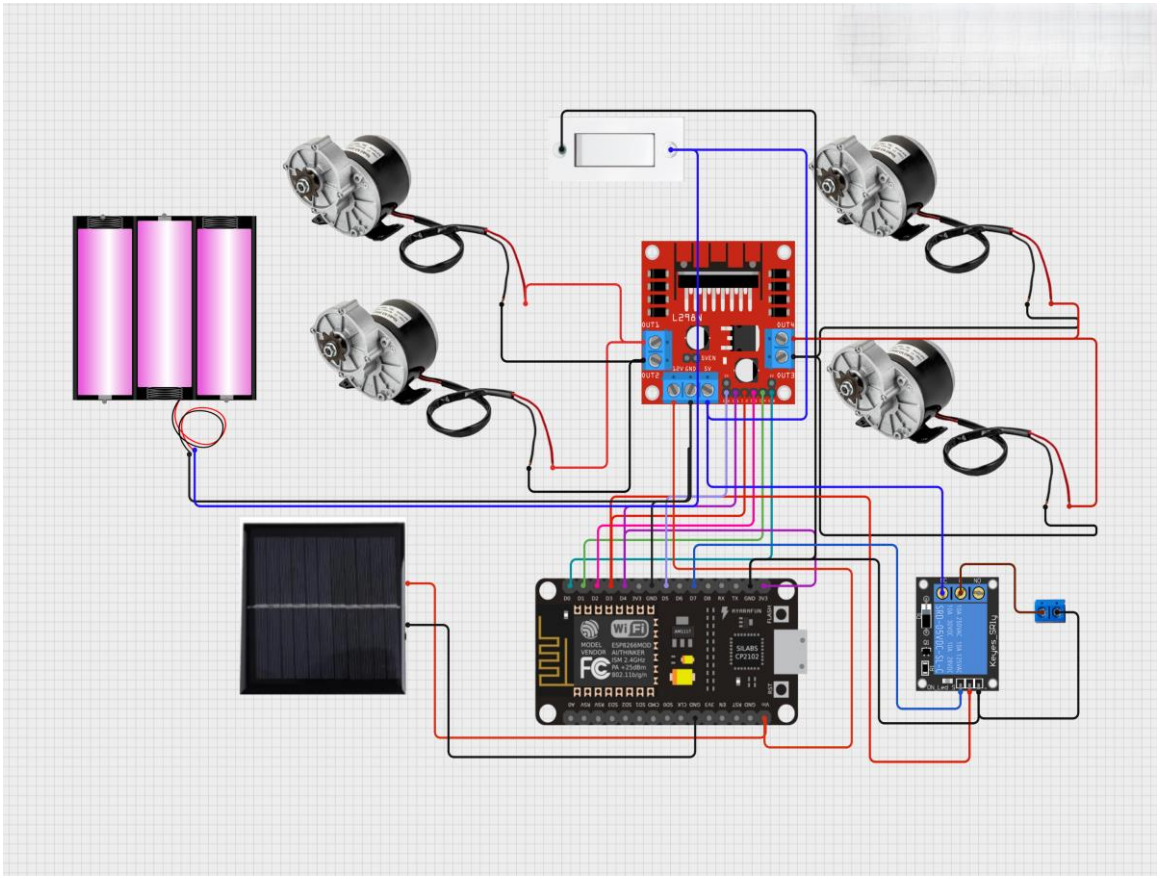

Fig 1: Circuit Diagram of Solar Powered Hybrid E-Vehicle

Working of the System:

1. Solar panel charges the lithium-ion battery via a charge controller.
2. ESP8266 reads battery voltage using a voltage divider & A0 pin.
3. L298N motor driver receives signals from ESP8266 to control 4 DC motors.
4. User controls movement using Blynk IoT App via Wi-Fi.
5. Power-sharing / Connecting terminals can transfer stored battery power to another vehicle in emergency cases.

Power Calculations:

Battery: 12V, 3Ah - 36Wh
Solar Panel: 12V, 100mA, Output - Approx. 6.5–7 hours to full charge
Run Time: ~1.5–1.7 hours at average current consumption
Distance: ~3km estimated based on speed and current draw.

Objective:

1. Use sunlight to charge the vehicle's battery.

2. Combine solar and electric power to increase driving distance.
3. 3. Implement a microcontroller (like ESP8266) for smart energy management.
4. Store extra solar energy for emergency use.
5. Reduce dependence on fossil fuels by utilizing renewable energy.
6. Enable remote monitoring and control through IoT platforms like Blynk.
7. Provide a solution for on-road charging challenges by enabling self-charging capabilities.

Results:

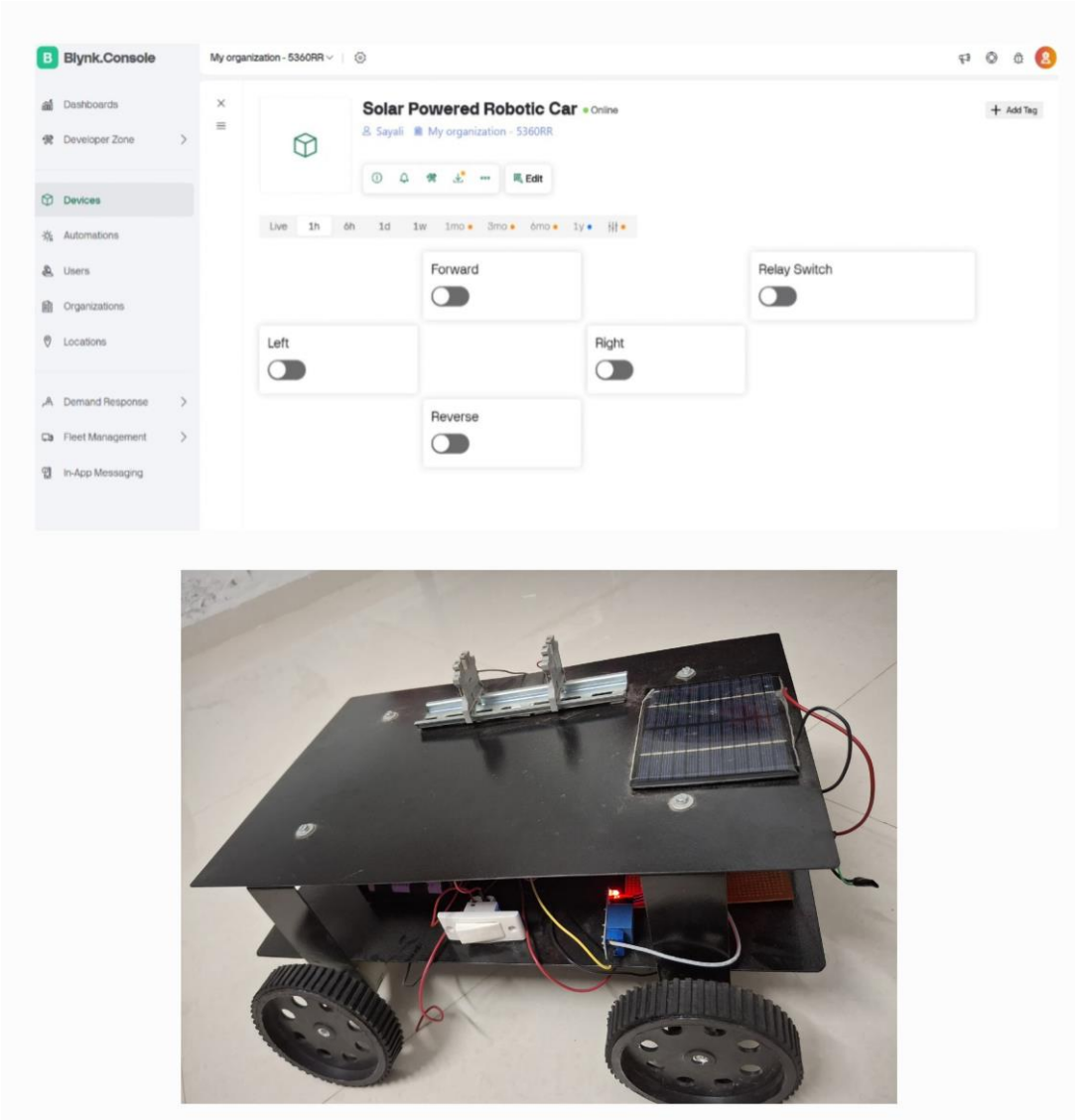

Fig 2: Solar Powered Hybrid E-Vehicle with Blynk IoT

The prototype was successfully connected to the *Blynk Console*, allowing smooth, real-time control of the vehicle's motion (forward, reverse, left, right) and activation of the *relay switch* for external power distribution. The physical model of the HEV demonstrated reliable motion on flat terrain. All *four brushed DC motors* powered via the *L298N motor driver* functioned precisely as controlled through Blynk, showcasing the *power-handling and directional control* accuracy of the system.

Conclusion:

The Solar Powered Hybrid EV project combines the strengths of *renewable solar power*, *autonomous vehicle control*, and *IoT-based monitoring* into one sustainable, multi-purpose mobility platform. It serves not only as a transport solution but also as an *on-demand energy provider*, addressing the energy accessibility gap in underdeveloped or emergency-prone areas. The use of ESP8266, Blynk, and a hybrid power system offers a glimpse into the future of *smart, self-powered vehicles*.

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