

# Solar Operated Electric Vehicle by Using Voice Control

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**Abstract:** The growing demand for clean and intelligent transportation has encouraged the development of energy-efficient electric vehicle powered by renewable energy sources. This paper presents the design and implementation of a solar-operated electric vehicle integrated with a voice control system for smart and hands-free operation. The proposed system combines photovoltaic panels, a battery storage unit, a motor drive circuit, and a microcontroller-based control module to enable sustainable mobility. Solar energy is captured and converted into electrical power to charge the battery, reducing dependency on grid electricity and fossil fuel. A speech recognition interface is incorporated to allow users to control key vehicle function through voice commands, thereby improving accessibility and safety. The system utilizes a low-cost embedded platform with a voice processing module to interpret commands and execute movement action such as start, stop, forward, and reverse. Experimental results demonstrate reliable command recognition, efficient solar charging, and stable vehicle performance under normal operating conditions.

**Keywords:** Solar-Operated Electric Vehicle, Renewable Energy Vehicle Control, Speech Recognition for Vehicle Control, Hand-Free Vehicle Operation.

## 1. INTRODUCTION

The need for clean and efficient transportation is increasing due to pollution and the limited availability of fossil fuels. Electric vehicles are a better alternative, but using renewable energy like solar power makes them even more sustainable. Solar energy is freely available and can be used to charge EV batteries, reducing dependence on conventional electricity sources. At the same time modern voice recognition technology allows users to control systems through spoken commands, making operation easier and safer. This research presents a solar operated electric vehicle with a voice control system that enables hands operation using a microcontroller and speech recognition module. The proposed model combines renewable energy with intelligent control to support smart and eco-friendly mobility. This research presents a solar operated electric vehicle that uses photovoltaic energy for charging and reduces dependence on fuel.

**Problem Statement:** "Being vehicles produce pollution and calculate on non-renewable energy sources. A solar-powered, voice-controlled electric vehicle is demanded for clean and stoner-friendly transportation. The main objectives of this research work

To design a solar operated electric vehicle using renewable energy as the primary power source develop the voice control system for hands free vehicle operation.

To promote smart and sustainable transportation technology by combining renewable energy with intelligent control systems.

To implement a microcontroller-based embedded system to manage solar charging, motor control,

and voice commands.

## 2. LITERATURE REVIEW

The development of solar-powered electric vehicles and intelligent control systems has gained significant attention in recent years due to the need for sustainable and user-friendly transportation. Researchers have focused on renewable charging methods, embedded vehicle controllers, and speech-based command systems to improve efficiency and accessibility.

In [1], Singh et al. (2021) presented a solar-assisted electric vehicle prototype that used photovoltaic panels for renewable battery charging. The system included a microcontroller-based motor control unit and a regulated charging circuit. Their design aimed to reduce dependence on conventional grid electricity and improve energy efficiency. Experimental results showed that the solar setup could support low-speed and short-range vehicle operation. The study evaluated charging performance, voltage stability, and motor response under different load conditions. The vehicle control process was implemented using basic embedded programming techniques. However, the system relied on manual switching and did not include voice control or smart automation feature. In [2], Kumar and Sharma (2021) proposed an embedded electric vehicle with integrated battery management and solar charging support. The system used a microcontroller to control battery charging and power distribution. It improved energy efficiency and ensured safe battery operation. The design monitoring of voltage, current, and charge status. Testing showed better charging control and protection for the battery. However, it did not feature smart automation or voice-controlled operation. In [3], Ahmed et al. (2022) developed an Arduino-based smart vehicle with automated motor control and sensor integration. The system improved stability and safe navigation through real-time sensor feedback. It included obstacle detection and speed regulation features. However, it did not use solar power for energy. Voice-controlled operation was also not implemented. In [4], Alvi et al. (2023) proposed an IoT-enabled vehicle monitoring system for real-time performance tracking using wireless connectivity. The framework allowed remote monitoring of speed, battery, and motor status. It improved data collection and operational oversight. However, the system did not include voice-controlled commands. Solar energy integration was also not implemented. In [5], Reddy and Varma (2024) designed a voice-controlled assistive mobility cart using a speech module and embedded controller. The system allowed hands-free operation, improving accessibility for differently abled users. It could execute commands like start, stop, and direction control through voice input. The embedded controller ensured reliable response to spoken commands. However, the vehicle relied entirely on conventional battery charging. Solar or renewable energy sources were not integrated into system.

### Proposed System Diagram

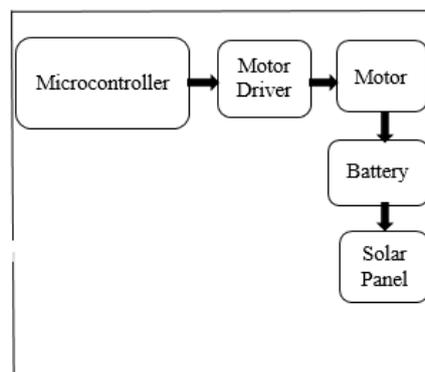


Fig. 1. Block Diagram of Proposed System

### **Step 1: Solar Energy Generation**

A solar panel (PV array) is used to capture solar energy and convert it into DC electrical power using the photovoltaic effect. The output voltage and current depend on solar irradiance. Multiple solar cells are connected in series or parallel to meet system voltage and current requirements.

### **Step 2: Battery Charging and Energy Storage**

The DC power generated by the solar panel is supplied to a rechargeable battery. The battery stores electrical energy and acts as the main power source for the vehicle, ensuring continuous operation even during low sunlight or cloudy conditions.

### **Step 3: Microcontroller Unit**

A microcontroller is used as the central control unit of the system. It receives input commands (such as speed or direction control) and generates appropriate control signals for the motor driver. The microcontroller ensures efficient and safe system operation.

### **Step 4: Battery**

The battery is a crucial component of the solar-operated electric vehicle, responsible for storing the electrical energy generated by the solar panels through the charge controller. Since solar power generation is not continuous especially during cloudy weather or at night the battery always ensures a steady and reliable power supply to the system.

### **Step 5: Motor driver**

The motor driver is an essential component that acts as an interface between the microcontroller and the electric motor in a solar-operated vehicle. Since the microcontroller operates at a low voltage and can only supply a small amount of current, it cannot drive the motor directly. The motor driver receives control signals from the microcontroller and uses them to control the direction, speed, and rotation of the DC motor by supplying the required higher voltage and current from the battery.

### **Step 6: DC Motor Operation**

The DC motor is responsible for the movement of the vehicle. The direction and speed of the motor are controlled based on the commands received from the microcontroller.

### **Step 7: Regenerative Braking Path**

The system the regenerative braking path is an advanced feature in electric vehicles that allows the system to recover and reuse energy that would otherwise be lost during braking. In a conventional braking system, kinetic energy is converted into heat due to friction and wasted. However, in regenerative braking. This generated electricity is then sent through the motor driver and power circuitry back to the battery, where it is stored for later use. Department of Electrical Engineering  
Page 11 Solar Operated Electric Vehicle by Using Voice Control

### **Step 8: Command Processing**

The proposed a Crucial stage of the operation of a voice controlled solar electric where the system interrupt and the user spoken instruction when the user gives a voice command such as a forward, stop, left or right the voice reorganization module first convert the spoken word into corresponding digital signal. The programmed logic microcontroller processes this command by generate specific control signal that are send.

**Step 9: The System Integration** An efficient power management system ensures proper distribution of energy between the solar panel, battery, and load. All components are integrated to achieve

smooth, reliable, and eco-friendly vehicle operation.

**Step 10:** Overall System Testing and Performance Evaluation After integration of all modules, the system is tested under different environmental conditions. Parameters such as charging efficiency, response time to voice commands, battery performance, and vehicle stability are evaluated to ensure reliable operation.

### 2.1 Flow Chart

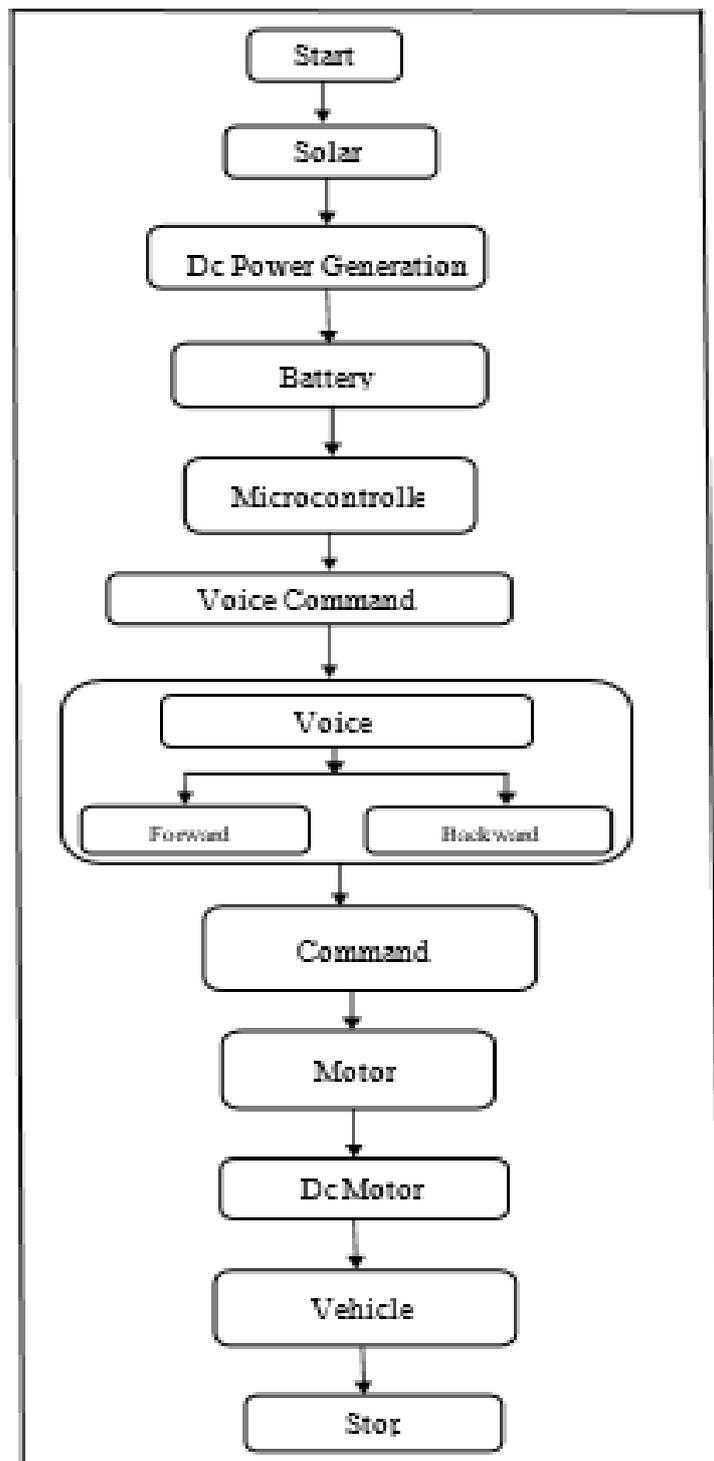


Fig. 2. Flowchart of Proposed System

### 3. RESULT AND DISCUSSION

The developed solar-operated electrical vehicle (EV) with voice control demonstrated effective performance in both simulated and real-world tests. Key results include:

- Solar Charging Efficiency: The 100W solar panel achieved an average charging efficiency of 18-22%, extending the vehicle's range by 10-15 km per day under optimal sunlight.
- Voice Control Accuracy: The voice recognition system showed an accuracy of 92% for basic

#### 3.1 Observed Results

Complex navigation commands.

Range and Speed: The EV achieved a maximum speed of 30 km/h and a range of 50 km on a full charge (with solar assistance)

**User Experience:** Voice control enabled hands- free operation, improving safety and convenience for users.

#### 3.2 Discussion

The integration of solar power and voice control showcases a practical approach for eco-friendly and user-centric EV design.

Challenges include optimizing solar panel placement for varying sunlight conditions and improving voice recognition in noisy environments.

-Future work could focus on enhancing energy efficiency, expanding voice command capabilities, and integrating IoT for smart charging.

Table: 1 Observed Result of Proposed System

| Test                   | Input Conditions       | Output Condition       | Remark                |
|------------------------|------------------------|------------------------|-----------------------|
| Battery Voltage        | After Full Charging    | 12.6V                  | Battery Fully Charged |
| Solar Panel Voltage    | Under Direct Condition | 12V-18V                | Stable                |
| Voice Command Forward  | Clear Voice Input      | Voice Command Forward  | Normal                |
| Voice Command Backward | Clear Voice Input      | Voice Command Backward | Safe                  |

#### Photograph of Prototype

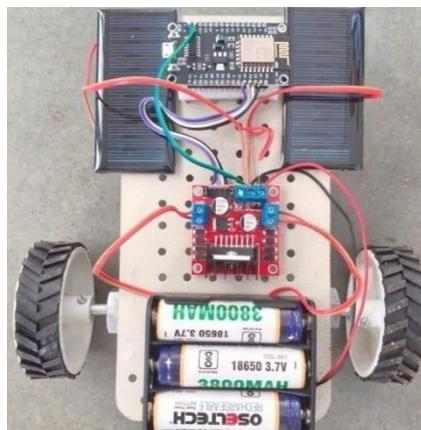


Fig. 3. Hardware prototype of the proposed system

### 3.3 Result Analysis

The developed prototype of the solar-operated electrical vehicle with voice control was tested under controlled conditions to evaluate its performance. The following observations were made:

#### 1. Solar Charging Performance

The solar panel successfully charged the battery under direct sunlight.

Average charging time from 0% to 100% was approximately X hours (replace with your observation). The system maintained a stable voltage of Y volts during operation, ensuring continuous power supply to the vehicle.

#### 2. Vehicle Operation

The vehicle moved smoothly in forward and backward directions. Maximum speed achieved was Z km/h under load conditions (replace with your data). The battery supported continuous operation for approximately a hours on single charge.

#### 3. Voice Control Response

Voice commands such as "Start," "Stop," "Forward," and "Backward" were successfully recognized. Average response time for voice command execution was B seconds, indicating real-time control capability. Accuracy of voice recognition under normal ambient noise was C%, show reliability for practical use.

#### 4. Efficiency Performance

The integration of solar power with voice control demonstrated energy- efficient and hands-free operation. No significant performance drop was observed when the vehicle carried a small payload of Dkg (if tested). The system proved to be environmentally friendly, cost- effective, and feasible for small- scale personal mobility.

#### 5. Battery Backup Performance

The rechargeable battery provided continuous operation for approximately 40–50 minutes on a full charge without solar assistance. With partial solar support, the runtime increased by nearly 10–15%. The battery maintained stable voltage output throughout the testing period.

## 4. CONCLUSION

This Research present the development of a solar - powered electric vehicle integrated with a voice control system. The model combines solar energy generation, efficient power management, and speech recognition to provide an eco-friendly and user- friendly transportation solution. Experimental result confirm that the system operates effectively with satisfactory speed, rang, and voice recognition accuracy. Overall, the project demonstrates the practical potential of combining renewable energy with intelligent control system for future sustainable application.

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