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Smart Control Systems for Solar Electric Vehicles: A Microcontroller and Sensor-Based Approach

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Abstract

The use of electric vehicles has significantly increased during the last ten years. Some actions being taken to halt climate change and reverse the effects of global warming include the following. An electric car that is powered by solar energy—generated by solar panels mounted on the outside of the vehicle—is known as a solar vehicle. As everyone knows, middle-class families cannot afford the constantly growing costs of gas and new cars. An automobile with an electric motor that is mostly charged by energy from solar panels mounted on the vehicle is known as a solar electric vehicle. The car's battery system stores the electrical energy that these solar panels convert sunlight into, which powers the electric engine. There are several benefits to solar electric vehicles over traditional gasoline-powered cars. Since they don't emit any toxic substances, they are, first and foremost, far more environmentally friendly. Second, because there is no need to buy fuel and solar energy is free, they are more economical to run. Because of this, the range of solar-powered cars may be restricted, necessitating additional charging from an external power source like an electrical outlet or charging station.

Keywords: Solar car, microcontroller, charge controller, battery, photovoltaic panel

INTRODUCTION

A solar vehicle is an electric car that runs on solar energy, which is produced by solar panels that are affixed to the exterior of the car. As everyone is aware, the cost of gas and new cars is always rising, leaving it out of reach for middle-class families. Therefore, our idea is to create a car that is both affordable and environmentally beneficial. The primary aim of the solar energy promising source concept for electric vehicles is to investigate the feasibility of harnessing solar energy for electric vehicles, thereby mitigating the use of fossil fuels and safeguarding the environment. Conventional cars and the possibility of utilizing alternative technologies in autos, including electric or hybrid vehicles that can be created by modifying an existing conventional car with an appropriate motor and battery [1-10].

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Solar electric vehicles (SEVs) represent an innovative convergence of renewable energy technology and sustainable transportation. With an increasing emphasis on reducing carbon emissions and combating climate change, SEVs offer a promising solution by harnessing the power of the sun to generate clean energy for driving. Equipped with solar panels on their roofs and surfaces, these vehicles can convert sunlight into electricity, which can either directly power the vehicle or charge onboard batteries for later use. This feature not only enhances energy efficiency but also significantly reduces reliance on traditional fossil fuels [11-21].

The technology behind solar electric vehicles continuously evolves, as advancements in photovoltaic cells and battery storage enhance their performance and efficiency. Modern SEVs are designed to maximize solar capture while maintaining sleek, aerodynamic profiles that minimize drag. Additionally, the integration of smart energy management systems allows for optimized energy consumption, extending driving ranges and enhancing the overall user experience. As urban areas face increasing traffic congestion and pollution, solar electric vehicles offer a clean and innovative alternative, encouraging a shift towards more sustainable urban mobility [22-32].

Governments and industries around the world are beginning to recognize the potential of solar electric vehicles. Various incentives, such as tax breaks, rebates, and investments in charging infrastructure, are aimed at promoting their adoption. Moreover, research and development initiatives are focusing on lowering production costs and improving battery technologies, which are crucial for making SEVs more accessible to a broader audience. The potential for solar electric vehicles to contribute not only to individual transport needs but also to smart grid systems makes them a critical component of future sustainable energy solutions. As the transition to a low-carbon economy accelerates, the role of solar electric vehicles will undoubtedly become more significant, paving the way for a cleaner, greener future [33-43].

As concerns about climate change and fossil fuel dependency mount, the automotive industry is undergoing a significant transformation. One of the most promising developments in this field is the emergence of Solar Electric Vehicles (SEVs). These vehicles harness solar energy to power electric motors, offering a sustainable and eco-friendly alternative to traditional gasoline vehicles. In this article, we will explore the technology behind solar electric vehicles, their advantages, challenges, and the future potential of this innovative mode of transportation.

A Solar Electric Vehicle combines two technologies: solar power and electric mobility. At its core, an SEV is equipped with photovoltaic (PV) panels that convert sunlight into electricity, which is used to charge the vehicle's battery. The electricity can also be utilized to power the electric motor directly during operation.

Key Components of Solar Electric vehicle:

1. *Solar Panels:* These are typically mounted on the roof and sometimes the body of the vehicle to maximize sunlight exposure. The most common type used is crystalline silicon, known for its efficiency and durability.
2. *Battery Storage:* Much like traditional electric vehicles (EVs), SEVs require a battery to store the electricity generated by the solar panels. High-capacity lithium-ion batteries are usually preferred for their energy density and longevity.
3. *Electric Motors:* These convert electrical energy into mechanical energy, powering the vehicle's wheels. Electric motors are known for their efficiency and low environmental impact compared to internal combustion engines.
4. *Energy Management Systems:* Advanced systems monitor energy production and consumption, optimizing efficiency and ensuring the vehicle operates within its energy limits.

Advantages of Solar Electric Vehicles are as follows:

1. *Environmental Benefits:* One of the primary advantages of SEVs is their potential to significantly reduce carbon emissions. By utilizing renewable solar energy, these vehicles decrease reliance on fossil fuels, helping to mitigate climate change and air pollution.
2. *Energy Independence:* SEVs can be charged using sunlight, which allows drivers to reduce their dependence on charging stations and fossil fuel-derived electricity. In sunny regions, a well-designed SEV could operate with minimal or no reliance on grid electricity.

3. *Cost Savings:* While the initial cost of an SEV may be higher than a conventional vehicle, the long-term savings on fuel and maintenance can be substantial. With increasing energy prices and the decreasing cost of solar panel technology, SEVs can offer a cost-effective solution for consumers over time.
4. *Low Operating Costs:* Electric vehicles have fewer moving parts than gasoline cars, leading to lower maintenance costs. Furthermore, with sunlight as a fuel source, drivers may experience even lower operational costs.
5. *Technological Innovation:* The development of SEVs encourages advancements in solar technology, energy storage, and vehicle design. These innovations can benefit the broader renewable energy sector and contribute to overall technological progress.

Despite their potential, solar electric vehicles face several challenges that need to be addressed to achieve widespread adoption.

1. *Limited Solar Energy Generation:* The efficiency of solar panels can be affected by factors such as weather, location, and time of day. While they can provide supplemental energy, relying solely on solar power for long-distance travel may not be practical under current technology.
2. *High Initial Cost:* The cost of integrating solar technology into vehicles can be prohibitive for some consumers. While prices are decreasing, the up-front investment may vary significantly depending on the size and efficiency of the solar system installed.
3. *Infrastructure Limitations:* The lack of solar charging infrastructure can deter potential users. Building a robust network of charging stations that can support SEVs is essential for their successful adoption.
4. *Energy Storage Issues:* Current battery technology, while advancing, still presents challenges regarding weight, range, and charging speed. Developing lighter, more efficient batteries will be crucial for improving SEV performance.

The future of solar electric vehicles looks promising as advancements in technology continue to unfold. Innovations in solar panel efficiency, energy storage solutions, and electric drivetrain technology are expected to enhance the viability of SEVs.

Car manufacturers are increasingly investing in this technology, experimenting with designs that incorporate light-weight, high-efficiency solar panels directly into vehicle skins. In parallel, governments are incentivizing clean transportation through subsidies and infrastructure development, fostering an environment that supports SEV adoption.

Research institutions and startups are also exploring creative solutions such as solar charging stations and vehicle-to-grid (V2G) technologies. These developments aim to create a seamless energy ecosystem that enhances the operational efficiency of solar vehicles while contributing to grid stability.

Solar electric vehicles represent an exciting convergence of renewable energy and sustainable transportation, promising to reshape the automotive landscape. While challenges remain, ongoing technology advancements and increased societal focus on sustainability are paving the way for SEVs to become a mainstream mode of transportation.

As we look to the future, it is clear that solar electric vehicles offer not only a solution to environmental challenges but also an opportunity for innovation and economic growth in the automotive sector. By embracing SEVs, we are not just investing in cleaner vehicles; we are investing in a cleaner, more sustainable future for generations to come.

LITERATURE SURVEY

SEVs, or solar-electric vehicles, offer a viable solution at the nexus of transportation and renewable energy. SEVs have become a major player in the automotive industry as the need to combat climate change and lessen reliance on fossil fuels grows. SEVs can use the abundant and clean energy from the sun to fuel their electric propulsion systems by installing solar panels on their cars. Numerous benefits flow from this mutually beneficial interaction between solar energy and electric vehicles, such as less carbon emissions, improved energy efficiency, and better energy autonomy. SEVs are a notion that has attracted a lot of attention lately, leading to global research and development initiatives in this area. The purpose of this literature review is to present an overview of the body of knowledge now available on SEVs, emphasizing significant discoveries, developments in technology, and patterns in study. This study aims to identify knowledge gaps and areas that require additional research by analyzing the current status of the field, thereby advancing and increasing the use of solar electric vehicles (SEVs). SEVs, or solar-electric vehicles, offer a viable solution at the nexus of transportation and renewable energy. SEVs have become a major player in the automotive industry as the need to combat climate change and lessen reliance on fossil fuels grows. By adding solar panels to their vehicles, SEVs may use the sun's plentiful and clean energy to power their electric propulsion systems. Numerous benefits flow from this mutually beneficial interaction between solar energy and electric vehicles, such as less carbon emissions, improved energy efficiency, and better energy autonomy. SEVs are a notion that has attracted a lot of attention lately, leading to global research and development initiatives in this area. The purpose of this literature review is to present an overview of the body of knowledge now available on SEVs, emphasizing significant discoveries, developments in technology, and patterns in study. This study aims to identify knowledge gaps and areas that require additional research by analyzing the current status of the field, thereby advancing and increasing the use of solar electric vehicles (SEVs).

In 2019 Ganesh et al. [44] has developed a charging system of charging of robotic system using microcontrollers. They proposed a Smart batteries that combine electronics for charge control and communication devices make up a common power management architecture. Nonetheless, the idea of intelligence should be included in the software design of basic batteries when a cost-effective system is needed. Implementing the SHM concept to create an affordable power management system for a robotic vehicle is one of the primary goals of there work. An electrical circuit connects a PV system, a charger device, a selector system, a battery monitor system, and a battery system. The PIC16F886 microcontroller, on which the SHM is built, is capable of fully autonomously monitoring VANTER use and decisions [22]. The SHM's primary duties include 1) determining the ambient light level and regulating the solar tracking system to maximize power and 2) analyzing battery and solar panel operating data to adjust the charger's mode of operation appropriately. the price of this system, independent of the VANTER and navigational aids. Below Figure 1 showing pic shot hardware architecture for VANTER.

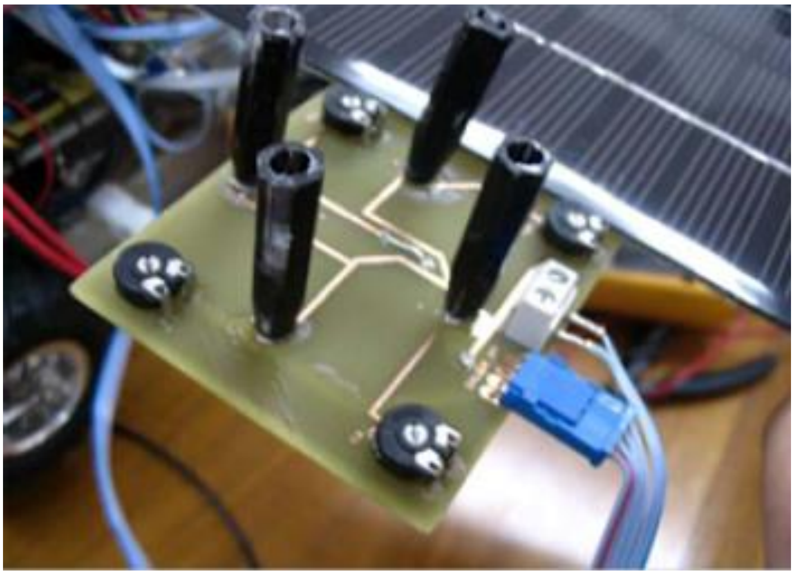

Figure 1. VANTER pic shot.

METHODOLOGY

Over the past many years, solar electricity has grown in popularity. More and more people are choosing to replace their usual energy source with solar energy due to its numerous benefits and cost-effectiveness. The principle of solar charging is the conversion of light energy into electrical energy (DC) using solar panels. A battery bank can be used to store DC voltage.

A safeguard circuit against reverse charging is included to prevent energy from the battery from flowing backward into a solar panel. Dual tone multiple frequency (DTMF) and motor driver (L293D) are used to operate the motor, and the vehicle is controlled as shown in figure. A voltage sensor is used to measure battery voltage. A microcontroller is used to measure the battery voltage and to indicate low battery voltage when it drops below a predetermined threshold. Figure 1 shows the proposed system.

Software Simulation in Porteous

Figure shows the simulation of our project, which includes a motor driver and dual tone multiple frequency (DTMF). Since we were unable to obtain DTMF Ic, we substituted logic gates for DTMF, which functions similarly to DTMF. We were unable to finish the remainder of the simulation due to a lack of components. This is a software simulation of using the DTMF to operate a motor.

Needed Components

Photovoltaic Cell

A solar cell as shown in Figure 3, often known as a photovoltaic (PV) cell, is a nonmechanical device that directly generates energy from sunshine. Certain PV cells have the ability to generate power from artificial light. Photons, or solar energy particles, make up sunlight. The different energy levels of these photons correlate to the various sun spectrum wavelengths. Semiconductor material is used to make PV cells. When photons hit a photovoltaic cell, they can either be absorbed by the semiconductor material, travel through the cell, or reflect off the cell.

The energy needed to create electricity comes only from the absorbed photons. Electrons are released from the semiconductor material's atoms when it receives enough solar energy. When the PV cell's surface is specially treated during manufacture, the front surface becomes more responsive to the liberated, or dislodged, electrons, allowing them to naturally move to the cell's surface.

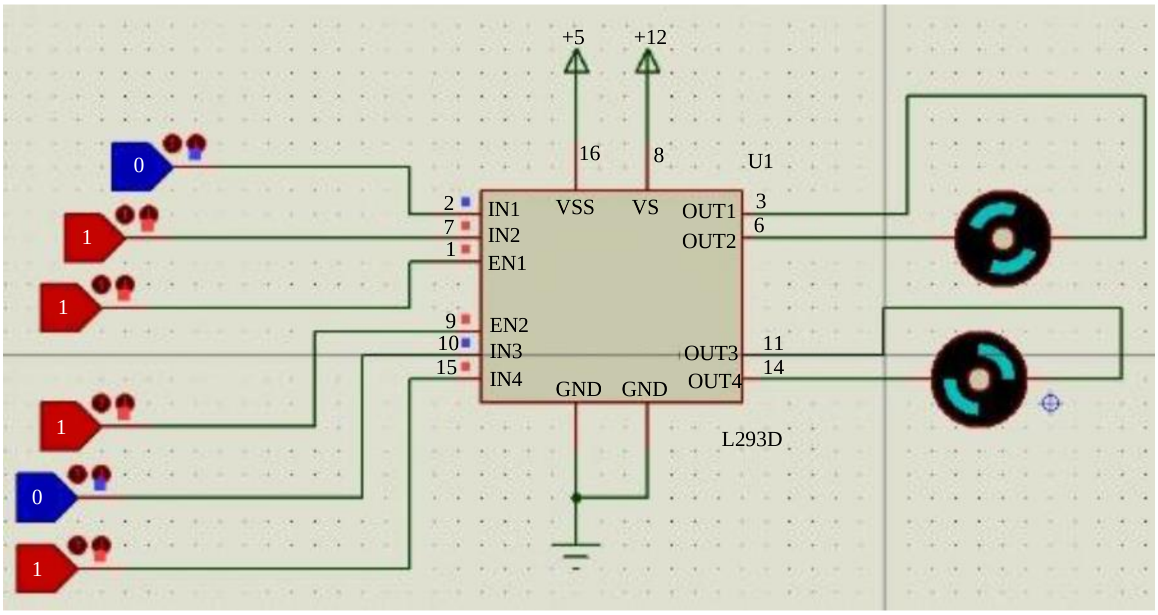

Figure 2. Proposed system.

L293D Motor Driver

The SunFounder L293D as shown in Figure 4 is a 4-channel, monolithic integrated driver with high voltage and high current. This basically implies that the L293D chip, also known as a form of H-Bridge, can give a maximum current of 600mA per channel and may be used with DC motors and power supplies of up to 16 Volts, which is a rather large motor. The L293D is a triple half-H driver with high current. With voltages ranging from 4.5 V to 36 V, it can deliver bidirectional drive currents of up to 600 mA. Both devices are made to drive high-current/high-voltage loads in positive-supply applications, including relays, solenoids, dc, and bipolar stepping motors, as well as other inductive loads. Every input is compatible with TTL. With a pseudo-Darlington source and a Darlington transistor sink, each output is a full totem-pole driving circuit.

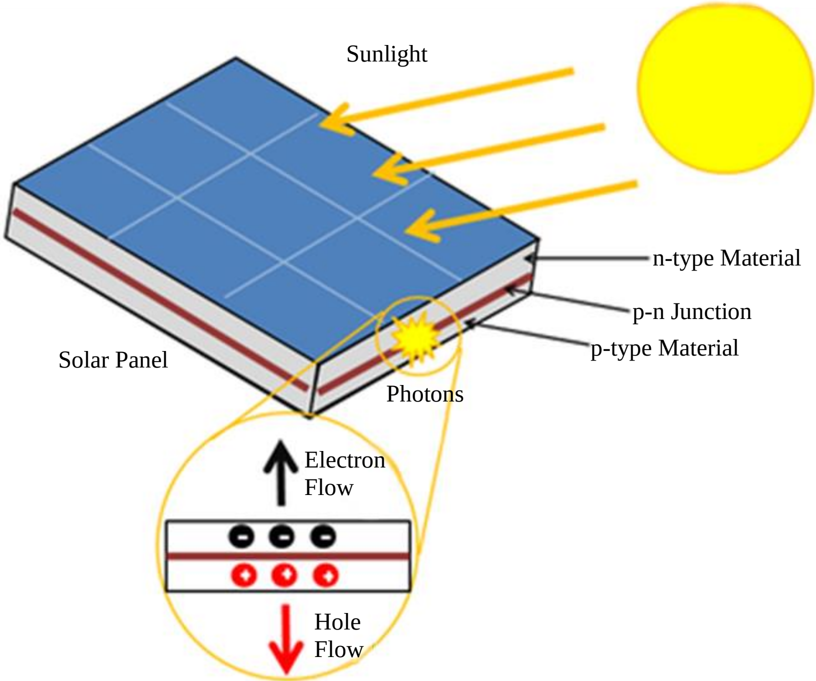

Figure 3. Photovoltaic cell.

Figure 4. L293D motor driver.

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Extension Cables

A length of flexible electrical power cable as shown in Figure 5. (flex) with a plug on one end and one or more sockets on the other end (often of the same kind as the plug) is known as an extension cord (US), extension cable, power extender, drop cord, or extension lead (UK). Although extensions for other kinds of cabling are frequently referred to by this name, mains (household AC) extensions are typically the focus. The phrase "adapter cord" may be used if the plug and power outlet are of different types. Although they can be up to 300 feet (91.44 meters) long, the majority of extension cords are between 2 and 30 feet (0.61 and 9.14 meters) long.

4. Multiple frequency, dual tones
5. 12 volt gear motor
6. Controller for solar charging
7. Adjuster of voltage (7805)
8. A 12-volt lithium-ion battery
9. 12 Volt Power Supply
10. Ply.
11. A cell phone.
12. Fevikwik
13. An aux cord
14. Tires

Working

ACTIVATED DTMF technology functions by producing tones on the handset at certain frequencies, which are then played over the phone line in response to keypad button presses. The exact sounds are detected by equipment at the other end of the phone line, which then translates them into commands.

Use

1. British Telecom (BT) receiver system or CEPT Spec (MT8870D-1)
2. Notification systems
3. Cellular radio networks and repeaters
4. Systems for credit cards
5. Utilizing a remote controller
6. Individual computers
7. A phone answering machine

Circuit Connection

Circuit connection is shown in Figure 6.

Figure 5. Extension cables.

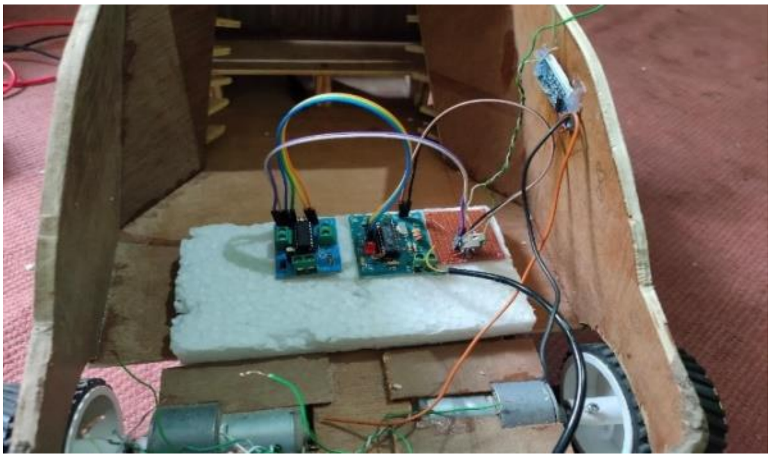

Figure 6. Circuit connection.

Benefits Include

- Cost effectiveness.
- Environmentally friendly.
- Not releasing any carbon emissions.
- Automobile without fossil fuels.
- Cuts down on noise pollution.

Drawback

- A large battery bank is needed because there is no solar power during the night,
- Exorbitant initial material and installation costs.
- Direct current devices tend to be more expensive.

Future Area

1. Technological Advancements in Solar Panels: More research and development may be done to enhance the flexibility, durability, and efficiency of the solar panels used in SEVs, which can increase the quantity of energy produced from small surface areas. This entails investigating novel materials, production processes, and solar cell innovations.
2. Innovations in Energy Storage: The performance, efficiency, and storage capacity of SEVs can all be improved by advances in battery technologies. Increases in cycle life, charging efficiency, and battery density can help batteries last longer and use solar energy more effectively. energy.

Conclusion

To sum up, solar electric car initiatives offer a viable way to reduce dependency on fossil fuels and promote sustainable transportation. Even though there are obstacles to be solved, the viability of solar electric vehicles can be improved by continuing research, development, and innovation in the fields of solar panel technology, energy storage, vehicle integration, and infrastructure. The usage of solar-powered electric vehicles has the potential to lower greenhouse gas emissions, increase energy efficiency, and lessen the need for conventional charging infrastructure. They provide vehicle owners with the advantages of using sustainable solar energy and lower operating expenses. But it's crucial to understand that heavy-duty or long-distance transportation needs might not be fully met by solar energy alone.

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