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Smart Wireless Charging Station using Solar Roof Top Power Generation

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ABSTRACT

The use of electric vehicles (EVs) is a vital measure in mitigating greenhouse gas emissions and tackling the issue of climate change. In order to facilitate this transition, it is necessary to build a charging infrastructure the fact that is both efficient as well as readily accessible. The present concept presents a solar-powered rooftop charging system specifically designed for electric vehicles (EVs), utilizing renewable energy sources to facilitate environmentally friendly car charging. The station utilizes Arduino-based control systems to effectively regulate power distribution, hence assuring the attainment of optimal charging performance. This system utilizes solar power to reduce reliance on conventional grid electricity and stimulates eco-friendly mobility. Moreover, the inclusion of Arduino technology improves flexibility and expandability, allowing for effortless absorption in various environments and user needs.

***KEYWORDS:** Electric vehicles, Solar power, renewable energy, eco-friendly, grid electricity.*

1. INTRODUCTION

1.1 A Summary Approach on Solar Wireless Power Transfer: Electric vehicles (EVs) have emerged as a significant alternative for sustainable transportation in light of the urgent imperative to mitigate carbon emissions. Nevertheless, the extensive implementation of electric vehicles relies on the establishment of effective and easily accessible charging infrastructure. The utilization of physical connections in conventional charging stations has several drawbacks in terms of ease, scalability, and urban visual appeal. Wireless charging technology presents a possible solution to surmount these obstacles. Wireless charging systems offer more flexibility and user friendliness for electric vehicle (EV) owners by enabling power transmission without the need for direct physical contact. Incorporating renewable energy sources such as solar power into wireless charging infrastructure not only improves sustainability but also reduces reliance on grid electricity. This project suggests the development of a solar rooftop wireless charging station for electric vehicles (EVs), utilizing Arduino-based control technologies to enhance its performance. Efficiently harnessing solar energy, the technology integrates photovoltaic (PV) panels onto rooftops. According to Arduino microcontrollers, the charging process may be monitored and controlled in real-time, hence optimizing energy economy and ensuring dependability. Wireless power transfer technology enables electric vehicles (EVs) to conveniently charge by parking on a specified location, hence avoiding the necessity for complex wires or connectors. The use of this efficient strategy not only streamlines the process of charging but also improves the durability of charging equipment.

The system has many essential elements, including photovoltaic (PV) panels, wireless charging coils, Arduino microcontrollers, and power management modules. These components collaborate together to deliver a charging experience that is both frictionless and environmentally sustainable for electric vehicle (EV) customers. By incorporating Arduino-based control systems, the charging station gains intelligence, enabling it to dynamically modify charging settings according on variables such as sun availability and battery state. This adaptable strategy maximizes energy efficiency and reduces ecological footprint while guaranteeing optimal charging efficiency.

A notable advancement in sustainable transportation infrastructure is exemplified by the solar rooftop wireless charging station. This project demonstrates the integration of renewable energy sources, wireless charging technologies, and Arduino-based control systems, showcasing the convergence of innovation and environmental stewardship in tackling the complexities of contemporary transportation

2. LITERATURE SURVEY

A solar charging station for electric cars using a solar panel array and a power conditioning device to convert solar energy into electrical energy was proposed by Bugatha Ram Vara Prasad et al. in 2021. To control the charging procedure and maximize the use of renewable energy sources, the system integrates an energy management system. The performance and efficiency of bipolar pads for wireless power chargers were assessed in a feasibility study by T.D. Nguyen et al. (2020). The study emphasizes how bipolar pads might help lessen the need for physical connections when it comes to wireless charging. A bidirectional battery charger was created by Bugatha Ram Vara Prasad and K. Aswini (2021) to enable effective charging and draining of electric vehicle batteries. A battery management system is part of the system to control charging and guarantee peak performance.

A real-time coordination system for electric cars at the distribution substation level was proposed by M. Singh et al. (2019). It uses sophisticated algorithms and a communication network to control charging and discharging. By using renewable energy sources more efficiently, the system lessens dependency on the electrical grid.

The literature study emphasizes how important wireless charging technology and renewable energy sources are to the advancement of effective and sustainable electric car charging systems. The findings highlight the need for sophisticated energy management systems and clever algorithms to control charging procedures and maximize the use of renewable energy sources. The idea of wireless charging with solar power was presented by Abhijith Nidmar et al. (2019). They used 555 timers to convert direct current and solar panels as a power source. They transferred power using inductive coupling.

Adel El-shahat et al. (2019) covered the fundamentals of wireless charging for electric vehicles as well as several approaches, with an emphasis on inductive power transmission. They provided details on a high-efficiency inductive wireless power transfer prototype. The tactics for charging electric vehicles were further developed by

A.M. Alsomali et al. (2017), who used temporal multiplexing to shorten the charging time and pulse width modulation to control voltage. Through simulation, they discovered that temporal multiplexing is an effective charging technique.

In order to charge electric automobiles wirelessly, Bhuvanesh Arulraj et al. (2019)

A solar-powered electric car charging module with an MPPT controller to measure maximum power generation and an Internet of Things device to monitor maximum power availability was launched by Akila.A, Akila.E, and Anu.K in 2019. Their system uses an Arduino UNO R3 to display power distribution and battery level on an LCD panel. It also has a web page for station location and charge availability, as well as a GSM modem for alarm messages. Their study attempts to lower the use of fossil fuels and greenhouse gas emissions.

3. SIMULATION MODEL

3.1 The construction of a solar panel system is shown in Figure 1. The photovoltaic effect uses light energy, or photons, from the sun to create electricity. A module's top layer (superstrate) or bottom layer (substrate) might be the load-bearing component. The majority of modules use thin- film or wafer-based crystalline silicon cells made silicon or cadmium telluride. A common semiconductor that is used extensively is crystalline silicon. In order for cells to be used practically, they need to be electrically linked to the rest of the system and to each other. They also need to be protected against mechanical damage throughout the manufacture, transportation, installation, and use processes (especially from snow loads, wind, and hail). For thin-film cells, protection against moisture is required to avoid corrosion of metal contacts and interconnections, hence preserving performance and lifetime. This is especially important for wafer-based silicon cells, which are fragile. While semi- flexible solar panels based on thin-film cells are rare, the majority of solar panels remain stiff.

In order to give an appropriate current source capacity, electrical connections are usually connected in parallel or series to obtain the needed output voltage. It could be necessary to use separate diodes to stop reverse currents, especially at night and in situations when there is partial or complete shade. Sometimes the reverse current properties of monocrystalline silicon cells' p-n junctions are sufficient, therefore separate diodes are not needed. Reverse currents can cause troublesome heating of shaded cells in addition to power losses. Reducing heat within the panels is desirable because solar cells lose efficiency at higher temperatures. Installers frequently try to provide enough ventilation behind solar panels, even though relatively few modules include characteristics in their design that lower temperature.

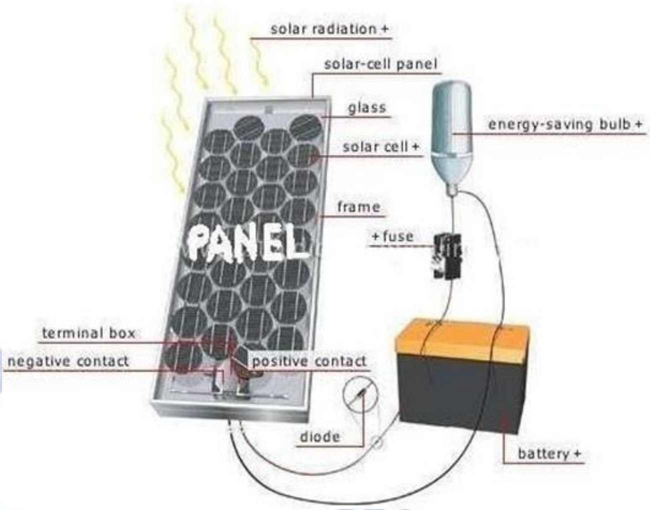


Fig.1 Solar Panel System

3.2 The solar panel is made up of a number of essential parts that cooperate to effectively capture solar energy. First, there is the glass cover, which shields the item from the weather. An anti-reflective coating is put over this cover to maximize the panel's capacity for light absorption by preventing light from bouncing off it. The electrical components, which are similar to battery terminals, are located underneath these layers. They are the top negative contact and the bottom positive contact. The N-type layer, treated with phosphorus, and the P-type layer, treated with boron, are the semiconductor layers that make up the panel between these connections. Through the photovoltaic effect, these layers help convert sunlight into electrical energy. All things considered, every part is essential to maintaining the solar panel system's efficiency and performance.

3.3 The suggested architecture meets varying load needs and requirements across different applications by combining solar energy with conventional electrical sources. This equipment, which was developed with the latest technical developments in mind, smoothly incorporates solar energy into the system in addition to traditional power sources. Both kinds of energy provide energy that is effectively stored in a battery for later use. This concept, which was created with cost in mind, attempts to provide regular people with access to dependable energy solutions. This system's implementation allows for the efficient and uninterrupted operation of residential loads, which is a major advancement in sustainability and economic utilization.

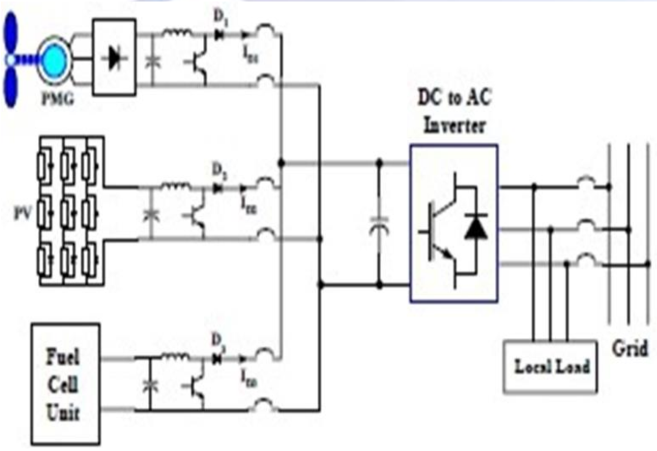
3.4 Topology of Power Circuits:

The main energy sources of the proposed hybrid system are a solar array and a wind turbine. Individual dc-dc converters connect all three energy sources in parallel to a shared PWM voltage source inverter. Figure 2.13 shows how the Hybrid Energy System is configured. In this arrangement, every energy source has a separate control mechanism. All three producing units, however, can be combined into a single unit with a total current of ID1+ID from the inverter's point of view. Diodes D1 and D2 are essential components of the circuit. They enable energy to go just from the sources to the dc-link or the utility grid, facilitating unidirectional power transmission. As a result, in the event that one energy source experiences a malfunction, the associated diode will immediately cut off that source from the whole

Fig:2 Topology of power circuits

3.5 Benefits and Uses:

The proposed energy system offers advantages over others. First, it maximizes renewable energy for green electricity. Itsconstant power addresses intermittency and reliability, unlike conventional systems. This system costs less to maintain than others, saving money over time. Technologyalso excels in efficiency. It manages loads to optimize energyutilization for many applications.



Solar wireless charging stations are multipurpose. These cordless chargers are mobile-friendly. These camping stations power lights, audio, and GPS. These backup power sources power essential gadgets in emergencies. Solar installations power remote monitoring and communication devices. In parks and malls, they charge iPhones as people buy or rest. Smart city lights and environmental sensors are powered by these stations, enabling sustainable urban expansion. They enable remote farmers run machinery, irrigation systems, and collect data. Solar stations promote environmental awareness by teaching renewable energy principles and applications in schools.

4. RESULTS AND DISCUSSION

For steady energy output, this project's solar PV array uses torches with LDR sensors to track the sun. Since the sun tilts from 0° to 180°, sensors on both sides allow tracking in any direction. PV cell energy is routed to a converter and buck regulator to regulate power output.

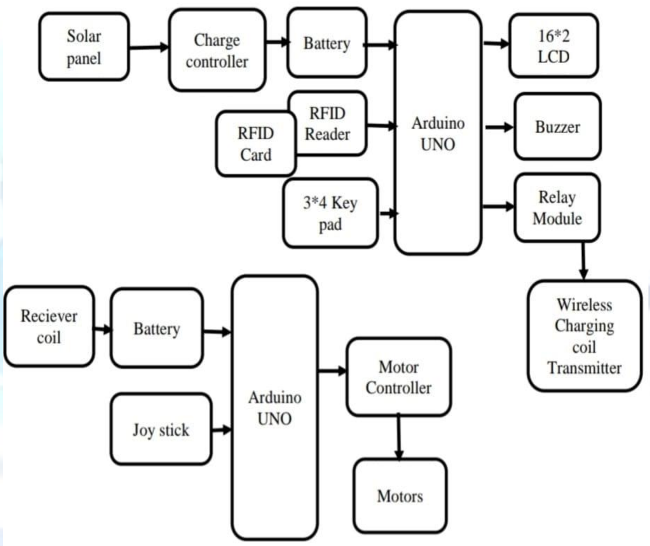


Fig.3 Proposed EV and Solar Charging Station Systems

To avoid hysteresis loss, the DC-DC converter arrangement keeps PV cell output impartial. First, the DC-DC converter absorbs DC input voltage and outputs DC voltage at a specified level. This adjustment fits the converter output voltage to the module power supply.

A switch in the basic DC-DC converter circuit controls supply-to- load connection and disconnection. A converter supplies controlled DC power to the battery. Before sending energy to the converter, the 1A synchronous buck regulator MCP1612 responds quickly to abrupt load changes and protects against overcurrent in short loads. It uses a 1.4 MHz switching clock frequency with input voltages from 2.7 to 5.5V and output voltages from 0.8V to VIN. To ease operation, the Arduino's analog input receives the regulated constant voltage, which is monitored by a meter. The microcontroller board is the Arduino UNO R3, with 20 digital and six analog inputs. An Arduino program tracks, delivers, and displays the needed power output supply using the user-friendly Arduino computer software.

Wireless electric vehicle design:

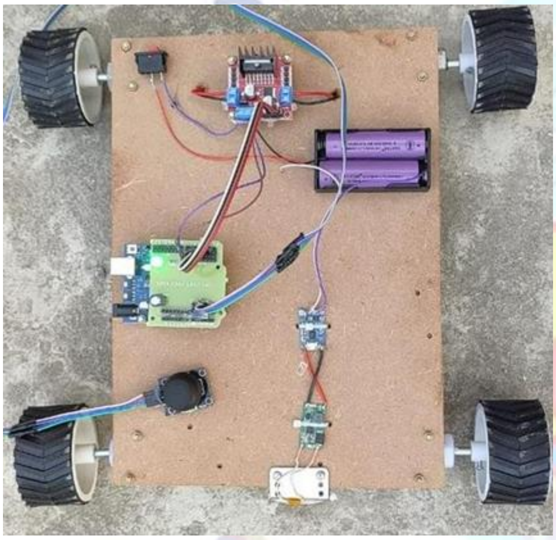


Fig.3. Electric vehicle circuit design

Wireless charging station design:

Fig.5. Wireless charging station design

5. CONCLUSION

The development of an Arduino-based control system for a solar rooftop wireless charging station designed for electric vehicles (EVs) is a notable advancement in the realm of sustainable transportation infrastructure. The project effectively integrates renewable energy sources with wireless power transfer technology, offering a solution that is both user-friendly and ecologically sustainable. This solution aims to address the growing need for electric vehicle (EV) charging. By utilizing Arduino microcontrollers, one can accurately monitor and optimize the charging process in real-time, assuring efficient energy usage and reliable performance. Through the implementation of wireless charging technology, the station effectively removes the need for physical hookups, therefore enhancing user experience and reducing the presence of clutter in urban areas. Moreover, by harnessing solar energy for electric vehicle (EV) charging, it diminishes reliance on conventional grid electricity, thereby assisting in endeavors to decrease carbon emissions and promote environmental sustainability. The system's modular design facilitates scaling and enables customized applications to accommodate unique requirements and site circumstances.

6. FUTURE SCOPE

- *Improved Efficiency:*

Ongoing research efforts are focused on enhancing the efficiency of solar energy collection and wireless power transmission technology. The potential for enhanced conversion efficiencies and faster charging rates in solar rooftop wireless charging stations is bolstered by advancements in materials and design.

- *Integration with Smart Grids:*

The incorporation of smart grid infrastructure enables the dynamic modification of charging settings in response to grid circumstances, energy consumption, and pricing signals. This optimization strategy aims to reduce grid pressure during moments of high demand, while simultaneously providing cost-saving prospects for electric vehicle (EV) owners.

- *Battery Technology Advancements:*

The development of battery technology, which involves higher energy density and faster charging capabilities, has the potential to enhance the performance and usability of electric vehicles (EVs). The continuous relevance and effectiveness of solar rooftop wireless charging stations in the developing environment of electric mobility are ensured by their compatibility with next-generation batteries.

- *Infrastructure expansion:*

Is a continuous process that involves the broad implementation of solar rooftop charging stations in various locations such as public spaces, residential neighborhoods, and roads. This initiative aims to improve accessibility and convenience for electric vehicle (EV) users. The expeditious implementation of such infrastructure necessitates the imperative collaboration of government entities, commercial companies, and communities.

- *Autonomous Vehicle Integration:*

The progress in autonomous vehicle technology enables the smooth integration of solar rooftop wireless charging stations, which simplifies the process of charging and maintaining autonomous electric car fleets. This promotes the shift towards self-driving

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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