A SOLAR POWERED WIRELESS POWER TRANSFER FOR ELECTRIC VEHICLE (EV) CHARGING

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Introduction:

Electric vehicles (EVs) are revolutionizing modern transportation by offering a sustainable alternative to fossil fuel-powered vehicles. With rising concerns about climate change, air pollution, and the depletion of non-renewable resources, EVs are seen as a critical solution to reducing global carbon emissions. They offer greater energy efficiency compared to internal combustion engine (ICE) vehicles and help mitigate the environmental impact of traditional transportation systems. By eliminating tailpipe emissions, EVs contribute to cleaner air, reducing harmful pollutants such as nitrogen oxides (NOx) and particulate matter (PM), which are major contributors to respiratory diseases and environmental degradation.

One of the key factors driving the adoption of EVs is the advancement in battery technology. Lithium-ion (Li-ion) batteries, which serve as the primary energy storage system in EVs, have seen significant improvements in capacity, charging speed, and durability. However, despite these advancements, Li-ion batteries still face limitations. Their energy density ranges between 89-110 Wh/kg, significantly lower than gasoline, which offers around 12,000 Wh/kg. This energy gap results in a limited driving range, with most EVs requiring a recharge after approximately 300 miles. Additionally, the high cost of battery production, long charging times, and battery lifespan concerns continue to challenge widespread EV adoption. The role of transportation infrastructure in supporting EVs is crucial. Smart road systems, intelligent traffic management, and innovative charging solutions are being developed to create a more sustainable and efficient mobility network.

Future roadways will likely integrate autonomous vehicle technology and embedded charging systems to optimize energy usage and enhance convenience for EV users. As cities move toward electrification, improving charging infrastructure remains a primary focus to address range anxiety and ensure widespread EV adoption. Despite their many benefits, EVs pose new challenges, particularly in terms of energy demand. A surge in EV usage increases electricity consumption, which, if primarily sourced from fossil fuel-based power plants, could negate some of the environmental benefits.

Thus, renewable energy solutions, such as solar-powered charging stations, are being explored to create a greener and more sustainable charging ecosystem. Wireless power transfer (WPT) technology has emerged as a promising innovation to complement solar-based EV charging. WPT eliminates the need for physical connectors, allowing vehicles to charge while stationary or even in motion through inductive charging systems embedded in roadways. By integrating solar energy with wireless charging technology, EV charging can become more efficient, reliable, and environmentally friendly. Such advancements will significantly enhance the feasibility of EVs and pave the way for smarter, more sustainable urban mobility solutions.

Objectives:

- Develop a solar-powered wireless EV charging system to improve sustainability and energy efficiency.
- Eliminate the need for plug-in charging by using wireless inductive power transfer.
- Integrate real-time battery monitoring and smart power management.
- Promote clean energy adoption and reduce carbon emissions.

Methodology:

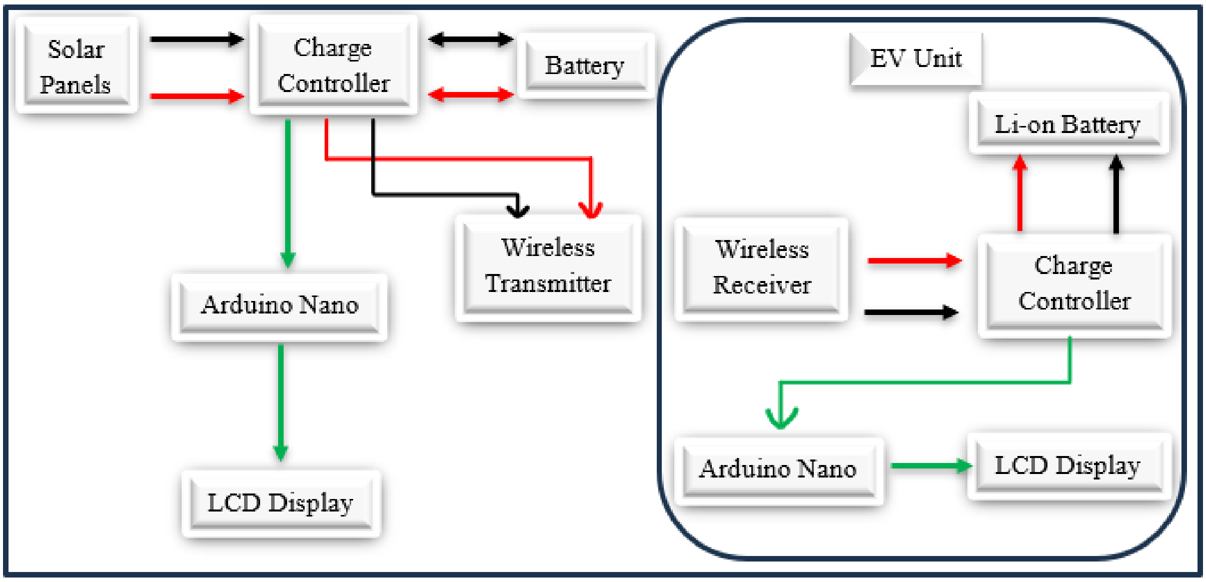

Figure 1: Block Diagram of the Proposed System

When an EV's battery depletes, it requires recharging, similar to fuel-based vehicles. In this project, when the EV is positioned over the wireless charging unit, a charge controller manages safe and efficient power flow. The Arduino Nano is interfaced with the charge controller to monitor charging/discharging in real-time, displaying the percentage on an LCD.

The solar panels are installed at an optimal angle for maximum efficiency. Power generated is stored in batteries and converted to AC using an inverter. This energy is then transmitted via transmitting coils embedded in roads, which induce current in receiver coils mounted on the EV. The system allows real-time charging while the vehicle is in motion—termed dynamic wireless charging.

Result and Conclusion:

Illustrates the working model of the solar-powered wireless EV charging system (SWEVCS). The charging unit stores solar power, which is wirelessly transmitted to the EV. State of charge (SOC) is displayed in real-time. LCDs confirm operation and allow user interaction.

The system supports flexible positioning, eliminates cable dependency, reduces maintenance costs, and improves sustainability. Results indicate successful shortdistance wireless power transfer with high efficiency. The project validates the practicality of solar-powered wireless EV charging for future deployment.

Project Outcome & Industry Relevance

The SWEVCS offers a sustainable alternative to traditional EV charging by combining wireless charging and solar energy. It has the potential to be deployed in public infrastructure, reducing reliance on plug-in systems and supporting clean energy goals. This innovation aligns with the automotive industry's shift towards autonomous, green, and connected transportation solutions.

Future Scope:

The solar-powered wireless EV charging system (SWEVCS) has the potential for significant future advancements. Future improvements may include increasing wireless charging distance via optimized coil design and resonance tuning, and enhancing power transfer efficiency using advanced electronics.

Integrating AI-based smart grids for dynamic power distribution will improve performance. Bidirectional charging (V2G) could allow EVs to return power to the grid. Public infrastructure deployment, smart city compatibility, and AI-driven battery management will increase adoption and scalability. These advancements can contribute greatly to smart mobility and clean energy transitions.