STSMC-Based Dynamic Wireless Charging System for Electric Vehicles

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ABSTRACT

This paper discusses the increasing demand for efficient charging systems due to the rapid growth of electric vehicles (EVs). Dynamic Wireless Power Transfer (DWPT) is introduced as an advanced technology that allows EVs to charge while in motion, eliminating the need for stationary charging systems. The proposed system uses a Super-Twisting Sliding Mode Control (STSMC) technique to improve the performance and stability of wireless charging.

The STSMC controller enhances system efficiency by handling uncertainties, disturbances, and variations in load conditions. It improves voltage stability, reduces power fluctuations, and ensures continuous power transfer even when the vehicle is moving. The system is analyzed through simulation by considering parameters such as misalignment, coupling variations, and dynamic loading conditions.

Comparative analysis with conventional controllers shows that STSMC provides better efficiency, reduced steady-state error, and improved robustness. The results demonstrate that the proposed system is reliable and suitable for real-time EV charging applications. This research contributes to the development of sustainable transportation by improving wireless charging technology and enabling efficient energy transfer in dynamic conditions.

Keywords: *Wireless Power Transfer, Electric Vehicles, Dynamic Charging, STSMC, Magnetic Resonance*

1. INTRODUCTION

The large-scale use of internal combustion engine vehicles has led to environmental pollution and global warming. Electric vehicles (EVs) are considered an effective alternative to reduce these problems. However, EVs face challenges such as limited battery capacity, long charging time, and high cost.

Traditional charging methods include plug-in charging systems, which require physical cables. These systems may cause safety issues and inconvenience due to cable handling. Wireless Power Transfer (WPT) is an advanced solution that enables contactless charging using electromagnetic fields.

Dynamic Wireless Power Transfer (DWPT) allows vehicles to charge while moving, improving efficiency and reducing downtime. This technology eliminates the need for large batteries and provides continuous charging during travel.

1.1 Literature Review

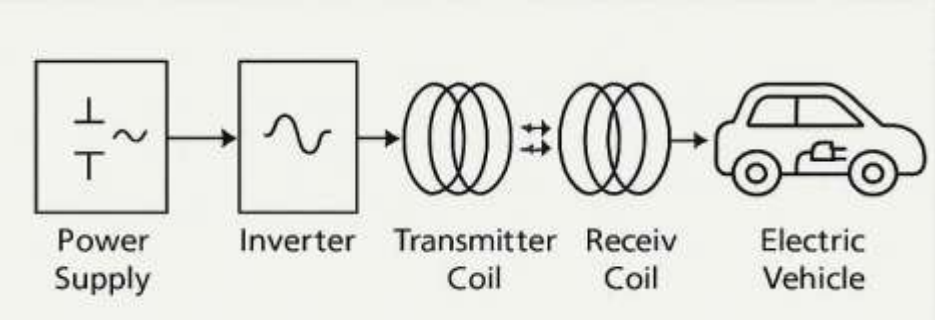
Several researchers have worked on improving wireless charging systems. Studies show that dynamic charging can increase vehicle range and efficiency. Advanced control techniques are used to manage system uncertainties and improve power transfer.

1.2 Wireless Power Transfer

Wireless power transfer is a method of transmitting electrical energy without physical connection. It works using electromagnetic fields between transmitter and receiver coils.

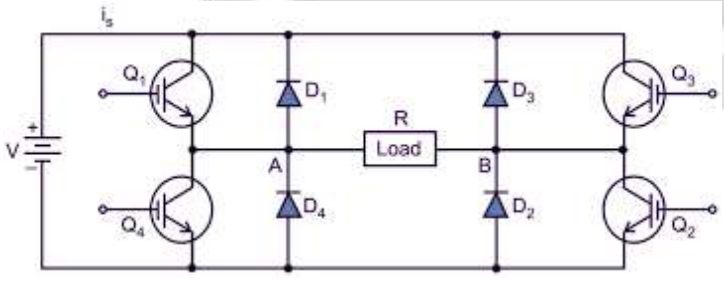
2. SYSTEM DESIGN

The DWPT system consists of:
Transmitter unit embedded in road
Receiver unit attached to vehicle
Power electronic converters
Control system (STSMC controller)



2.1 Working Principle

AC current generates electromagnetic field
Receiver coil captures energy
Power is converted and stored in battery



2.2 Advantages

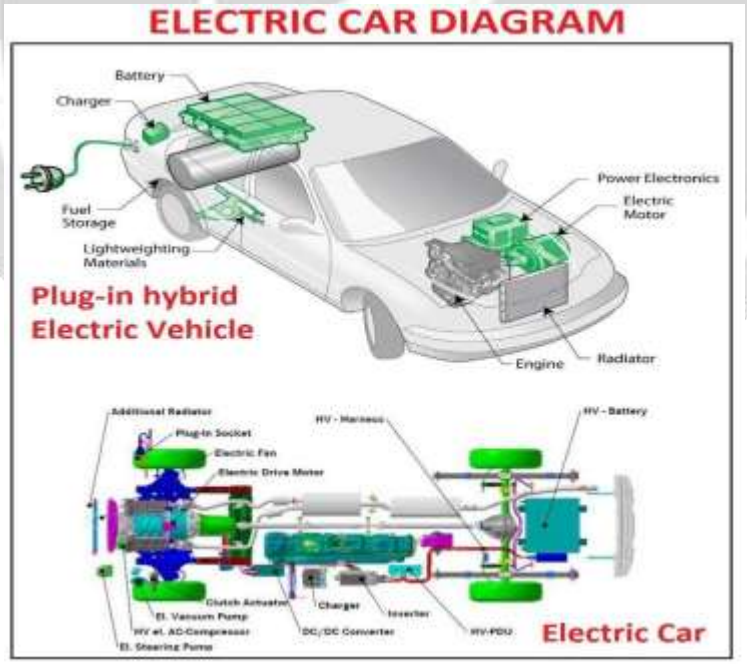
•No cables required
•Safe and convenient
•Supports automation
•Suitable for smart transportation

3. CONTROL STRATEGY (STSMC)

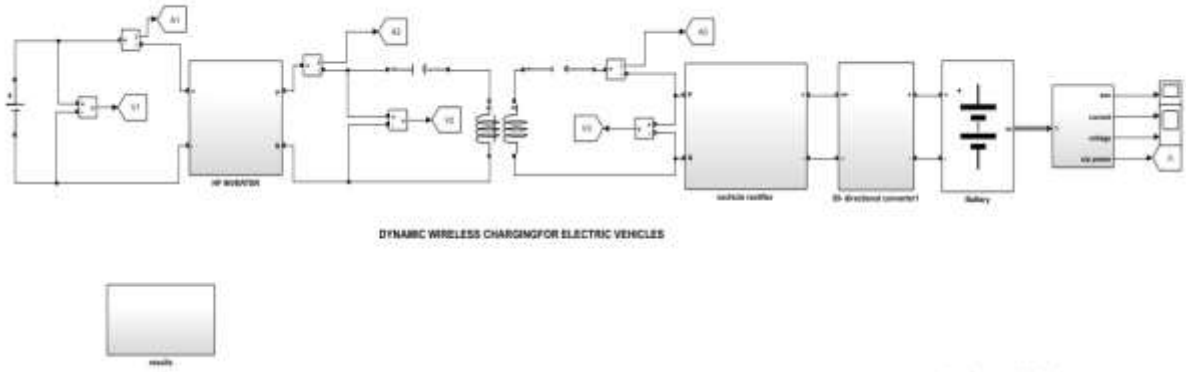
The Super-Twisting Sliding Mode Controller improves system performance by:
•Reducing disturbances
•Maintaining voltage stability
•Improving efficiency
•Providing fast response

3.1 Applications

•Electric vehicles
•Smart roads
•Industrial automation
•Renewable energy systems

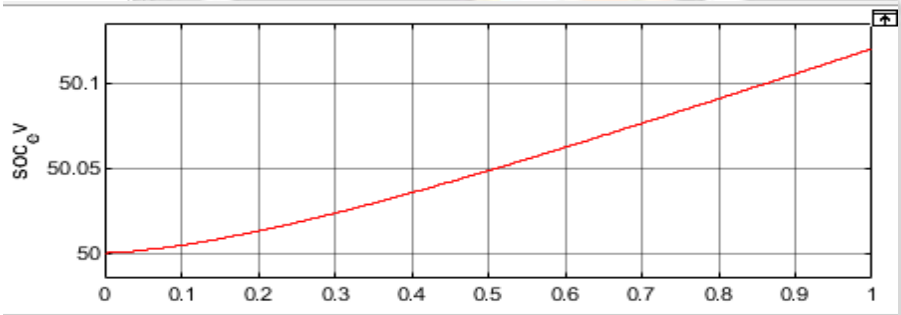


SIMULATION RESULTS

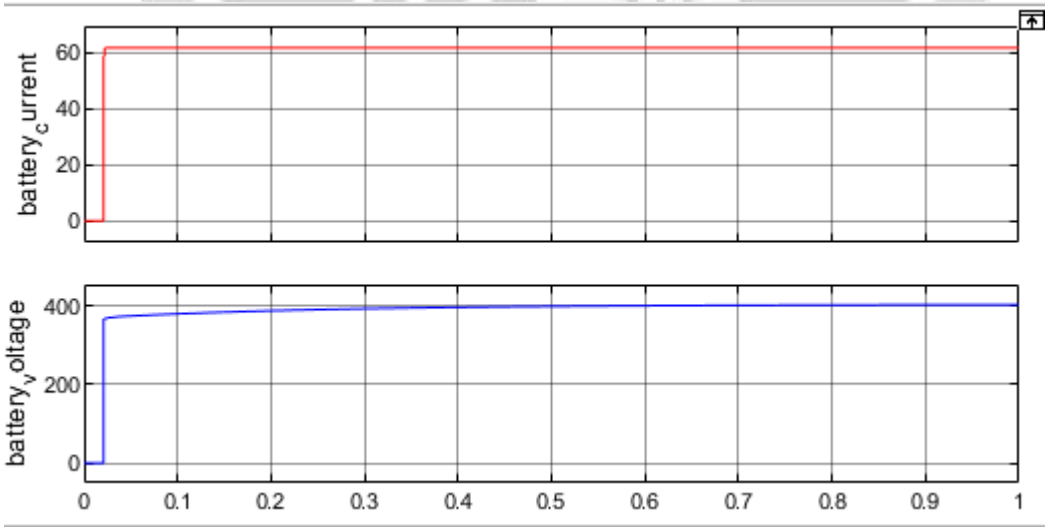


schematic diagram of dynamic wireless charging of electric vechicle

In this study the Dynamic Wireless Charger for EV is designed in MATLAB Simulink environment. The proposed WPT dynamic charging system is based on an optimal designed, power electronic converters and a magnetic coupler

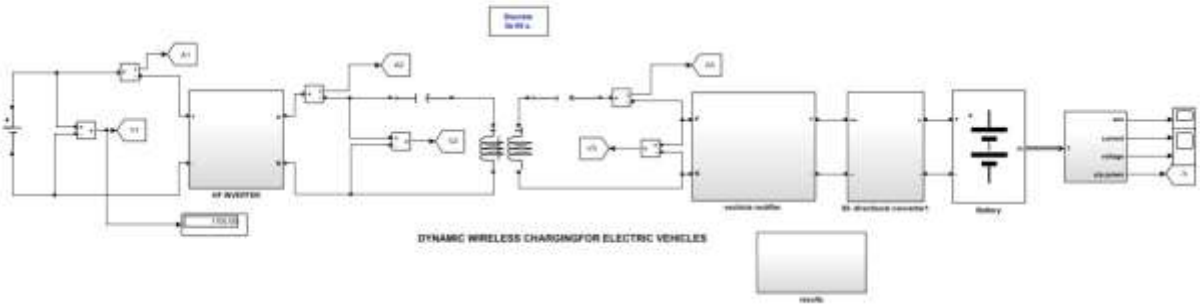


EV SOC



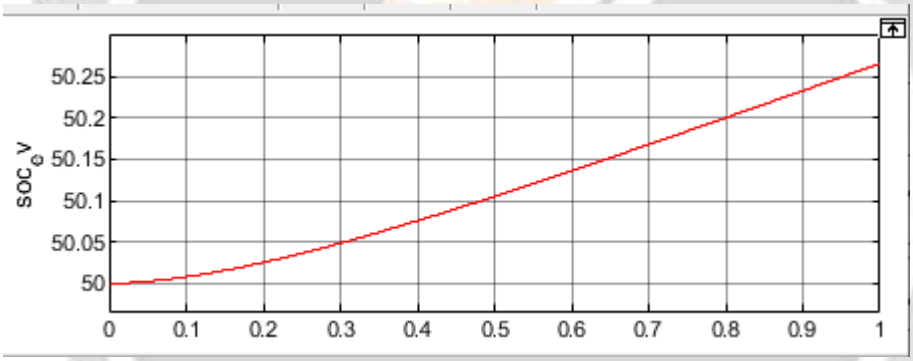
Ev battery voltage and Ev current

EXTENSION RESULTS

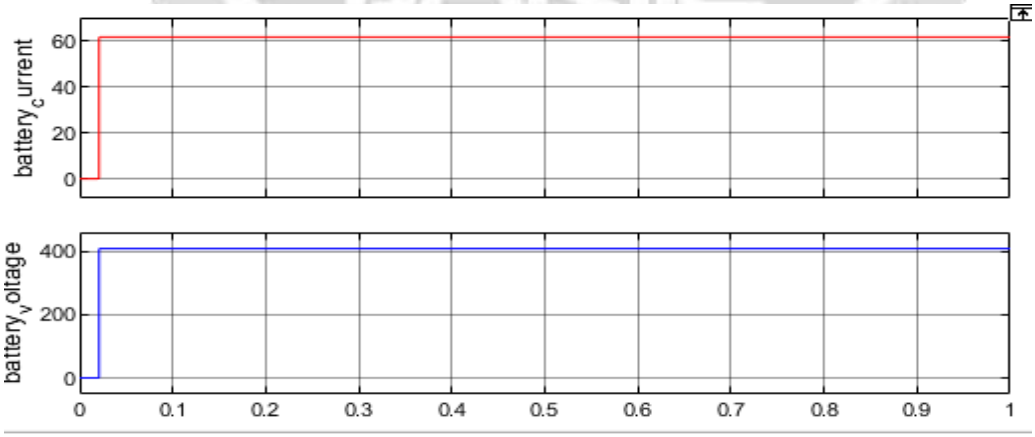


Simulation schematic diagram of dynamic wireless charger for electric vechicles

In this study the Dynamic Wireless Charger for EV is designed in MATLAB Simulink environment. The proposed WPT dynamic charging system is based on an optimal designed, power electronic converters and a magnetic coupler and then by using the Stsmc controller to control then generate pulses .



Ev soc



Ev battery side voltage and current

CONCLUSION

Dynamic wireless charging using STSMC is an efficient and reliable solution for EV charging. It improves power transfer efficiency, reduces charging time, and enhances system stability. The technology supports sustainable transportation and future smart infrastructure development.

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