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A Super-twisting SMC Design for Bidirectional DC–DC Converters in Electric Vehicle Applications

Ghadbane Houssam Eddine*, Zorig Anwar [2] and Dehmeche Ibrahim [3]

[1]*Electrotechnical and Automatic Engineering Department / Electrical Engineering Laboratory, University of Guelma, Algeria*
[2] *Electrotechnical Engineering Department /Telecommunications, Signals and System Laboratory, University of Laghouat, Algeria*
[3]*Electrotechnical Engineering Department / Exploitation and development of Saharan energy resources Laboratory, University of El Oued, Algeria*

**(ghadbane.houssameddine@univ-guelma.dz)*

Abstract – Many industrial and electrical systems, such as electric vehicles, employ DC/DC converters. Since DC/DC converters are nonlinear and time-varying systems, it is inappropriate to regulate them using linear control techniques. In this paper, a super-twisting sliding mode control (STSMC) is applied for bidirectional DC-DC converter in electric vehicle applications. The traction chain of the electric vehicle consists of a battery-supercapacitor energy storage system (ESS) linked in parallel to the DC bus through two bidirectional DC–DC converters and a synchronous reluctance motor drive (SynRM). The benefit of sharing power in an HPS, which is primarily made up of a supercapacitor and battery, is the ability to use the strengths of both sources, with the former having high specific energy and the latter having high specific power. The on-board energy storage system's performance is enhanced by this hybridization in terms of cost, mass, and charging time. In addition to the proposed control, the hybrid power system (HPS) needs a strategy for routing energy between the two sources and the motor. This strategy is based on frequency decoupling (DFS), which protects the battery from peak current during the acceleration and deceleration phases. The objective of using the control law based on super-twisting sliding mode control (STSMC) is to follow the reference trajectories in finite time with high precision, very good robustness, and a reduction in chattering. Using the MATLAB/Simulink software, a thorough simulation of an electric vehicle was performed in order to confirm the effectiveness of the suggested control approach and assess the effectiveness of the source's energy management strategy. This control method ensures a reduction in the bus voltage stress (Δv=5V) and improves the quality of the power. The overshoot voltage for a load power of 21 kw is reduced to 15V (3.2%) compared to the linear control techniques, improving the system's robustness and reliability..

Keywords – Super-Twisting Algorithm, Bidirectional DC–DC Converters, Hybrid Power System, Electric Vehicles, Frequency Decoupling Strategy.