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40

Cohesive DS-PID and FQL Control Mechanisms to Enhance the Performance of the Electric Vehicle System

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***Abstract*—Electric Vehicles (EVs) have become more popular and attractive in recent days, due to their benefits of zero carbon emissions, cost effectiveness, reduced maintenance, and effectiveness. In which, controlling the speed of motor and proper power regulation are the important tasks for designing the EV systems. For this purpose, various control techniques have been developed in the existing works, but it limits with the major problems of reduced efficiency, increased error output, and high time consumption. To solve these problems, this paper intends to develop an advanced and novel optimization-based control algorithms for controlling the speed of motor and regulating the output power of EV systems. Here, the Maximum Peak Point Control (MPPT) technique is utilized to extract the increased amount of power from the PV panels. Then, the Dual Fold Luo (DFLuo) DC-DC converter topology is utilized to regulate the output DC power to improve the battery storage of the EV system. Consequently, the optimization-based Dynamic Supervision-PID (DS-PID) control mechanism is employed to recognize the maximum power from PV to generate the control pulses for switching activities. After that, the Fractional Quadratic Linearizer (FQL) control technique is utilized for controlling the speed of BLDC motor, in which the current limiter controls the speed based on the input features of the brake and the speed of motor running at each time instant. During the simulation evaluation, the results of the proposed control mechanisms are validated and compared using various performance measures.**

***Index Terms*—Electric vehicle; Dynamic supervision-PID controller; Dual fold Luo DC-DC converter; Fractional quadratic linearizer (FQL); Solar photovoltaic system; Maximum peak point tracking (MPPT).**

I. INTRODUCTION

In the present days, the Electric Vehicle (EV) [1], [2] application has gained a significant attention due to their enormous benefits of being noiseless, having no vibration, having no smell, and the comfort of gear changes. Generally, the EV is a kind of electrically driven vehicle that can use electric motors for its impulsion. Furthermore, applications such as smart grid, EV, and other electrical devices use solar PV system with DC-DC converters to regulate and increase the input DC voltage to the desired level [3]–[5]. Conventionally, various types of DC-DC converters have been utilized, which can be differentiated based on their design properties and the architecture of the switching arrangement. In which, the efficiency of converter topologies depends on the control of switching components present in it. Converters can reduce and boost the input power based on the arrangement of switching devices, filtering components of inductors, and capacitors. In existing works [6]–[8], closed-loop controllers have been mainly used to generate pulses in random width size according to the estimated error signal obtained from the feedback loop. To control the switches, several methods are developed to generate triggering pulses based on the feedback signal and reference parameters. Those methods [9]–[12] refer to some fixed rules with certain limits to evaluate the error signal. Since these traditional control methods are limited with the problems of reduced efficiency in regulating the power with distorted output.

To solve this problem, a novel control methodology is proposed in this work that helps to solve the fixed-range issues by estimating the control signal with respect to the varying parameters, which are dynamically updated at every time instant based on the feedback signal. This type of dynamic update will tune the performance of controller with reduced error values and regulated DC power at the output terminal. This model helps to extract the signal features for tuning the parameters of controller and, provides dynamic change in gain properties to regulate the DC power. The control signals are used to trigger the switches present in the converter circuit and the current limiter. In this case, the current limiter controls the speed of EV based on the input features of the brake and the speed of the motor running at each time instant. The main objectives of this research work are listed as follows:

– To properly regulate the maximum amount of power generated from the PV modules, the Dynamic Supervision-based PID (DS-PID) control technique is

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