ABSTRACT

The development of electric vehicles demands improvements in drive system performance, particularly in Brushless DC (BLDC) motors for electric bicycles. This study compares two BLDC motor speed control methods: Field Oriented Control (FOC) and Pulse Width Modulation (PWM). Simulations were carried out using MATLAB/Simulink, while experimental testing was conducted on the PWM method using a 36V 350W BLDC motor and a commercial controller. Evaluation parameters included rise time, steady-state error, torque stability, current waveform, and system efficiency

The simulation results show that the FOC method achieved a rise time of less than 0.3 seconds, a steady-state error of less than 2%, a sinusoidal current waveform, and smoother torque. In contrast, the PWM method exhibited a rise time of approximately 0.4 seconds, a steady-state error of 2–3%, and current and torque waveforms with high ripple. Experimental testing of PWM produced a peak speed of 950 RPM at the 4-second mark, with fluctuations occurring between the 2–6 second interval, followed by a gradual decrease to 200 RPM by the 10-second mark. The actual data supports the simulation results, demonstrating characteristics consistent with PWM control.

Therefore, the FOC method is recommended for electric bicycles requiring fast response and comfort, while PWM remains relevant for simpler and low-cost implementations.

Keywords: BLDC, FOC, PWM, electric bicycle, simulation, speed control