Sensorless control of permanent magnet synchronous machine

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Keywords: permanent magnet synchronous motor, sensorless control, positi on esti mati on method.

Abstract. Permanent magnet synchronous motors (PMSMs) are widely utilized in the aerospace sector, serving as actuators for flight surface control in aircraftand as driving units for satellite attitude control. These applications benefit significantly from the high dynamics and energy efficiency inherent to PMSM drives. This paper focuses on the development of sensorless control methods for PMSMs, which enhance reliability and reduce costs by eliminating mechanical speed and position sensors. Sensorless control techniques rely on estimating the motor's speed and rotational angle, which can be categorized into two primary approaches: high-frequency signal injection methods, effective at low speeds, and back electromotive force (back-EMF) estimation methods, which excel at higher speeds. The objective of this study is to investigate a back-EMF-based sensorless control method through simulations using MATLAB/Simulink, followed by experimental validation with a dSPACE1104 board. The proposed control strategy is implemented on a three-phase synchronous permanent magnet motor, enabling phase excitation without the need for rotary or linear position sensors. This approach mitigates energy loss due to heat dissipation and minimizes potential sensor wear and maintenance requirements. The implementation utilizes an Extended Luenberger Observer (ELO) for sensorless control, coupled with a Phase-Locked Loop (PLL) rotor position tracker. The synergy between ELO and PLL enhances estimation accuracy, robustness against disturbances, and overall

system responsiveness, making it a powerful solution for practical applications. The performance of this system is evaluated using the dSPACE1104 platform, demonstrating its effectiveness in real-world scenarios.

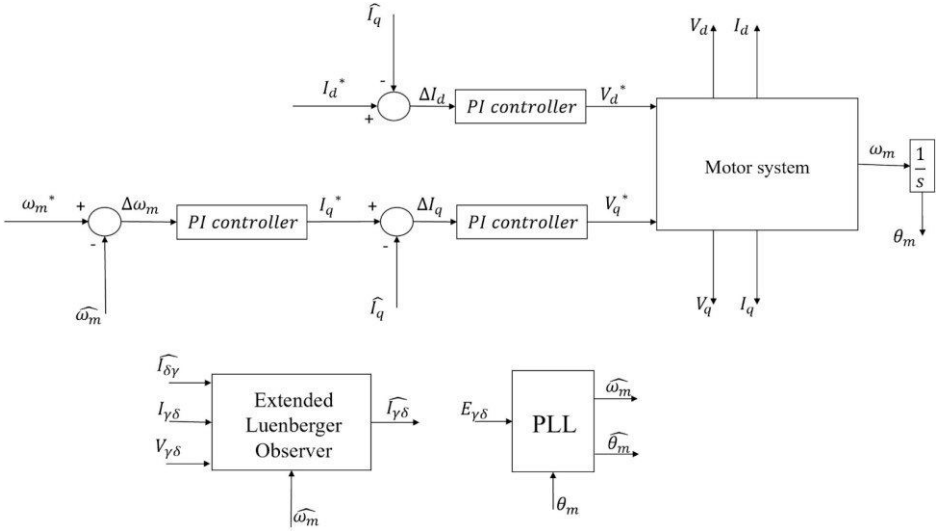

Fig.1 Sensorless control system using ELO and PLL

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