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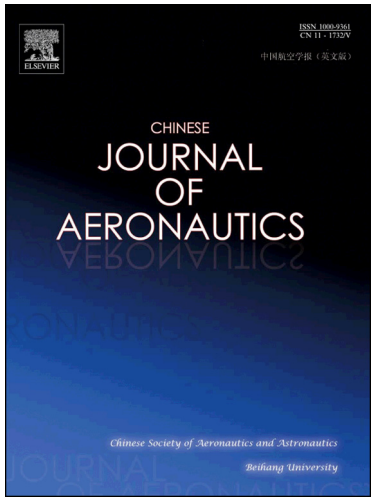

Full Length Article

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Start-up current adaptive control for sensorless high-speed brushless DC motors based on inverse system method and internal mode controller

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Abstract

The start-up current control of the high-speed brushless DC (HS-BLDC) motor is a challenging research topic. To effectively control the start-up current of the sensorless HS-BLDC motor, an adaptive control method is proposed based on the adaptive neural network (ANN) inverse system and the two degrees of freedom (2-DOF) internal model controller (IMC). The HS-BLDC motor is identified by the online least squares support vector machine (OLS-SVM) algorithm to regulate the ANN inverse controller parameters in real time. A pseudo linear system is developed by introducing the constructed real-time inverse system into the original HS-BLDC motor system. Based on the characteristics of the pseudo linear system, an extra closed-loop feedback control strategy based on the 2-DOF IMC is proposed to improve the transient response performance and enhance the stability of the control system. The simulation and experimental results show that the proposed control method is effective and perfect start-up current tracking performance is achieved.

Keywords: Brushless DC motors; Start-up; Support vector machines; Neural networks; Inverse systems; Adaptive control; Internal model controller

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1. Introduction[1]

The high-speed brushless DC (HS-BLDC) motor has been used extensively in pumps, blowers, compressors and control moment gyroscopes due several distinct advantages offered in areas such as power density, efficiency, and magnetic bearing system.[1-5] To ensure that the motor can be operated in high-speed environments and reduce the hardware circuit cost, an investigation into sensorless control is essential for further development of HS-BLDC motor drive systems.[6,7] Extremely small stator inductance and resistance characteristics are not conducive to controlling the start-up current of sensorless HS-BLDC motors.[6,8] Consequently, sensorless HS-BLDC motor start-up current control is a challenging research topic. Highly precise start-up current control without a large ripple is required in the motor drive system.[6,8] Without this, a large start-up current is harmful for the power circuit and motor,[8-10] and can even cause motor start-up failure.[10] Recently, a common commutation instant detector based on back electromotive force (BEMF) zero crossing point (ZCP) detection has been utilized,[11,12] the improved BEMF integration method[13]

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