

# 順滑模態估測器應用於 無感測無刷直流馬達之速度控制

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因高功率密度及高效率的特性，使得無刷直流馬達被廣泛的應用在日常生活  
中，舉凡個人電腦週邊的機器、家電機器、產業用動力馬達、大眾運輸系統等皆  
屬於其應用範疇。一般要控制無刷直流馬達的轉速都倚賴安裝在馬達內部的位  
置感測器或編碼器，但位置感測器或編碼器卻存在著一些缺點，諸如增加馬達的體  
積及成本、受馬達內部運轉溫度影響等，因此，近年來對於無感測控制方法的研  
究日益蓬勃發展。

本論文以一個三相直驅式軸向磁通之無刷直流車輪馬達為研究對象，旨在設  
計順滑模態估測器在無感測無刷直流馬達之速度控制中估測轉速及位置。首先以  
Matlab<sup>®</sup>-Simulink<sup>®</sup>建立其數學模型，接著設計順滑模態估測器於無刷直流馬達的  
速度回授控制中，用以驗證本論文提出的無感測轉速估測方法。最後，輔以xPC  
Target的即時控制工具，將順滑模態估測轉速之方法，實現於硬體實驗，在本論  
文中將完整呈現設計順滑模態估測器的過程。

# SLIDING MODE ESTIMATOR DESIGN FOR SENSORLESS BLDC MOTOR IN SPEED CONTROL

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## ABSTRACT

Owing to the high power density and high efficiency, BLDC motors have been used in various applications, such as the computer peripheral machines, household appliances, industrial machines and public transit systems. In general, the information of the motor's position is required in controlling the BLDC motor. However, some drawbacks exist. For instance, the motor size and cost will be raised and the position sensor will be influenced by the motor temperature inside. Therefore, recent investigators have paid more and more attention to sensorless MLDC motors, which can be operated without any position sensors.

A 3-phase BLDC axial-flux wheel motor is used in this thesis. It is a low speed and high torque direct-drive motor. The goal is to design the sliding mode estimator for sensorless BLDC motor in speed control. The motor's model is established by Matlab<sup>®</sup>-Simulink<sup>®</sup> at the beginning. Next, the sliding mode estimator is designed and added upon the speed feedback control. Finally, the hardware experiment is set up to verify the method proposed in this thesis. The whole design process will be proposed in detail in this thesis.