

國立臺灣大學工學院機械工程學研究所



碩士論文

Department of Mechanical Engineering

College of Engineering

National Taiwan University

Master Thesis

使用諧振濾波器進行低電感永磁馬達的磁場導向控制

Low Inductance Permanent Magnet Motor Drive with LC

Filter for Field Oriented Control

許誠中

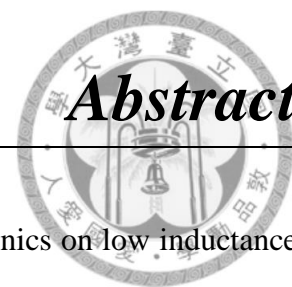
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This thesis aims to improve switch reflected current harmonics on low inductance permanent magnet (PM) motor drives. To reduce current harmonics, inverter output LC filter is usually implemented on motor drives. However, additional current/voltage sensors are required to realize the motor drive with output LC filter. This sensor requirement might not be suited for standard inverter products where only two or three phase current sensors are embedded inside inverters.

To overcome this additional sensor requirement, this thesis proposes a cascaded dual observer for the estimation of filter capacitor voltage and motor current using only inverter available current sensors. With the knowledge of motor current, the position sensorless field oriented control (FOC) can be achieved without filter output current sensors. In addition, the capacitor voltage is estimated for the electromotive force (EMF) voltage estimation and sensorless drive. The parameter sensitivity on the proposed dual observer is analyzed. A low inductance high speed PM motor prototype is used to verify the inverter drive with LC filter. It is concluded that the sensorless FOC drive can be achieved on the drive with LC filter using the proposed dual observer estimation.

Keywords — permanent magnet motors, motor drive, LC filters, dual observers, state estimation



本篇論文旨在研究低電感馬達電流諧波問題。為了有效降低電流諧波，在通過變頻器後加上 LC 濾波器是常用方法。然而為了控制變頻器後方的濾波器及馬達系統，需要使用額外感測器量測濾波器輸出的電壓電流訊號。對於現有變頻器產品，這些產品已經安裝固定電流感測器且並不會留下多餘的腳位接收額外的感測器訊號，導致加裝濾波器的方法較難使用在現有產品上。

本篇論文提出串聯式的雙估測器設計，只需要使用變頻器上既有電流感測器，估測出濾波器電容電壓以及馬達電流。利用這些估測訊號，可以在使用現有變頻器電流感測系統，實現電流諧波抑制且做到無位置感測器向量控制。本論文估測器的理論及參數敏感度將會詳細討論。實驗的部分會使用一顆低電感的高速永磁馬達，並在變頻器輸出端加上設計的 LC 濾波器。透過實驗的結果，可以在現有驅動器，利用串聯式雙估測器進行 LC 濾波器對低電感馬達電流諧波改善。

關鍵字 — 永磁電機，電機驅動，LC 濾波器，雙估測器，狀態估測