自手排傳動系統之動態模擬及最佳化

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摘要

自手排傳動系統(Automated Manual Transmission System, AMT)近年來由於低成本、高效率、及方便性的優點，已開始迅速的發展並被廣泛的運用。目前市售車輛中，從BMW M3、Ferrari 355、Alfa Romeo 156之類的高級跑車，到Opel Corsa、Renault Twingo之類的平價車款，都已採用此類傳動系統。然而自手排傳動系統換檔時離合器的控制較難達到與傳統自排系統(Automated Transmission, AT)扭力轉換器相比擬的舒適性，是目前自手排傳動系統尚無法完全取代傳統自排系統的主因。

為了改善自手排傳動系統換檔時的不舒適性，本文以自手排傳動系統中離合器的控制為主要研究目標。本論文主要包含三個部分:動態模型的建立、控制方程式的設計、及最佳化設計。在動態模型的建立上，主要是建立AMT傳動系統由引擎、離合器、離合器致動器、變速箱、到車輛負載的動態模型，藉以模擬AMT系統在換檔時的動態表現。由於本研究與工研院(ITRI)機械所先進車輛動力組合作，協同進行工研院所開發離合器致動器原型的修改，因此整個動態模型的建立特別著重於離合器致動器。在控制方程式的設計中，則針對所建立出動態模型的特性，再藉由控制法則及參數調整理論，設計出整個離合器致動器的控制器的數學模型，藉以模擬整個傳動系統由控制指令到動態表現的完整行為。在最佳化的部分之中，則藉由最佳化原理更改原本離合器致動器部分零件的設計及控制方程式中的參數，使換檔時離合器的嚙合與分離有更符合設計需求的表現。

Dynamic Modeling and Optimization of Automated Manual Transmission System

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ABSTRACT

Automated Manual Transmission (AMT) system is gradually prevailed in recent years since it has high transmission efficiency, auto shifting capability, and low cost. Vehicles from high quality sports cars like BMW M3, Ferrari 355, Alfa Romeo 156, etc., to general sedans like Opel Corsa, Renault Twingo, etc. have introduced such system. However, the key point that AMT can't completely substitute Automated Transmission (AT) system is the smoothness that a auto clutch system on AMT can't transmit power as smooth as a torque converter on AT.

Clutch control of AMT system is the main subject in this study, which includes three objectives: dynamic modeling, control function design, and optimization. The first objective is to create a dynamic model of AMT system, which includes engine, clutch, clutch actuator, gear box, and vehicle loading. Clutch actuator is focused in this model, since this study is a project cooperating with Industrial Technology Research Institute (ITRI) to modify a prototype of clutch actuator. The second objective uses the dynamic model created before to design a control function for the clutch actuator, some control methods and parameter turning methods are introduced here. According to the control model and dynamic model, a complete

shifting process from controller to vehicle dynamic is simulated in this study. The third objective is optimization, some parts in the clutch actuator and some parameters of the control function are optimized to give a better performance on clutch engagement and disengagement.