國 立 成 功 大 學

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碩 士 論 文

大型臥式搪銑床之面盤幾何誤差量測與驗證

Measurement and Verification of Geometric Errors in Facing Head on Large Horizontal Boring and Milling Machines

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摘要

本論文提出一套利用觸發式測頭與標準校正球的量測系統，能夠量測旋轉軸位置的幾何誤差，此量測系統除了安裝操作方便、成本較低，還可應用在不同構型的工具機上，做為快速檢測旋轉軸位置誤差的機上量測系統。本論文以遠東機械臥式搪銑床 BMC-110FT2 做為研究對象，所量測的目標為其面盤旋轉軸線的 4 項幾何誤差，解決此機器因為面盤與主軸之間的位置誤差，造成搪孔加工的工件呈現內外圓不同心的問題。

透過建立臥式搪銑床的幾何誤差模型，推導量測時的正逆向運動學，分析此機器的面盤在不同角度下，理想與實際標準校正球之間的位置差異，並由建立的誤差計算方程式，解出面盤旋轉軸線影響最大的 4 項位置誤差。在最後將測得的誤差補償於控制器後，透過切削測試直接驗證了此量測系統的可行性與可靠性。由結果顯示，搪孔加工的工件其內外圓同心度的偏差在補償後有顯著的下降，減少了原本同心度偏差量的 86.6%，為廠商提供了一套有效檢測面盤位置誤差的方法，並預期此量測系統能應用於更多情境，做為一快速檢測旋轉軸幾何誤差的機上量測系統。

關鍵字：機上量測、觸發式測頭、旋轉軸、幾何誤差、誤差補償

Abstract

This study proposes an on-machine measurement methodology for identification and compensation of location errors of rotary axis on machine tools by using a touch-trigger probe and a precise sphere. The advantages of this measuring system are not only convenient for installation and operation, but also can be applied to different configurations of machine tools. This thesis takes the horizontal boring and milling machine BMC-110FT2 produced by Far East Machinery as the research object, measuring the location errors between the facing head and the spindle of this machine. These location errors lead to the problem that the inner and outer holes are not concentric in the boring workpiece.

By establishing the geometric error model and analyzing the difference between the ideal and real center positions of the precise sphere when the facing head of this machine is at different angles, the four location errors of the rotary axis of the facing head are calculated. At the end of the experiment, the measured location errors are compensated to the controller. The results show that the deviation of the inner and outer hole concentricity of the boring workpiece is significantly reduced after compensation, which reduces the original deviation by 86.6%. It is expected that this method can be applied to more situations as an on-machine measurement solution for quickly analyzing the geometric errors of rotary axis on machine tools.

Keywords: On-machine measurement, Touch-trigger probe, Rotary axis, Geometric error, Error compensation