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超精密加工环境监控系统参数采集与数据库开发

Development of Parameters Acquisition and Database on  
Ultra-precision Machining Environment Monitoring System

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## 摘 要

大口径非球面光学元件在激光核聚变装置、高能激光、红外热成像、大型天文望远镜、卫星用光学系统、医疗影像设备等国家重大光学工程及国防尖端技术中有着广泛的需求。大口径非球面光学元件在高尖端技术领域的广泛应用对其表面加工精度提出了越来越高的要求,而当前我国自主设计研发的精密超精密加工装备与国外相比有着较大的差距,因此,对精密超精密加工装备及其关键技术的研究具有非常重要的意义。精密超精密加工与机床、刀具、工件、控制和监测系统以及加工环境等因素密切相关,这些因素的综合参数性能决定了超精密加工的加工精度。以超精密磨削加工为例,影响加工精度的主要因素有:磨削热与磨削温度、砂轮轴与磨床主轴微振动、砂轮磨损以及加工环境因素等。实现对各种环境参数的监控,可实时了解加工系统的工作状态,为深化对精密加工过程的认识、优化加工参数、砂轮适时修整、故障诊断等方面提供依据,从而提高加工精度。

本文以国家自然科学基金项目为依托,以超精密加工环境为研究对象,分析了加工环境对超精密加工精度的影响,阐明了实现超精密加工环境监控的重要意义。文章阐述了系统的整体结构,进行了振动监测、温度监测以及声发射监测所需硬件的选择及硬件平台的搭建,详细介绍和分析了超精密加工环境动态信号的分析与处理技术,然后以 Windows XP 为操作平台、LabVIEW 作为开发工具、SQL Server 2005 作为 DBMS 开发了超精密加工环境监控参数采集与数据库管理系统。文章对软件系统初始设置、振动监测、温度监测、声发射监测以及数据库管理五大模块的设计原则、思路以及功能实现做了详细的分析与阐述,最后在 2MK1760 精密平面磨床非球面加工过程中进行了软件系统的测试实验,验证监控软件的可行性和有效性。

**关键词:** 大口径非球面; 超精密加工; 环境监控; 数据库管理

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## Abstract

In the fields of laser fusion devices, high-energy lasers, thermal infrared imaging, large astronomical telescopes, satellite optical systems, medical imaging equipments, and other national major optical engineering and national defense sophisticated technique, large scale aspheric optical components are in great demand. As large scale aspheric optical components are widely used in the fields of sophisticated technique, higher and higher demands on its surface machining accuracy are proposed. However, there is a large gap between the precision, ultra-precision machines designed by China and abroad. Therefore, the study on precision, ultra-precision machines and its key technology has very important significance. Precision and ultra-precision machining are closely related to the machine tools, the cutting tools, the work-pieces, the controlling and monitoring systems, and the processing environment, etc. The accuracy of precision and ultra-precision machining is determined by the comprehensive properties of these factors. Taking ultra-precision grinding machining for example, the main factors affecting machining precision are grinding heat and grinding temperature, micro vibration of grinding wheel and grinding machine spindle, the grinding wheel wear, and the processing environment, etc. The implementation of monitoring various environmental parameters helps us understand the working state of the machining system in real time. It provides a basis for deepening the understanding of precision machining process, optimizing processing parameters, grinding wheel dressing timely, diagnosing fault and other respects. Thus, we can improve the machining precision.

The paper, based on National Natural Science Foundation of China and taking ultra precision machining environment as the research object, analyzes the influence of the machining environment on ultra-precision machining accuracy and illustrates the significance of achieving monitoring the ultra-precision machining environment.

In this paper, the overall structure of the system is discussed, the required hardware for monitoring the vibration, the temperature and the acoustic emission are selected, and the hardware platform is constructed. The signal analysis and processing technology of the ultra-precision machining environment dynamic signal is described and analyzed in details. Then taking Windows XP as operating platform, LabVIEW as the development tool, SQL Server 2005 as the DBMS, Parameters Acquisition and Database Management on Ultra-precision Machining Environment Monitoring System is developed. The design principles, train of thought and function implementation about the system five big modules are analyzed and elaborated in the paper. The system five big modules consist of initial setup, vibration monitoring, temperature monitoring, acoustic emission monitoring and database management. Finally, the experiment is carried out in the aspheric processing on the 2MK1760 precision surface grinding machine, demonstrating the feasibility and effectiveness of monitoring software.

**Key words:** Large Scale Aspheric; Ultra-precision Machining; Environment Monitoring; Database Management.

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