Faculty of Electrical Engineering & Computer Science
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Development of a Monitoring System for Prediction of Material Removal Rate in Polishing Precision Glass Optics.

ABSTRACT - Masterthesis

Precision glass optics represents essential parts in optical systems, which are used in many fields of applications. Because modern optical systems ask for an increased quality of the glass lenses, the manufacturing must aim for minimization of defects and surface roughness as well as an increase of the shape accuracy, while keeping the manufacturing effort low. An important step in the manufacturing sequence of precision glass lenses is the chemo-mechanical polishing step. It determines significantly the quality of the lenses. The process result is determined in addition to the machining parameters by the chemical and mechanical interactions in the process area between the polishing pad, the polishing agent, the polishing slurry and the sample surface.

Up to now the polishing process shows the highest uncertainty and instability in the manufacturing sequence. It requires high efforts for process monitoring and taking corrective measures to meet the specification or keep the rejection rate low.

These facts motivated the development of a prototype for an automated process monitoring system at the department of fine machining and optics of the Fraunhofer Institute for Production Technology (IPT) in Aachen. The prototype enables the automated monitoring of the system and analyzes a set of significant parameters. This monitoring system on the other hand is intended to be used for the prediction of the material removal rate in the polishing process. After the first series of the experiments, there seems to be a correlation between the dissipated power in the spindles and the work-piece material removal rate.

The goal of this thesis is the development and implementation of the online prediction of the material removal rate during a polishing run, based on the power measurement of the spindle drives. Furthermore, it is intended to enhance the system with additional monitoring devices and turn the current system into a stable and standalone platform where the data from various sensors as well as different power meters on the spindles can be recorded and analyzed to create models based on the dissipated power of the Tool spindle. The major steps were upgrading the existing system by improving the program structure, graphical user interface and architecture

of the data storage. The integration of further devices concerning the material removal rate prediction includes the testing of different power meters and the evaluation of the correlations with the material removal rate. Based on these results, a model for the online prediction were developed and integrated into the system and GUI. The results of this thesis are an upgraded monitoring system with an additional feature for the prediction of the material removal rate. Final demonstration runs confirmed the effectiveness of both.

The final results show robustness of the model to some limited variations of the polishing pressure and speed, but to have the best estimation outcome, the models need to be calibrated according to the input speed and pressure. The calibration step in the online prediction is done using the first five polishing runs and the model will be used for further predictions.