A Study of Optimized tool path for Uniform Scallop-Height in Ultra-Precision Grinding of Freeform Surfaces

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Abstract

Freeform surfaces have been widely used in complex optical devices to improve the functional performance of imaging and illumination quality and reduce sizes. Ultra-precision grinding is a kind of ultra-precision machining technology for fabricating freeform surfaces with high form accuracy and surface finish. However, the complexity and variation of curvature of the freeform surface impose a lot of challenges to make the process to be more predictable. Tool path as a critical factor directly determines the form error and surface quality in ultra-precision grinding of freeform surfaces. In order to study the influence of wheel path and path parameters on the surface generation in ultra-precision grinding of freeform surfaces. In this paper, a freeform mold is designed and two kinds of tool planning strategies are used to fabricate the freeform surfaces. They include constant angle and constant arc-length methods and the form errors and surface scallop-height are analyzed. Moreover, a theoretical surface generation model is developed to study the influence of grinding parameters and the radius of curvature for freeform surface profile on ground surface evolution. Hence, iterative closest point (ICP) matching method is adopted to determine the surface error between the measured surface and the designed surface. Hence, an optimized tool path generator is built to realize both the uniform scallop-height and good surface finish on the freeform surfaces.

Keywords: Freeform surfaces, Ultra-precision grinding, scallop-height, surface generation, optimization

Acknowledgments

The work was supported by a PhD studentship (project account code: RU3K) from The Hong Kong Polytechnic University. This research work was also supported by the State Key Basic Research and Development Program, China (973 program, Grant no. 2011CB 013202) and Guangdong Provincial Department of Science and Technology, Guangdong, P.R. China for The Introduction of Innovative R&D Team Program of Guangdong Province (Project no. 201001G0104781202).