Robust tool path generation for three-axis ball-end milling of sculptured surfaces

Joung-Hahn Yoon

School of Mathematics, Korea Institute for Advanced Study, 207-43 Cheongryangri-dong, Dongdaemun-gu, Seoul 130-722, Korea

jhyoon@kias.re.kr

ABSTRACT

Tool path generation is the main issue in the finishing stage of NC machining. In order to satisfy surface finish quality, tool paths are generated so that the scallop height formed by two adjacent tool paths is controlled within a predefined machining tolerance. In order to fill this requirement, the path interval should be small enough, and consequently, the machining efficiency is limited. To achieve a significant improvement in machining efficiency, the scallop height is kept at a constant which is equal to the predefined machining tolerance. This constant scallop height machining was first proposed by Suresh and Yang [4]. Improvements on the preliminary work were later proposed by Lin and Koren [2] and Sarma and Dutta [3]. Several rough approximations were used in their algorithms, and consequently, the generated tool paths cannot guarantee that the scallop height is even within the predefined machining tolerance. To improve the machining accuracy of constant scallop height machining, Feng and Li [1] proposed an iterative approach for tool path generation using a thorough understanding of the machining geometry. In the iterative algorithm, it was utilized a function which indicates the distance to the design surface. The bisection method could be used because the distance function is continuous. The present author found that the distance function is also differentiable and analytic [5]. Therefore the bisection method could be superseded by the Newton method, and consequently, the total computing time is reduced. In the works of Feng and Li [1] and Yoon [5], the iterative algorithms need the explicit solution of the orthogonal projection to the design surface for a point. However, modern CAD/CAM systems fail to provide sufficiently robust method for the orthogonal projection. In this talk, I will suggest a new iterative approach for constant scallop height machining while avoiding the projection and therefore also improving the computational speed significantly. In order to avoid the point projection, it is proposed a new model denoted by effective cutting profile for the machined strip detection.

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