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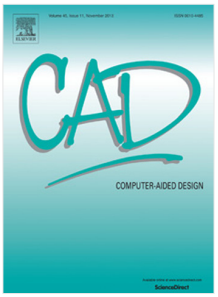

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Multi-axis variable depth-of-cut machining of thin-walled workpieces based on the workpiece deflection constraint

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Abstract

In multi-axis machining of thin-walled workpieces such as a blade, especially at the semi-finishing and finishing stage, the depth-of-cut is in general selected very conservatively in order to alleviate the deflection of the workpiece during the machining. Moreover, for both semi-finishing and finishing, the depth-of-cut is usually set to be a constant. Aiming at achieving higher machining efficiency while maintaining a good finish surface quality, in this paper we present a new multi-axis machining strategy for thin-walled workpieces based on the idea of variable depth-of-cut machining. The proposed machining strategy strives to maximize the depth-of-cut locally for every cutter-contact (CC) point while respecting a threshold of the cutting force that is normal to the workpiece surface as it is the major effective force causing the deflection. The threshold of the normal cutting force varies depending on the position of the CC point on the workpiece and it is calibrated through physical experiments. A variable offset distance function is defined by setting the offset at each CC point equal to the maximum depth-of-cut at the point and based on which a multi-pass semi-finishing tool path is generated by offsetting the finishing tool path with the computed variable offset distance. Both computer simulation and physical cutting experiments are performed and their results show that a substantial reduction in both total machining time and machined surface error can be achieved by the proposed machining strategy for thin-walled workpieces.

Keywords Variable depth machining, cutting force, multi-pass machining, variable distance offset, thin-walled workpiece.

1. Introduction

CNC machining of complicated shapes such as a blisk (bladed integrated disk) is a time-consuming and complex process due to its rather strict constraints on finished

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