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Curvilinear Grids for Five-Axis Machining

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Abstract

Machining large complex industrial parts with a high accuracy often requires tens, hundreds of thousands or even millions of cutter location points and hundreds hours of machining. That is why reducing the machining time is one of the most important topics in the optimization of CNC codes for five axis milling machines.

We propose and analyze a new method of constructing curvilinear tool paths which partly or even entirely align with the direction of the maximum material removal rate. The alignment based on the curvilinear elliptic grid generation allows to minimize the machining time while keeping the convenient zigzag-like topology of the path. The method is applicable to a variety of cost functions such as the length of the path, the machining speed, the material removal rate, the kinematic error, etc., generating different machining strategies. The method has been combined with a new version of the adaptive space filling curves.

The approach has been tested against the standard iso-parametric zigzag, MasterCam X5 and the conventional space filling curves. The material removal rate cost function has been tested against the tool path length criteria. The numerical experiments, the real machining as well the accuracy measurements demonstrate a considerable advantage of the proposed method.

Key words: numerical grid generation, milling machine, error minimization, tool path planning.