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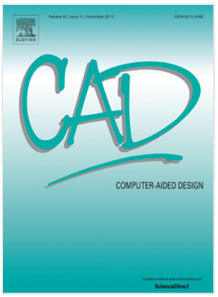

Smooth tool path generation for 5-axis machining of triangular mesh surface with nonzero genus

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Abstract: NC machining of a nonzero genus triangular mesh surface is being more widely confronted than before in the manufacturing field. At present, due to the complexity of geometry computation related to tool path generation, only one path pattern of iso-planar type is adopted in real machining of such surface. To improve significantly 5-axis machining of the nonzero genus mesh surface, it is necessary to develop a more efficient and robust tool path generation method. In this paper, a new method of generating spiral or contour-parallel tool path is proposed, which is inspired by the cylindrical helix or circle which are a set of parallel lines on the rectangular region obtained by unwrapping the cylinder. According to this idea, the effective data structure and algorithm are first designed to transform a nonzero genus surface into a genus-0 surface such that the conformal map method can be used to build the bidirectional mapping between the genus-0 surface and the rectangular region. In this rectangular region, the issues of spiral or contour-parallel tool path generation fall into the category of simple straight path planning. Accordingly, the formula for calculating the parameter increment for the guide line is derived by the difference scheme on the mesh surface and an accuracy improvement method is proposed based on the edge curve interpolation for determining the CC (cutter contact) point. These guarantee that the generated tool path can meet nicely the machining requirement. To improve further the kinematic and dynamic performance of 5-axis machine tool, a method for optimizing tool orientation is also preliminarily investigated. Finally, the experiments are performed to demonstrate the proposed method and show that it can generate nicely the spiral tool path or contour-parallel tool path on the nonzero genus mesh surface and also can guarantee the smooth change of tool orientation.