Path Finding Method for Various Applications

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Abstract. Increasing the robustness and flexibility of the tool path finding method may broaden the application fields of pocket machining. We aim to develop a path finding method for various applications. Through an integration of the entire tool path finding process, the method becomes not merely optimal to generate an efficient path but also robust enough to be applied to any system with any configuration. The flexibility of the devised method enables us to broaden the application fields of pocketing to fields such as prototype printed circuit board manufacturing. The devised method is applied to generate a clearing path for prototype printed circuit boards. The results verify that the method is concise and simple, but robust and flexible enough to achieve the optimal path in any configuration.

1 Introduction

Conventionally in pocket machining, the contour-parallel tool path is most widely used for large-scale material removals. Many researches on contour-parallel cutting have been performed [1], [2], [3]. Various methods for generating tool paths have been developed [4], [5]. To produce a tool path without tool-retraction satisfying the Guyder's guidelines [6], several methods have been developed but those are not flexible enough to handle every kind of pocket configuration. The limitations on existing approaches are found in the literature. Bridges connecting a pocket and islands are inserted to form a boundary [2]. The particular sub-path is merged into the corresponding path to treat specific occasions such as nested offset loops [5].

Recently, Seo et al.[7] proposed a systematic approach on contour-parallel tool path generation in order to achieve all of the goals in the three categories simultaneously. In their approach, the contour-parallel tool path generation from offsetting to path linking was totally integrated hierarchically on classified levels being engaged by the devised process flow. Through their work, problems finding proper offset curves, preventing uncut regions and producing a tool path without tool-retraction were resolved sequentially.

In the present study, we aim to develop a path finding method for various applications. By increasing the robustness and flexibility of the path finding method, the application fields of pocketing can be easily broadened. The fields

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may be enumerated as laser cutting, wire electrical discharge machining and prototype Printed Circuit Board (PCB) manufacturing. The PCBs are essential for products associated with mechatronics. Especially during the development period, highly customized prototype PCBs are required.

Nowadays, a prototype PCB is manufactured by either the printing or cutting method. For large quantities or mass production, the printing method may be better. For small quantities of customized manufacturing, cutting is proper. Therefore PCB layering, especially for highly customized prototypes, may be the right place to apply pocket machining, even though the features are more complicated than pockets.

To attain our aim, the tool path finding process is reconsidered in conjunction with the work of Seo et al.[7]. By the systematic integration of the entire tool path finding process, the method becomes not merely optimal to generate the efficient path but also robust and flexible enough to be applied to any system with any configuration.

To verify the proposed method, a prototype system is implemented and the system is examined with actual pocket machining. The results show that the proposed path finding method is proper and reliable. Moreover, the robustness and flexibility of the devised method enables us to broaden the application fields of pocketing. The devised method is applied to generate a clearing path for prototype PCBs upon cutting. The results verify that the devised method is concise and simple, but robust and flexible enough to achieve the optimal path in any configuration, even for PCBs.

2 Concepts

To integrate the complicated path generation process, we adopt some concepts defined by Seo et al.[7]. The Offset Loop Entity (OLE) was devised to be the unique object of every generation procedure. Throughout the entire path generation process in the OLE approach, each generation procedure was conserved upon various pocketing conditions.

The concepts for path finding used in this work is shown in Fig.1. The OLE is defined as the sequential linkage of the offset curves. The Path link Entity (PE) is defined as the element linking all validated OLEs. The Tool Path Entity (TPE) is defined as the entire path composed of all validated OLEs and all PEs. The cutting boundaries are shown as bold solid lines. Thin solid lines and thin dotted lines represent the OLEs and PEs, respectively. Consequently, all thin lines belong to the TPE.

3 OLE Generation

We focus our attention more on path finding. Thus, the offset curve generation procedures are briefly discussed based on the Offset-loop Dissection Method (ODM) by Seo et al.[7]. The ODM and extended ODM were proposed based on the OLE concept that enables the method to be implemented easily into