Ain Shams University

Faculty of Engineering

Design & Production Engineering Department

COMPUTATION OF OPTIMAL POCKETING TOOL PATH USING GENETIC ALGORITHM

By

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This thesis is submitted for partial fulfilment for the Requirement for the Degree of

Master of Science in Mechanical Engineering

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Statement

This dissertation is submitted in partial fulfillment for the degree of Master of Science in Mechanical Engineering, Design & Production Engineering Department.

The work included is this thesis was carried out by the author in the Design & Production Engineering Department, Faculty of Engineering, Ain Shams University.

No Part of this thesis was submitted for a degree or a qualification at any other university or institution.

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Signature

Acknowledgment

First of all, thanks and indebtedness are due to **ALLAH** who made this work possible.

I am immensely grateful to Prof. Atef Afifi Afifi for his sharing of my excitement as well as frustrations in this research. Without his constant support, encouragement and guidance, this work wouldn't be possible.

I also would like to thank Assoc. Prof. Mohamed Ahmed Awad for providing valuable advice on various occasions during this study and for reading the dissertation and providing valuable comments.

I deeply thank my family and my friends. Their love and support are a constant inspiration to me in striving to improve myself.

Abstract

The calculation of the optimal path of the tool during the machining process is one of the most important steps in the entire production process. The length of the tool path affects the machining time, which affects the cost of the manufacturing process. This is why an algorithm was created to calculate the optimal path for pocketing using genetic algorithms. This algorithm consists of four main modules.

The first module is to extract the engineering data stored in a file of the programs to increase the efficiency of the proposed algorithm. The neutral data files were selected to transfer the data from the CAD softwares and select the files (STEP and DXF). The STEP file was selected specifically as it is one of the most recent files where the DXF file is the most common of the files used in CAD softwares.

The second module is to recognize all pockets types like circular pockets, rectangular pockets and irregular shapes pockets and also to recognize all holes types.

The third module is to calculate the tool path for all pockets types, Therefore, five strategies used to calculate the tool path of the cutter (Contour Offset, Horizontal Zig Cut, Vertical Zig Cut, Horizontal Zigzag cut, Vertical Zigzag Cut), Then the shortest path length is selected.

The fourth module is to calculate the non-productive time, which is the transfer of the tool from the end of each pocket or hole to the beginning of the next pocket or hole. Genetic algorithms were selected to calculate the optimal tool path which represents the least time to move the tool in the air without cutting.

This algorithm has been implemented by Java language since it does not depend on a specific operating system and is suitable for all systems. The validity of the proposed algorithm was tested by four cases study, which included the various types of pockets expected from circular pockets, rectangular pockets, irregular pockets, and holes of different types. The length of the tool path was calculated using different methods and the best method was calculated to be the smallest value. It is noted that there is no specific strategy for all pockets, but it depends on its shape. It is necessary to calculate the tool paths for each pocket by all strategies not with a specific one. Concerning non-productive tool path, genetic algorithms were applied to find the best path to be chosen, where the shortest route was, and the path was calculated and compared manually. Thus, this proposed system has proved successful in selecting the shortest path in all cases tested.

Chapter 1

Introduction

This research is focused on developing the methodologies required to optimize the productive and nonproductive tool movements for 2.5 D axis milling machines using generic computer-based techniques, while taking into account the non-productive tool movement between different pockets will result in the reduction of non-machining time using GA (Genetic Algorithm).

This problem can be solved by defining the available dimension of each pocket, its position relative to its component origin, which will seek the minimization of non-productive tool movement and using an optimization algorithm to optimize tool path to reduce machining time.

1.1 Thesis Outline

This thesis consists of six chapters:

Chapter 1 “Introduction”

This chapter discussed and defined different terms used in this study, which are:

1. CNC Machine Concept
2. Computer Aided Manufacturing
3. Pocketing
4. Genetic Algorithm

Chapter 2 “Literature Review”

In this chapter the important criteria of CAM and computer aided part programming systems will be discussed. Feature recognition, Genetic algorithm and general review of previous works in computer aided manufacturing, pocketing and part programming systems are presented.

Chapter 3 “Optimization”

This chapter defined the meaning of genetic algorithm and its procedures and compare between it and other algorithms.

Chapter 4 “Algorithm Implementation”

This chapter discussed and defined how the software extracted data and recognized all feature from the STEP and DXF files and how to calculate optimized productive and non-productive time.

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