



Ain Shams University
Faculty of Engineering

Advanced techniques in CNC programming

A Thesis

By

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Statement

This thesis is submitted in the partial fulfillment of master degree in Mechanical Engineering to Ain Shams University.

The author carried out the work included in the thesis, and no part of this thesis has been submitted for a degree or qualification at any other university.

Signature

Amr Ahmed Sayed Shaaban

Acknowledgment

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Advanced techniques in CNC programming

Abstract

As STEP-NC grows as the new technique for programming CNC machine tools, the traditional interface so called M & G code (ISO 6983) commonly used for CNC since 1950s is about to be obsolete. Establishing, developing and implementing STEP-compliant CAD/CAM/CNC system based on the new data model is drawing worldwide attention. This research focuses in two points. Firstly, a comparison between the two programming methods of CNC machine tools, namely, the G and M codes and the new technique of programming CNC machine tools known as STEP-NC which is a new interface for the CAD-CAM-CNC chain formalized in (ISO 14649 and ISO 10303 AP238). Secondly, a conversion system between Step-NC and G-code. By this automatic conversion the problem of legacy code -preserved by companies when STEP-CNC becomes widely available- has been overcome.

Thesis Structure

The thesis consists of six chapters:

Chapter 1:

Introduction

Chapter 2:

A comparison between the current technique and the new one is discussed together with a case study to show the shortcomings of the G-code, and then a literature review is made about the new data model.

Chapter 3:

A theoretical background of the new technique is discussed with a detailed description of the ISO10303, the ISO 14649, the STEP-NC file structure, and finally, the design considerations, functional architecture, and implementation architecture of a STEP-compliant CNC software are discussed together with an application that show in details the steps of producing a part program based on the new technique.

Chapter 4:

The design considerations and the functional architecture of the recommended conversion system between the current technique and the new one are discussed. This chapter focuses on the conversion from G-code to STEP-NC. The information that can be extracted from a G-code part program is clarified with the information necessary to form a STEP-NC part program. The procedures of conversion are illustrated supported with a case study.

Chapter 5:

This chapter focuses on the conversion from STEP-NC to G-code. The procedures of conversion are illustrated supported with a case study

Chapter 6:

The main conclusion of the research is presented, and the recommendations for future work are discussed.

Summary of the M.Sc. Thesis

"Advanced techniques in CNC programming"

STEP-NC has recently raised a lot of interest in the research due to its evolution as a new data model replacing the old technique (G-code). Researchers studied STEP-NC from different aspects. Some researchers studied the architecture and implementation of a shop-floor programming system based on STEP-NC for both turning and milling applications. Other researchers were interested in retrofitting an existing CNC machine tool to develop a STEP-compliant CNC one. Others made a development of ISO 14649-based conversational programming system for multi-channel complex machine tools. Others were interested in how to use the intelligent functions of STEP-NC like on-line inspection in support of closed-loop machining.

Limited research studied the conversion process between G-code and STEP-NC to overcome the problem of legacy code preserved by companies when STEP-CNC becomes widely available. However, these researches suffer from some shortages and didn't give a complete study as the standard was not yet complete at the time when these researches made. On the other hand these researches only studied the conversion from G-code to STEP-NC only.

In this thesis, the basic considerations, the functional architecture and the implementation procedures of a system that can generate a STEP-NC code are discussed supported with a case study. On the other hand, the thesis studied the functional architecture of the auto-conversion system (reincarnation system), which is one of the main modules in the recommended STEP-NC system that can convert either from G-code to STEP-NC and from STEP-NC to G-code.

The study recommends that the STEP-NC code generation process can be done by a system that contains 6 modules: (1) Interpreter module, (2) Feature recognition module, (3) working steps generation module, (4) ISO14649 part

program generation module, (5) Cutter location path simulation module, and (6) Reincarnation module. Each of the mentioned modules is discussed in details showing the entity-index map which is the structure of any STEP-NC file, and the standard entities that represent the machining operations, machining features, machining strategies, and machining technology.

On the other hand, the study recommends that the reincarnation system can convert G-code to STEP-NC using the following functions: (1) Working steps generation function, (2) Machine tool generation function, (3) Technology generation function, (4) Machine function generation function, (5) Machining operation generation function, (6) Feature recognition function, (7) Machining strategy generation function, (8) STEP-NC part program generation function and finally, (9) Part program verification function. Each of the mentioned functions was discussed followed with a casestudy.

Finally, this thesis introduced a study about the conversion process from STEP-NC to G-code. The study recommends that the reincarnation process can be achieved by using the following functions: axis movement generation function (which is the main function that select the appropriate G-code format), machining technology generation function, machine tool generation function, and finally part program verification function. Each of the mentioned functions was discussed supported with a casestudy.

Table of contents

Subject	Page
Abstract	V
Summary	VI
Table of contents	VIII
List of tables	XII
List of figures	XIII
 Chapter 1. Introduction	 1
Chapter 2. Literature review	4
1. Current method (G and M codes) technique	
1.1 Introduction	4
1.2 Generation of a G-code part program	5
1.3 Shortcomings of G and M codes techniques	11
1.3.1 The G- code problem	11
1.3.2 The postprocessor problem	11
1.3.3The IGES problem	12
2. Historical background of STEP-NC	13
2.1 STEP-NC data model	17
2.1.1 STEP ISO 10303	17
2.1.2 STEP-NC data model (ISO 14649)	18
2.1.2.1 ISO 14649[1]	20
2.1.2.2 ISO 14649[10]	20
2.1.2.3 ISO 14649[11]	20

2.1.2.4 ISO 14649[12]	21
2.2 STEP-NC file	21
2.2.1 Structure theory of STEP-NC file	21
2.2.2 Structure of STEP-NC file	22
2.2.3 Express Language	23
2.2.4 Machining working steps	24
Chapter 3. Programming system based on STEP-NC	25
1. Design considerations	26
2. Functional architecture	27
3. Generation of Step-NC file	30
3.1 Milling	31
3.1.1 Manufacturing feature for milling	31
3.1.2 Milling operations	39
3.1.3 Milling strategy	41
3.1.4 Milling technology	43
3.2 Turning	44
3.2.1. Manufacturing feature for turning	44
3.2.2. Turning operations	47
3.2.3. Turning strategy	50
3.2.4. Turning technology	54
4. Case study	54
5. Step-CNC	59

Chapter 4.	Conversion from G-code to STEP-NC	61
1.	Problem clarification	61
2.	Conversion methodology	62
3.	The functional architecture of the conversion system	64
4.	Developing of the Step-NC file	65
4.1	Working step generation function	65
4.2	Machining operation generation function	67
4.3	Feature recognition function	70
5.	Case study	71
5.1.	The conversion system input	73
5.2.	The conversion process	74
5.3.	The generated STEP-NC part program	76
Chapter 5.	Conversion from STEP-NC to G-code	80
1.	Introduction	80
2.	Conversion methodology	80
3.	The architecture of the auto-conversion system	81
4.	Developing the G-code part program	83
4.1.	Contouring (simple cylinder)	83
4.2.	Contouring (profile)	85
4.3.	Facing	87
5.	Case study	90

Chapter 6.	Conclusion and future work	96
References		98
Arabic summary		100

List of Tables

No	Table	Page
2.1	Application Protocols, ISO 10303.	18
2.2	Major Parts of ISO14649.	19
5.1	Symbols used in the G-code format for Contouring and facing operations.	89
5.2	Parameters extracted from STEP-NC file for facing operation (roughing and finishing).	91
5.3	Parameters extracted from STEP-NC file for contouring operation (roughing and finishing).	92

List of Figures

No	Figure	Page
2.1	Interface between CAD and CNC systems	5
2.2	3D modeling of a part using Autodesk Inventor Software	6
2.3	Tool path generation of a milling operation using CAM software called “Edge Cam	7
2.4	Stock identification	8
2.5	Feature recognition.	8
2.6	Setting up the details of a roughing operation.	9
2.7	Tool Store for milling operations.	9
2.8	Setting the machining sequence of the part.	10
2.9	Generation of G-code.	10
2.10	Machine tool control type selection	12
2.11	Step-NC interface.	19
2.12	Structure of Step-NC code	22
2.13	EXPRESS representation of overall schema of STEP-NC data model.	23
2.14	Structure of entity-index map	24
3.1	Functional diagram of a STEP-CNC programming system.	29
3.2	Machining a closed pocket.	34
3.3	Machining an outside profile.	35
3.4	Circular pattern.	37
3.5	Compound feature	38
3.6	Transition feature	39
3.7	Plan milling strategy	41
3.8	Unidirectional strategy	42

3.9	Bidirectional strategy for milling	43
3.10	Axis and motion nomenclature of turning operation	44
3.11	Outer diameter (left), and outer diameter with taper (right)	45
3.12	Revolved flat	46
3.13	Groove	47
3.14	Facing operation	48
3.15	Grooving operation	49
3.16	Contouring operation	50
3.17	Unidirectional strategy for turning operation.	51
3.18	Bidirectional strategy for turning operation.	52
3.19	Machining a contour turning.	53
3.20	Generation of STEP-NC code.	58
3.21	Types of STEP-CNC.	59
4.1	The main idea of the reincarnation system	63
4.2	procedures of the working steps generation function.	66
4.3	The procedures of the machining operation generation function.	68
4.4	The detection of roughing and finishing operation.	70
4.5	Procedures of feature recognition function.	71
4.6	2D sketch and 3D model of the turned part using Autodesk Inventor software.	72
4.7	G-code part program of the turned part generated by MasterCamX3.	73
4.8	Turning tools stored in the tool manager of MasterCamX3.	74
5.1	The Procedures of conversion from STEP-NC to G-code	82
5.2	The contouring operation for an outer round.	83

5.3	The strategy of contouring operation for an outer round.	84
5.4	The contouring operation for a profile.	85
5.5	The strategy of contouring operation for a profile.	85
5.6	The facing operation for a revolved flat.	87
5.7	The strategy of facing operation for a revolved flat.	87