A Computer Aided CNC Programing System

Jia Yazhou, Qiu Jian
(Jilin University of Technology)
Han Rongjiu
(State Key Laboratory of Applied Optics)

Abstract

In the paper the hardware for CACP is introduced briefly; the design thought, general structure and functions of the system are explained in details; the technique of interaction and menu driven methods are described. Finally, the authors give out the CACP system structure diagram. The paper will have some help to the readers that want to design CACP no matter in theory or in practice.

1. Introduction

In the area of ultra precision manufacturing, Computer Aided CNC Programing is very important, because it is impossible that manual programing for some parts. The authors developed a Computer Aided CNC Programing system (CACP), the system is designed to prepare CNC programs forMSG-325machine tool(a versatile two-axis ultra precision contour turning system designed for use with single-point diamond cutting tools) and allows the user to program parts directly and simply. The system features operator interaction, prior viewing of part contour through use of computer graphics, floppy disc program storage and tool radius compensation. The computer will automatically send the tool back to a home position near the start of the cut. The system has getten pass in AST-286 computer and been applied by State Key Laboratory of Applied Optics.

2. Hardware Configuration

The CACP system hardwares include a microcomputer, a dot-matrix printer, a tape reader/punch, a plotter, and a switch box. The microcomputer is an AST 286 which consists of a system unit, a keyboard, and a high resolution monitor. It is equipped with an Intel 80287 mach coprocessor chip to increase calculation speed. The microcomputer provides

two additional serial input-output ports named as COM1 and COM2. COM2 is dedicated to the plotter but COM1 can be used by several different peripheral devices depending upon the configuration of the system. The dot-matrix printer is an Epson FX-80. It is connected to the computer's system unit through the unit's parrallel printer port. The plotter is a HP7475A. The plotter is connected to the computer's system unit through the serial port COM2. Switch box is a device that allows the COM1 port of the microcomputer to be shared with up to two different peripheral devices. The tape reader/punch is a Data Specialties, Inc. Model NC 2400HX. It should be connected to the computer's COM1 port, either directly or through the previosly described switch box.

Loading program of a part into CNC controller generally has two methods. One is the manual data input (MDI) through Operator Panel Keyboard, another is the tape input through the tape reader. CACP system support serial communacation between microcomputer and CNC controller. Part program can be downloaded directly to some CNC controllers. This can be done by removing the tepe punch from its connection on the microcomputer (COM1) and replaceing it with CNC controller itself, or through switch box.

3. Software

The CACP system facilities the construction of numerical control programs for the generation of optical surfaces. CNC program block can be formatted for two axis (X, Z) contouring. It is very difficult to program manually for the optical surface (Fig.1). If use the CACP system to generate the CNC program, it will be very easy. We only need to input following data:

Tool radius: 1.524
Part parameters (A,B): 50,75
Starting point coordinate (X, Z): 50,75
End point coordinate (X, Z): 0,0
Tool path desciption: 1

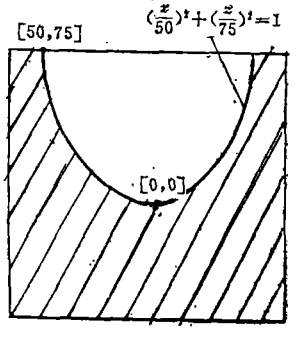

Fig.1 A aspherical optical surface

For the sakes of developing and expanding, CACP adopt module structure (Fig.2) Each module have certain relationship and different function, but they are relative independent.

The CACP system softwares include main-processor module, post-processor module, service module.

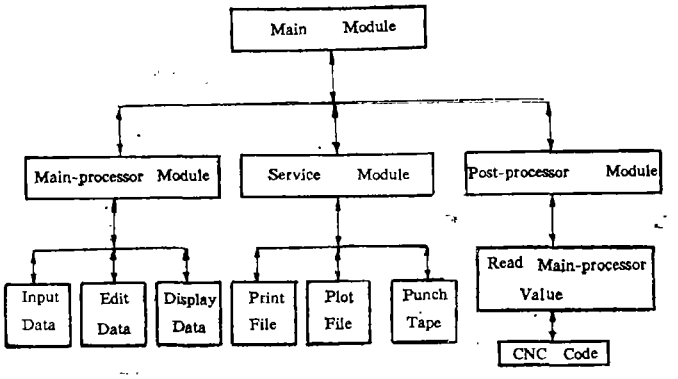

Fig.2 CACP structrue diagram

The functions of main-processor module are inputing data (inluding tool radius, surface increament, manufactured part parameters, tool path description etc), editing data, and calculating. The function of post-processor module is that convert results which main-processor made out into CNC code, The functions of service module are deleting file, printing data, punching paper tape. We will mainly discuss main-processor module and post-processor module.

Main-processor module

Inputing data and editing data are common knowledge for someone to have operating computer experience. Here, we mainly discuss calculating function. Main-processor will calculate tool aperture, tool position angle, tool position coordinate, and tool compensation.

1. Tool aperture

Tool apertrue is angle that tool will go through to cut part. The actual tool apertrue should be greater than this. That is

$$\text{Tool aperture} = [tg^{-1}(\text{maxslope}) - tg^{-1}(\text{minslope})] * 57.3$$

2. Tool position angle

Tool position angle is that tool should be from spindle axis. This is

$$\text{Tool position angle} = |[tg^{-1}(\text{minslope}) - tg^{-1}(\text{maxslope})]| * 28.65$$

Maxslope——Maximum slope of cut surface.

Minslope——Minimum slope of cut surface.

3. Joint point calculation

All equations for curves within the CACP program have been solved for Z in terms of X. The CACP program uses the slope of the curve to determine the next point along the curve.

4. Tool compensation

Tool of ultra precision manufacture generally is diamond tool. Diamond tools do not come to a point, they are circular. Because of this, all the

points on the curve to be cut must be compensated to account for the curvature of tool. What CACP program does is to output points that the center of the tool should follow. When the computer is outpuing the points on the curve, it firstly calculates the normal X and Z values for the point, then it calculates the slope using the first derivative point. The final compensated point is on the line perpendicular to the slope, and R along the line where R is the radius of the tool.

Post-processor module

The function of post-processor module is converting tool position coordinate values into CNC code. The tool position coordinate values should be accompanied with function code, example, G_{xx} F_{xx} S_{xx}. Finally it finish that print part program and load part program into CNC controller. Because different CNC controller use different CNC code and data format, post-processor is special to different CNC controller. Our software is adapted to ALLEN-BRADLY COMPANY SERIES 8200 CNC.

4. Conclusions

1. The CACP system developed in the paper is mainly used for manufacturing optical parts in the area of ultra precision manufacturing.

2. The CACP system have been applied by State Key Lab of Applied Optics and is successful.

References

[1] Weng Zhicheng and Sun Guoliang, Optics and Fine Mechanics, 4(1987), 19 (in Chinese)

[2] Werner Rieben, Bienmial International Machine Tool Technical Conference (1984),128

计算机辅助CNC编程系统

贾亚洲　仇　健　　韩荣久

（吉林工业大学）　　（应用光学国家重点实验室）

摘要：简要介绍了 CACP 的硬件，详细介绍了该系统的设计思想、总体结构和系统功能。最后，本文给出了 CACP 系统的结构图。