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Geometrical Transformation on
a NC Program

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GEOMETRICAL TRANSFORMATIONS ON A NC PROGRAM

SUMMARY

This report deals with the subject of part program transformation. Here the transformation of a part program means to change the position of workpiece ,to change the size of workpiece or to rotate the workpiece about one of the coordinate axis .With the help of the computer all of these transformations can be done in a few seconds .The program MAH01.PAS is developed for this purpose.

Although most of the CNC milling machine use the same G-code there still is some difference from machine to machine .This part program transformation program is made for a milling machine with a philips 432 CNC controller.

This report presents the main principles and some important details of this program .

1 INTRODUCTION

From time to time we want to make a workpiece which has the same shape but bigger or smaller then the old one or to move the workpiece on the table . Of course we can make a new program for this new workpiece but it is more easy to transform the old part program. It will save a lot of time and you can be sure the new part program is correct.

The total transform task will include three main parts ;
1. read the part program from disk, 2.transform the part program line by line, 3.write the new part program to disk with the proper syntax.

Also some edit functions are available in this program so that the user can change the part program if necessary.

2HOW TO USE THIS PROGRAM

a)Starting the program

Check the disk for the file 'MAH01.COM' then type 'MAH01'. After displaying the headline the program will prompt for the file name of the part program to be transformed. After entering the file name , the program will prompt several options as follows;

```
Function [C]hange [L]ist [D]elete [E]dit [P]rint [F]ile  
[Q]uit
```

you can choose any of the functions by entering the first character of the function.

b)The change function

After the function call the user will be requested to indicate the scale factor, the rotation angle and the coordinate of new origen .If the scale fact is equal to 2 then the new workpiece will be two times bigger than the old one.If the angle of rotation is positive then the workpiece will be rotated counter clockwise. After this

has been done the user will be requested to enter the new part program name . The new program name must be different from the part program name to be changed.

c)The list function and the print function

The list function can be used to show the part program on the screen .The user can enter the beginning line number and the last line number to be listed. The print function will print the part program in a printer.

d)The delete function

The delete function can be used to delete one or several part program lines by entering the number of the program lines.

e)The edit function

The edit function can be used to edit one program line . After the function call the user can enter the line number and push the return key . The program line to be changed will be displayed in the screen . the user can type the new program line and return key to save the new program line in the disk file.

f)the file function

The file function can be used to enter the part program name which the user does want to edit or transform .

3 READ PART PROGRAM FROM DISK

The part program can be transmitted from the machine to the PC and be saved in to the disk in dos text file .Un like other file types , text files are not simply sequences of values of some type.Although the basic components of a text file are characters, they are structured into lines,each line being terminated by an end-of line maker(a CR/LF sequence).The file is further ended by an end-of-file marker(a Ctrl-Z).The next program lines are used to retrieve the part program ;

```
Assign(FilVar,FileName);
Reset(FilVar);
While not Eof(FilVar) Do
Begin
  Readln(FilVar,Line);
END;
```

4 Transformation of the part program

The procedure AnalyseLine is the main procedure used to transform the part program. In the beginning of the procedure we use the case statement to analyze the part program line. Some lines need not to be changed . For example , a program line that beginning with '%' or '(' we need not to change anything . we can simply copy these program line by calling the procedure" CopyLine ". The procedure "CopyString" is used to copy a part of the program line.The CopyString procedure will copy the first character and the numbers behind it.For most of the G code ,the number after the code must be changed , the program use the standard procedure"Val"to change the number from character string to a real number.after this

some of the numbers will be changed by multiplying a transform matrix according to the demand . some of the numbers which function as the parameters of the canned cycle should be treated in another way. The detail descriptions are as follows;

- a)Code 'N' means program line number and this will be same in the new program so that we simple copy it.
- b)Code 'F','S','T'are the feed ,speed and the tool number of a part program.In this program we did not chang them.but if the size of a workpiece is changed the tool diameter must be changed too.The speed and feed should also be changed accord to the tool diameter.
- c)All the M-function are kept the same in this program so that we simple copy them
- d)The 'G' code we don't change so it will simply be copied . In this program we use different flags for different G-functions . For instance if G41 is encountered we set a flag name G41flag to 1 .at same time other flags in the same G-function group are set to 0 .
- e)'P','X','Y','Z','R','B','I','J','K' are the names of parameters in the part program .the value of these parameters will be changed according to the flags which have been set.

The coordinate transformation is done by calling a subroutine named " Translation " . The subroutine "Translation" is a matrix that can transform point coordinates with in a coordinate system. The ordering of the sequence of transformation is quite important. In general,changes in the order of transformations will change the effect of the sequence. in this program we first rotate the workpiece then translate it to certain point. For the increment mode we must change the value to absolute coordinate mode.After the transformation we change the value back to the increment mode.

In the canned cycle such as the rectangular pocket G87,some of the parameters such as X,Y,Z no longer refer to the X,Y,Z coordinates of the machine, but the first side length,second side length and milling depth . For these parameters the transformation can be done by multiplying the scale factor K . Other parameters such as R,P,I,J,K also should be considered according to its meaning.

For the rotation of the pocket cycle , the MAHO432 controller use 'B1= ' format in G79 function to change the orientation of the pocket circle.This can be done by adding the format to any G79 function .

Since the repeat cycle G14 has no inference in the transformation so we can simple copy it.

There is no no workpiece zero point function G92 and G93 in this program .The user must be careful not to use these function.

5 Make the new part program line

After the transformation we get a lot of new strings such

as XNST,YNST,ZNST..... and we link them together .In this program we use the character string Newline as the new part program line. the procedure ShortenNewline is used to delete the unnecessary space between the new strings. After this we open a new text file and save the new part program line by line.

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APPENDIX 1 LIST OF SUBROUTINES

Change ; {Enter the necessary information of transformation,read the program line,tranform it and write the new part program line into a disk file}

Choice ; {Choice of the different functions of the program}

Comment(Question:ST80) {Write comment line on screen}

CopyLine(Var I:INTEGER;VAR BfStr:ST80); {Copy a hole part program line into a character string}

CopyString(C:ST1;I:INTEGER;VAR CopyStr:ST10) {Copy a character string(code+number)into a new character string}

EditLine(line:ST255;N1,N2,Mode:INTEGER); {The edit function of the program Mode=0 delete, Mode=1 list , Mode=2 print Mode=4 edit}

EnterChar(Question:St80;Var V:st10); {Enter character string from keyboard}

EnterReal(Question:ST80; V:REAL); {Enter a real value from the keyboard}

EnterInteger(Question:ST80;VAR V:INTEGER);{Enter an integer value from the keyboard}

EnterprogramName;{Enter the name of the part program to be changed}

HeadLine(X,Y,C:INTEGER); {Draw the headline of the program 'MAH01' on the screen}

MakeNewString(C:St1; V:REAL;VAR NST:ST10);{Change the real value V to character string and link it to the code character to make a new string}

MakeNewString3Ch(C:st3;V:REAL;VAR NST:ST10) ; {For the 3 character format string such as 'B1='}

NumberString(I:INTEGER;Line:ST255;VAR NString:ST8) {Read the number from the old part program line into a character string}

```

SETFLG ;           {Initialize all the 'G' flags to 0}
ShiftString(Var   Str:ST8); {Delete all the unnecessary
                             spaces in the string}
ShortNewLine;     {Delete all the unnecessary spaces in
the new part program line}
Translation(X1,Y1,Z1:REAL;Var X2,Y2,Z2 :REAL);
                 {Coordinate transformation for
rotation,translation,and the change of
scale}
TransCircle(X1 ,T1 ,Z1 : REAL; Var X2, Y2, Z2 : REAL);
                 {Coordinate transformation for circle}
AnalysLine(line:ST255); {Analyse the part program line
and transform it to a new part program
line}

```

APPENDIX 2 LIST OF IMPORTANT GLOBAL VARIABLE

A	Angle of rotation of new workpiece
AB	Value of rotation in G79 function before transform
BB	Value of B before transform
CanFlg	A general flag for all the canned circles
Circleflg	A general flag for G2 and G3
CircleFlgBuffer	Buffer of circleflg
FilVar	Variable for the file name to be changed
FileName	The name of the part program file to be changed
I1,J1,K1	Real value of I,J,K of a circle to be transformed
I2,J2,K2	Real value of I,J,K after transform
I2B,J2B,K2B	Buffer of I2,J2,K2
IB,JB,KB	Real value of I,J,K of a circle before transform
IncremFlg	Flg for increment mode
IncrementFlgBuffer	Buffer for IncremFlg
K	Scale factor
Gbuffer	Buffer for the G code
NewFileName	Variable for the new file name
RB	Real value of R before transform
X1,Y1,Z1	Real value of X,Y,Z coordinate read from the part program to be transformed
X2,Y2,Z2	Real value of X,Y,Z coordinate after transform
XB,YB,ZB	Real value of X,Y,Z coordinate before transform
XBB,YBB,ZBB	Buffer of XB,YB,ZB

X2B,Y2B,Z2B	Buffer of X2,Y2,Z2
X2Buff,Y2Buff,Z2Buff	Buffer of X2,Y2,Z2
XO,YO,ZO	New zero point of workpiece
XYZFlg	A general flag for G1 and G0
XYZFlgBuffer	Buffer of XYZflg