

Analysis of Auto CAD Plot file for the Carving Machine

Nareerat Boonsung, Krit Smerpitak, Sawai Pongswatd, and Prapart Ukakimapurn

Department of Instrumentation Engineering, Faculty of Engineering, King Mongkut 's Institute of Technology Ladkrabang
Ladkrabang, Bangkok ,10520 Thailand
(Tel : 66-2-739-2406; Fax : 66-2-739-2407 ; E-mail: klsawai@kmitl.ac.th)

Abstract: This paper presents the analyses of Auto CAD plot file for carving machine. The plot file is first analyzed and then sorted to properly perform a sequence of the line segments. The experimental results show that this technique can improve the carving performance, reduce the operating time, and save the tool and machine's lifetime. In addition, this proposed technique can also be extended to apply for other coordinate machines.

Keywords: Auto CAD, Carving Machine, Plot File, Pen Up, Pen Down

1. INTRODUCTION

The Auto CAD plot file or other plot files generally consists of a variety of character commands representing lines and the pen status in various formats. Usually, the coordinates of lines and the continuity of the data are not suitable for using with the 2 or 3 coordinate machines as well as the carving machine since the machine can work slower and its efficiency can be poorer. This paper presents the technique using the program written in Visual Basic 6.0 to analyze the plot file for 3 coordinate carving machine before transferring the plot file to the carving machine. The experimental results show that this technique can improve the carving performance, reduce the operating time, and save the tool and machine's lifetime.

2. PRINCIPLE AND THEORY

The prototype written in Auto CAD can be transferred to the plot file by using the plt type plot command. Fig. 1 displays a draft in Auto CAD of character 'B' with AngsanaNew font and size of 40. Using the plt type plot command and the HP-7475 driver, a part of the plot file of this character is shown in Table 1.

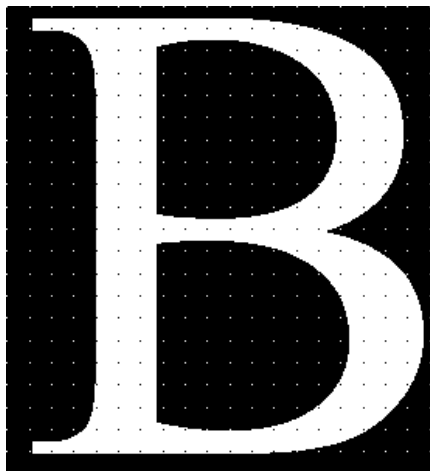


Fig.1 A character 'B' with Angsana New font, size of 40

Table 1 part of the Plot file of a character 'B'

```

< .(;< .I81;;17:< .N;19:IN;SC;PU;PU;SP1;LT;VS
36;PU;PA431,390;PD;PA431,497;PA577,497;P
A692,508;PA792,541;PA878,597;PA878,5973,4
292;PA2534,4281;PA2659,4267;PA2778,4247;P
A2889,4224;PU;PA2994,4197;PD;PA3093,4165;
PA3184,4129;PA3269,4088;PA3347,4044;PA34
19,3995;PA3484,3942;PA3542,3885;PA3593,38
23;PA3638,3758;PA3746,3050;...;PA3736,864;P
A3718,842;PA3641,760;PA3559,686;PA3473,62
3;PA3381,568;PA3285549,4043;PA1549,2542;P
U;PA0,0;SP;
    
```

The data in the plot file are an absolute coordinate, which consists of 3 parts.

1. Header

```

< .(;< .I81;;17:< .N;19:IN;SC;PU;PU;SP1;LT;VS36;
    
```

The header part includes the start coordinate, pen number, and speed for plotting.

2. Data

```

PU;PA2994,4197;PD;PA 3093,4165
    
```

The data part contains the pen path and plot where
 PU = Pen up
 PD = Pen down
 PA = Absolute coordinate with the numbers followed representing X-axis and Y-axis, respectively.

3. End

```

PU;PA0,0;SP;
    
```

The end part gives the information to stop the operation.

After loading the data in the plot file to the carving machine, only the frame of the string is constructed as shown in Fig. 2

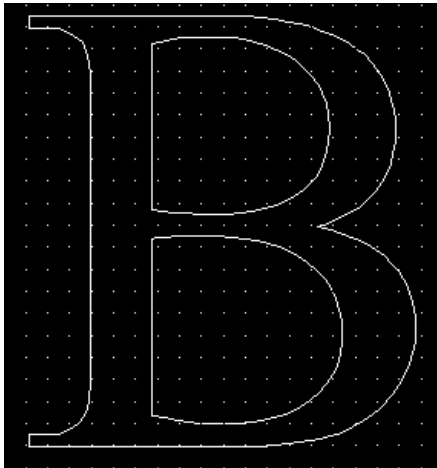


Fig.2 A frame of string constructed from the plot file in table 1

Since only the frame of the string is constructed, a pattern of several zero-degree lines inside the string must be created in order to obtain a filled-in string. In addition, another smaller frame inside this string must be considered instead when filling in to avoid any action taking place right on the frame because the diameter of the engraver's tip is larger than that of the pen point. However, there is no standard tool in Auto CAD that can transfer a character into a frame; therefore, this paper presents the technique using the program written in Visual Basic 6.0 to analyze the plot file toward the construction of the frame. Then, the frame is offset so that it can fit into the original frame (the proper offset should be three-times less the diameter of the engraver's tip). Fig. 3 displays a character 'B' after offsetting and applying several zero-degree lines. A part of the plot file can be found in Table 2.

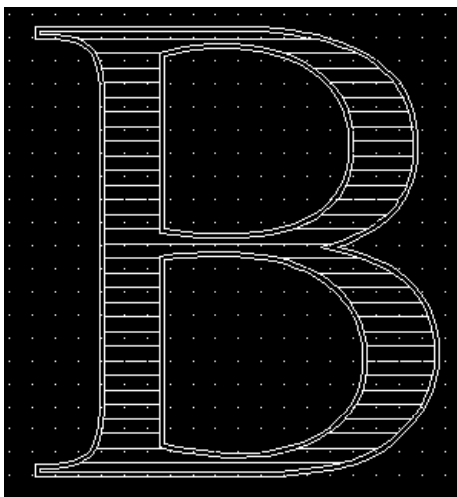


Fig. 3 A character 'B' after offsetting and applying several zero-degree lines

Table 2. A part of the plot file from Fig. 3

```

← .(;← .I81;;17;← .N;19;IN;SC;PU;PU;SP1;LT;V
S36;PU;PA431,390;PD;PA431,4975,523;PA31
83,488;PA3161,482;PA3078,461;PA2987,442;
PA2889,426;PA2784,414;PA2672,404;PA2553
,396;PA2427,392;PA2294,390;PA2277,390;PD
;PA996,1825;PU;PA996,1905;PD;PA1549,190
5;PU;PA1549,1984;PD;PA996,1984;PU;PA99
6,2063;PD;PA1549,2063;PU;PA1549,2143;PU
;PA1561,2540;...;PA955,3968;PU;PA921,4048
;PD;PU;PA3537,38831,4206;PD;PA2955,4206
;PU;PA2471,4286;PD;PA431,4286;PU;PA
0,0;SP;
    
```

Considering the plot file in table 2, data representing zero-degree lines are not continuous described by the alternative occurrences of the PU and PD. The path can be written as in Fig. 4.

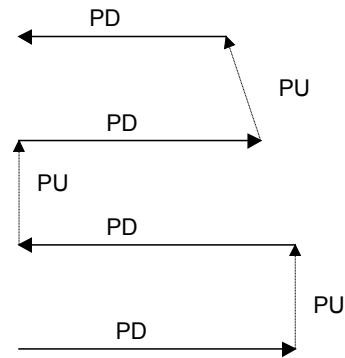


Fig. 4 Tool path for zero-degree lines

After transferring the data in Table 2 to the carving machine, the operation is not continuous resulting in the serrated surface that can slow down the whole operation. This paper proposes the method to analyze the motion of the data in the plot file and then rearrange the path so that it is continuous and in the proper sequence. The main consideration of the rearrangement is based on the following conditions:

1. If pen plot is PU and the distance is less than the diameter of the engraver's tip, the pen plot is changed to PD.
2. If pen plot is PU and the distance is more than the diameter of the engraver's tip, the pen plot is kept unchanged.

3. DESIGN OF THE SYSTEM

The block diagram of carving machine system including the analysis of the plot file created by the Auto CAD before transferring to the carving machine is shown in Fig. 5

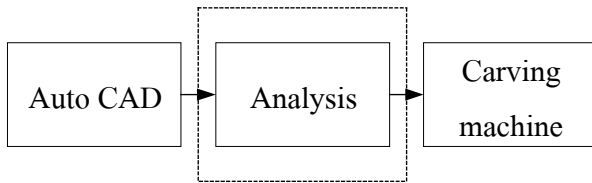


Fig. 5 Block diagram of system.

The data analysis flow chart can be illustrated as in Fig. 6.

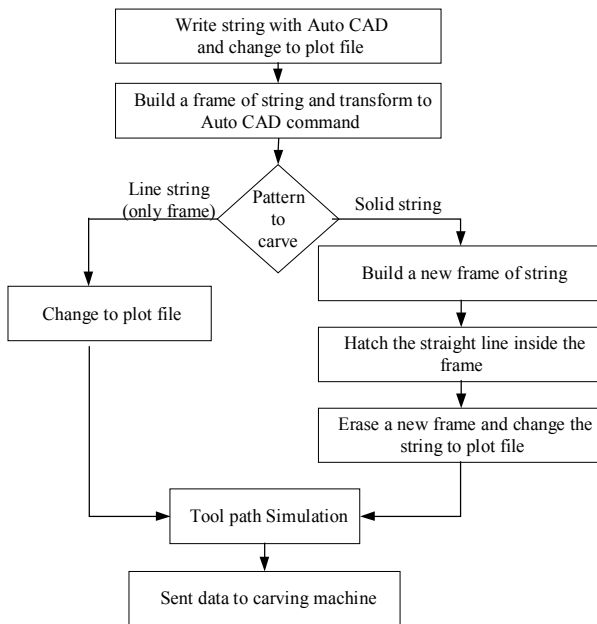


Fig. 6 Flow chart to analyze data.

From the result shown in Fig. 7, it can be obviously seen that the operation is smoothing noticed from the lines joined inside the frame.

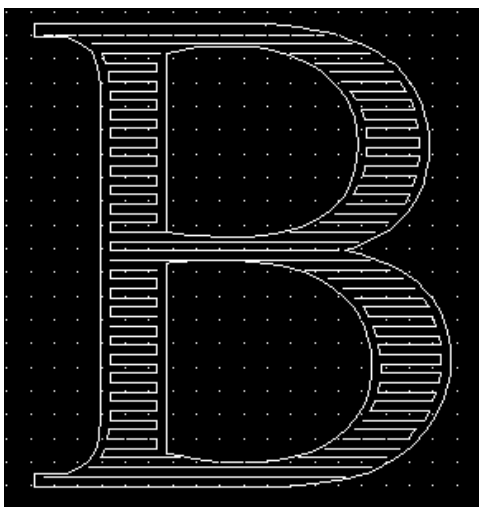


Fig. 7 Results after analyzing and rearranging

Table 3. A part of the plot file from Fig. 6

```

    (.;← .I81;;17;← .N;19;IN;SC;PU;PU;SP1;LT;
    VS36;PU;PA431,390;PD;PA431,497;PA577,
    497;PA692,508;PA792,541;PA878,597;PA92
    3,651;PA956,730;PA980,834;PA993,964;PA
    996,1082;PA996,3608;PA991,3758;PA977,3
    882;PA952,3982;PA918,4056;PA885,4095;P
    A802,4149;PA702,4182;PA585,4193;PA577,
    4193;PA431,4193;PA431,4300;PA2119,4300
    ;PA2264,4298;...;PA511,4206;PD;PA2875,4
    206;PU;PA2391,4286;PD;PA2391,4286;PU;
    PA0,0;SP
  
```

4. EXPERIMENTAL RESULT

The experimental result perform to carve the “School” character in the two conditions, with analysis of the plot file and without analysis of the plot file, are compared. The sequence to carve can be shown in the Fig. 8, Fig. 9, Fig. 10 and Fig. 11 respectively.



Fig. 8 A character 'School', size 40

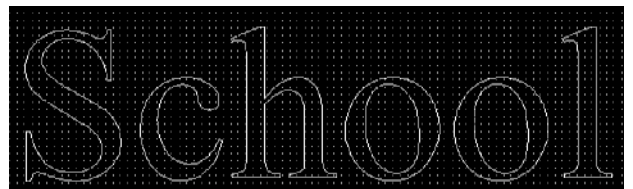


Fig. 9 A frame of string

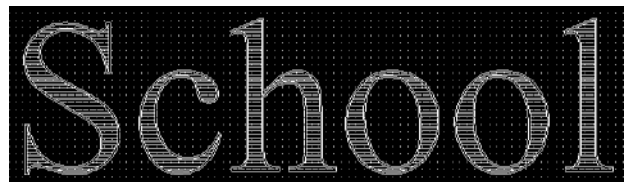


Fig. 10 A character 'School' after offsetting and applying several zero-degree line

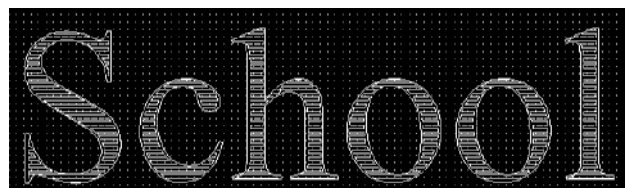


Fig. 11 Results after analyzing and rearranging

The experiment is to engrave 1 mm. deep on the 3 mm.-deep plastic surface. Under the same plotting speed and the diameter of the engraver's tip of 1 mm, the results are shown in Table 4.

Table 4. Show the results compared between data with analysis (Fig.11) and data without analysis (Fig.10).

	Time	Smoothness
Data with analysis	6 min	More
Data without analysis	11 min	Little

From Table 4, the operating time when analyzing the plot file is less than that when the plot file is not analyzed. Moreover, the surface created from when the data is analyzed is smoother than that crated without analyzing the plot file.

5. CONCLUSION

This paper suggests the analyzing of the plot file created from Auto CAD to rearrange the path so that it is continuous and in the proper sequence. The results show that when analyzing the plot file not only the operating time required is less but also the surface obtained is smoother than when the plot file is not analyzed. The Fig. 8, Fig.9, Fig.10 and Fig. 11 show the sequence to carving the "School".

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