

Development of Synchronized CUI and GUI for Universal Design Tactile Graphics Production System BPLO_T3

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Abstract. Synchronized CUI and GUI are developed for the universal design tactile graphics production system BPLO_T3. BPLO_T is the first tactile graphics production system for the blind that enables the blind to produce tactile graphics by themselves. With the new synchronized CUI and GUI of BPLO_T3, the blind and the sighted can collaboratively produce tactile graphics. Proofreading of tactile graphics by a blind person is necessary in order to produce elaborate tactile graphics which can be used in textbooks or questions of entrance examinations. Because a blind person can modify tactile graphics by himself with BPLO_T3, it will be a powerful tool.

Keywords: Blind, Tactile Graphics, Universal Design, User Interface.

1 Introduction

In this paper, we introduce synchronized CUI and GUI newly developed for universal design tactile graphics production system BPLO_T3. BPLO_T is the first tactile graphics production system for the blind that enables the blind to produce tactile graphics by themselves [1,2]. BPLO_T produces tactile graphics from a source text file written in our specially designed plotter control language for BPLO_T. Because a source file for BPLO_T is a text file, it is editable with any text editors by any person who has learned the plotter control language. Therefore, BPLO_T enables not only the sighted but also the blind to produce tactile graphics by themselves. Since BPLO_T can be used only with CUI (Character User Interface) and is not WYSIWYG (What You See Is What You Get), the development of GUI (Graphical User Interface) was requested. In 2007, GUI for BPLO_T was developed, and BPLO_T2 was introduced [1]. With GUI, the usability of BPLO_T2 for the sighted was significantly improved because a sighted user does not need a detailed knowledge of the plotter control language. This time,

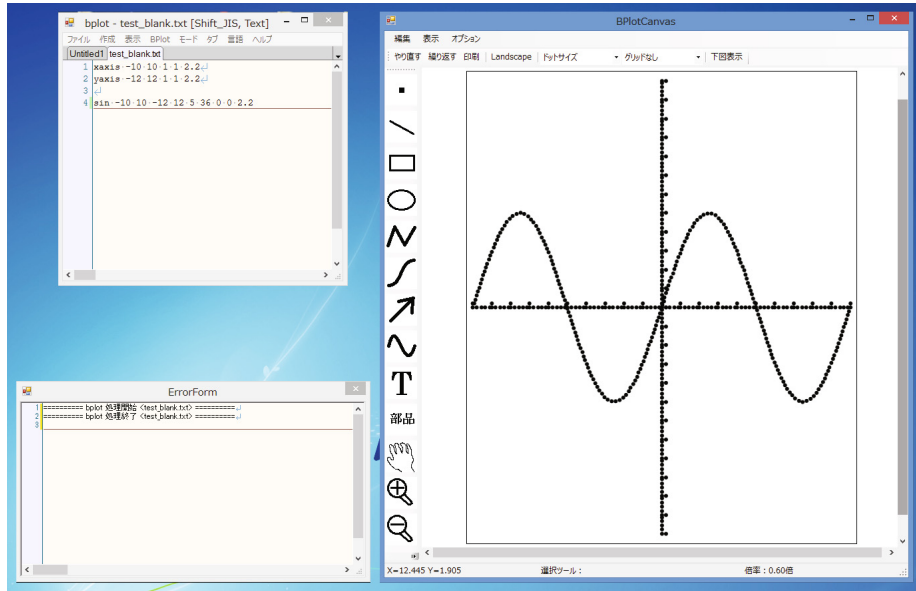


Fig. 1. Synchronized CUI and GUI of BPlot3

a synchronized mechanism between CUI and GUI was developed, and we introduce BPlot3 (Fig. 1). With the new synchronized CUI and GUI of BPlot3, the blind and the sighted can collaboratively produce tactile graphics.

Tactile graphics design applications such as BES [3] and EDEL-plus [4] have sophisticated GUI and enable the sighted to produce tactile graphics easily. However, because of the necessity for mouse operations, the blind cannot use these applications by themselves. Tiger Software Suite [5] can create tactile graphics by translating graphics on computer screen into tactile graphics automatically. Both the blind and the sighted can use it. However, it is not enough for the blind to produce elaborate tactile graphics for figures in textbooks or questions of entrance examinations.

Some other new features are also implemented in BPlot3.

2 Outline of BPlot3

2.1 The System

BPlot3 runs on Microsoft Windows XP, Vista, 7 or 8. It works with the braille printer ESA721 or ESA600G (JTR Corporation). In order to obtain tactile graphics of high quality, we chose ESA721 and ESA600G. They are braille graphic printers that can produce tactile graphics with very high resolution: 73 dpi (dot/inch) for ESA721 and 100 dip for ESA600G. The resolution of ordinary braille printers is only about 20 dpi. The main program of BPlot3 is written in C++, and the user interface part is written in C#.

2.2 Plotter Control Language

The plotter control language of BPLOT is like a computer programming language which consists of plotter control commands. The plotter control commands were mainly imported from ones formerly used to control vector-graphics printing devices. Each command consists of a command name and parameters. Basic figures such as a circle and a straight line can be described by a single command.

For example, the horizontal axis, the vertical axis and the sine curve in Fig. 1 are described by the following three commands in the plotter control language.

```
xaxis x0 x1 unit pic pitch
yaxis y0 y1 unit pic pitch
sin x0 x1 y0 y1 a b px py pitch
```

`xaxis` and `yaxis` are command names to draw a horizontal axis and a vertical axis, respectively. The parameters `x0` and `x1` (`y0` and `y1`) specify the range of an axis, `unit` means the intervals of divisions, `pic` indicates the length of divisions, and `pitch` sets the pitch of a dotted line. Likewise, `sin` is a command name to draw a sine curve. The parameters `x0`, `x1`, `y0` and `y1` specify the domain and the range of a curve, `a`, `b`, `px` and `py` indicate the parameters of a sine curve $y = a \sin(b(x - px)) + py$, and `pitch` sets the pitch of a dotted line.

We can magnify and reduce the output tactile graphics with the same sense of touch because dotted lines are drawn with the same pitch. The pitch a dotted line is specified in the parameter of a command.

The detail of the plotter control language is described in [1].

2.3 New Features of BPLLOT3

Synchronized CUI and GUI. The new synchronized CUI and GUI of BPLLOT3 enables the collaboration between the blind and the sighted in production of tactile graphics. A screen shot of the synchronized CUI and GUI is shown in Fig. 1. On the desktop, there are a text editor window, a canvas window and a message window. When a user edits a text, the change will be reflected on the canvas window. Similarly, when graphics on the canvas window is manipulated, the result will be reflected on the text editor window.

Tablet Input for the Blind. BPLLOT3 supports tablet input for the blind. When a tablet device is connected to a PC, we can draw a picture directly on the canvas window of BPLLOT3. See Fig. 2. This feature is very important for the blind. By typing a shortcut key on the keyboard instead of clicking an icon on the canvas window, a blind user can change the drawing method. When the tablet is touched with a stylus pen, coordinates are inputted, and both the canvas window and the text editor window reflect the input. With this feature, a blind user can input a picture by tracing a draft version of tactile graphics on the tablet. A sample of a traced picture inputted by a blind user is shown in Fig. 3. The character ‘i’ consists of connected straight line segments, while the other characters are drawn as connected spline curves.

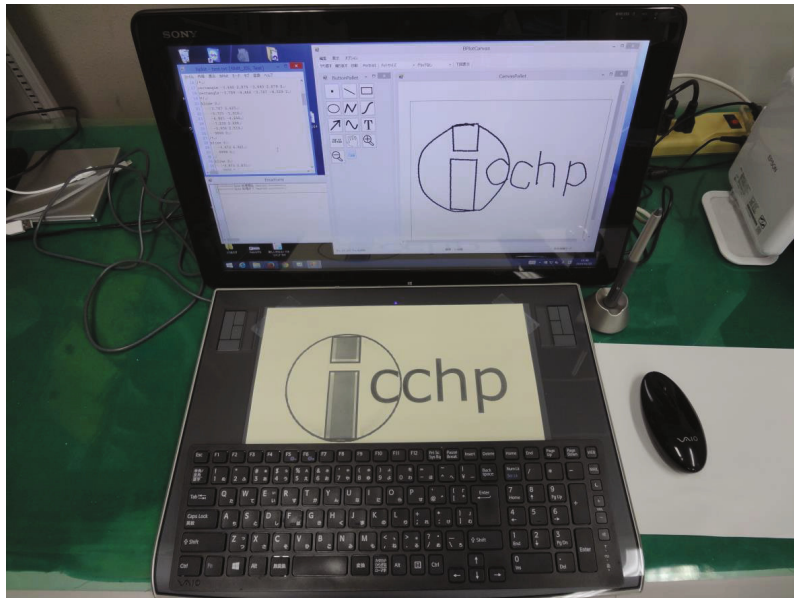


Fig. 2. Tablet Input for the Blind

Presenting a Draft Picture as a Background Picture. On the canvas window, a draft picture can be presented as a background picture. A sighted user can easily trace the draft picture. A draft picture can be made with a digital camera or an image scanner.

This function enables the digitization of a large amount of tactile graphics produced in the past. These digitized tactile graphics can be modified and reused.

3 Practical Evaluation

3.1 Usability Check by a Blind Person

In order to check whether BPlot3 can easily be used by the blind, we asked a blind person to use BPlot3. This person is an instructor working for a sales and support company of computers and software for the blind. The followings are the results:

1. BPlot3 can be installed on Windows 7 by the blind person by himself with some screen readers on Windows.
2. Text commands can be inputted on the text editor window.
3. Text files can be loaded to the text editor window, and the contents can be read easily.
4. Tactile graphics can be printed out with a braille printer.
5. Online help can be used. However, the person pointed out that a manual is desired in addition to online help.

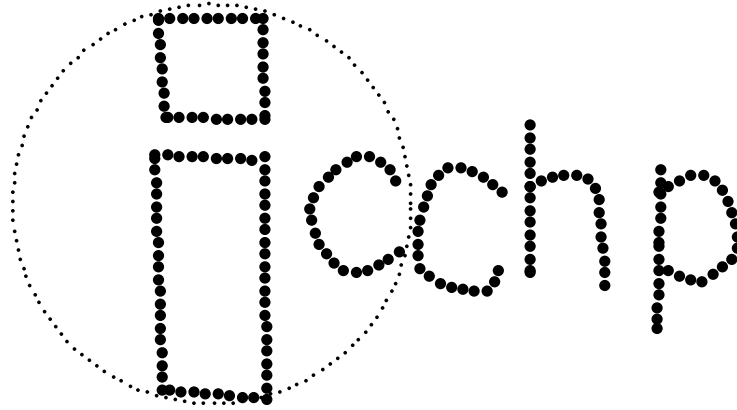


Fig. 3. A Sample of Traced Picture

3.2 Production of Tactile Graphics with the Tablet Input Function for the Blind

The usability of the table input function for the blind was checked by producing tactile graphics of the logo of ICCHP shown in Fig. 3. The followings are the steps to produce tactile graphics with this function.

1. Make a draft version of tactile graphics using heat sensitive capsule paper (PIAF).
2. Place the draft on a tablet device connected to a PC. See Fig. 2.
3. Type a shortcut key on the keyboard to select a drawing method and trace the draft by touching some points with a stylus pen. To trace the character 'i', "connected straight line segments" was selected as a drawing method and corners of the rectangles were touched. To indicate the last point of a figure, it was double-tapped. To trace the other characters, "connected spline curves" was selected as a drawing method and some points on the characters were sequentially touched.
4. Modify tactile graphics on the text editor window. The circle enclosing the character 'i' was first traced as connected spline curves, and then it was replaced by a circle drawing command after calculating the radius and the coordinates of the center.

3.3 Example of Practical Use

It was evidentially proved that only blind persons can produce tactile graphics of a one-year amount of the graphs and figures in the questions of the National Center Test for University Admissions of all subjects (mathematics, English language, Japanese language, physics, chemistry, biology, earth science, world history, Japanese history, geography, contemporary sociology, and politics and economy).

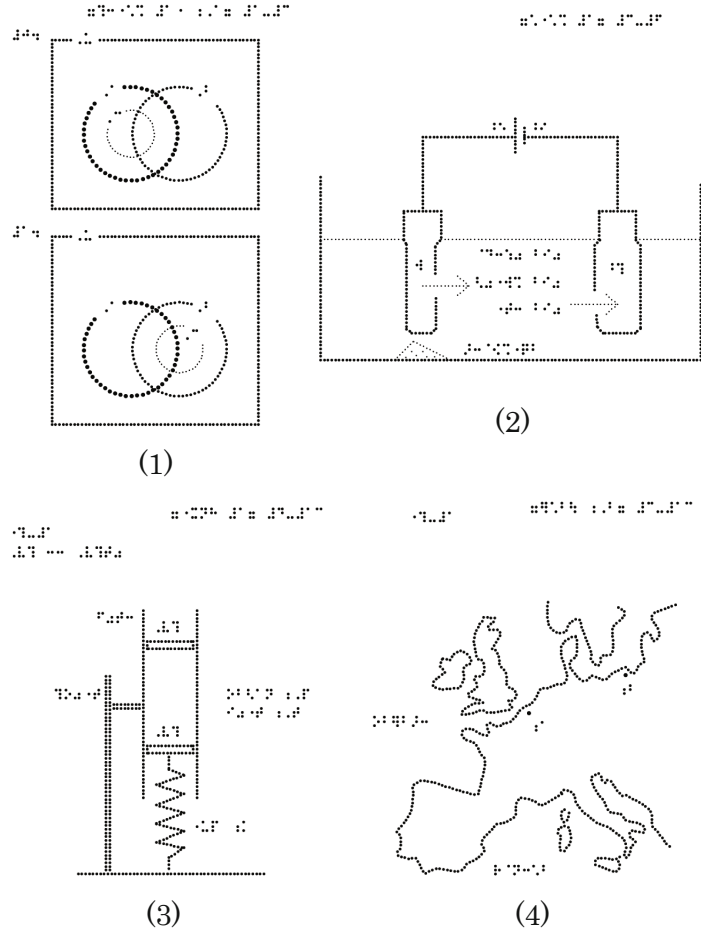


Fig. 4. (1) Venn Diagrams in Mathematics, (2) Electrolysis in Chemistry, (3) A Cylinder and Pistons with a Spring in Physics, and (4) A Map of Europe in World History

First, a draft version of tactile graphics of original figures was made using heat sensitive capsule paper by a sighted person. From the draft version, a blind person produced tactile figures with BLOT3. The tactile graphics were proofread by a pair of another blind person and a sighted person. In accordance with the result of proofreading, the blind person modified the tactile figures. This proofreading and modification process was continued three times with different pairs of proofreaders.

Some examples of tactile figures used in the National Center Test for University Admissions are shown in Fig. 4.

4 Conclusion

Synchronized CUI and GUI were newly developed for the universal design tactile graphics production system BLOT3. With the new synchronized CUI and GUI, BLOT3 enables the blind and the sighted to produce tactile graphics collaboratively. Since proofreading of tactile graphics by a blind person is necessary in order to produce elaborate tactile graphics which can be used in textbooks or questions of entrance examinations, a system which enables a blind person to proofread and modify tactile graphics by himself was strongly demanded. With the new synchronized CUI and GUI of BLOT3, a blind person can edit tactile graphics on the text editor window, and a sighted person can check the modified tactile graphics on the canvas window, repeatedly. We think that BLOT3 reduce the cost of production of tactile graphics. In addition, we expect that BLOT3 will expand employment opportunities for the blind in education and tactile graphics production business.

Actually, BLOT3 has been used by the blind to produce all tactile graphics of braille format tests for the National Admission Test for Law Schools and some tactile graphics for the National Center Test for University Admissions in Japan. Fig. 4 shows examples of tactile figures used in the National Center Test for University Admissions in the past.

Since detailed modification of tactile graphics is possible with BLOT3 by adjusting numerical values in parameters of plotter control commands and the functions of the latest braille graphic printers can be fully used, we think that BLOT3 can make tactile graphics with the best quality on paper.

Recently, the development of tactile graphics displays for a PC is remarkable [6,7]. GUI is useful not only for the sighted but also for the blind. We want to offer GUI to the blind so that they can make use of a tactile graphics display with BLOT in the near future.

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