Development of Tactile Graph Automated Creation Software

Tetsuya Watanabe
University of Niigata
Niigata, Niigata, Japan
t2.nabe@eng.niigata-u.ac.jp

Toshimitsu Yamaguchi
University of Niigata
Niigata, Niigata, Japan
t.yamaguchi@eng.niigata-u.ac.jp

Masaki Nakagawa
University of Niigata
Niigata, Niigata, Japan
t10f915g@mail.cc.niigata-u.ac.jp

Abstract

This paper describes the reason why tactile graph automated creation software is needed and requirements of the software we are planning to develop.

1 Purpose of Research

When numerical data are presented in the form of a graph, the main gist of the data (e.g. relative sizes, relative ratios, interpretation of trends, etc.) can be understood instantly. Reading graphs by touch takes longer than by sight, but even then, it should be possible to understand the gist of the data more quickly than when presented in tabular form. While it is easy for people with normal vision today to create graphs using spreadsheet software, etc., those with visual disability have yet to benefit from such merits. Thus, the purpose of this research is to develop a system for automatic creation of tactile graphs from numerical data that can also be operated by blind people.

2 Related Research

Systems designed to make graphs accessible to blind users are classified as follows, depending on the method of presenting graphs and the method of inputting data.

There are three methods of presenting graphs: (1) conveying data via sound pitch and 2-dimensional acoustics[1], (2) vocalizing the form of the graph and individual data[2], and (3) making graphs tactile[**?**, 4]. It is difficult to convey data accurately with the acoustic method, and moreover, since acoustics are volatile, information can easily be misheard. There are advantages in the method of vocalizing graph data as long as a screen reader is provided. To interpret trends in the data, however, the shape of the graph has to be imagined inside the user's head. Tactile graphs have the advantage that the general shape of the graph can be understood by touching it carefully, but hardware is needed to generate tactile charts.

There are two methods of inputting data into graphs: (1) reading an electronic file of numerical data forming the basis of the graph, and (2) scanning a printed graph. Although the former method is easier to use, in many cases only textbooks or other printed matter can be obtained. To address this, the method of scanning a graph, dividing it into text and graphics and re-pasting the Braille-converted text into the graphics is being studied[3, 5].

We therefore decided to develop software that would easily allow data to be made tactile. This was based on an assumed situation in which users possess electronic data and make them tactile so that they can read the gist of the data by themselves. Research aimed at the same objective is also underway overseas[4]. There, the user is mainly assumed to be a sighted Braille transcriber, and the software has a graphical interface. The output is an SVG-format image file, which is printed on capsule paper and passed through a heater to create a tactile graph. In Japan, on the other hand, there are many users of embossed diagrams as tactile charts, and there is a good environment for people working in intellectual professions to use Braille embossers in the workplace. Our development target, therefore, was software for automatic creation of tactile graphs operated by CUI (character user interface, which is easy for blind persons to use), and equipped with an embossed diagram output function.

3 Development Requirements

After interviewing a researcher with visual disability who works in analyzing numerical data, we designed the system requirements as follows.

3.1 Accessibility by Visually Impaired Users

Software should be compatible with screen readers, enabling blind users to operate the system by themselves. CUI will be used in view of its ease of operation by voice. However, if requested by other potential users, we will also consider adopting GUI.

3.2 Flow of Operation

The following steps will be followed to create tactile graphs.

1. Read CSV data.
2. Input titles, labels and other text.
3. Set graph display parameters (type of graph, maximum values, minimum values, scale intervals, etc.).
4. Use a Braille embosser to print graphs.

3.3 User Environment

OS, etc.: operated via Linux console. We could consider a Windows environment depending on demand.

Braille embosser: will be JTR, ESA721 ver.95, which can make embossed diagrams and is widely used in Japan. This model can print three sizes of dots – large (diameter 1.7mm), medium (1.5mm) and small (0.7mm). Plotting accuracy is 0.34mm horizontally and 0.38mm vertically.

3.4 Graph Elements

Graph elements are as follows.

1. Images: axes, scales, scale lines, graph body.
2. Text: title, axis labels, unit labels, scale labels.

The user inputs these text elements in *kana* phonetic letters, which are then displayed in Braille.

3.5 Tactile Readability

We will create graphs that are easy to understand by touch, in accordance with guidelines on the creation of tactile graphs and tactile charts in general[6, 7, 8, 9]. The main points to bear in mind here are as follows.

(1) Discriminability of tactile symbols

We will use mutually discriminable surface, line and point symbols. Of these, the discriminability of line symbols is particularly important in graphs. Of the types of dot made by the Braille embosser we are planning to use, the small dots are definitely discriminable from the other two sizes, but medium and large dots are harder to discriminate from each other. Therefore, it will only be possible to discriminate two different types with certainty by the type of dot. Types of lines formed from the same size of dot can be increased by changing the intervals between the dots, but only these two types can be discriminated with certainty. This will enable us to use four types of lines (two discriminated by different dot sizes and two discriminated by different dot intervals).

Scale lines have to be easily and reliably discriminable from graph lines. To this end, it would be ideal to use reversely embossed dots (a method of embossing dots from the front of the tactile surface), which feels different to the touch. However, it would be too troublesome to reset the Braille printing paper, and it would also be difficult to accurately align the front with the back of the diagram. Therefore, we intend to create scale lines and graph lines using different-sized dots.

(2) Searchability of tactile symbols

In line graphs, it has to be easy to search for point symbols from the graph lines. To this end, we either need to use sensorily characteristic point symbols, or leave a large enough gap between graph lines and point symbols (around 3mm), or take both of these steps.

4 Future Plans

We will develop software for automatic creation of tactile graphs to achieve the functions mentioned in the requirements, and will conduct experiments to verify its accessibility and tactile readability of graphs. On the accessibility of software, we will verify that blind users can operate the system with a screen reader, and will identify problems in operation. On the tactile readability of graphs, we will verify that lines can be followed and plot searches made accurately.

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References

[1] L. Brown, S. Brewster, R. Ramboll, M. Burton and B. Riedel Design guidelines for audio presentation of graphs and tables Proc. of ICAD 2003, 2003.

[2] L. Ferres, P. Verkhogliad, G. Lindgaard, L. Boucher, A. Chretien, and M. Lachance, Improving accessibility to statistical graphs: The iGraph-Lite system, ASSETS'07, Proc. of 9th Int. ACM SIGACCESS Conf. Computers and Accessibility, pp.67-74, Tempe, AZ, October 2007.

[3] C. Jayant, M. Renzelmann, D. Wen, S. Krisnandi, R. Ladner and D. Comden, Automated tactile graphics translation: In the field, ASSETS'07, Proc. of 9th Int. ACM SIGACCESS Conf. Computers and Accessibility, pp.75-82, Tempe, AZ, October 2007.

[4] C. Goncu and K. Marriott, Tactile chart generation tool, ASSETS'08, Proc. of 10th Int. ACM SIGACCESS Conf. Computers and Accessibility, pp.255-256, Halifax, Nova Scotia, Canada, October 2008.

[5] N. Takagi, Pattern recognition in computer-aided systems for transformation of mathematical figures into tactile graphics, IC-MED Journal, Vol.3, No.1, pp.43-56, 2009.

[6] P.K. Edman, Tactile Graphics, AFB Press, New York, 1992.

[7] Y. Eriksson and M. Strucel, A guide to the Production of Tactile Graphics on Swellpaper, AB PP Print, Stockholm, 1995.

[8] Braille Authority of North America, Guidelines and Standard for Tactile Graphics, http://www.brailleauthority.org/tg/index.html.

[9] Japan Braille Library, An introduction to tactile graphics for Braille transcription, Japan Braille Library, Tokyo, 1986.