Estimating of Quality Parameters of Convex Copies for the Blind

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Abstract Heading

The development of convex copies has important aspect on education and life of the blind. Convex copies on capsule paper are used in education as maps and as information papers for the blind. Quality and quantify control of image parameters may be come a tool for the evaluation of convex copies. Quantitative and objective quality control of convex prints could help to improve the design and performance of Braille copiers.

In the paper we present the attempt and measurements of the parameters (high of the convexity, non-uniformity of the shape of Braille points, diameter of Braille point), influencing the perceived quality of Braille printouts. We also present trial determination of a combined index of the quality of the Braille characters and convex copies of graphics. In order to improve the design of the copying device on microcapsule paper being developed. We intend to apply the index to assess the influence of the parameters of the copying process on the quality of the copies.

Introduction

Very dynamic development of printing technologies for the blind has been observed lately. Until recently, only Braille printouts and thermal images on foil were used. Thermal images were too expensive (due to thermoform matrix process) for economic, everyday use. Recently, use of convex thermal microcapsule paper and convex ink jet printing has become popular. Costs of these two new convex printing technologies are gradually reduced. They enable printing of very affordable single copies of convex printouts with complicated graphics.

Convex copies become very important part of printouts for the blind. They are used as educational equipment, support-teaching methods, and to create plans and maps for the blind. Convex copies help blind children in perception of environment, discovering shapes and properties of a flower, geometrical figures, etc. Convex copies are important tool for developing spatial orientation in the nearest surroundings, i.e. house, streets, location of light posts, phone both, store, etc. Especially important are convex maps that enable the blind person to navigate even through unknown cities (for example independent sightseeing of monuments in Rome by a blind stranger).

Figure 1. Blind person using convex map

Quality of Convex Printouts

Quality of convex maps is the subject of this paper. Convex map include Braille text (descriptions on the map) and lines that mark outlines of particular areas. These areas are shaded with lines and described in map's legend.

Preliminary studies[1,2] established that convex Braille printouts have the following parameters: height of point H, shape and roughness of point's relief, and such geometrical parameters as point's diameter, dimensions of Braille character, space between characters and space between lines. Geometrical parameters are normalized geographically: in Europe-German standards are used, in USA, Japan and Canada-American standards and pattern "meteo" in Australia and Latin America- see Table 1.

Table 1. National Standards for Geometrical Parameters of Braille Characters.

	Marburger			US Standard	Meteo
	big	middle	small		
a [mm]	2,7	2,5	2,3	2,3	3,0
z [mm]	6,6	6,4	6,2	6,4	7,5
d [mm]	1,6	1,5	1,4	1,4	1,2-1,6

Values of the parameters in the table are different and are specified by manufacturers of Braille equipment. These parameters are not universally normalized. In depth studies and creation of international standard is suggested.

Conducted studies1,2 proved that point's height should be between 0,3 - 1mm, and basic dimension of Braille character '2a' should be between 4,6 – 6 mm.

These values came out from preliminary studies2 on group of 25 blind children from High School in Owinska, Poland.

Basic parameters of convex lines are: height and width of line on copy, and "friendliness" for blind's finger. "Friendliness" is determined by shape of the line's edge and roughness of relief.

Microcapsule paper was used in study of test printouts. Firstly flat back & white copy was made and then it was brought into relief by laser printer. Test printouts were made on three types of paper: manufactured in USA, in Sweden, in Japan and in Norway. Convex copies were made by thermal copier PIAF. Thermal copier was empirically set up this way, that amount of thermal energy delivered during the process, resulted in the best print quality.

Black & white flat control test copy consisted of lines with different width: from 0,5 to 6 typographic points - as shown on Fig. 2. Flat copy was made on a copy machine.

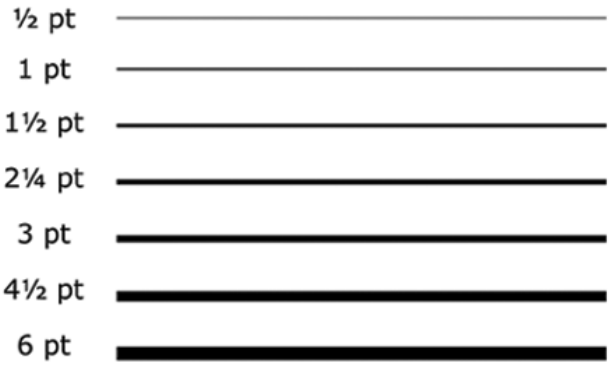

Figure 2. The part of the black & white flat control test printout on microcapsule paper – The test of lines width.

Table 2. Heights and Widths of Lines Obtained.

line	width [mm]	Height "H" [mm]
½ pt	0,181	0,055
1 pt	0,199	0,079
1½ pt	0,512	0,121
2¼ pt	0,564	0,187
3 pt	1,005	0,253
4½ pt	1,396	0,232
6 pt	1,701	0,242

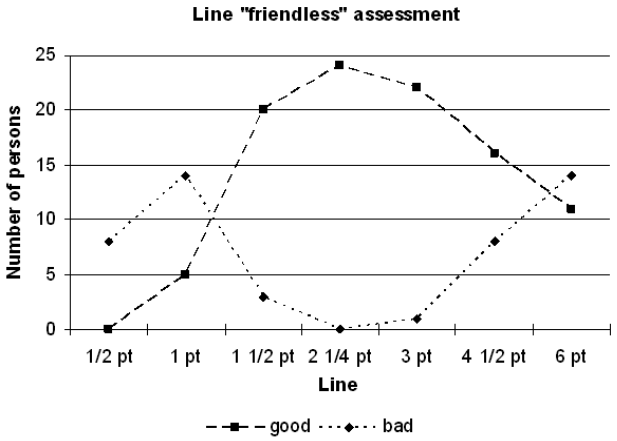

Figure 3. Line "friendless" assessment

Heights and other parameters of quality of convex printouts were measured by interference stripes method on measuring stand in Optical Engineering Division of Institute of Micromechanics and Photonics of Warsaw University of Technology.[2]

Conclusions from study of quality of convex lines:
- convex lines of widths from 0,5 mm to 1mm were qualified by blind as tactile "friendly"
- convex lines of widths above 1,3 mm were determined by the blind not "friendly"

Measurement of quality of convex lines is important due to their widespread use in manufacturing of maps for the blind and vision impaired.

Similar study was conducted with control test printout with rectangles of various degree of darkness. The height of convex rectangles is correlated with the degree of darkness of control test printout – Fig. 4.

Figure 4. Control test printout of rectangles with various degrees of darkness and its relation to the height of convex rectangles.

Interestingly, the perception of the shape of a rectangle by the blind person is much better when rectangle is determined by the convex lines forming its edges. When the whole surface of the rectangle is convex- the shape of the rectangle is perceived much worse.

Braille characters were also tested. Control test printout consisted of lines of 6-points Braille characters with various linear dimensions and different degree of darkness.

Readability of short Braille text was also tested - Fig 6.

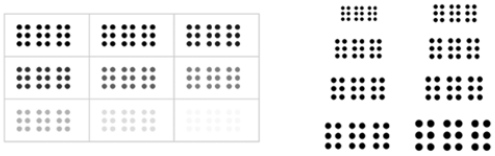

Figure 5. Control test printout: 6-point Braille character with different dimensions and darkness of flat copy

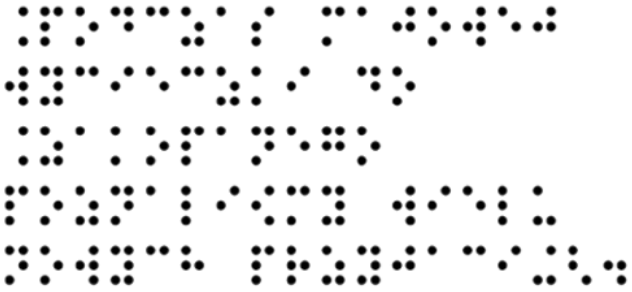

Figure 6. Control test printout: Braille test text

The Braille text did not include common expressions but it was forcing the blind reader to read each word separately. Control test printouts were prepared as described above in regards to lines and rectangles.

Evaluation of quality of convex copies was conducted in two studies: quantitative measurements on convex Braille points and tactile study by group of blind children from school in Owinska, Poland[1-3]

Examples of values of quality parameters of Braille points are in Table 3. and graphs Fig. 7.

Table 3. Values of Heights of Convex Braille Points in Relation to Degree of Darkness of Flat Copy.

height "H" [mm]	darkness [%]
0,309	100
0,321	94
0,321	81
0,256	69
0,227	56
0,150	44
0,000	31

Table 4. Values of Heights of Convex Braille Points in Relation to Diameter.

height "H" [mm]	diameter [mm]
0,2	1,03
0,24	1,29
0,25	1,4
0,28	1,59
0,27	1,6
0,3	1,78
0,31	1,95
0,35	2,42
0,2	1,03

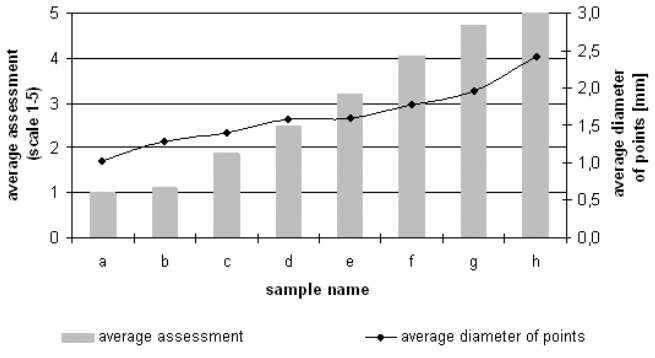

Figure 7. Relation of diameter of Braille points to Blind's assessment

Study of perception of Braille characters[1-3] proved that the most important parameter for the blind is the height of convex points. Little less important are: the size of the point and quality of surface, described as "friendliness" for the blind. The surface of convex points is determined by shape and roughness of points. Quantitative measurement of these factors is very difficult and should be a subject of more sophisticated study.

The tested group of blind evaluated importance of the parameters in conducted poll, results are shown on Fig. 8.

Obtained results are treated as preliminary and will be confirmed by testing of higher number of the blind.

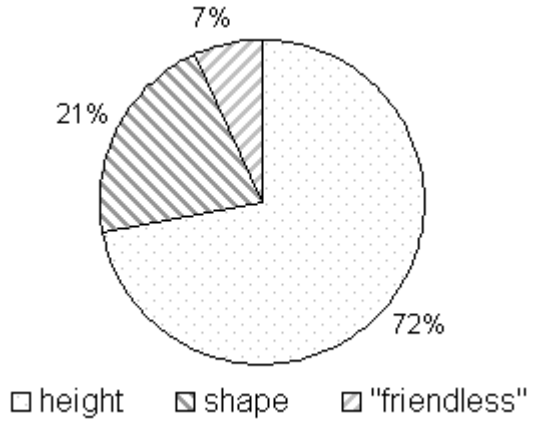

Figure 8. Tactile evaluation of importance of parameter of convex print quality.

Conclusion

1. The height of Braille convex character or image is the most important parameter for evaluation convex print quality.
2. Imaging of rectangular surfaces and other images with width bigger than 1mm should be done by bringing into relief of their edges only.
3. The best imaging of lines is achieved with convex line heights from 0,15mm. That requires flat copy widths of 0,55mm, with high degree of darkness.
4. It would be interesting to further study how convex printout quality parameters influence perception of the blind.

References

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2. Barczyk Roman, "Analysis of Qualitative Parameters of the 3D Convex Printing for Visually Impaired People" (2004) (in polish)
3. Buczynski Ludwik, "The Evaluation of the Quality of Braille Prints and Convex Copies in the Aspect of Teaching the Blind" The European Conference on Modern Education Techniques for Blind and Visually Impaired Children, Owinska, Poland, 2003

Biographies

Roman Barczyk received his Mgr Eng. degree from the Warsaw University of Technology at Warsaw in January 2004. Since February 2004 he is working on PH DR degree. His work is primarily focused on problems of quality of convex copies for blind and visually impaired people.

Ludwik Buczynski received his PH DR degree in micromechanics from Warsaw University of Technology in 1972. Since 1963 he worked in Micromechanics and Photonics Institute of Warsaw University of Technology and since 1986 to 2003 in R&D Center Office technique PREBOT Radom Poland. He is member of IS&T. Since 1990 his main area of interest are computer peripheral's devices and image quality investigations.