New Technologies of Convex Printing of Maps for the Blind and Weak-sighted People

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Abstract

For the blind and weak-sighted people is very important to be able to move around independently. They use of white sticks, dogs and other aids are useful, but prior knowledge of an area can further aid mobility. Convex (tactile) maps are potentially very helpful in knowing the layout of a city, plans of public transport, the type of terrain to be encountered and so on.

In the last few years, two new technologies for convex printing have been developed: microcapsule paper and convex inkjet printing. With these technologies it is easy to produce convex graphics, be they maps, charts, diagrams, graphs or even artworks.

Introduction

Convex printouts (Braille text and raised-line copies of graphics) are very important in the development of visually impaired peoples' spatial awareness, education and mobility.[2]

They can play a significant role in a blind person learning the spatial distribution of their living environment (e.g. with scheme of corridors in a block of flats, streets, bus stops, locations of shops etc). The convex maps can also be used to learn about completely foreign places.

They are also very helpful in teaching geography, history, math and other subjects.

Figure 1. A person, reading a tactile plan.

Main Requirements for Convex Maps

The content and form of convex maps should be adapted to for their final use and due consideration should be given to destination and to the limited perception resolution of touch in comparison to sight.

For example, when learning of the environment of a city, the map should contain crossroads, symbols of light-sound road signaling, bus stops, post offices, banks and other common landmarks. Also helpful are maps with schemas of lines of trams, buses and subways.

The maps are also used as didactic help. During geography lessons schoolchildren experience schemas of rivers in states, location of administrative districts, states boundaries.

Figure 2. Convex map of Europe

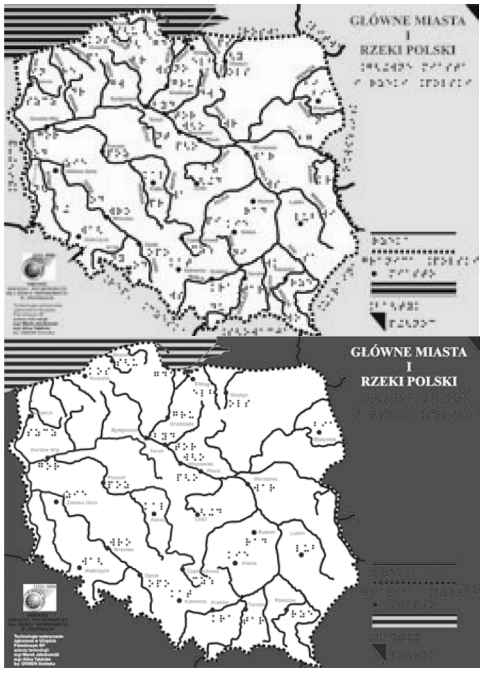

Figure 3. Maps showing the rivers and cities in Poland

The maps should contain only necessary elements. Figure 3 shows the main cities and rivers in Poland. The excessive accumulation of elements on figure 3a caused disorientation of blind children. Removing the needless inscriptions (names of rivers and smaller cities – Figure 3b) made the map more readable and understandable.

The structural quality of convex lines and Braille labels is a very important feature of convex maps. Research[3] with a group of blind participants showed that one of the most important features of convex printouts is the height of lines and Braille points. This height should be at least 0.3 millimeters, but this height shouldn't be too excessive (too high lines are poorly recognizable by blind people).

The other geometric dimensions of convex elements are also important factors of such printouts. Too thin or too wide lines are poorly recognized tactually. Prior research[3] showed that lines should be wider than 0.5 millimeters but thinner than 1.5 millimeters (thus with larger convex elements it is better to have just the outline).

The distance between Braille points and other convex elements on maps should be adapted with the perceptual capabilities of touch in mind In general the interval between tactile elements should be much bigger than interval between points in optical reading.

Another very important feature is the roughness of convex places. Roughness is a dominant factor in the discrimination of textures and contributes strongly to the perception of points and lines. Though increasing roughness can aid in map performance it should not be too excessive, as this can cause hardening of finger's skin and decrease tactile sensitivity.

In the Institute of Micromechanics and Photonics at Warsaw University of Technology have researched the influence of quality parameters in convex copies on tactile perception, and correlations are made between convex printouts and their perception properties. Innovation and modernization of convex printing technologies of maps greatly improves their quality and reduces the cost of production.

Production of Maps

Previously[5] maps for people with visual impairment were made using a number of methods. A common method is by thermoforming, whereby a special thermal foil or plastic is heated and formed over a master matrix. This technology is useful for high volume production. as once the master matrix is made copies are easily produced. Even earlier maps were handmade with very labor-intensive methods (e.g. outlines of drawings by sticking cord or string to a substrate).

Nowadays convex maps are produced using a number of technologies though two technologies use a digital process: copying on a microcapsule paper and inkjet printing.

Microcapsule Paper

A special type of convex maps are color maps made using microcapsule paper (a technology developed[1] in "School – Educational Center for the Blind Children" in Owinska, Poland). These maps are helpful for blind and weak-sighted people.

The process (see Figure 4) of making convex maps using this technology consists of three phases:

- making of graphic file (map or diagram) using a computer
- printing this file on a microcapsule paper on the laser or inkjet printer
- making convex copy with a special Braille copier (Braille heater)

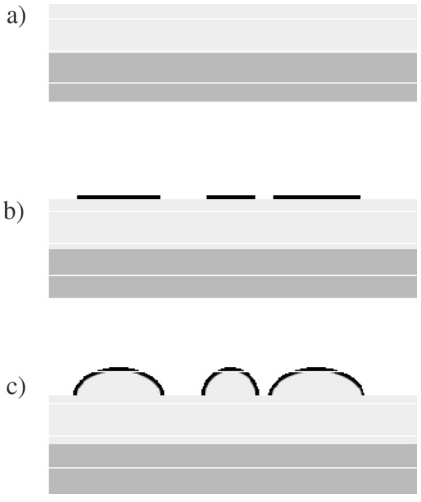

Figure 4. Process of copying on microcapsule paper (a) bare microcapsule paper, (b) flat copy, (c) convex copy

The file with the map can be prepared in any program for digital imaging (like Corel Draw or Photoshop). This process is relatively easy and allows the use of different textures for different areas. The process allows changes to the data file very easy. Using of scanner allows one to create a map based on existing drawings, sketches, cartographic maps or architectural plans of buildings.

An important advantage of electronic versions of maps is the ease with which they can be uploaded or downloaded to the internet.

The second phase of making a microcapsule paper print is to make the a flat copy (Figure 4b). The color map file is printed on a laser or inkjet printer. The outlines of areas are black colored (these are the parts that will be convex). For weak-sighted people the areas are colored with contrasting colors. It's possible to differentiate of lines changing their width, or using continuous, dashed and dotted lines.

The outlines become convex in third phase of copying. In the third phase of copying on microcapsule paper, black places on a flat copy become convex in a special Braille copier (Braille heater). In this device light of high intensity is emitted onto the surface of the paper. The black colored places are absorb more energy, triggering the microcapsules to expand once a critical temperature is reached. Non-black places remain flat.

The most important advantages of this technology are:

- ease of making map file with computer.
- the possibility of using existing maps and plans of buildings
- ease of making changes
- ease of propagation of maps via internet

Principles of Convex Inkjet Printing of Maps[4]

Microcapsule is a very useful method of producing tactile maps; it is relatively easy, cheap and has a digital foundation. However the paper the maps are produced on is not overly robust, it is not useful for wet weather or out-door use and the convex features can be scratched off or destroyed, even in normal use. Though using different intensities of black or slightly dotted textures, differences in the elevation of features can be created, the technique, as a whole does not lend itself to good three-dimensional reproducibility.

Ink-jet is now being widely used in the production of three-dimensional products. Acrylic inks which can be jetted as liquids and cured hard using ultraviolet light form excellent polymer structures. These structures bond well to polymer substrates such as PVC or polystyrene. They are rigid (though inks have been tried that are deliberately compliant or rubbery after curing, to give variation in the feel) and tough and suitable for a wide range of applications.

The Anglia Polytechnic University has developed a printer that uses such inks in a 500-nozzle 180 dpi printhead. A3 axis motion controllers drive a substrate under the print-head in a multi-pass process until the required elevations. The drop deposition is determined by the image sent to the printer (this image can be created in the same way as for a microcapsule map). By varying the image sent to the printer for each pass, different elevations of the convex print can be produced, leading to a nearly three-dimensional capability.

The output from the printer has been shown to be highly discriminable. Easily perceived sets of tactile elements and textures line types have been developed.[7,8] Recent developments in the understanding of height requirements for convex features[8] together with increased deposition rates of ink-jet print-heads means that it should be possible to produce a fully cured A4 tactile map in under 2 minutes.

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