SOUND MAP AS A WAY TO TOPOLOGICAL RECOGNITION OF REALITY FOR THE BLIND

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Abstract

With the increasing use of GIS and the rapid growth of new mapping software for PC-computers it may be expected that contemporary cartographic tools ought to be accessible also to the blind users. The proposed method of sound coding of point elements creating digital design seems to be well-turned trial of overcoming the main barrier.

1. Introduction

Map is the specific kind of model that combines the cognitive functions with applied ones in relation to various spheres of man's activity [1]. This is the reason why we can notice the development of new technologies as well as the increase of social role of contemporary cartography. Unfortunately, the majority of new solutions, base on visual form of modelling, are useless for the blind therefore the efforts to publish some special braille atlases as well as tactual maps are made [2, 3, 4].

It seems to be unintelligible that in the endeavours to make the maps accessible for the blind the sight is always replaced by the touch but never – by the hearing.

In the history of culture the connection between visual- and sound-impression has been often described. The trials could be interpreted as the search of world-homogeneity in world-heterogeneity... Many examples of illustrative pieces are known as well in baroque as in XIX c. program-music. But for our purposes more interesting seems to be the inverse transmission: from visual to sound space organization. Such proposal has been lately undertaken by Bargielski, the composer from Vienna. He created some musician pieces as the adaptations of the part of very interesting collection of Szpakowski's designs [5]. Both kind of artistic works could be treated as the "compositions". Receiving visual and sonoric stream of signals (at the same time) we obtain considerable enrichment of final impression. But it must be added that while for the sighted person the sound adaptations of scene is only complementary impression, for the blind it is the sole one.

2. The sonoric network

The main idea of proposed method is to replace each of visual signal belonging to the content of map by the suitable one of the collection of sounds.

Sound coding is realised only for the positions which represent definite group of elements being in our interest. It can be for instance river as a stream of points or – settlement as a distorted group of points. Because on 2D space the visual localisation of point element can be fixed by two x and y coordinates, the suitable sound signal can be also definited by two characteristics. In the proposed model the height of sound along vertical axis and the receiving intensity along horizontal axis have been used.

Whole operational area (30 cm × 42 cm) consists of 9 sections according to the rules of natural terrain orientation. The central-observer position appoints central row and central strip. Two other rows are: on the left (west) and on the right (east). Two other strips are: before (north, upper) and behind (south, lower). Owing to division the operational area into the sectors the blind users of model obtain the possibility of *general* recognition of geometrical as well as topological organization of element, representing the objects of reality on 2D space: the general shape of figures, course of lines, distribution of isolated points. In sonoric model the borders of the sectors has been distinctly fixed by rapid change of suitable characteristic: heigh or intensity of a sound.
For the *individual* perception connected with more detailed localisation of point elements each of sectors has been divided into 560 elementary squares (5 mm × 5 mm). As the result of this division each of three vertical rows consists of 1680 elementary subareas, each represented by specific couple of sonoric characteristics. Along vertical direction there has been applied the half-tone step on differentiation, according to dodecaphonic musician scale, except cross of each of the two horizontal borders of strips which has been fixed by 2.5 tone step. Finally the whole scale of height changes from F_1 (octava contra) to C_4 and inside the sectors: F_1–c, f–c_2, f_2–c_4. Along horizontal direction all three rows have been the same kind of coding, because over than 84 steps of the receiving intensity of sound could not be well distinguished. As a result of repeating in following rows the increase of acoustic force of sound according to semi-logarytmic curve (from 8 dB to 35 dB) it has been obtained the effect of expressive sound differentiation in the all operational area.
The accuracy of S(ound) L(ocalization) S(ystem) has been raised owing to division each of elementary squares into the 25 subareas (1 mm × 1 mm). Inside an elementary area all sound-signals have been equalised. Finally – the accuracy of sound coding is 1 mm × 1 mm, while the differentiation of sound – only 5 mm × 5 mm. Whole number of coding positions is 126000 (in each of three rows – 42000).

3. The instrument

The portable SLS has been destined to the blind pupils. Such destination caused that it has been applied the operational desk with two perpendicularly situated conducting lists precisely steering orthogonal move of the mouse working as an electro-mechanical processor. The mouse can transfer the digital informations relating to the position of point element to the little box serving as the C(entral) S(ystem) of D(ata)-R(egister) and data-T(ransform) to the sound signals.
Whole content of map has been separated into several layers. The choice of the layer is realised immediately by voice from menu situated in CSDRT-box.
The mouse has been equipped in the keyboard reduced to only three buttons.
The central one serves to start the work, the left for coding an optional design, the right to call the sonoric network or, together with the central, to reduce the coding of elements.
After pressing the central button the process of research of point-collection may be realised by manually steering the move of the mouse and contemporary hearing the sound signals, using the headphones.
To proper use of SLS the users ought before to test the sound collections characterising base configurations of points, lines, curves, figures and shapes according to the localisation of objects in the whole mapped area.

The SLS has been tested in Wrocław's Centrum of Blind and Visual Handicapped Children. Specially prepared tests collection has been used. After several repeating of sound distributions according to the characteristic lines the general shapes of continents, the courses of rivers and the situations of capitals have been memorised in the pupils minds. As the special test has been used the Polish tactual map of Europe with braille codes. Owing the SLS this map has been completed by the lines of geographic nets.

4. Remarks and conclusions

The method can be adapted to more precisely process of sonoric coding as well as – to more generalised. The first one could be destined for schools or institutes. All system will consists of camera, scanner and computer. The content of map could be scanned and stored in the memory of computer. The suitable program has to assume the high accuracy of the coding process. Instead of mouse, desk and pair of list the fibber optics, Fresner's lens and light pen can be used.
By applying to SSL the good known system of windows the accuracy of sound coding could be almost equal to the visual one.
For little children the sound could be far simplified, therefore the scale of both characteristics – more generalised. It might be eventual the same signal in the sector area.
Edwards [6] has been remarked that human perceptual system uses a variety information to identify and understand a scene. The interpretation of abstract figures appears to closely resemble map reading. Applying SLS to form the mentally fixed spatial orientation for blind children it could be create a new kind of play: *the sound puzzle*. Fitting up the pieces of puzzle the child could exercise the perceptive faculty of the metric relations distance, direction as well as topological ones, connectivity, orientation, adjacency, containment and finally the blind children could sequentially create the analogical picture of reality.

References

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