GEODEZJA I KARTOGRAFIA
t. LIII, z. 1, s. 41–48 (2004)

Janusz Kuchmister

Department of Geodesy and Photogrammetry
Agricultural University of Wrocław
(50-357 Wrocław, ul. Grunwaldzka 53)

Perceptual limitation of using sonic digitizer in spatial education of blind children

Four years of work with the individually tested group of congenitally blind pupils from the Educational Centre for Blind Children are the base for formulating some conclusions connected with the usage of the method of sonic coding contour-lines in early stages of education. In the paper practical effectiveness of applying the sonicly coded scenes as well as ergonomic limitation according to the age of pupils have been shown.

INTRODUCTION

For born blind children models are of great importance in the trials of presenting an appearance of the world: differentiation of the forms of the world objects creating, their spatial distribution and relation between their sizes.

As far as blind children are concerned, usage of the models has opposite function than when it comes to children with good eyesight. Model should be used as a base for creating images of complicated reality and not as its reduction after revealing spatial structure. Blind children are rarely encouraged to draw. Drawings as a form of controlling effectiveness of tactual methods aiming at creating correct spatial images are still not sufficiently used.

The reason for that, which is treated as an argument, is the difficulty of keeping by a blind person correct orientation of the drawn scenes, that is – their mutual layout of elements. This fact can be noticed even in decomposition of human's body, which is very characteristic for the drawing of a blind child (Fig. 1).

In this paper the characterization and initial estimation of the effects of completing tactual modelling with sonorical modelling are proposed.

Thus, education is based on polisensorial creation of spatial images in which children include in the process of recognition also visions deduced from a specified sound sequence. The essence of the method is the association of the movement of the blind's hand along the line coded on the flat operation area (kinaesthetic impressions) and the sequence of sounds (acoustic impressions), related to the course of that line (that is the sequence of the points

creating that line). Each point of the line has the attributed sound emitted at the moment when the indicator driven by the blind meets it.

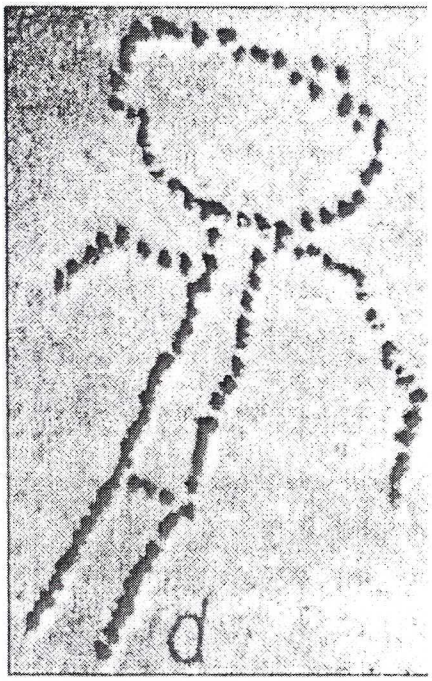

Fig. 1. Orientation of object [1]

The idea of the sonic coding of the points which create a specific "scene" on the plane is the reference to the way of visual coding based on the "contrast rule" which is the most natural for the human being. The point – single element of the scene – is percepted at the background of its surrounding. As a "black sign" it is *visible* over a white background, as a "sound" it is *audible* over a background of the silence [2].

The method lies in sequential leading of a hand of blind person who holds an indicator along the sonic path crossing the outside silence (Fig. 2). The points, coded by sound proper for their position, create segments, open lines or the lines that close the contours.

Children learn the recognition of a code:
- by listening to the sonic path,
- in active course with assistance, in which the hand of blind person is led in operational area (by a person with good eyesight),
- by decoding elements by themselves (Fig. 3).

The object of modelling itself, size, shape and the number and layout of creating elements should be adjusted to the age of children and their physical and mental development, in other words – to their real perceptual possibilities. Four-year researches of the effect iveness of this method based led of numerous sets of tests allowed us to create various remarks and inferences.

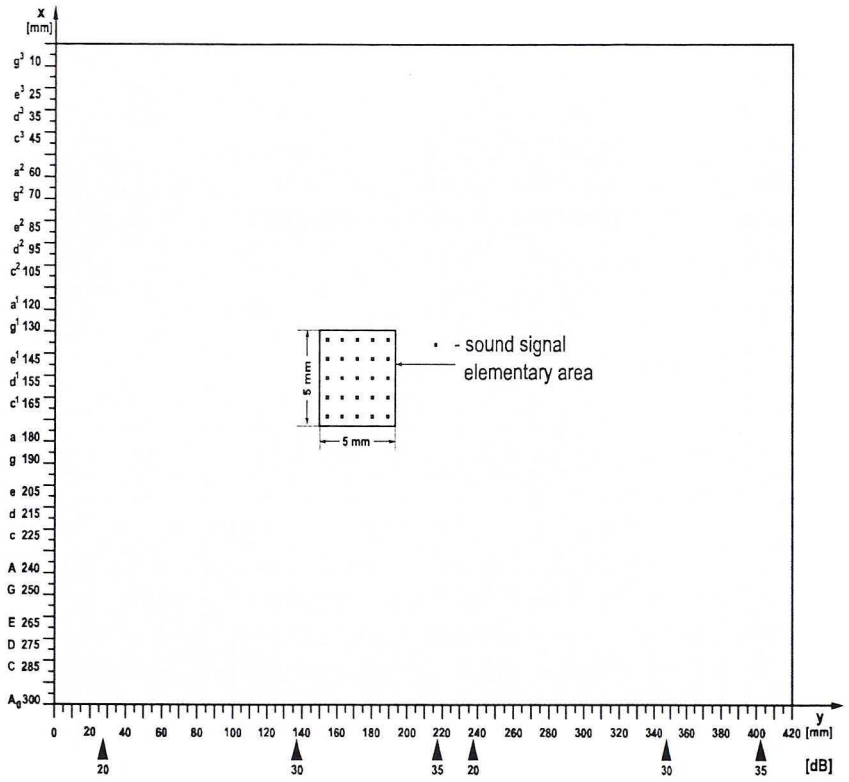

Fig. 2. The operational field

Fig. 3. Decoding elements by the blind girl

1. *Emotional receipt*

Children were very willing to take part in tests with the exception of 15% of shy children. Boys were more courageous while girls were more careful about the correctness of steering. Using approval and encouragements to repeat the trials and properly quick reaction to the failures by changing recommendations appeared to be extremely important.

Time of work without tiredness was:
- for children at pre-school age – 10 min,
- 7-10 years-old children – 15 min,
- 11-17 years-old children – 35 min.

2. *Operational remarks*

Only 30% of children use both hands for steering the indicator. Most children use the left hand to find out what the distance from the frame of operational area is. Younger children (7-10 years old) should have smaller indicators (mouse). For 89% of right-handed children a direction of steering does not matter. Not all left-handed children choose to work in the right part of operational area. However, preferred direction of steering is connected with the usage of left hand. This remark is not inference because of the small number of children taking part in the trial.

The direction of steering does not have any influence on the differences between the times needed for decoding a figure or a line, while the time needed for decoding is a function of:
- resistance of the steering mechanism,
- position of the element in operational area,
- complexity of the shape of coded line.

3. *Time of decoding*

Easiness of extracting sonic path is controlled by comparing the time needed for decoding elements representing objects or the whole scenes. Level of tiredness is controlled by comparing the time of decoding vertical lines with the possibility of independent localization of element indicating the beginning of the contour line – sonic path. Resistance of the steering mechanism causes that minimal time of decoding is noted for vertical lines and maximum time for horizontal lines. Position of the element or scene in operational area has important influence on the time needed for decoding.

It appears that optimal results are achieved by placing elements in the part of area restricted by horizontal lines (c and a^1) and vertical lines (20dB and 28dB). Time of work in narrowed area is about 20% shorter in comparison with the time of work in the whole operational area. Time needed for transition of complex line of determined length is a function of the number of directions' changes and proportion between lengths of

neighbouring segments. In the neighbourhood of the segments of proportion exceeding 4:1, over 50% of children do not notice any change of orientation. Time of transition is also function of rhythmical and non-rhythmical layout of elements creating the line.

4. *Identification of objects and qualifying their sizes*

a. Pre-school education level

When tactual method is completed with sonorical method, 100% of children recognize simple geometrical figures: square, rectangle, triangle, circle. Correct estimation of the height of squares in ordinal scale is obtained by using sides not smaller than 4.5 cm (4.5-tones modulus in vertical scale by Orff) and their mutual relations of height – 1:1.33. For circles the results of estimations are correct when the relation of diameters is 1:1.5 (in test the diameters of compared circles were 4.5 cm and 6 cm). In case of comparison between diameters of three circles, correct results are obtained when the relation of diameters is at least 1:1.6.

b. School education level

While comparing the length of short (3 cm) horizontal segments in the group of 9-year-olds, 12% change of length is not recognised, 40% change of length is recognised by 35% part of the group and only 50% (and more) change of length may be practically used. While comparing vertical segments, better results of differentiating between their lengths are obtained in upper parts of operational area, independently of the length – 1 cm (1 ton) the difference is noticeable in the group of older children. In the group of 8-year-old children correct indications of relative size of rectangles' and triangles' heights are obtained when they are placed on modular lines of intervals: 5 t, 10 t in Orff's scale, in other words, when the proportion of their heights is 1:2. For 11-year-old children recognition of 10 times a change of the length both of vertical and horizontal segments appears to be effective. Proportion 1:10 describes border possibility of direct comparison between childs hand and arm sizes.

Positioning in the group of 11 years old pupils vertical relative localization of signs representing different objects appeared to be effective in 100%. The exception was signs lying in even distance for which the level of correct estimations was 75%. In the class 5 also 75% correct estimations were obtained while comparing neighbouring, equally marked elements. In vertical relative positioning only 25% of the tested group correctly estimated position of 8-points group. Positioning of the points which are elements of the line (towns at rivers) (Fig. 4), in the group of 11 years old and over was fully effective.

Individual drawing (Fig. 5) appears to be a very useful form of controlling effectiveness of polisensorial creation of spatial images by blind children.

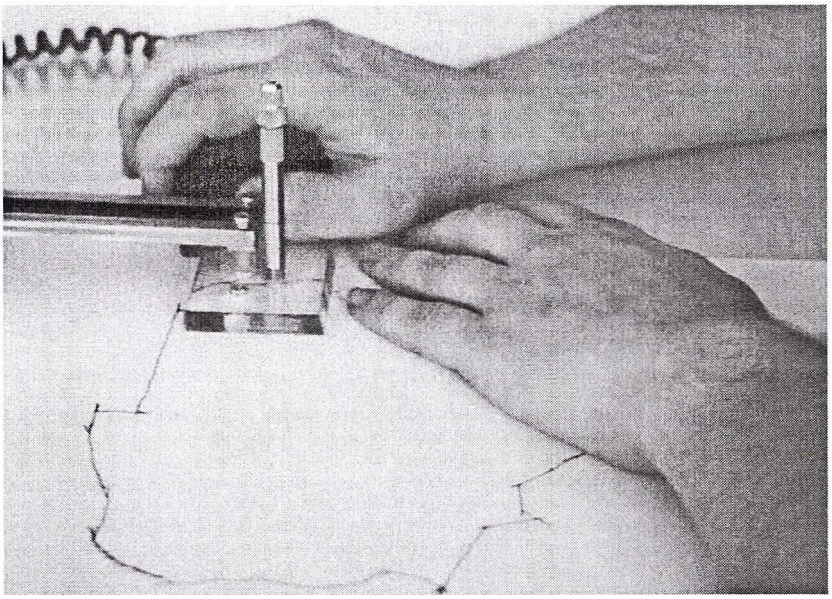

Fig. 4. Positioning of the points

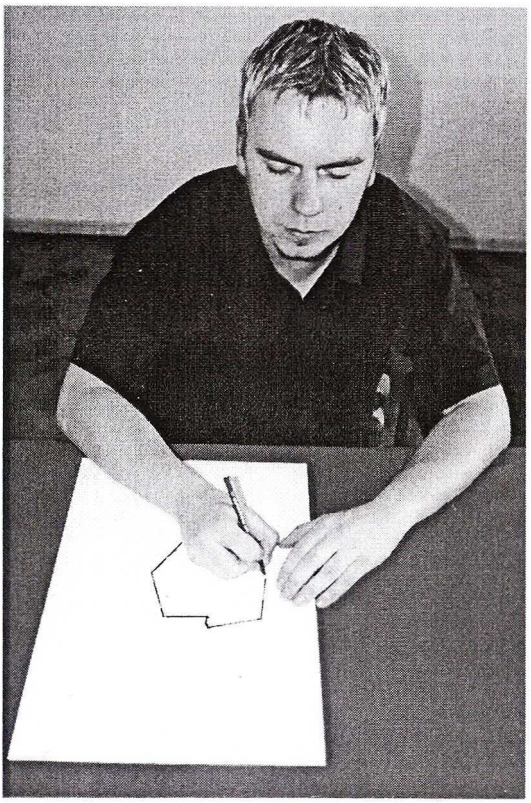

Fig. 5. Individual drawing

5. *Range of useful memory*

Table 1 presents the results concerning conditions of sonoric models' usage. Another remarks connected with personal conditions of practical effectiveness of the method have been described in [3].

T a b l e 5. Obtained results concering conditions of sonoric models

Age	Number of objects	Size of object (cm)	Width of sonic path	Effectiveness in % group of tested pupils
8–9	1	3–5	70%	Identification of object sing
10	2			Comparing in ordinal scale
11	3			Measuring 1:10 (x times)
12–14	4	1–2	60%	Recognition of geometry during independent decoding of lines

CONCLUSIONS

Sonoric aids appeared helpful at every level of school education. As many as 15% of children in higher forms correctly located elements basing only on sounds' recognition and 85% of children located them with help based on estimating (with hand) the distance from co-ordinates (the frame enclosing the area). Correct images of shape closed by contour line were obtained even while using 8-sonoric modules. However, composition of only 5 elements may be treated as practically useful in school education.

The tendency to the generalization of the shape is reasonable with reference to the education in practice: the spatial imagination is the base for right recognition of elements of the real scenes in real space

REFERENCES

[1] Bendych E., *Badnia nad rysunkiem niewidomego dziecka (część 1)*, Szkoła Specjalna, 5/94, WSiP, Warszawa 1994, str. 276-287.

[2] Krzywicka-Blum E., Kuchmister J., *Modelowanie sonoryczne w edukacji niewidomych (The sonic modelling in blind people education)*, Katedra Geodezji i Fotogrametrii Akademii Rolniczej we Wrocławiu, Wrocław 1999.

[3] Kuchmister J., *Personal conditions of practical effectiveness of applying sonic tests collection and sonic digitizer in education of blind children,* Proc. of the 21st Int. Cart. Conf., Cartographic Renaissance, Durban 2003, pp. 645-651.

Received December 12, 2003
Accepted January 14, 2004

Janusz Kuchmister

Percepcyjne uwarunkowania zastosowania digitizera sonorycznego w edukacji przestrzennej dzieci niewidomych

Streszczenie

Czteroletnie badania indywidualnie testowanej grupy dzieci niewidomych od urodzenia, uczących się we Wrocławiu w Ośrodku Szkolno-Wychowawczym Dzieci Niewidomych pozwoliły sformułować szereg wniosków dotyczących użyteczności metody sonorycznej w różnych grupach wiekowych. Oprócz ocen dokładnościowych, w pracy przedstawiono ważne dla przyszłych zastosowań parametry ergonomiczne.

Zastosowanie metody w procesie audio – kinestetycznego wychowania przedszkolnego i edukacji szkolnej ma na celu rozszerzenie poznania dotykowego kształtu, wielkości i układu realnych obiektów i modeli o poznanie multisensoryczne.

Януш Кухмистер

Перцепционные обусловленности применения сонорного дигитайзера в пространственном обучении незрячих детей

Резюме

Четырёхлетние индивидуальные исследования тестированной группы слепых с рождения детей, учащихся во Вроцлаве в Школьно-Воспитательном Центре для Незрячих Детей, разрешили сформулировать ряд выводов, касающихся полезности сонорного метода в разных возрастных группах. Кроме оценок, касающихся точности, в работе представлены важные применения в будущем эргономические параметры.