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# NEW WAY IN CARTOGRAPHY FOR THE BLIND: SONIC CODING OF CONTOUR LINES

**Abstract**: This paper presents the results of sonic method of coding shapes using the sonic digitizer. The instrument has been made as original author's solution. The succession of sounds representing object are decoded during sequential orthogonaly oriented motion inside the operational area composed of two (A4) parts.

**Keywords**: maps for blind users, sonic digitizer.

## Introduction

Many kinds of different object's localisation are known. In case of sonic method (Fig. 1) operation field ($2 \times A4$) consists of $2 \times 2520$ elementary areas (0.5 cm $\times$ 0.5 cm) each of them represented by 25 internal signals (1 mm $\times$ 1 mm) according to the position $(X, Y)$. Total number of signal points is $2 \times 263000$.
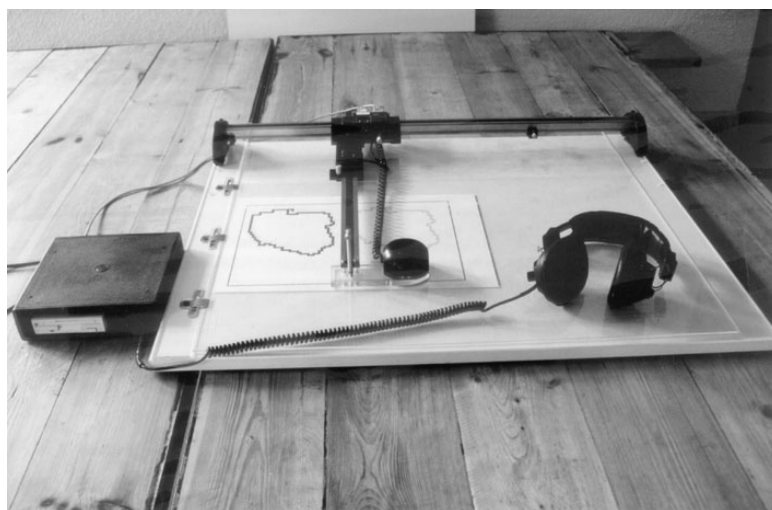


Fig. 1 The sonic digitizer

The $X_i$ variable is substituted by the pitch of signal when the $Y_i$ variable by the volume. The scale of change is about five octave of frequency and about 30 dB. The background for elements of "the scene" is the silent range. Figures representing real or artificial objects are encoded as the succession of sounds. Differentiation of signals allows identify the position of each point element being of blind's interest. Lines are usually created as triple or double streams of sounds to make easier searching of elements inside of operational area (Fig. 2).

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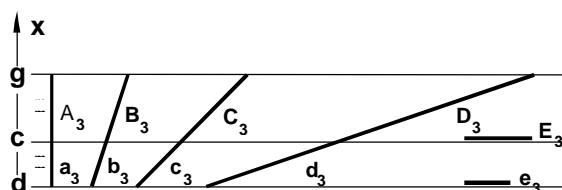
Fig. 2  Modules of the triple lines (scale 1:1)

Authors have prepared the collection of tests introducing as well as educating ones (Fig. 3). Children are very interested of method. Generalisation of shape using only several distances according Kodaly's and Orff's musician scales (changes of sound signals) caused simplification of the process of creating imaginations connected with special notions such as shape, relative position, orientation, dimension of object and whole composition of scene.
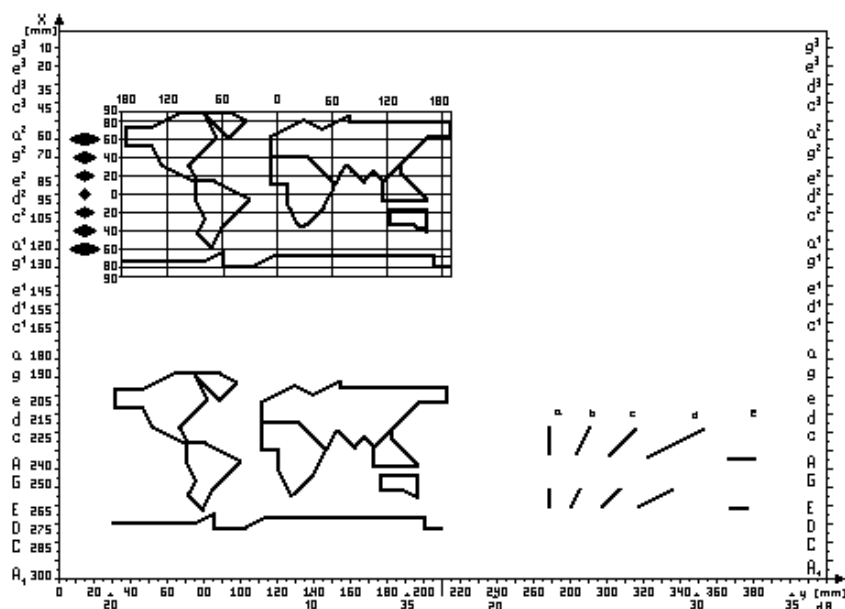


Fig. 3 World in equi-aerial projection

## Coding of contour lines

Coding of the sonic scene may be performed by use of:
a) the computer and the appropriate software,
b) the sonic digitizer. Each sonic test (Fig. 4) consists of two files:
  ▪ the graphic file, containing the coded scene as a bit-map, with the extension "bmp",
  ▪ the sonic file, containing verbal comments to the test, with the extension "vox".

Coding of the sonic tests by use of the sonic digitizer is a two-stage procedure (Fig. 5). Coding of the graphic file and saving the verbal comments are two separate processes.

Before the beginning of coding the contents of the test the device should be appropriately prepared and initially tested. The final effect of the sheet orienting lies the in the fact of the mutual identity of the local co-ordinate system X', Y' of the sheet and the co-ordinate system X, Y of the plate. After orienting the sheet is immobilised on the surface of the plate by use of the fixing platelets. Afterwards the sheet is covered by the transparent plate. Subsequently one should check out if the sheet orienting is made properly and if the location detector moves in the range of the operation area.
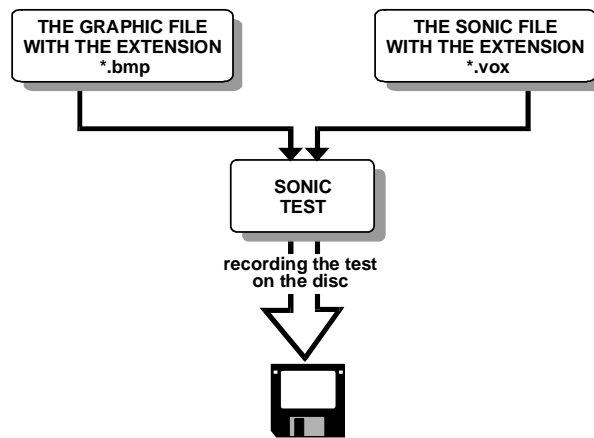
Fig. 4  Building of the sonic test

After these preparation the coding of the graphic image of the scene becomes possible. The person, who is going to code the scene puts the phones on, puts the disc into the disc-station. At that moment the control-lamp lights up and the continuous sounds signal occurs in the phones.
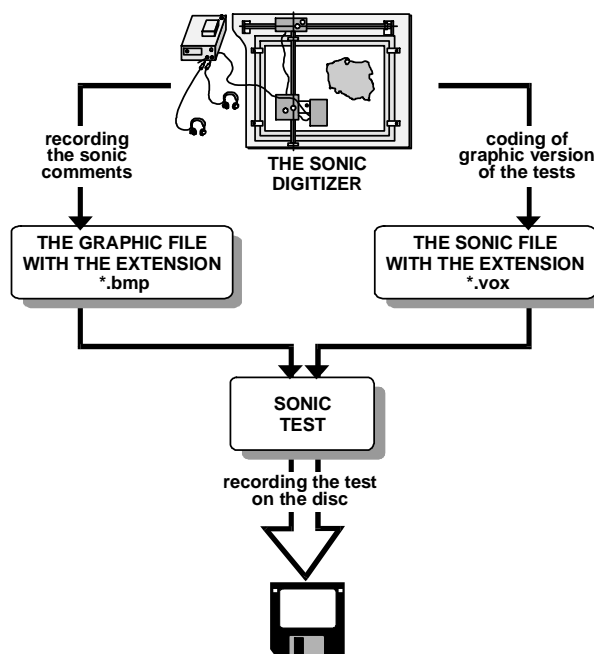


Fig. 5  Formation of the test using the sonic digitizer

In the next stage one should manually move the location detector so that the right cross meets the first point of the coded scene $P_{ij}$ and subsequently press the left button. The result of that is coding of that point and in the phones the sound signal appears with the volume and altitude dependent on the location of the coded point in the operation area. Analogically and gradually operator proceeds point by point, line by line until the end of coding all points $P_{ij}$ of the coded scene.

Using the microphone after the activities relevant to the coding one may save the verbally spoken comments to the contents of the sonicly coded scene. The spoken comments are saved to the disc placed in the disc-station.

Coding of the sonic tests is convenient by use of the computer and appropriate software (Fig. 6). The graphic files may be coded by means of any graphic editors, but anyway if the simplicity of operating is concerned the most-convenient may be the "Paint" or "Paint Brush" Editor. The graphic image of the coded scene has to be contained in the frame $300 \times 420$ pixels.
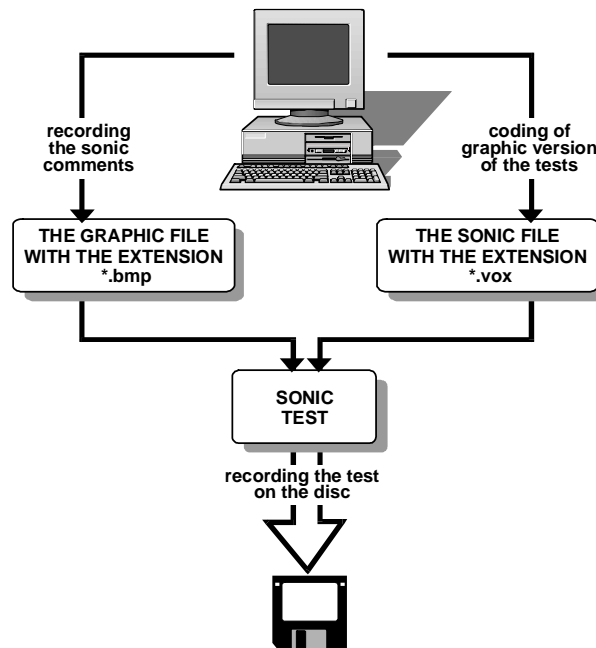


Fig. 6 Formation of the test using the computer

When coding one should use the graphic image of the scene in the area limited by the frame, drawn at the scale 1:1. Marking co-ordinates of the characteristic points of the co-ordinate system of the frame is an important simplification in coding of the scenes. The spoken comments may be saved by use of any accessible musical programmes.

Practical experiences prove that coding of the graphic files of the sonic tests is best and most conveniently made by use of computers and appropriate software however the spoken comments are easily and rapidly saved using sonic digitizer (Fig. 7).

## Decoding of contour lines

Decoding of the elements of the scenes may be performed in three different versions:
A) the teacher decodes the scene on his own moving the detector in the operation area while the pupil hears out the sounds in the phones;
B) the teacher and the pupil decode the scene together (the hand of the pupil and the teacher move the detector in the operation area together) while the pupil hears out the sounds in the phones;
C) the pupil decodes the contents of the scene unaided, steering the movement of the detector in the operation area and simultaneously hearing out the sounds in the phones.
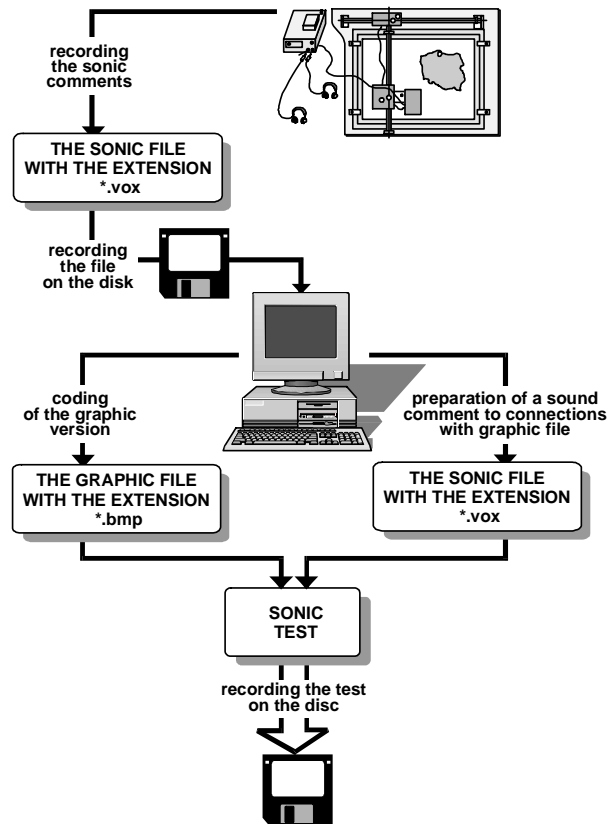
Fig. 7 Formation of the test using the sonic digitizer and the computer

Usually the educational process includes subsequent use of all versions – A, B and C.

At the beginning of the course the instructor moves the location detector in order to set it over the point closest to the zero-point of the system. Then the sound signal with the specified volume and altitude appears in the both phones. These parameters of the signal are determined by the location of that point in the Cartesian co-ordinate system X, Y. Subsequently the detector is moved along the linear element of the scene so that the signal in the phones does not disappear. When the instructor is doing all described acts the blind pupil is concentrating upon listening to the sounds that appear in the phones.

In the second stage of the course the blind person puts a hand or both hands on the location detector so that the index finger rests on the sight-cross. The sight cross is marked on the outrigger in order to be manually detectable. Aided by the instructor, who uses the sheet with the graphically visualised scene, the pupil moves the location detector so that the sight cross covers sharply "the start-point" of the scene. Then the specified sound appears in the both phones. After that the blind person moves the location detector along in the operation area in the way enabling continuous hearing out the signal. In the early stages of the course the instructor may help the pupil to move the location detector in the proper direction using the graphic image of the scene.

## Conclusion

The experiences authors have obtained hither to shows that young children can learn to work if challenged in an interesting interactive manner. It is very important to use the

proper (for student's age) sequence of instructions. Discouragement could cause the prevention of chance to discover the spatial structure of environment.

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## R e s u m é
### Nový spôsob v kartografii pre nevidiacich: zvukové kódovanie vrstevníc

V príspevku sa prezentujú výsledky zvukovej metódy kódovania útvarov použitím zvukového skenera. Ide o originálne autorské riešenie. Poznáme veľa spôsobov lokalizácie objektov. V prípade použitia zvukového spôsobu (obr. 1) operačné pole (2 x A4) pozostáva z 2 x 2500 elementárnych plôšok (0,5 x 0,5 cm) z ktorých každá reprezentuje do 25 vnútorných spojení (1 x 1mm) v závislosti od polohy (X,Y). Celkový počet spojení je 2 x 263 000. Premenná Xi sa nahradí výškou tónu a premenná Yi hlasitosťou. Rozsah zmien je okolo piatich oktáv a sila okolo 30 dB. Zvukové pozadie pre „scénu" je hranica ticha. Znaky reprezentujúce reálne alebo umelé objekty sú kódované ako sled zvukov. Odstupňovanie signálov dovoľuje identifikovať polohu každého bodu. Čiary sú tvorené zvyčajne trojitým alebo dvojitým plynutím zvukov, čo umožňuje ľahšie vyhľadávanie prvkov vo vnútri areálu (obr. 2).

Autori pripravili súbor testov a ich výučbu (obr. 3). Deti to veľmi zaujíma. Na schematizáciu tvarov sa používa len niekoľko smerov podľa Kodályho a Orffovej hudobnej stupnice (zmenami zvukových signálov), čo uľahčuje vznik obrazotvornosti pri takých špeciálnych pojmoch, ako sú tvar, relatívna poloha, orientácia, rozmer objektu a kompozícia ako celok.

Zvukovú scénu možno kódovať pomocou počítača a vhodného softvéru, alebo pomocou zvukového skenera. Každý zvukový test (obr. 4) pozostáva z dvoch súborov: z grafického súboru (bitovej mapy) s koncovkou „bmp" a zvukového súboru s verbálnym výkladom a s koncovkou „vox". Použitie grafického súboru a zapamätanie si verbálneho výkladu pozostáva z dvoch separátnych procesov. Použitie zvukového skenera si vyžaduje dvojetapovú procedúru (obr. 5). Na kódovanie zvukových testov je vhodné používať počítač s vhodným softvérom (obr. 6). Grafické súbory sa môžu kódovať pomocou grafických programov, ale najvhodnejší je program "Paint", alebo "Paint Brush". Grafický obraz zakódovanej scény má 300 x 420 pixelov. Praktické skúsenosti dokazujú, že kódovanie grafických súborov testov je lepšie a vhodnejšie robiť pomocou počítačov s príslušným softvérom, ale hovorený komentár sa lepšie a rýchlejšie zapamätá ak sa použije zvukový skener (obr. 7).

Dekódovanie prvkov scény možno robiť viacerými spôsobmi, pričom výučba pozostáva obyčajne zo všetkých troch spôsobov: učiteľ a žiak dekódujú spolu, žiak dekóduje obsah scény sám, dekóduje učiteľ a žiak počúva zvuky v slúchadlách.

Skúsenosti autorov potvrdzujú, že deti môžu využívať takéto učenie aj interaktívne. Pre študentský vek je dôležité zvoliť správnu postupnosť úkonov. Znechutenie by mohlo znížiť ich vyhliadky na spoznávanie priestorovej štruktúry životného prostredia.

Obr. 1  Zvukový skener
Obr. 2  Moduly trojitých čiar (mierka 1:1)
Obr. 3  Svet v ekvivalentnom zobrazení
Obr. 4  Schéma zvukového testu
Obr. 5  Tvorba testu pomocou zvukového skenera
Obr. 6  Tvorba testu pomocou počítača
Obr. 7  Tvorba testu pomocou zvukového skenera a počítača

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