



ICT for Research and Education of Blind or Low-Sighted People in Agriculture

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Abstract: The article examines methods and means of providing ICT resources to disadvantaged people to facilitate their access to education and research. Types of disabilities especially visual disabilities are described. Approaches to teaching people with visual impairments through three-dimensional models, graphical Braille screens, and tactile graphic tiles are presented. The structure and functioning of a graphic Braille screen and a tactile graphic tile for the blind, patented in Bulgaria, are described. A tactile thermometer for the blind, patented in Bulgaria, was also presented. Research has been done to improve the mechanical and electromagnetic characteristics of the devices. Applications of three-dimensional models, tactile graphic Braille screens, and tactile graphic tiles for the visually impaired in training visually impaired farmers in agriculture, particularly in animal husbandry, are reviewed. The advantages and disadvantages of a tactile approach to learning and research for people with visual impairments are discussed.

Keywords: Visually impaired people, ICT, Braille screen, tactile tiles, animal husbandry.

Introduction

Some people suffer as a result of a variety of limitations, often associated with types of illness, that reduce their capabilities and quality of life. This puts them at a disadvantage compared to other people. For children and students, this also leads to learning difficulties. In people of working age, in addition to difficulties in continuing education, there are also difficulties in performing activities in the usual work practice.

There are different types of inequalities. In hearing and motor limitations, various mechanical, electrical, and electronic aids have been developed to help the disabled to function fully and increase their quality of life.

In case of visual limitations regarding textual information, methods, and means have been developed to help disadvantaged people to function fully and increase their quality of life (Braille books and Braille terminals), [1], [2]. For tactile information for orientation, such methods and means have also been developed (relief floor and pavement coverings).

Greater difficulties occur when it comes to graphic information - maps, paintings, tapestries, computer screens, and video information. This article presents ICT for research and education of visually impaired people when it comes to graphic information.

Methodology

Research and ready development of graphical Braille displays are available from various manufacturers, [3] – [7]. The offered devices are based on piezo, ultrasonic, phase change, and other materials.

For training people with visual impairments, we have developed several approaches based on digitization and 3D technologies:

3D scanning and construction of 3D models of biological objects.

For this purpose, 3D scanners and 3D printers with high accuracy are used. The created and printed 3D models can be used to perceive knowledge through touch by people with visual impairments - Figure 1.

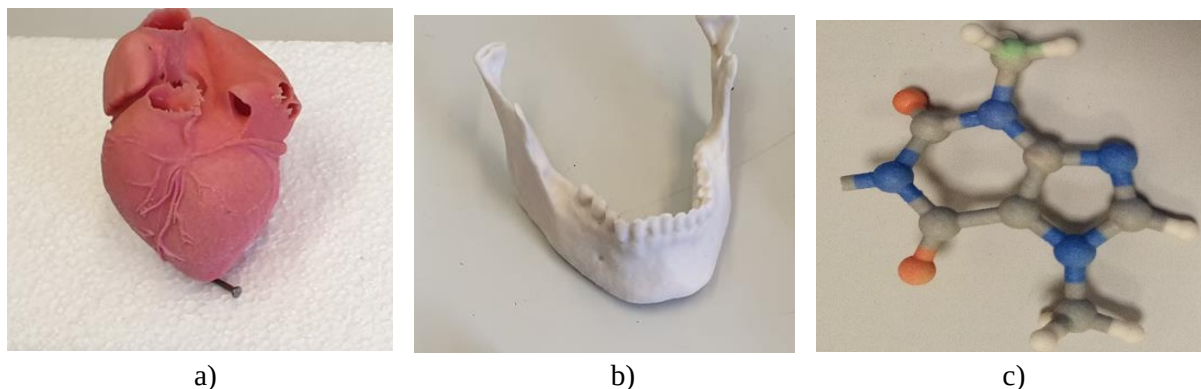


Figure 1. 3D models of biological objects: a) Heart, b) Jaw, c) Cell structure

Electromagnetic graphic Braille screen

For disadvantaged people - low vision and blind, 3D digitization is aimed at perception through finger touch. In this way, a whole category of users can "see", "perceive" and "understand" the content of a given area of human knowledge, from which they have been deprived until now due to their unequal position.

The purpose of the development is to create an auxiliary computer interface (graphic Braille screen - Figure 2) for the needs of training, when working with computers, when perceiving objects from the cultural-historical heritage, for training and carrying out scientific research, [8] – [13]. Each element of the Braille screen represents an electromagnetic linear micromotor - Figure 3.

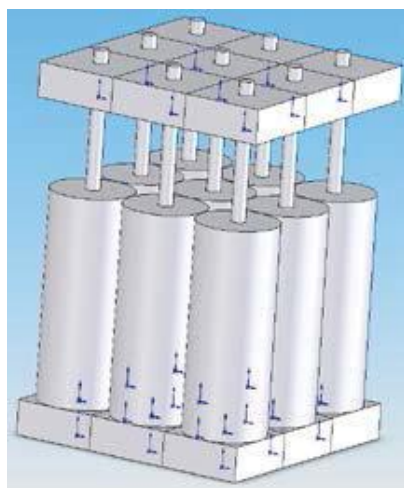


Figure 2. Graphic Braille screen

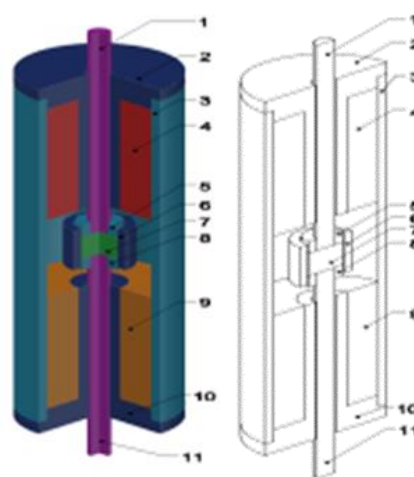


Figure 3. Principal construction of the studied actuator:
1 - Needle; 2 - Upper core; 3 - Outer core; 4 – Upper coil; 5 - Upper ferromagnetic disc; 6 – Non-magnetic bush; 7 - Permanent magnet; 8 - Lower ferromagnetic disc; 9 - Lower coil; 10 - Lower core; 11 – Needle

The linear electromagnetic micromotor works as follows: When electrical impulses are applied in a certain direction to the coils, the needles together with the permanent magnet move up and their rounded tips are displayed above the plane of the Braille screen as buds. When the power supply to the coils fails, the needles are held in the reached position by the permanent magnet, which sticks to the corresponding ferromagnet washer. When applying pulses in the opposite direction, the needles together with the permanent magnet are detached from the ferromagnetic washer in the opposite direction. The same happens when the power goes out in the opposite direction.

Tactile graphics tiles for the blind

Tactile tiles for the blind are a 3D model of a planar (2D) object. They are created on 3 levels: level 1 – for the base, level 2 – for contours, and level 3 – for Braille annotation – Figures 4a, and 4b. Contours enclose the different shapes of the 2D object, and for adjacent shapes, shapes with only an outer contour and those with the entire shape filled in the contour alternate. The different levels help the visually impaired to better perceive the content of the object by touch. Inside the outline of each shape is a Braille symbol (bud) which is the first letter of the shape's name. There is also a field with detailed Braille annotations, [14], [15].



Figure 4. Tactile graphic tile: a) Tapestry detail, b) Tactile tile

Tactile thermometer for the blind

impaired people cannot see an ordinary thermometer, and touching hot objects is often dangerous. We offer a tactile thermometer for the blind for based of buttons and a removable bimetallic spiral - Figure 5. When heated, the spiral unfolds and successively raises the buttons and vice versa.

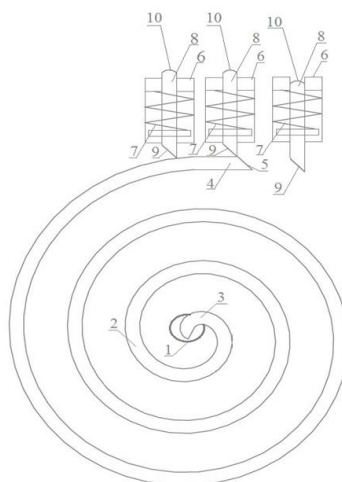


Figure 5. Tactile thermometer for the blind:

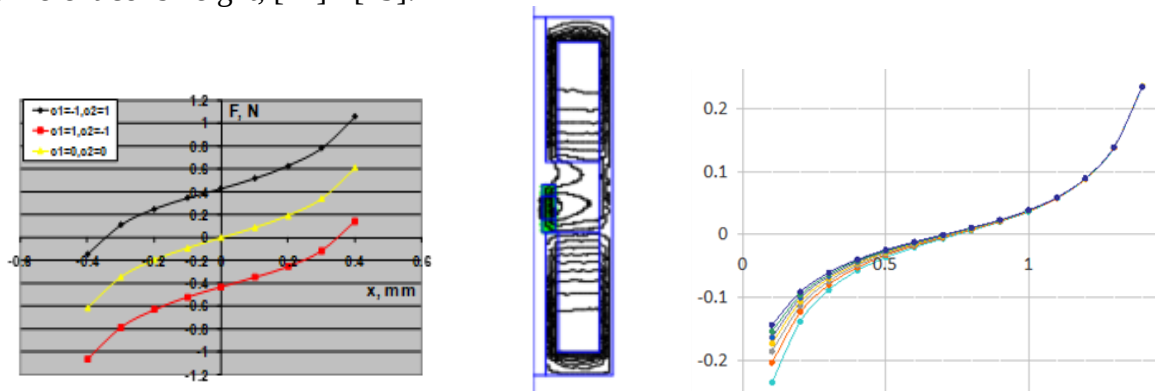
The thermometer includes hub 1 and bimetallic spiral 2. The inner end 3 of the spiral is mounted to the hub, the outer end 4 of the spiral is free, and the tip 5 of the outer end is beveled. Above the outer edge of the spiral are located tubular beds 6 with springs 7 and movable elements placed in the beds - buttons 8 of different lengths. The bases 9 of the buttons are beveled, and the top 10 of the buttons 8 are rounded. Under the influence of temperature, the spiral expands radially and the outer edge moves in a circle, successively raising buttons depending on the temperature, [16].

Results

The main results are related to reducing the size and improving the electromagnetic characteristics of linear electromagnetic micromotors. With tactile graphics tiles, we have several applications.

Braille screen

The static force characteristics, the flux lines distribution, and the force-displacement characteristics were examined (Figure 6a, 6b, 6c) for different diameters of the core, different air gaps between the upper and lower core, different lengths of the permanent magnet, and different coils height, [17] - [19].



a) Static force characteristics b) Flux lines distribution c) force-displacement characteristics
Figure 6. Braille screen feature studies

Tactile tile

We have several applications of 3D tactile graphic tiles from 2D original works of cultural and historical heritage. For the Brera Gallery in Milan, we created a 3D tactile tile based on the painting "Christ and the Samaritan Woman at the Well" (Figure 7). The tactile tile is displayed next to the painting in the Gallery.



a) The original painting and the tactile copy b) The tactile tile based on the painting

Figure 7. The painting „Christ and the Samaritan Woman at the Well” – Brera Gallery, Milan

Applications in Agriculture

In agriculture, we can find activities that can be performed qualitatively by people with visual impairments, not only blind people, but also elderly people with low vision. In animal husbandry, for example, especially in large cattle farming, activities such as robotic milking of cows can be controlled by a tactile panel or a Braille tablet. Feeding and cleaning can also be done by machine if the operations are automated.

To train visually impaired farmers, different procedures can be presented through a series of tactile graphic tiles for the blind, [20].

Conclusion

Information and communication technologies (ICT) are used more and more widely in education, scientific research, and in several industrial and agricultural activities. On the other hand, their development enables disadvantaged people to more easily perceive knowledge and participate more fully in these activities. A person perceives the environment mainly through his eyes, so the greatest difficulties are encountered by people with reduced vision or the blind. The approaches and developments presented in the article help this category of disadvantaged people to engage in daily activities and improve their quality of life.

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