Preliminary report

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Simulation of durability the evaluation of relief-dot Braille images

ABSTRACT

The paper presents a model of factors that influence on the quality of relief-dot Braille inscriptions in their intensive use by blind people. It was constructed matrix of depending and distancing by using a directed graph. It allowed establish a hierarchy between studied criteria's of impact the on durability of relief prints. It was developed a basic structure of digital system of assessment the conformity of Braille symbols to applicable international standards and definition of operational stability.

KEY WORDS

model, Braille, relief-dot image, digital system, quality.

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Introduction

Tactile way of information perception by blind people dictates the appropriate requirements for quality of relief-dot labeling that must remains at consistently high level for a long period of use (European Union, 2004), which directly affects on the accuracy and correctness of the perception of the printed text (International Organization for Standardization, 2013). To ensure the durability of Braille symbols it is necessary to carry out deep analysis of process and conditions of relief prints' operation, reveal the maximum complete set of influencing factors on their quality in the use of blind readers. Many of these factors and relationships between them allow for their systematization and displaying by means of a directed graph. Designed model can be used for making decision and finding the best options for increasing the lifetime of printed products for blind people.

In the era of global computerization and automation the necessary decision in problem of quality control of relief-dot labeling is to develop a digital system of conformity assessment Braille symbols with requirements of international standards and predict changes in the dot's parameters during its tactile use by blind people.

Recent researches and publications

Research issues of ensuring blind people of printed tactile information devoted to works of local and foreign scientists, such as: Beskov, Vakulich, Havenko, Kibirkshtis, Labetska (Havenko, Labetska & Khadzhynova, 2013; Havenko et al., 2013a; Havenko, et al., 2013b; Havenko et al., 2015a; Havenko et al., 2015b; Havenko, Labetska & Havenko, 2016), Mayik (Mayik, 2013), Onishchenko, Stepien, and others, where considered problems of tyflo technology and equipment for the reproduction of information in Braille. However, analysis of the literature and patent information indicates the lack of deep scientific developments regarding to research of the tactile information durability, automation of control process of its quality.

The aim of research

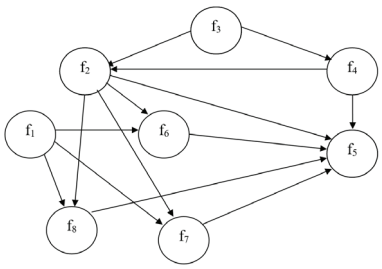
The aim of research was to carry out simulation of evaluation process of Braille image's durability by developing a digital system of control the conformity of Braille symbols parameters according to applicable international standards with defined its operational stability; to consider influencing factors on the quality of tactile labeling in their use of the blind.

Methods

Printing products, specially adapted for use by blind people (with relief-dot printed markings), characterized by much shorter service life. Detailed analysis of influencing factors on the durability of Braille symbols allowed to isolate them in a set $F=\{f_1, f_2, \ldots, f_n\}$, and select the most important ones (subset $F_1=\{f_1, f_2, \ldots, f_8\}$):

f_1 – environmental impact;
f_2 – frequency of use;
f_3 – reader age;
f_4 – reader qualification;
f_5 – method of formation of relief elements;
f_6 – the type of carrier material of relief image;
f_7 – type of printing composition;
f_8 – additional coating of base material.

To represent the links between above listed factors used graph theory (Figure 1).



» **Figure 1:** The graph of the links between factors that influence on the durability of relief-dot products

Based on the building graph and using the known method (Havenko & Gunko, 1996) it was constructed a matrix of dependency and distancing (Table 1,2) (Hlinenko & Suhonosov, 2003) for further installation of all levels of the hierarchy of factors (Stotsko, 2013) that influence on the durability of relief-dot markings and build the appropriate model (Figure 2).

Table 1
Matrix of dependency

	f_1	f_2	f_3	f_4	f_5	f_6	f_7	f_8
f_1	0	0	0	0	0	1	1	1
f_2	0	0	0	0	1	1	1	1
f_3	0	1	0	1	0	0	0	0
f_4	0	1	0	0	1	0	0	0
f_5	0	0	0	0	0	0	0	0
f_6	0	0	0	0	1	0	0	0
f_7	0	0	0	0	1	0	0	0
f_8	0	0	0	0	1	0	0	0

Table 2
Matrix of distancing

	f_1	f_2	f_3	f_4	f_5	f_6	f_7	f_8
f_1	1	0	0	0	1	1	1	1
f_2	0	1	0	0	1	1	1	1
f_3	0	1	1	1	1	1	1	1
f_4	0	1	0	1	1	1	1	1
f_5	0	0	0	0	1	0	0	0
f_6	0	0	0	0	1	1	0	0
f_7	0	0	0	0	1	0	1	0
f_8	0	0	0	0	1	0	0	1

Results and discussion

Analysis of the received model allowed the claim that between all influencing factors on the durability of inscriptions in Braille the highest priority has their methods of formation and used materials. The next level is the frequency of use of relief-dot images by blind people. Further, on the less important levels of graphical model placed criteria's of environmental impact and reader's age.

Simulation of assessment process of the impact of a combination of factors on the quality of relief-dot characters during the use by blind people carried out by formalization of relations between the criteria by means of a directed graph and corresponding matrix of distancing.

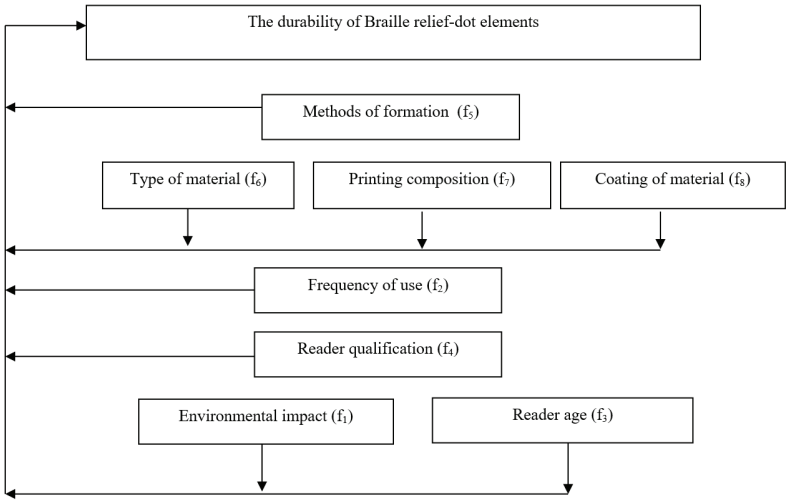
The received model can be used to obtain the numerical weight values of the studied factors and predict the duration of the life cycle of printed products for blind people with high quality that meets international standards.

Simulation of process assessment the conformity parameters of Braille symbols to this requirements and durability of relief-dot images realized by developing a digital system, which algorithm is shown in Figure 3.

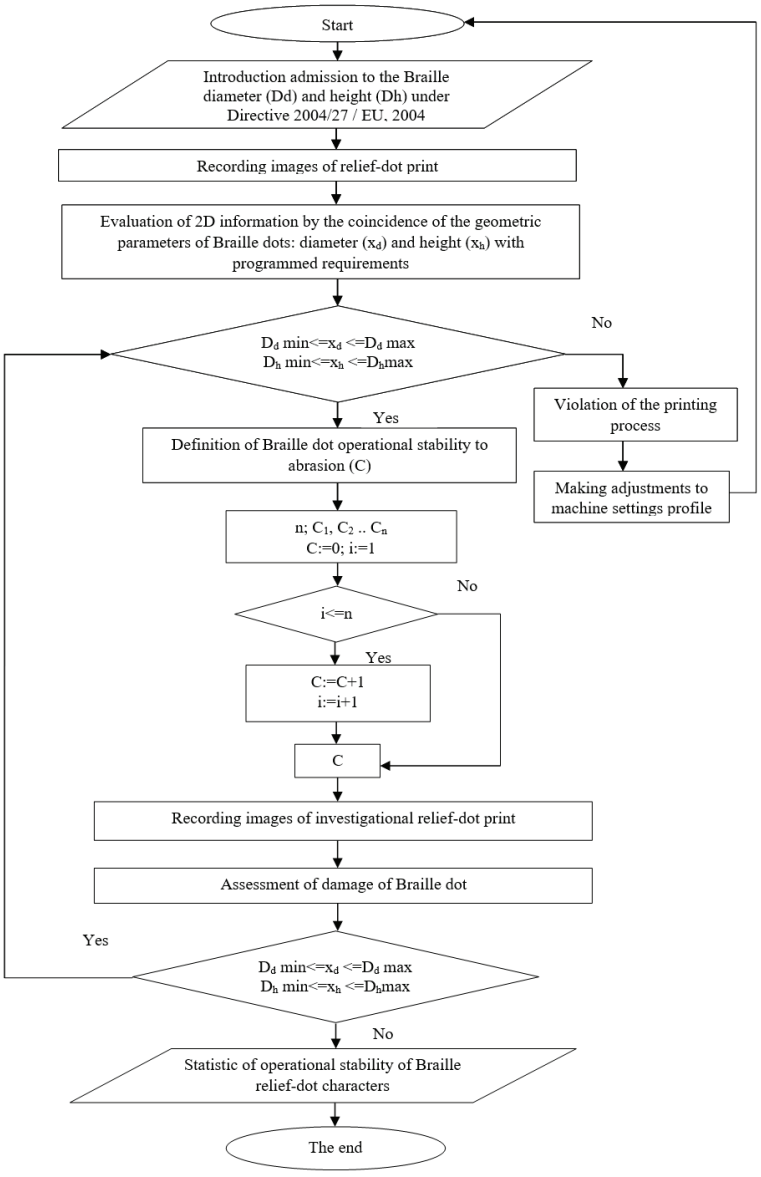
The principle of the digital system of automatic quality control of relief markings during their operation is based on the simultaneous recording of Braille print and assessment of matches the geometric parameters of point with programmed requirements of existing international standards after each wear cycle. The result of this system is to establish the operational stability of relief prints by determining the level of damage.

Conclusions

It was presented the model of factors that influence on the Braille durability with the definition a hierarchy between them, which makes it possible to perform forecasting and improve operational stability of relief-dot marking.



» **Figure 2:** Graphic model of hierarchy between impact factors on the durability of Braille relief-dot elements



» **Figure 3:** Scheme of algorithm of developed digital system of Braille image's quality evaluation during their operation

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