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DEVELOPMENT AND REALIZATION OF THE ALTERNATIVE METHODS FOR DIGITAL DATA REPRESENTATION

New methods for alternative representation of digital data are considered as well as the possibilities of their implementation in timer devices. Automatic system for modeling of timer devices operating modes has been developed in order to conduct research on the efficiency of the proposed method application for digital image formation in information representation means.

Key words: *means for digital information representation, timer devices, digital forms, indicators, clock.*

Introduction

Dynamic rhythm of modern life requires new methods and means for time information representation that are oriented towards providing high efficiency of data perception in the context of the existing diversity of information flows. This caused the development of the new principles of ergonomics, of forms and means for digital information representation directed towards the provision of higher image informativity in the operation process of digital data representation devices [1]. Provision of comfortable conditions for information perception and simplification of its identification process is an important requirement in the development of the means for man-machine interaction process realization in various operating modes [2, 3]. So, it is vitally important to develop new alternative methods of digital data representation that are oriented towards the improvement of qualitative characteristics of timer devices informativity.

The work is aimed at providing higher qualitative characteristics of data perception processes in man-machine interaction systems by implementation of the alternative forms for digital information representation realized using the principles analog-digital image formation.

Digital information representation and perception processes and methods for the implementation of new forms of its informative representation are considered to be the research object. The subject of the research consists in digital data imaging at the stage of the representation device information model formation.

Development and investigation of the alternative methods for digital information representation in timer devices are viewed as the main goals of the work.

Analysis of the alternative methods for digital data representation

Alternative representation of quantities is, undoubtedly, a new scientific trend that requires comprehensive study and investigation.

There exist two principle approaches to the representation of alternative digits: linear and circular representation [1]. In time information representation an alternative image is a hybrid of a digit and an arrow with circular orientation. Principles of the alternative digital image formation are oriented towards representation and perception of data in analog-digital form, which increases informativity of the representation process [4]. As the alternative representation methods are used, signal level of coding is based on the combination of pulse-phase and pulse-width modulation, which could result in considerable increase of data channel throughput [5]. The distinguishing feature of alternative coding is the ability to use multidimentionality principles in the representation of quantities, which determines the prospectiveness of the alternative data representation trends.

The diversity of the modern methods for the alternative digital representation we classify according to the principles of digital forms construction (fig.1).

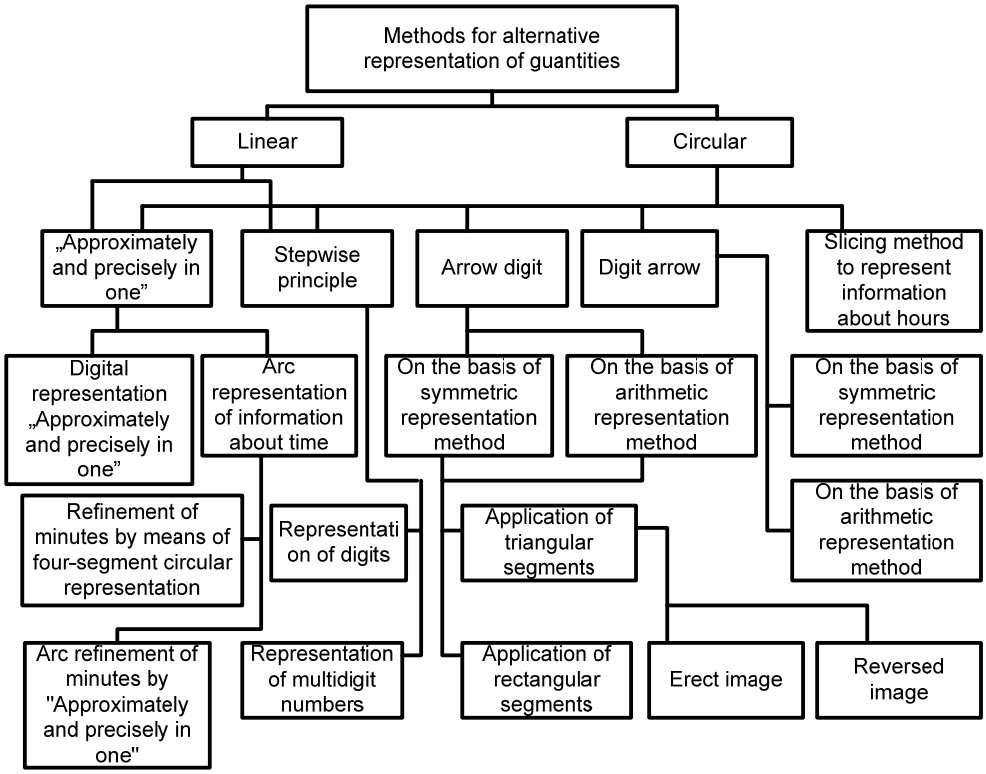


Fig. 1. Diagram of the alternative digital forms classification

Each of the above alternative methods for digital image formation is, undoubtfully, interesting and original, with its own peculiarities and advantages as to the application in different digital, analog, and analog-digital representation means.

The final choice and implementation of the methods requires comparative analysis and profound investigation of their performance characteristics.

Development of new methods for digital data representation

In order to investigate the informativity of timer devices, we chose the following methods of semiotic image formation: digital arrows (fig. 2-a), combination of compatible scales with ribbon-sector filling (fig. 2-b) and the mask method for analog-digital data representation (fig. 2-c).

A clock with the application of digital arrows is realized on the basis of a special display panel where information about hours is presented on the external circle, about minutes – on the intermediate circle and the internal circle gives information about seconds (fig. 2-a). Representation of the information about hours is realized by a four-segment indicator that implements synchronic representation of the alternative alphabet of digital arrows. To represent the information about minutes and seconds, twelve-segment indicator field is used that enables representation of 60 code combinations for minutes and seconds indication. An important characteristic of such clock hardware part is simple realization of control circuits for synchronic activation of indicator sectors in the process of timer device operation through the identical circuit realization of service devices for controlling the group coloring of working segments of “digital-arrow” data representation.

The explicite name of “digital-arrow clock” indicates the realization of the principle of analog-digital representation and perception of informative time space image flows, which is one of the main advantages of alternative timer devices as compared with traditional means for digital data representation. This advantage is determined by the psychological peculiarities of the man, which explain comfortable perception of digital information in the analog form [3].

The second alternative model of time information perception is realized by the combination of

compatible scales that are synchronically filled as time goes (fig. 2-b). The second scale implements per-second countdown and may be a separate device for a user (a seconds counter), and two external scales combine the formation of minutes and seconds representation of informative flows when the second gradation filling causes synchronic coloring of the next countdown of the time scale. Without additional increase of the indicator area, separation of the three scales makes it possible to increase the resolution of information perception as compared with usual disc panel where three arrows are moving in one data field. Besides, the proposed method for time space representation is more advantageous in terms of informativity than the arrow-disc method because of strengthened sense of the time that has passed and of the time that is to pass in the reference system of each scale.

The third method, proposed for numerical data representation, is also based on the analog-digital principle of image formation and is oriented towards only one rotational disc panel being used by the clock device without the need of additional implementation of arrow data identification. We propose to use two scales in the modernized panel for representation of information about hours and minutes. A mask has the form of a restricted sector with central indicating arrow. A working opening of the mask is designed for representation of two hour sectors, because one hour sector will be percepted by an individual as the one restricted by time limits of a definite situation, while three hour sectors would be characterized by excessive informativity. Fig. 2-c shows the disc panel and the mask of the alternative clock device.

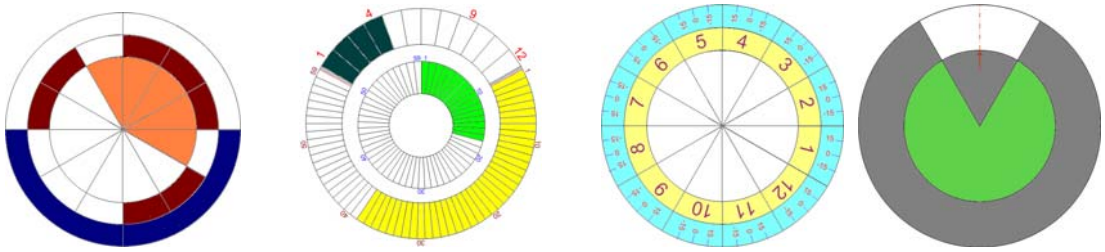


Fig. 2. The models of alternative timer devices based on:
a) "digital-arrow" form of alternative coding;
b) combinations of compatible scales of ribbon-sector colouring;
c) the mask method of analog-digital data representation.

Development of the system for modelling of the alternative digital data representation methods and timer devices based on them

Structure of the system for interactive evaluation of the digital information representation means (DIRM) includes the module of algorithmic realization of the alternative methods for digital data representation, which performs DIRM operation modeling on the basis of the chosen digital representation method. The system makes it possible to evaluate the qualitative characteristics of the information flow perception, to substantiate the choice of the semiotic DIRM alphabet, depending on the condition of its further operation, and to determine the prospects of semiotic systems implementation in display devices. A generalized model of the interactive system (fig. 3) presents structural interconnections of its software modules.

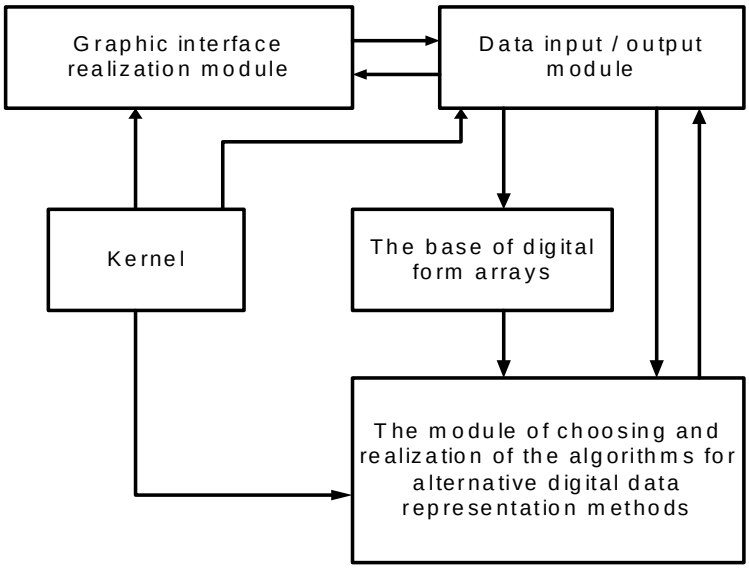


Fig. 3. Generalized model of the interactive DIRM evaluation system

The kernel of the system controls data flows and supports interaction between the main modules of software environment.

The data input / output module enables the base supplementation with digital form arrays, ensuring the openness of the system dataware by displaying the results of the work in the user's dialog window by means of the graphic interface realization module. This module is serviced directly by the system kernel, which provides dynamic mode of operation.

The base of the digital forms arrays contains a set of alternative character alphabets that are prospective means for dynamic formation of digital images: digital arrows and arrow digits, "approximately and exactly in one" principle, a stepwise principle of digits representation, slicing principle of the alternative digital imaging, alternative digital-analog disc, ribbon-sector filling.

The module for choosing and realization of the algorithms of the alternative methods for digital data representation (MCRAADDRM) provides selection of a definite algorithm from the base and its implementation in the process of modelling the operation modes of timer devices.

The model of the user's graphic interface (fig.4) illustrates functional capabilities of the interactive system software environment.

With the help of the program the possibility to choose two modes for the initial data array formation is provided: by choosing a digital representation algorithm from the system information base and by supplementation of the base resources through conversion of the data from the file of the additional software.

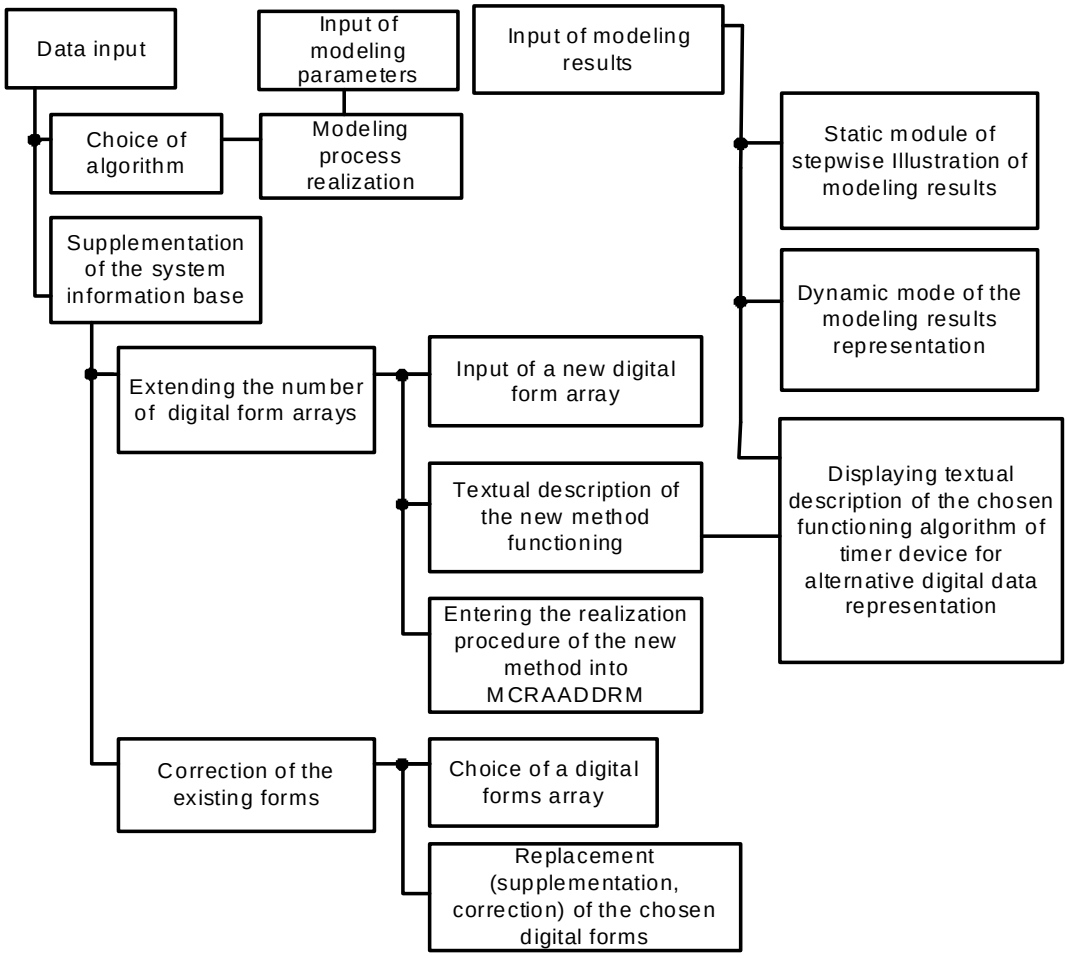


Fig. 4. The model of the system user graphic interface

Supplementation of the system information base is performed by extending the number of the digital form arrays or by correcting the existing forms (by changing the character forms and updating the algorithmic description of the methods for their representation).

Selection of a definite algorithm for digital data representation enables system modelling of DIRM operation modes taking into account the pre-determined functional parameters of timer devices.

Testing investigation of semiotic systems of alternative digital information representation facilities

Let us consider the operation of the interactive system for character alphabets evaluation by the example of the alternative clock device operating mode modeling that is provided by the choice of its functioning algorithm oriented towards the implementation of the new methods for digital information representation through the formation of “digital-arrow” forms of the alternative data coding, combination of the compatible scales of ribbon-sector colouring and realization of the mask method for analog-digital data representation (fig. 5).

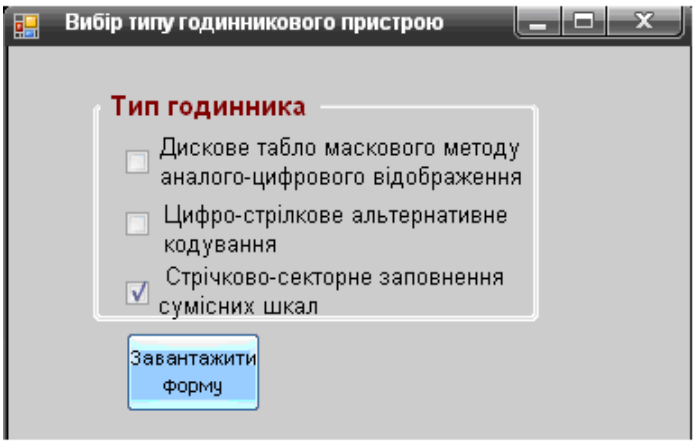
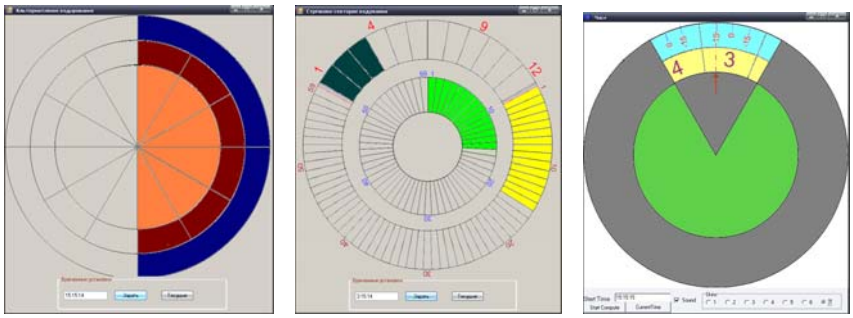


Fig. 5. MCRAADDRM graphical interface

The operation of timer devices with the alternative representation of digital data is illustrated by the graphical model of time information representation. Fig. 6 shows a static fragment of the alternative DIRM, that illustrates digital information representation at a definite moment of time (3:15:15).



a) b) c)

Fig. 6. Static fragment of the alternative DIRM operation at a definite moment of time (3:15:15):
a) indicator of "digital-arrow" clocks;
b) indicator of DIRM with ribbon-sector colouring of the compatible scales;
c) disc panel of the mask method for analog-digital representation.

Losses caused by the reduction of the operator's work efficiency are determined by the operator's experience *W(D)*, by the intensity *W(N)* of his work, by the losses in the reliability of information perception depending on the operator's tiredness *W(V)*, on the provision of ergonomic and esthetic indices, usage of the artistic design methods $W(E_2)$, choice of the optimal information representation and coding in the display unit $W(OK_2)$, by the presence of interference while displaying th information *W(Z)*:

$$W_0 = W(D, N, V, E_2, OK_2, Z).$$

Losses of the operator's work reliability, caused by his tiredness *W(V)*, are estimated depending on the work duration *W(C)*, on satisfying of the engineering-psychological requirements that influence the creation of the optimal conditions for the operator's work *W(IP)*, on the state of the operator's health and his psychological state *W(Z, PS)*:

$$W(V) = W(C, IP, Z, PS).$$

W(IP) losses are determined depending on satisfying the engineering-psychological requirements to the information representation devices (IRD) W(IPIRD) and to the workplace (WP) equipment W(IPWP):

$$W(IP) = W(IP_{IRD}, IP_{WP}).$$

The efficiency of operator's work depends considerably on the choice of the information representation and coding means in IRD W(OK2), which, in its turn, is determined by the quality and characteristics of the symbol being represented.

Experimental investigation of the convenience of the alternative digital systems perception was performed using Burdon's test [6]. The research performed on the semiotic systems of DIRD has confirmed the efficiency of the analog-digital principle application for data representation in the process of building the alternative digital image forms. Besides, timer devices oriented towards the implementation of the proposed digital representation methods have been developed. They are distinguished by the simplicity of hardware realization using the existing elemental base, which makes it possible to minimize the expenditures. The increased resolution, that enables information perception by the users of such DIRM through the usage of the entire indicator area, determines the prospects for wide application of the proposed methods for building alternative digital image forms in timer devices.

Conclusion

The developed models of the system for the evaluation of the digital forms of data representation are implemented in the interactive software complex designed for performing research on the efficiency of using different semiotic alphabets in digital information representation facilities. The research is conducted by modeling different operation modes of the alternative timer devices in order to estimate the efficiency of the new digital forms perception by DIRM users and evaluation of the prospects for their application under various operation conditions.

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