METHODS AND MEANS OF EVALUATION USABILITY OF HUMAN-MACHINE INTERFACE

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Abstract
For a achieving the real usability goal, the designer's activity demands a additional toolkit for the quality evaluation of graphical and multimedia products, including quality from psychological and ergonomic standpoint. In this paper, an analysis of modern methods for assessing the effectiveness of websites was conducted and research development in the field of promotion of web-resources on the Internet was generalized. The methods of obtaining data for the quantitative assessment of visual perception, which can be used in the development of both information technology and personal identification technologies, are explored. It is revealed that with the use of cognitive technologies that take into account the peculiarities of person's visual perception of graphic information, it is possible to create effective tools and methods for the development of technological modules and completed application information systems. As a result of the work, an algorithm for improving the efficiency of UI web-systems was developed.
Keywords: *website, usability, testing, Eye tracking, Heatmap, modular grid, pattern, algorithm.*

Introduction

Current trends lead to the fact that each company has a website that contains information about company services and its product catalog. With the growing number of companies engaged in activities in one industry, the user poses a question services of which company is better for him to use, and often a potential customer chooses in favor of the company that has the most attractive or convenient website [1].

Usually, users value everything by appearance, sites are not an exception. Users in this case – a wide range of people whose qualitative characteristics (such as age, gender, physical, psychological characteristics) each year expand the boundaries. This additionally requires adaptation of the design of sites for people of different segments of the population, including elderly

people, people with visual impairment, color vision impairment, etc., which will not only increase the amount of users of the site, but will also ensure the principles of information availability.

That is why, given the contingent of users, the designer's activity demands a additional toolkit for the quality and convenience evaluation of graphical and multimedia products, including quality from psychological and ergonomic standpoint [2]. After all, the very convenience is the most important factor in determining whether visitors will use your site or make purchases on it.

In order to achieve the real purpose of usability, certain technologies and methods of evaluation are needed. Their development has been taking a very long time [3], but so far there is no clear metrological provision for conducting research (number, age of respondents, health restrictions), which complicates work in this direction and makes the obtained indicators probabilistic, not certain. This, in turn, raises the need for a scientific study the aspects of the quality and convenience of multimedia products, the way of presenting these data and the method of their interpretation for designing the human-machine interface.

Materials and methods

If designing models of the most effective and convenient design is based on well-known mathematical approaches and principles, due to the use of certain methodologies, the methods for evaluating the effectiveness and convenience of using websites are based on the achievements of scientific research in many branches of science: psychology and medicine, publishing and printing technologies, information technology, economics and project management, mathematics and many others.

Traditional usability research methods often find the flaws in interaction with the product, but often can not answer the question why. The assessment of the quality and usability of a business site is carried out only on the basis of those indicators that can be checked according to certain criteria, therefore, methods of conducting the usability-examination and usability testing are used. In this case, usability-expertise provides a qualitative assessment of the site, and usability testing – quantitative [4–5].

One of the methods that gives objective results to such studies is the EyeTracking technology, the main advantage of which is the impartiality of the respondents being tested, since in this technology the equipment captures natural human reactions (by studying the movement and reaction of the pupil) that can not be simulated [6]. The device impartially recognizes the movement of the user's pupil and provides objective information, collecting

the database. Then these data can be visualized, which helps to interpret the user's eye behavior [6] by applying appropriate metrics over one hundred of which exist [7]. The main metric in this work is the metric of productivity, using which the researcher is able to assess the convenience of using the interface and the attractiveness of design.

Also, for further research, attention is drawn to the existing relationship between the users' attention and the modular grid using which the page is developed. For an example, pages that are considered are created with the method of using mathematical models: Fibonacci numbers; rules of the thirds; the principle of the "Golden Rectangle"; the principle of "Golden Section" [8].

It also takes into account the generally accepted order of placing the main elements of the page, which leads to the emergence of such a concept as "reading gravity," or "pattern", which returns readers to the logical axis of orientation, accelerating reading and understanding of the text. In connection with this, it was discovered that reading of the text usually follows F-pattern, Z-pattern, golden triangle or Gutenberg diagram [9].

The main idea in this paper is that the information on a page, constructed according to the proportions of the "Golden Section" is perceived better than just a block of information because of the fact that the information acquires a more natural look and it is found that the movement of the user's eye in such a case is carried out in the F-pattern, which repeats the natural trajectory of the user's eye movement.

Based on these dependencies, a reference sample for comparison with EyeTracking technology can be created.

Results and discussion

Based on the conducted analysis, to achieve the research goal it is necessary to develop a method for increasing the efficiency of the UI of the web-system at the design or improvement stages.

This method will be developed taking into account the problem of the uncertainty of the amount the optimal sample of respondents for obtaining a thermal map and qualitative characteristics of the investigated groups [10]. Therefore, it is necessary to consider creating an additional toolkit, in this case a reference sample, for assessing the quality from the psychological and ergonomic standpoints.

In further work, evaluating a web site only by indicators of one group of users, it can be predicted which problems will arise from users of other categories.

The basic parameters necessary for solving the problem are determined and presented in the form of the following expression

$$UI =< N, M, P, T, S >, , \quad (1)$$

where N – a set of modern methods of constructing modular grids; M – a set of Internet users; P – a set of patterns description; T – a set of parameters of design quality assessment; S – conditional set of site design (by purpose).

For a correct and adequate mathematical existence (1) it is necessary and sufficient that the following conditions are fulfilled $\{N, M, P, T, S\} \in UI$ and $(N, M, P, T, S) \neq \varnothing$. .

The received "Thermal maps" can be represented as a matrix Θ provided that $a_{i,j} \neq 0, \forall i.j$ and also $a_{i,j} = (0,1,...,255)$, that is, the "thermal map" ("transparency map") will have color coding in the grayscale format, which means that any web-site can be mathematically represented in the following form

$$\Theta = \begin{Bmatrix} a_{11} & a_{12} & \cdots & a_{1j} \\ a_{21} & a_{22} & \cdots & a_{2j} \\ \vdots & & \ddots & \\ \vdots & \cdots & \cdots & a_{ij} \end{Bmatrix}. \quad (2)$$

For convenience of data processing, the matrix Θ is split into submatrices ($\Theta_1, \Theta_2, ..., \Theta_p$, where $p = 1,..., m$) of a same size, which will give an opportunity to evaluate the influence of the parameter N . The next step is to analyze the entire matrix Θ and find $a_{ij} \xrightarrow{\max} 255$. Let's denote through Δ tolerance – as a deviation in the direction of reducing the maximum value of 255.

Let's assume that Δ = 100, so the minimum value that will interest us in this method $a_{ij} \geq 155$. That is, in the map of intensity, in further research we will be interested $a_{ij} \geq 155$, which will show areas that have attracted the attention of the user.

It is worth taking into account the possible existence of several zones. So you can determine which submatricles are "areas of attention".

$$\Theta = \begin{Bmatrix} [\Theta_1] & [\Theta_2] & [\Theta_3] & [\Theta_4] \\ \ddots & & & \\ & \ddots & \ddots & \\ & & & [\Theta_p] \end{Bmatrix}. \quad (3)$$

This solution will determine the type of modular grid used in the web site under study.

Next, we will conduct a study on the matrix, in terms of determining the type of pattern. To do this, we will introduce ξ, as the admission of values between, which will give an opportunity to evaluate the "route" of the user's or expert's eye, who analyzes this web site. An example of constructing a matrix Θ is represented in (3).

$$\Theta = \begin{Bmatrix} [a_{ij} \geq 155] & [70 \leq a_{ij} \leq 155] & [70 \leq a_{ij} \leq 155] & [a_{ij} \geq 155] \\ \vdots & [a_{ij} \leq 69] & [a_{ij} \leq 69] & [a_{ij} \leq 69] \\ [70 \leq a_{ij} \leq 155] & \cdots & [70 \leq a_{ij} \leq 155] & [a_{ij} \geq 155] \\ [a_{ij} \geq 155] & [a_{ij} \leq 69] & [a_{ij} \leq 69] & [a_{ij} \leq 69] \end{Bmatrix}. \quad (4)$$

Analyzing (4) one can clearly see that there are 4 sub-matrices in which there are elements $a_{ij} \geq 155$, therefore - these are the areas that have attracted the attention of the user and the submatrices in which the elements are within $70 \leq a_{ij} \leq 155$.

That is the "gravitational way", all other areas in which the value is $69 \leq a_{ij}$, can be disregarded as the areas that have not attracted the user's attention. Based on the assumptions suggested above, parameters can be defined for the categories of sites being analyzed N, P, and combining them with the weighting factors obtained from the experts who test the web site, it is possible to uniquely identify and to scientifically recommend the method of placing the main graphic elements that will increase the effectiveness of usability [11-12]. So the developed method can be graphically presented as an algorithm presented in Fig. 1.

Conclusions

This algorithm is generalized, since "quality assessment" should always take into account the relationship between the elements and the actual values of their metrics, and therefore, have a statistical nature [13].

In further work, it is possible to use factor analysis for each parameter to assign the defined values and thereby concentrate the source information: reduce the number of variables (data reduction); group, classify and compactly visualize data.

Possible continuation of this work is the possibility of automation of this process by creating a base of reference samples, which will increase the efficiency of the testing process by reducing the cost and time of evaluation.

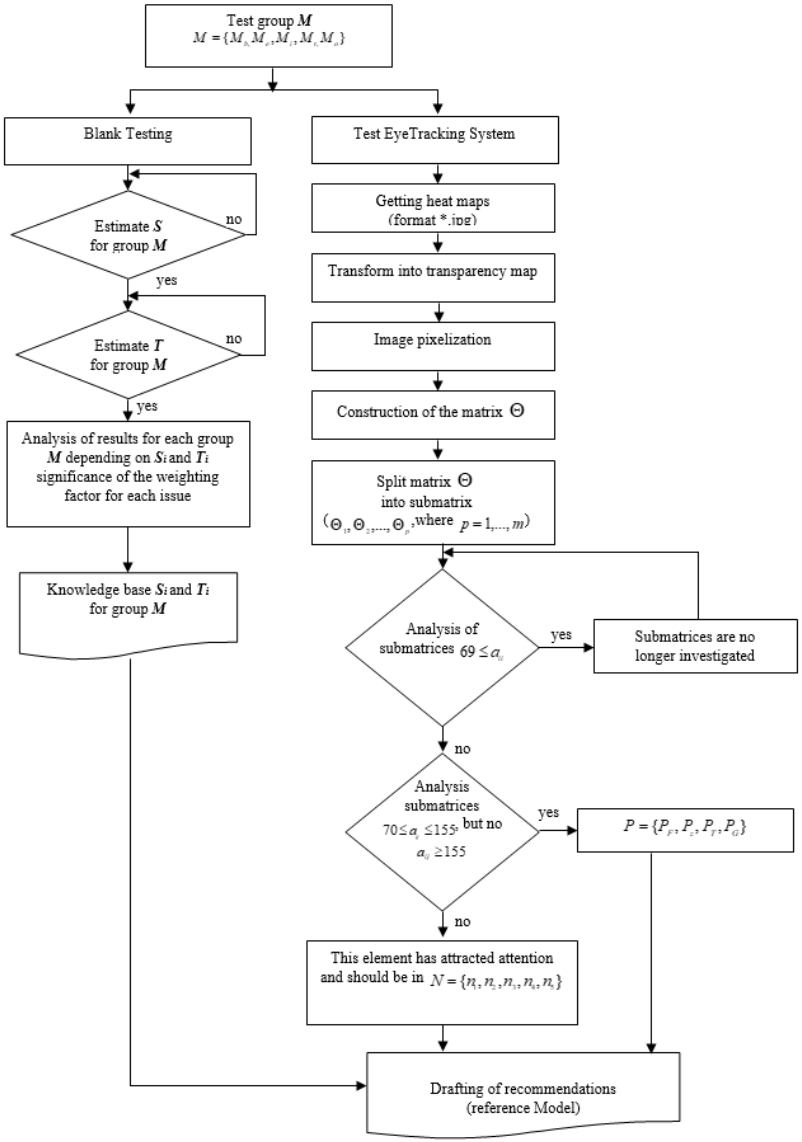

Figure 1. Algorithm for creating a reference sample

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