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OF SOME APPROACHES TO THE PERSONALIZED USER INTERFACE ORGANIZATION IN AUTOMATED SYSTEMS

In modern automated systems, users are often facing the problem of information overload due to the ever increasing amounts of information to be processed in a short time. Working in these conditions affects the quality of users performing their functions in the system and the reliability of the systems themselves.

In the article different existing approaches to solving this problem are described and analyzed, which are based on the idea of creating customized tools for users work with information. On the basis of these solutions a complex methodology of information representation and storage forms personalization is suggested, as well as software architecture based on it.

Key words: *automated system, information presentation, information storage form, dialog modeling, personalized UI, means of UI personalization.*

As a result of increasing of the number and variety of automated systems the scope of their use has significantly expanded — from interactive guides to decision support systems and process management in various industries. Respectively, the number of users of such systems has increased.

The human operator is an important part of the automated system, regardless of its destination. But at the same time — the least reliable part of it. If earlier (70-80s of the XXth century) the cause of most of the automated systems associated accidents was the unreliability of their technical component, in our time the creation is often the operator. On the one hand — reliability of the technical component of the automated system has increased, on the other — the user is faced with the need to process significant (and constantly increasing) amounts of information for decision-making process in limited time. The resulting information overload condition adversely affects the performance and reliability of the operator as well as the entire automation system.

Because of this, the requirements for the design of automated systems have changed: besides high functionality, an important factor was the user' comfort level, while interacting with the system. Studies [1] show that when the user processes information in the comfort mode the level of information overload decreases and efficiency is increased.

Researches are conducted to provide comfortable conditions for the operator's work with information in the system. Most of them are divided into

two areas: management of the presentation of information on the screen of the user's desktop (interface personalization) and information storage form control and links between its units management(context-sensitive adaptation).

Personalization UI in automated systems. Operator interacts with the information in the system via the user interface.

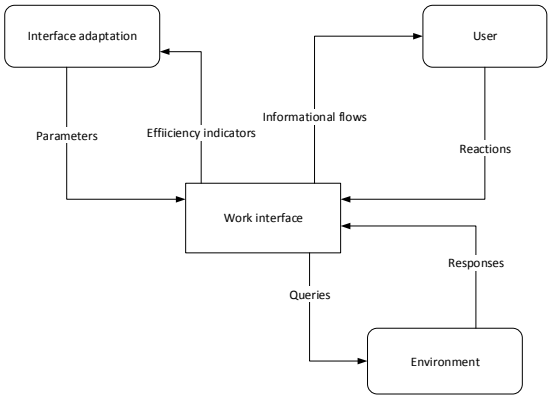

Fig. 1. *Scheme of user interaction with the external environment (system) using adaptive interface*

In general, the interface is a set of data output items (text boxes, displays, scales). Number and positioning of output elements depends on the task user performs when working with the system.

The most popular method nowadays to increase the comfort of the user interface is to use different approaches to its ergonomic organization (sizes, color scheme of working window element optimization). However, the effectiveness of ergonomic approach is limited because of its orientation to the average user of the system. Therefore, when the existing ergonomic ways of organizing of workstations no longer provide satisfying user comfort level with the system, to improve the efficiency of professional activity of the user there was a task of creating software for forms of storing and presenting information adaptation.

In [2; 3], a model of user interaction with information systems is propesd as a part of the of user interfaces adaptation system that that takes into account the individual characteristics of specific users, and grants users the ability to modify the interfaces of the system. The authors have developed a variety of tests to determine the psychological and intellectual user's characteristics. To create adaptive interfaces, the following tests are selected: Eysenck verbal test to assess intellectual ability and inclination to think outside the box, the scale of self-assessment by C.D. Spielberg and Yu. L. Hanin, designed to determine the level of reactive and personal anxiety and Eysenck EPQ questionnaire procedure for studying individual psychological personality traits. Using these

tests provides data to determine: a user's ability to learn and unconventional thinking (intellectual ability), especially psychological types of users, the user's state of mind (anxiety, psychological comfort and discomfort in the workplace), the characteristics of user bandwidth that is optimal for the user's health characteristics of the workplace.

In [4], a functional block diagram of software user interfaces adaptable to the peculiarities of perception and activity of specific operators is suggested. Procedure deals with the definition and use of basic user functions in the interpolation method, the average quadratic approximation and spline interpolation. The method of adapting the user interface software is the approximation of experimental data implementation, based on component architecture interface, non-traditional for a given domain. A set of software interfaces, sufficient for interaction between the subsystems form the user interface. A tool for visualization of approximation of experimental data based on the specified architecture and methods of generating the user interface is proposed.

In [5] the focus is on the on the development of models of adaptive interfaces for different problem areas (within branches specifications), the influence of individual characteristics of a person is not considered, which means that no models of adaptive interface is provided, as well as no possiblilities for the UI customization.

Researches, that are based on the idea of controlling the data presentation form, also include the development of interfaces with automatic transfer controls to the desired user language [6] or the provision of a large set of elements of the user with the ability to output any of their placement in the window (or windows) working interface [7].

There are also «exotic» approaches that use user's «cultural profile» to personalize the interface [8].

This research states, that one of the largest impediments for the efficient use of software in different cultural contexts is the gap between the software designs — typically following western cultural cues — and the users, who handle it within their cultural frame. The problem has become even more relevant, as today the majority of revenue in the software industry comes from outside market dominating countries such as the USA. While research has shown that adapting user interfaces to cultural preferences can be a decisive factor for marketplace success, the endeavor is oftentimes foregone because of its time-consuming and costly procedure. Moreover, it is usually limited to producing one uniform user interface for each nation, thereby disregarding the intangible nature of cultural backgrounds.

To overcome these problems, this thesis introduces a new approach called 'cultural adaptivity'. The main idea behind it is to develop intelligent user interfaces, which can automatically adapt to the user's culture. Rather than only adapting to one country, cultural adaptivity is able to anticipate different influences on the user's cultural background, such as previous

countries of residence, differing nationalities of the parents, religion, or the education level. We hypothesized that realizing these influences in adequate adaptations of the interface improves the overall usability, and specifically, increases work efficiency and user satisfaction.

In support of this thesis a cultural user model ontology is developed, which includes various facets of users' cultural backgrounds. The facets are aligned with information on cultural differences in perception and user interface preferences, resulting in a comprehensive set of adaptation rules.

This approach is evaluated with the culturally adaptive system MOCCA, which can adapt to the users' cultural backgrounds with more than115'000 possible combinations of its user interface. Initially, the system relies on the abovementioned adaptation rules tocompose a suitable user interface layout. In addition, MOCCA is able to learn new, and refine existing, adaptation rules from users' manual modifications of the user interface based on a collaborative filtering mechanism, and from observing the user's interaction with the interface.

The results of evaluations showed that MOCCA is able to anticipate the majority of user preferences in an initial adaptation, and that users' performance and satisfaction significantly improved when using the culturally adapted version of MOCCA, compared to its' standard 'US interface.

Approach to adapt the user interface to the specific features of perception allows the operator to raise the level of comfort while working with the information, but does not completely solve the problem of information overload, as solutions using this approach don't provide means to control the characteristics of information flow fromo the system to the user. To implement this, you have to control how the data required for the working process is stored in the system and how it are displayed to be process by the user.

Context-sensitive adaptation of forms of storage and presentation of information. To facilitate the user processing of system information and improve the efficiency of work one should consider the characteristics of information flows (related pieces of information displayed by the system to operator for processing). These characteristics include: the pace, intensity, blocks coherence.

Optimal for information perception pace and intensity of its display depend on psychophysiological characteristics of the user (attention span, memory man, level of fatigue). These characteristics are interrelated and partly dynamically changed during operation, thus adapting the process to the information output of the diagnosis requires a mechanism for real-time characteristics.

Work in this direction is actively underway in our time, but the approaches to the implementation of a system of diagnosis may vary significantly.

For example, in [9] it is recommended to use the camera and motion sensors the user's eye.

An approach is proposed with interactive genetic algorithm to compute fitness based on the eye-movement data metrics. Adaptation strategies for content and layout design of the user interface. A digital camera recommendation prototype is proposed, and in the user study, the authors find that users can get interested products information with less physical effort and more satisfactions.

Another option is the use of operative testing subsystem with feedback signals tracking from the user's workplace. [10]. The advantage of this approach is the ability to easily implement it in the system interface personalization subsystem for cognitive and psychophysiological characteristics diagnosing (necessary for optimal presentation of information). The downside of this approach is to intervene in the workflow — active feedback system distractors can distract the user, which is unacceptable in critical situations. Information from passive distractors may be insufficientl, it will not allow to adequately adapt the characteristics of the information flow to the current state of the user.

To control the cohesion in the information blocks a network must be built on their basis in which nodes are connected according to the information processing requirements.

In a study of information adaptation in teaching systems such a network is based on the overlay model of the learner [11] that allows to create individualized education plans.

Another option is using behavioral model of the user. [12] In human-computer interaction, user interface, states this research, events and frequencies can be recorded and organized into episodes. By computing episode frequencies and implication relations, we can automatically derive application-specific episode associations and therefore enable an application interface to adaptively provide just-in-time assistance to a user. The authors identify five issues related to designing an adaptive user interface: interaction tracking, episodes identification, user pattern recognition, user intention prediction, and user profile update. In particular, they demonstrate how to identify episodes and associate them with an interface that can act on a user's behalf to interact with an application based on certain recognized plans. To adapt to different users' needs, the interface can personalize its assistance by learning user profiles. For example, by detecting and analyzing users' behavior patterns in using Microsoft Word, the interface can automatically assist users in several Word tasks. The authors' Word interface provides episode associations at two levels: text-level (phrase association) and paragraph-level (formatting automation). They conducted two pilot experiments to evaluate the interface's performance. The suggestions it provided and its ease of use were well received by users, and the interface can to a certain extent increase the productivity of type-setting.

In [13] it is proposed for data output management to take into consideration the context of the environment, from which information comes through the sensors of an armored vehicles.

As humans and computers generally undertake their respective part in intelligent transportation vehicle, human is in charge of the supervision of the overall task at the higher level. But as the tasks allocated to the computer increase, the heavy cognitive load and defective context-awareness caused inevitable errors and tedious work during operation process. Adaptive interface is useful to support the operators in complex dynamic task controls. AHCI (adaptive human-computer interface) is an interface which is supposed to adapt its interaction contents, information processing modes, and behavior patterns automatically to meet changing task requirements and user characteristics at any time considering operator abilities, workload variations, and skill levels.

PT operation platform is a real-time interactive platform on military intelligent transportation vehicle, whose interface directs impacts on huge amounts of information transmission and combat efficiency in the information warfare. PT's interface is influenced by tasks, devices, environments, and other contextual factors that determine the modes of task execution and the patterns of interaction. The current situation is that the HCI of PT is limited by mobility, computing ability, input / output modes, and some other factors; although it can support the task execution, it still lacks user friendliness and autonomy. To address these challenging HCI demands, it is possible to understand the requests of states and users well enough to adapt the interface components, content, structure, and form, in terms of the dynamic changed situation, as well as to provide the operator with the necessary data and information. Therefore, studying new human-computer interaction modes and designing AHCI based on PT's characteristics become a new important subject which would be capable of detecting and responding to changing contexts of the user and the task in the PT operation platform.

In order to design and develop AHCI of the PT operation platform on the basis of mission analysis and reasonable human-computer function assignation, a conceptual architecture was established on general AHCI theory in this paper. Technologies of context-awareness were used in adaptive mechanism in response to dynamic context changes. The favorable context-modeling technology for the context types and the methods of adaptive knowledge reasoning were discussed according to the practical application of PT, by which a mapping relationship between context information and interface visualization could be generated. And an AHCI of the PT can be realized based on the visualization modes and interface design tools, which is supposed to provide information and operation services appropriately for different users, stages, and tasks automatically in time.

To construct a network based on the information blocks can also use ideas dialog modeling [14; 15], according to which the modules communicate depending on scenarios of interaction between participants of the process.

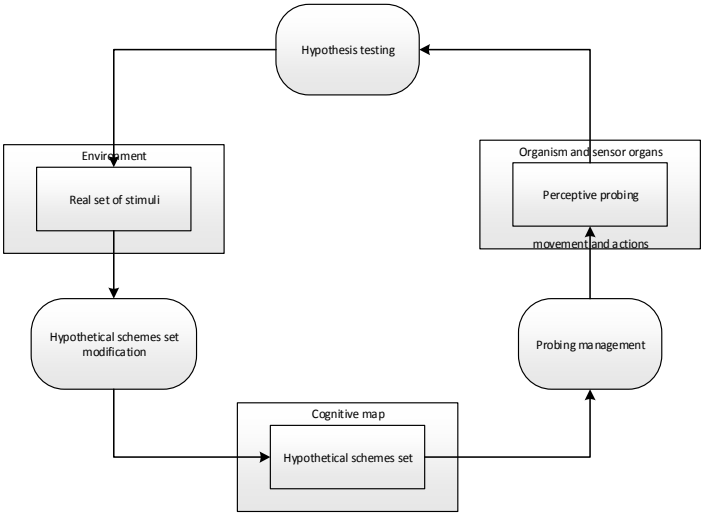

Fig. 2. *Scheme of the user's dialog interaction with the external environment (system) based on a modified Neisser cycle*

Dialog interaction model allows to customize the network of information units automatically (depending on the context of the workflow) or manually, making it as flexible as possible. However, the use of this model requires a high level of formalization of the stored information, as well as the introduction of elements and subsystems of artificial intelligence (for the system to participate in the dialog process).

Approaches to software implementation means of user interaction with information in automated systems. For efficient and effective user-data interaction the personalization system should be able to configure this interaction at the user level. Otherwise, for making changes to the operating interface system or form of storage of information in it one will need to refer to the developers that complicates the process of adaptation of the system, it will stretch over time — and thus significantly reduce the effectiveness of the whole approach.

Currently, of the «on the spot» problem, researchers propose to use interface personalization and customization principles of Web-application interfaces. In work [16] AdAgent software is proposed, allowing to adapt the shape and placement of display elements of web pages for specific user perception based on his cognitive and behavioral models.

«Infusion» system developers with original architecture «Fluid» [17] is proposed to create personalized interfaces from a set of output elements built into the system, using mechanisms based on the concept of Java-Script Framework.

Infusion includes:

- an application framework for developing applications with JavaScript and jQuery,
- a growing collection of user interface components,
- a modular CSS framework that allows you to add, remove and mix classes to get effect you want.

Infusion embraces unobtrusive, functional techniques that promote less code and greater flexibility. Infusion takes the pain out of developing accessible, high performance, clean and nimble front-ends for applications that want to do more. Our approach is to leave you in control — it's your interface, using your markup, your way.

One can also combine the user interface personalization and interaction scenarios customization subsystems into one system with the means of diagnosing cognitive and psychophysiological characteristics of the user.

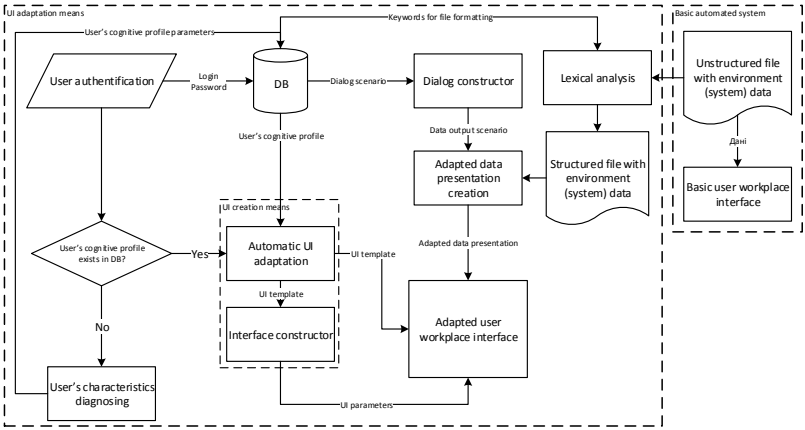

Fig. 3. *Scheme of complex user-data interaction personalization software*

This solution allows to implement a comprehensive approach to the problem of adapting the user's interaction with the information system [18; 19].

Conclusions. While all dealing with the problem of user-data interaction efficiency, existing approaches usually to cover one of the aspects of the problem, differing in their underlying ideas, complexity, implementation concepts. Analysis and selection of an approach provides a foundation for a means to reduce information overload and improve user productivity of its work with the information in the performance of necessary functions — from learning to make decisions. Proposed on fig. 3software scheme implements a combination of existing and new approaches and means to guarantee a flexible and complex customization of user-data interaction, regardless of the data input format, user tasks and cognitive characteristics.

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У сучасних автоматизованих системах користувачі часто стикаються з проблемою інформаційного перевантаження через постійно зростаючі обсяги інформації, що вимагає обробки за короткий час. Робота в таких умовах негативно позначається на якості виконання користувачами їх функцій в системі і на надійності самих систем.

У статті розглянуто та проаналізовано різні підходи до вирішення цієї проблеми, в основі яких лежить ідея створення персоналізованих засобів роботи користувачів з інформацією. На основі розглянутих рішень пропонується методика комплексної персоналізації форм представлення і зберігання інформації в системі, а також архітектура заснованих на ній програмних засобів.

Ключові слова: *автоматизована система, форма подання інформації, форма зберігання інформації, діалогове моделювання, персоналізований користувальницький інтерфейс, засоби персоналізації інтерфейсу.*

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