

## ABOUT AN APPROACH TO MODEL DEVELOPMENT OF MAN-COMPUTER INTERACTION

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**Abstract:** *In this paper are presented the results of investigations concerning development of methodic for extraction of expert knowledge in the process of man-computer interaction with intellectual information system. During the investigations a model is developed describing the interaction process with the intellectual information system, the process of criteria formation for evaluation of the alternatives also the process of decision making. One of the problems concerning the model developed herein is extraction of original heuristics applied by the experts in the process of decision making.*

**Keywords:** *decision making, knowledge retrieval, man-computer interaction, modeling.*

**ACM Classification Keywords:** *H.4.2 Types of Systems - Decision support*

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### Introduction

Information and telecommunication technologies change before our own eyes human environment which is now impossible without ubiquitous electronics devices. Intellectual information media is a natural development of the electronic, intelligence and communication technologies.

We will consider that the presence of an intellectual agent in a media makes this media intellectual. Under the term intellectual agent we will understand any program (program-apparatus module) executing monitoring of the surrounding media which is capable of learning and is acting in this media and their behavior is rational because their actions aim a specific goal.

The problem of interaction between the man and the intellectual information media in particular the system of decision making support is one of most significant in the contemporary world. This problem has many aspects the most important of which is connected with the investigation of processes of intelligence interaction between the man and the system. During the examination of these processes the man is considered as a subject and the system for decision making as a tool.

The significance of the investigation of man – intellectual system interaction model is a result of the importance of the part that intellectual systems play in the everyday life and the impact that they have on the life regardless their direct or indirect involvement. The increased number of social nets, intelligence and communication systems and the increased number of their users also shows the importance of this type of investigation.

To problems of interaction between man and intellectual information system (for example decision making support or expert system) are dedicated many papers, between them those of Anderson, Bobrow, Charniak, Luger, Kahneman, Minsky, Tversky, Zadeh, also Velichkovskii, Larichev, Petrovskii, Podinovskii and other famous scientists. In the process of interaction with the intellectual intelligence system (IIS) the man has to consider of great amount of factors and to solve problems connected with multi-criteria choice. For a human system multi-criteria problems are a very complicated type of problems (Петровский А.Б., 2004). The presence

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of many criteria leads to overload of the human system, making man to use different often original heuristics in order to solve a specific problem (Ларичев О. И., 1987).

Original heuristics extraction used by man in the process of interaction with the intellectual – the goal of the herein developed model.

In this paper are presented investigation results leading to development of a methodic of extraction of expert knowledge in the process of man-computer interaction with the information system. During the investigations a model is developed describing the interaction process with the intellectual intelligence system, the process of criteria formation for evaluation of the alternatives also the process of decision making. One of the problems concerning the model developed herein is extraction of original heuristics applied by the experts in the process of decision making.

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### **Human-computer interaction modeling**

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We will briefly describe information interaction in the terms of the present model.

Using the devices of information reflection (in our case monitor) information is sent to a man. The man receives information, actually an image of it that is not every time adequate to the emitted information. Under term information model we will consider a set of qualitative and quantitative characteristics of information sent to man by devices for information reflection. As a result of sensing information inside the man is created subjective conceptual model. The conceptual model is a dynamical synthesis of information sensed and the information already available till the given moment. The conceptual model is usually representation not of the individual object but of the whole situation itself.

In the frames of the discussed model the interaction between the man and the intellectual information media is a process of reaching specific goal which consists of a sequence of actions that have to be executed in order to full field the task. The term action means a functional element of human activity with a well defined goal.

In the suggested model interaction between man and intellectual media is described using information theory as well as game theory. From the game theory point of view the process of interaction of the man with intellectual information media is presented as a closed system capable of transition from one state to another and every transition lead to decreasing of the uncertainty (Вентцель Е.С., 2005), i.e. entropy of the system. From the game theory point of view man-computer interaction can be considered as a game which starts from some (initial) state and consists of a sequence of steps at which each of gamers makes a choice between several possibilities. The game ends which some result (profit). By representing man-computer interaction as a game we are given the possibility to describe and design man-computer interaction using the mathematical apparatus of the game theory. This way, using the mathematical apparatus of the information theory and as well as the game theory we are able present the model of man-computer interaction with the intellectual information media. Let introduce a function that describes the interaction of the observer with the intellectual information media  $F(d, I, T, S)$  where  $I$  – information matrix (information presented, information received, information retrieved), determined in particular using the mathematical apparatus of the information theory,  $d$  – some coefficient characterizing the subjective confidence to the presented information,  $T$  – time matrix determined according to the memory model suggested by Alan Baddeley (Baddeley, 2009),  $S$  – set of strategies considering cognitive and style particularities of decision making of the individual him/herself, determined by using the mathematical apparatus of the game theory and mathematical psychology..

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This function makes possible to take into account the interconnections between the mathematical apparatus of the information theory, the memory model by Baddeley and also set of strategies considering cognitive and style particularities of decision making of the individual him/herself.

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### Experiment description

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In accordance with the goal of this paper an experimental investigation is executed of the interaction between the man and the intellectual information media on the example of the interaction between a man and a decision making support system. During the experiment is modeled the work of people making decisions (the decision maker). The work of the decision maker is to be acquainted with the document – by reading the text on the monitor a to make a decision where it belongs i.e. where to send the document – department or other part of the organization where the document has to be sent for further retrieval.

It is necessary to say that in the organizations every day is received a mass of documentation and a mistake of the decision maker will not only lead to a mistake during the document retrieval and execution but to the document bad execution and even not execution if it enters the wrong department. For the work with documents (even entering) in big organization are used electronic document flow systems (Баканова Н. Б., 2007). In this system can be added a program module that plays the role of the making decision support system. This module provides the initial retrieval of the document text colors the basic words and visualizes the structure of the document. In the frames of the experiment the aim is to investigate the process of decision making as a part of the problem of document sorting by experts i.e. people with experience as a decision maker as well as novices i.e. people with no experience as a decision maker. During the investigation some of the decisions are reaches with and some without making decision support system. Two groups of peoples take part in the investigations:

- 1) Experts i.e. people with experience as a decision maker;
- 2) Novices i.e. people with no experience as a decision maker – students from the high schools in Moscow.

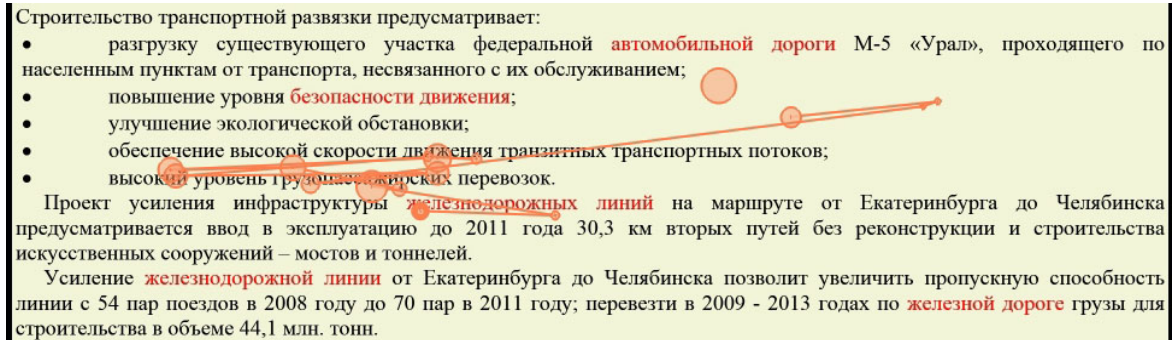
The investigations are executed using equipment capable of following the trajectory of the eyes of the user in the process of reading of information as well as in the process of making the decision ([www.smivision.com](http://www.smivision.com)). Alongside with this experiment are executed investigation of the cognitive style – impulsive/reflective (Холодная, 2002), also the style of self regulative behavior by methodic of Morosanova (Моросанова, Индина, 2011). To the examined persons is presented some document that consists of text and after the reading it a decision has to be made concerning a choice between several alternatives (a decision concerning the document sorting). To the tested are presented documents that are preliminary retrieved by the decision making support systems as well as documents without retrieval. If the document is retrieved the text structure is determined and a content analysis is provided using a specially designed thesaurus (Figure 1).

As a result of the retrieval the text structure is visualized and the basic words are colored (Баканов А.С., 2009). The succession of the texts (with or without retrieval) on the monitor is changed in order to avoid the possibility that the tested person is accustomed to a given type of text and this person makes a decision. The investigator observes and fixes (also in \*.mpeg format) the trajectory of the examined person eyes in process of text reading as well as in the process of decision making. On the stage of decision making to the tested are presented (also on the monitor) questions of two types. The first type questions are questions presented in the following order:

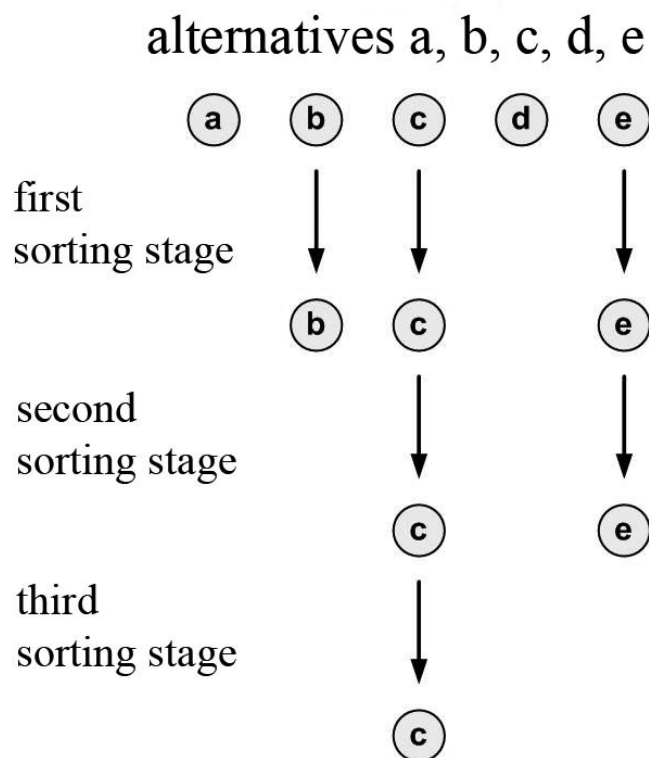
- 1) Choose alternatives (from a list) to which a given document/text belongs;
- 2) Choose alternatives (from the chosen before) to which the chosen document mostly belongs;

3) Choose only one alternative (from the chosen before).

This way in the process of answering to the questions of type one in order showed above the structure of the mental representations of the user, formed during the reading of the given document, is revealed (Figure 2).



**Figure 1.** A fragment of the text with the determined basic words and the gaze tracking of the expert in the process of the text reading



**Figure 2.** Sorting scheme. The process of choosing one alternative

There are a lot of definitions of the term mental representation (Брушлинский А.В., Сергиенко Е.А., 1998) so we will use the following definition: mental representation - subjective image of the objective reality, reflection of the inner and outer world in the consciousness of the person or applicable to our investigation the subjective image of the document/text in the consciousness of the tested person.

While answering to the questions of the type two (also presented on the monitor) the examined has to evaluate using numbers the rate to which a given document/text is close to the chosen alternative. The trajectory of the eyes of tested during the experiment is fixed by the observer.

Except from the eyes trajectory, the observer checks the time for needed for the text reading, the diameter of the people, the speed of the eyes movement, the for the decision making after the reading of a text with or without colored basic words.

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## Experiment results

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The expert are considerably better at sorting documents when their structure is preliminary determined (15313 ms with and 21328 ms without preliminary retrieval respectively); in the same time for the novices the preliminary retrieval is not very helpful (24322 ms и 25757 ms respectively).

The solution of the problems type two - quantitative evaluation i.e. estimate in number the rate at which the document/text is close to the chosen alternative is slightly slower for the experts in comparison with the preliminary retrieval but the number of the correct answer is bigger in comparison with the cases without retrieval (12528 ms и 11226 ms respectively).

The most important in the process of text reading by the tested are criteria on which is based the decision of the tested in the process of interaction with the intellectual information media.

During the investigation the following correlations are determined:

- Answering time for the question about quantitative estimation of the alternatives with experience – positive correlation;
- Confidence coefficient for decision making with experience – negative correlation;
- Confidence coefficient for decision making with style field dependent/field independent– negative correlation;
- Basic words coefficient with style field dependent/field independent– positive correlation;
- Confidence coefficient for decision making with style synthetic/analytic – negative correlation.

At the present moment the investigations continue.

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## Conclusions

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In the frames of the executed investigation is developed a model describing the process of interaction with the intellectual information system, process of the criteria formation for alternative evaluation and process of decision making.

The applied in the investigation device for following of the trajectory of the user's gaze gives a possibility to reveal original heuristics used by experts for task solving in the process of interaction with the intellectual system.

Availability gaze tracking system allows their usage in the system for control decision support, increasing their efficiency.

Introduction of such a device in the information system allows receiving quickly and in real time feedback from the user which allows adjusting the system to the user, to extract knowledge in the process of work etc.

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