INTERFACE ENGINEERING AND DESIGN: ADAPTIBILITY PROBLEMS[1]

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Abstract: The paper describes some investigation's problems intended to construct user model via psychological assessment for further interface adaptation. The proposed concept of user model comprises formal representation of demographic, professional, physiological and psychological data about the user with stress put on psychological features. Essential users physiological, communicative and cognitive peculiarities are in the center of view in the research theoretical part. The presented research develops flexible user-centered approach as a unity of two main investigation directions – user modeling and adaptive interface's design. The adaptation engineering procedure is investigated via special interface modeling approach. The targeted implementation is distance learning process. Special software tool InterTrivium for interactive questionnaire presentation is described

Keywords: human-computer interaction, user model, adaptive interface, web-based learning system.

Introduction

The user interface development is one of the main stages in the computer software design process now. The main requirements for user interface are friendliness, comfort and easy studied. The branch of science called usability is working to build main principles of the user interface design now. Psychologists, ergonomists, computer specialists try to find out basic criterions of the user interface development.

In this paper a major research focus we concentrate on the problems of the human-computer interaction in the distance learning systems with the stress on individualised teaching. Web-based system design problems are actively discussing by the usability engineers [Nielsen, 1999]. The main idea of there work is to think out fundamentals of user interface design as "User Interface for all". This approach is not corresponding to the main psychologist's conception. Users are differing by their own characteristics and peculiarities such as age, education, psychological and cognitive peculiarities. The other approach to user interface design – developing of adaptive interfaces on the base of the user model - is supposed to be more fruitful for the user interface elaboration to such computer applications class as web-based systems.

The main reason of user model developing for the distance learning system is to adapt learning process. Use model may include the group of user characters that can influence the learning material generation, navigation via learning course parts, type of students testing. In this paper problems of the user model generation for the distance learning systems and the task of the interface adaptability in this class of the intelligent systems are discussed.

The paper discussed the first results of the current co-operative Russian-Byelorussian project intended to work out the methodology of distance learning systems interface adaptation and to develop special software tool to carry out interface adaptation. User and interface models' assembling for the distance learning system are the initial project milestones. The major distance learning interface properties able to adapt were combined into several special groups of the user interface model as well as key user features were arranged to the set of the user model groups. The preliminary propositions of the user and interface model's correlation were formulated to prove by the series of experiments. Special software tool InterTrivium was developed to provide the experimental part of research. It carries out the user questioning and user model design. Some single-purpose questionnaires were composed to determine user's interface preferences.

Interface Model of the Web-based Learning System

The distance learning system interface model involves four groups of interface parameters (see Fig. 1). There are functional, interactive, service and lay out features of the distance learning user interface. More than 50 different interface characteristics were primarily selected to include to the interface model. The investigation of

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all interface parameters adaptation attainability is a very difficult task. Thereby several interface characteristics, which have the significant influence the human-computer interaction and education process, were selected for our research.

Functional interface parameters contribute greatly the system interaction behavior. It means difference in the representation of learning material and tests' performance. The examination of distance learning systems allowed to choose the following user functional parameters, which can be adapted:

- The set of the available working processes. This characteristic implies several distance learning system access modifications – for students, for administrator and for lecturer.
- The learning course material's structure. The user is allowed to study a certain limited suite of learning material according to his education, psychological peculiarities, interaction time and tests' results.
- Tests' content. Each user is provided by individual set of tests according to his user model.
- The navigation tool. The navigation tool adaptation supposes individual route for learning material study.

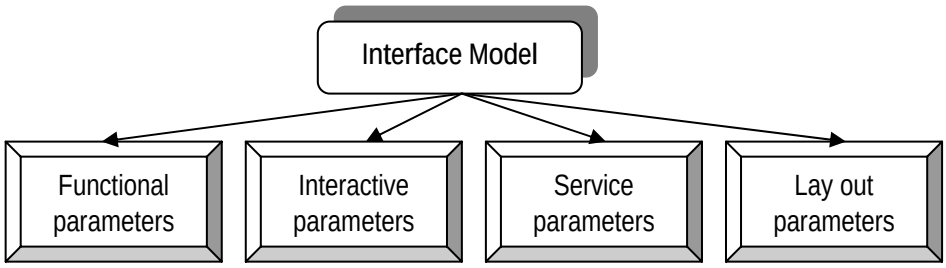

Fig. 1. Distance Learning System Interface Model Structure.

Interactive interface parameters determine the usability during the interaction with the system, the interaction scenario features. These characteristics group includes the information layout in the distance learning systems. it Is advisable to select the following parameters within this group:

- Dialogue type. The dialogue type management supposes providing different forms of tests.
- Controlling elements composition (menu configuration). The individual menu configuration should be formed for each user.
- Learning materials and tests' content being shown to the user at a time. The hypothesis of this parameter's adjustment according to the user's psychological peculiarities and his skills is put forward.
- Learning material performance format. Adaptation of this interface component assumes learning material presentation (font size, structure, graphic material availability) in the format most suitable to the user individual peculiarities.
- The highest possible hyperlink level (hypertext depth). According to the individual user model parameters' values the hyperlinks' number and hierarchy are generated to the distance learning system user.
- Navigation status. This characteristic's adaptation task is to follow the user navigation via learning material, to remind last visited page for starting with it during the next interaction with the system.

Service interface parameters include all objects participating in the reference and information dialog interface's functions. In our project we study adaptability of the reference information level, in other words we study individual user support system development feasibility.

Lay out interface parameters characterized information layout on the user display and level of user participation in it. In our project we tries to investigate adaptability of the following lay out interface parameters:

- Current window set-up. Distance learning system interface should be optimized to user screen sizes.
- Information lay out influences the learning material assimilation effect. Taking into consideration of psychological, physiological user's features will let to adapt this web-interface parameter.
- Menu appearance. The task of this parameter's adaptation is to design menu, which will be suit to user's psychological characteristics (as a text, icons, special images etc.).
- Background color.

- Text color.
- Hyperlinks color.

User Model

User model is not a new concept. First it was introduced in 1974 by the Institute of Informatics of the USA Congress. Now user model is interpreted as system's notion about the user, which generates either on the base of predetermined information about the user or on information acquired in the process of human-computer interaction. In spite of the fact that the user modelling is studying for a long time, there are no common principles of user model generation and it's implementation as a complex adaptation criterion.

The basic tendencies of the current user modelling research are:

- the number's increase and variety expansion of parameters included to the user model;
- user modelling use for adaptive systems development,
- user modelling implementation for the wide range of software systems development,
- attempts of generalized user models generation.

The network technologies expansion ensured new application fields for user modelling. Thus user model generation uses in adaptive hypertext navigation systems.

In the adaptive hypertext navigation systems the user model includes:

- users' goals,
- user's knowledge,
- user's hyperspace experience,
- user's background,
- user's preferences.

Also the more simple stereotype model (Rich model - [Rich, 1983]) is used for user knowledge representation. The stereotype model differentiates several groups of typical or «stereotype» users. For each user model measuring the system should offer several possible stereotypes.

The distinctive feature of our research is an attempt of user model generation process systematization and also including of psychological, physiological and cognitive features into the user model. Up to nowadays the major part of users modelling approach have comprised only the group of the human-computer interaction parameters (number of errors, main executed commands, visited pages) and also user knowledge about the subject domain. We suppose that including of psychological, physiological and cognitive features into the user model should improve human-computer interaction process quality as well as it will considerably increase user interface adaptation flexibility.

In our research we propose the concept of the user model [Rich, 1983; Wagner, 1982] as a set of formal representation of different factors, which affect the user's productivity in distance learning system environment. The user characteristics are grouped into several classes. The proposed distance learning system user model structure is shown on the Fig.2.

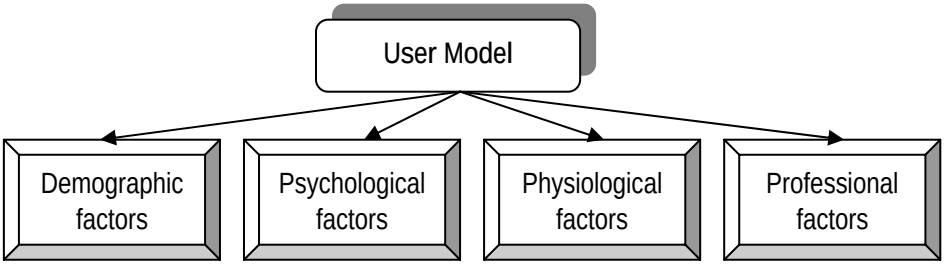

Fig. 2. Distance Learning System User Model Structure.

Demographic factors comprise such essential user's parameters as age, gender, first language, place of birth, social and cultural peculiarities. In our research we study two demographic factors – gender and age.

The group of the psychological factors in the distance learning system's user model consists of cognitive and communicative psychological peculiarities. The distance learning system's user model in our study

includes the following psychological factors: *ability to study, conformism, the level of locus control, cognitive style, logical mentality style*.

The study of the psychological characteristics group is in the centre of attention in our research. For the distance learning systems tasks the user cognitive style [Witkin, 1981] is an extremely important factor. It considerably influences the problem solving way. The study of the user logical mentality style or deductive/inductive strategies can help to present the learning material more comfortable for the student, because those who are using deduction always perform their cognitive activity with the top-down strategy from the higher level of abstraction to more and more detailed schema and in the variant of induction the users ascend from the unconnected elementary concepts to metaconcepts.

The user's physiological parameters have the greatest influence the productivity of the human-computer interaction. We have included two factors into the distance learning system user model - *attention* and *mistakes frequency* - for the purposes of our research.

In our study professional factors group consists of the following user features: *expertise level, user professional experience in the subject domain, user education and user computer skills.*

In this part we have described the most common structure of the distance learning user model. In our project we study all factors mentioned above and some other factors to be included at the distance learning systems user model final structure.

Adaptation of the Distance Learning System

We consider the process of the distance learning system adaptation twofold – as interface adaptation and scenario adaptation. Scenario adaptation implies adjustment of the learning process scenario to the user peculiarities. Therefore we have included some characteristics, which in our opinion influence the learning materials navigation scenario, to the user model. Our adaptation comprehension corresponds the classical adaptation notion [Brusilovsky, 1996] (see Fig. 3).

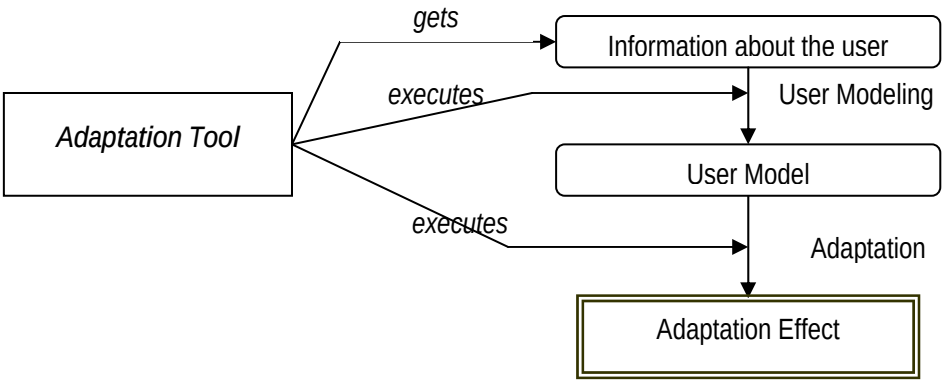

Fig. 3. Classical notion of the adaptation process in the adaptive systems

The major aim of the reported project is to develop interface adaptation tool for the distance learning systems. The process of the interface adaptation supposes inferences rules implementation to the interface generation. We are going to form knowledge base comprising user/interface models correlation rules. Now we carry out special experiments, which will allow to study correlation between user and interface models. The special software tool InterTrivium was developed to provide this experiments.

InterTrivium – User Model Acquisition Tool

InterTrivium is a specially designed software system to form distance learning system's student model (first version called TOPOS was developed by Voinov, second version TRIVIUM developed by Geleverya T.).

It is an application for multi-factor quiz's data interpretation developing and the user model generation. The system can work with all types of question-answer tests (graphical tests, multi-factors test etc.). InterTrivium includes tools for interactive visual editing of tests' descriptions and tests' scales.

The main InterTrivium major targets are:

- test development,
- quiz/questionnaire executing,
- the result data interpretation,
- user model generation.

In the system there is an intelligent tool for automatic verbal interpretation of test results for each respondent using rules, defined by experts-psychologists.

The prototype of InterTrivium is implemented in the framework of PHP scripting language and can store data in MySQL database or in text files.

The outcome of the described application may then be used both by Internet-based and standalone computer-aided learning systems. InterTrivium can serve as a user model generation tool and as an application for the different testing and queering support.

Now InterTrivium supports several tests on the user interface preferences and some professional psychological tests. Some experiments aimed to find correlation between the user model and distance learning interface components are providing. The interface adaptation tool for the distance learning system will be developed on the base of experiments results.

Acknowledgments

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Conclusion

The importance of the user interface adaptability is evident. The intelligent interface development can noticeably improve distance learning systems outcome. The approach described in this paper can be titled as design and building of adaptive interfaces embedded in the distance learning systems via user modelling. This approach is based on the user-centred technology that puts stress at the usability, handiness and efficiency of human-computer interaction.

The described project is under active development. Currently, different system components are studied – up to considerable extent – separately. This is referred to, e.g., user modelling, distance learning, Internet programming, description of subject domain.

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