Human Factor-Driven Adaptive Web Environments
The AdaptiveWeb System

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Abstract.

The research that is described in this paper focuses on incorporating theories of individual differences in information processing within the context of generic Hypertext and Hypermedia Environments. The main objective of this paper is to introduce a framework for the automatic reconstruction of Web content based on human factors. Our approach provides a new comprehensive way of reconstructing Web content; that is creating a comprehensive user profile based on specific metrics of visual, cognitive and emotional processing parameters that have specific impact onto the information space. Based on an ongoing experimental evaluation with approximately 500 users, both in an eLearning and eCommerce personalized environment, it has been shown that the incorporation of human factors in web environments increases users' performance and satisfaction while interacting with the complicated Web structures, as well as learning ability.

Introduction

The research conducted for developing the AdaptiveWeb system focuses on adapting Hypermedia Environments based on human factors. The theoretical foundations of our work are based on multi-disciplinary domains such as Adaptation and Personalization, Cognitive Psychology and Semantic Web technologies.

Our approach provides a new comprehensive way of reconstructing Web content; that is creating a comprehensive user profile based on specific metrics of visual, cognitive and emotional processing parameters that have specific impact onto the information space.

In the proposed system we extend the notion of the "traditional" user profile introducing the *User Perceptual Preference Characteristics* [1], that serve as the primal personalization filtering element.

This approach emphasizes also on critical factors that influence the visual, mental and emotional processes that mediate or manipulate new information that is received and built upon prior knowledge, respectively different for each user or user group.

These characteristics, which have been primarily discussed in our previous publications [2], have a major impact on visual attention, cognitive and emotional processing that takes place throughout the whole process of accepting an object of perception (stimulus), until the comprehensive response to it. Henceforth, with the use of the AdaptiveWeb system, users will be able to switch between the raw and the personalized content, realizing in practice that their individual characteristics play an important role during the adaptation and personalization process, in order to reach higher levels of usability, user satisfaction, effectiveness and quality of presentation.

Description of the system

The current system, AdaptiveWeb (http://www4.cs.ucy.ac.cy/adaptiveweb) (see Fig. 1) [1], is an adaptive Web-based application. It is detached into four stand alone interrelated components, outlined below:

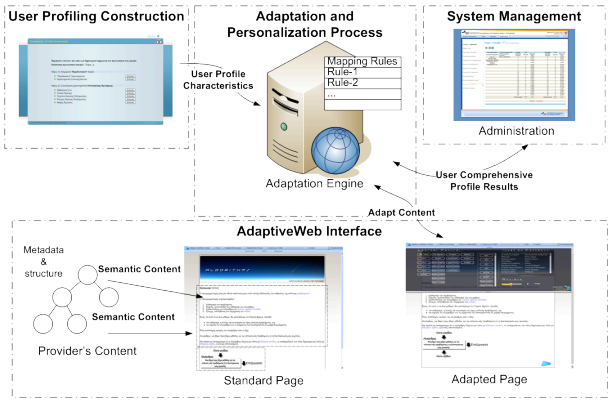

Figure 1. AdaptiveWeb system architecture

1. The *User Profile Construction* component. The user gives his / her traditional and Device Characteristics and further the component extracts the *User Perceptual Preference Characteristics* by completing a number of real-time tests (attention and cognitive processing efficiency grabbing psychometric tools) as well as answer some questionnaires for generating his / her cumulative profile.
2. *Semantic Content Creation*. The provider will create his / her own content by annotating any XHTML content based on the AdaptiveWeb RDFa schema.
3. The *Adaptation and Personalization* component. It runs the "mapping rules" process applied to the provider's content according to the user's comprehensive profile. For example, in case a user identified as

"Wholist-Imager" will get the information in a diagrammatic form (Imager) and a floating menu with anchors (Wholist) will be added so to guide the user on specific parts into the content while interacting.

4. The *AdaptiveWeb User Interface,* AdaptiveInteliWeb. It provides a framework where all personalized web sites can be navigated. Using this interface the user will navigate through the provider's content (normal and personalized mode), with the necessary learner and navigation support provided based on his / her profile.

The AdaptiveWeb system is currently at its final stage, and has been evaluated in the field of *eLearning* [3], and *eCommerce* multimedia environment.

Evaluation of the eLearning paradigm

A total sample of 232 students was used, providing matched and mismatched environments, depending on the factor we were controlling each time. Our main hypothesis was that students in a matched environment perform better than those in mismatched conditions. The initial evaluative results were really encouraging for the future of our work since we found that in many cases there is high positive correlation of matched conditions with performance, as well as between the dimensions of the various factors of our model. This fact demonstrates the effectiveness of incorporating human factors in Web-based personalized environments.

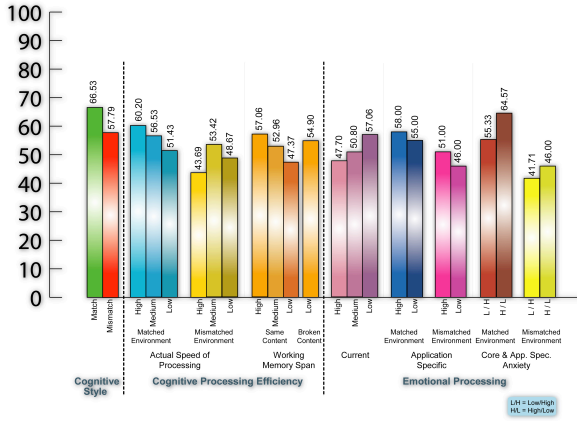

Figure 2. Basic Performance Indicators according to UPPC Factors

More specifically, our methodology and control hypothesis was successful since we have seen increased performance by students interacting and learning through matched environments (see Fig. 2), with regards to their cognitive style, actual cognitive speed of processing, working memory span, and emotional processing.

Evaluation of the eCommerce paradigm

A total sample of 89 students used from the Universities of Cyprus and Athens. The content was about a series of laptop computers. The dependent variables that were considered as indicators of differences between the two environments (original and personalized) were: (a) Task accuracy (number of correct answers), (b) task completion time, and (c) user satisfaction. The most robust and interesting finding was the fact that users in the personalized condition were more accurate in providing the correct answer for each task. The same user in the raw condition had a mean of 1 correct answer, while in the personalized condition the mean rose to 1.9.

Equally interesting is the fact that users in the personalized condition were significantly faster at task completion. The mean aggregated time of answering all three questions was 541 seconds in the raw condition, and 412 in the personalized. Both results were statistically significant at zero level of confidence. As it concerns the satisfaction questionnaire, 31 users leaned towards the personalized environment, 38 had no preference while 20 preferred the raw. The evaluation results of the eCommerce environments are consistent to our previous findings, and perhaps are a little more impressive, considering the fact that such an approach in a non-educational setting is rather novel.

It has to be mentioned that in both experiments, a paired sample t-test was performed demonstrating significance at zero level of confidence; showing that the personalized environment is more efficient.

The AdaptiveWeb System Demo Presentation

The AdaptiveWeb System Demo Presentation aims to give the audience a quick insight on how the system's components and mechanisms work for adapting Web content based on individuals' human factors. Various user instances will be presented, for example a user identified as "Analyst-Imager" with low working memory will get the information in a diagrammatic form (Imager), the content will be enriched with menu tabs (Analyst) to be easier accessible and with the "myNotepad" tool (temporary memory buffer) for storing sections' summaries (low working memory). In case that a user is identified as "Wholist-Verbalizer" the content will be automatically reconstructed where a floating menu with anchors (Wholist) will be added so to guide the user on specific parts into the content while interacting. In this case no diagrammatical presentation will be used because the user is a Verbalizer.

References

[1] Germanakos, P, Tsianos, N, Lekkas, Z, Mourlas, C, & Samaras, G. (2008). "Realizing Comprehensive User Profiling as the Core Element of Adaptive and Personalized Communication Environments and Systems", *The Computer Journal*, Special Issue on Profiling Expertise and Behaviour, Oxford University Press, doi:10.1093/comjnl/bxn014.

[2] Germanakos, P, Tsianos, N, Lekkas, Z, Mourlas, C, & Samaras, G. (2007). "Capturing Essential Intrinsic User Behaviour Values for the Design of Comprehensive Web-based Personalized Environments", *Computers in Human Behaviour Journal*, Special Issue on Integration of Human Factors in Networked Computing, doi:10.1016/j.chb.2007.07.010.

[3] Tsianos, N., Germanakos, P., Lekkas, Z., Mourlas, C., & Samaras, G. (2008). "User-centered Profiling on the basis of Cognitive and Emotional Characteristics: An Empirical Study", *Proceedigns of the 5th International Conference on Adaptive Hypermedia and Adaptive Web-based Systems (AH 2008)*, Hannover, Germany, July 28 – August 1, 2008, Springer Verlag. (accepted