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User-Oriented Adaptivity and Adaptability in the AVANTI Project

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ABSTRACT

Visitors of web sites are generally heterogeneous and have different needs. The aim of the AVANTI project is to cater to these individual needs by adapting the content and the presentation of web pages to each individual user. The special needs of elderly and handicapped users are also partly considered. A model of the characteristics of user groups and individual users and a domain model are exploited in the adaptation process.

Keywords

Adaptive hypermedia, individualization, adaptivity, adaptability, user modeling, user model server

INTRODUCTION

The aim of AVANTI [1], a collaborative R&D project partially funded by the European Commission within the ACTS programme, is to develop and evaluate a distributed information system which provides hypermedia information about a metropolitan area (e.g., about public services, transportation, buildings) for a variety of users with different needs (e.g., tourists, citizens, travel agency clerks, elderly people, blind persons, wheelchair-bound people, and users with (slight) forms of dystrophy).

In order to develop an information service which is able to take the aims, interests, experiences, and abilities of its different users into account, AVANTI will take advantage of:

- methods and tools developed in the context of adaptive and adaptable systems during the last few years,
- standardized software components in the area of the World-Wide Web (WWW), and
- the widespreadness of computers interconnected in metropolitan-area networks,

The AVANTI system can be accessed from offices, public information booths, people's homes, and appropriate mobile computing devices (e.g., message pads and palmtops) throughout the world. Internal models both of user groups and individual users will help match the content and presentation to each user's individual needs.

User Needs

Investigations with respect to user needs have shown a considerable heterogeneity of the above-mentioned user groups. Moreover, individual differences in user needs have also been encountered. Some examples might illustrate this:

- For users who have never used the AVANTI system before, the topography of the hypermedia space should be kept simple (e.g., restricted to a sequence, grid, or tree [21]) in order to reduce the efforts necessary for building an appropriate mental model [7] [20]. Likewise, links to other hypermedia pages should be augmented by a label, or short comment. Both adaptations can however, be redundant (or even cumbersome) for citizens who use the information system of their home town frequently.
- For users interested in a specific subject, interesting detailed information should be provided, like e.g. an assessment of each painter in a web-based virtual museum. If the user lacks this specific interest, such detailed information should not be presented in order to reduce the efforts for building a mental model of the current hypermedia page [16] [20].
- For laypersons like tourists in a travel booking scenario, a technical term like 'check-out time' should be augmented by an explanation. This is (normally) not necessary for domain experts like travel agents.
- For users with low-bandwidth network access (e.g., via a modem), information that requires high bandwidth (like videos and high-resolution pictures) should be replaced by less demanding but nevertheless appropriate equivalents.
- For blind users, the modality of the presented information must be changed in the case of tactile and/or audio output. Moreover, additional orientation and navigation aids (e.g., table of contents, indices) are helpful for this user group [10].
- For wheelchair-bound users, information concerning the accessibility of premises (e.g., the existence and the dimensions of ramps and elevators, the type and width of doors) is important and should therefore be provided.
- For users with (slight) forms of dystrophy, the man-machine interface (i.e., the interaction objects and associated manipulation techniques) should be adapted accordingly, i.e., made less sensitive to erratic hand movements.

When implementation issues are considered, it becomes obvious that all these needs can hardly be addressed within the scope of a single project. Consequently, we are currently consolidating the findings and focusing on a subset of these user requirements, mainly with respect to the field trials that are planned for the third year of the project. The elicited user needs are compiled into a requirements specification for the envisaged information system, thereby taking both the dedicated user groups and resource limitations into account.

Adaptability and Adaptivity

In order to cater to different user needs, information systems can be tailored manually by the user or automatically by the system. Systems that allow the user to change certain system parameters, and adapt their behavior accordingly, are called adaptable [17]. Systems that adapt to users automatically based on their assumptions about them are called adaptive.

Both features, adaptability and adaptivity, will be provided by the AVANTI system:

- *Adaptivity and adaptability within the user interface* We plan to implement (special) I/O devices (e.g., macro mouse, Braille display, speech synthesizer), visual and non-visual interface objects, and associated interaction techniques [19].
- *Adaptivity and adaptability within hypermedia pages* We plan to implement adaptation of the information content, information modality, information prominence, orientation and navigation aids, search facilities, and links to other hypermedia pages [3].

Whereas the first group of adaptations aims at enabling and improving the overall access to the information system, the second group of adaptations aims at individualizing one specific hypermedia system.

In the rest of this paper we will focus on adaptivity and adaptability within hypermedia pages since this seems to be a rather novel approach which complements existing solutions and products that aim at providing access to the WWW for everyone (i.e., including users with disabilities).

User Modeling

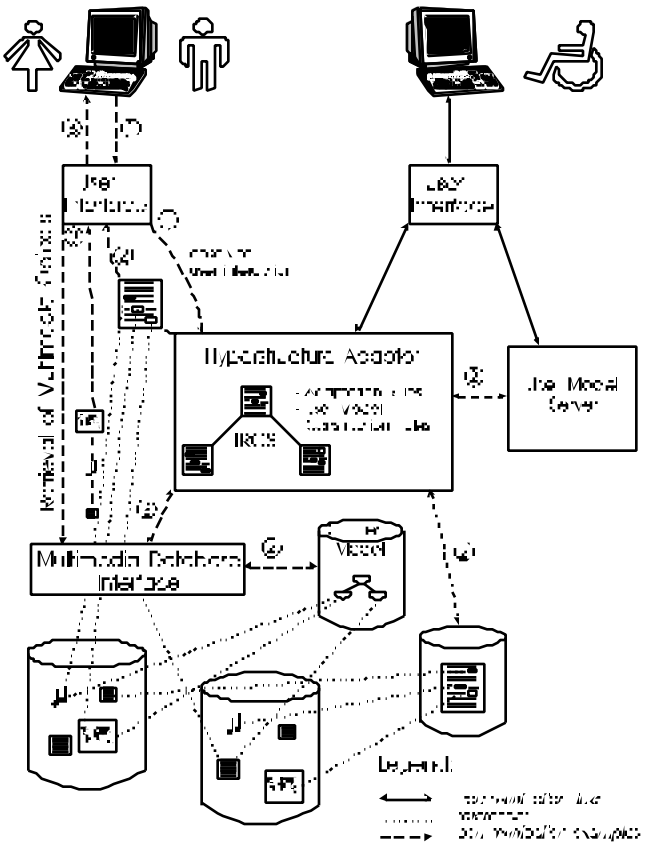
In order to provide adaptive system behavior, a so-called 'user model' has to be set up and maintained by the AVANTI system. A user model contains explicitly modeled assumptions which represent interesting characteristics of an individual user, like his or her background knowledge, preferences, interests, and abilities. Different methods for acquiring assumptions about the user have been discussed in the literature [6].

In AVANTI, assumptions will be acquired based on the following sources of information:

- An initial interview allows for the acquisition of primary assumptions about the user and is therefore a valuable source of information for initially assigning the user to certain user subgroups (see the 'stereotypes' below).
- Certain dialog actions performed by the user can be exploited for the acquisition of primary assumptions. For instance, if the user requests an explanation for a technical term then it could be assumed that she/he is not familiar with it [11].
- Based on primary assumptions about the user and additional information about the application domain, the system can draw inferences in order to acquire further assumptions about the user. For instance, if the user is interested in paintings and, being a tourist, has a special interest in one of the famous pieces of art of the Louvre, we can anticipate the user's interest in 'The Mona Lisa'.
- So-called 'stereotypes' [18] contain assumptions about interesting characteristics of user subgroups (e.g., tourists, blind users). If certain preconditions are met, a stereotype can be activated for a specific user which means that the assumptions contained in the stereotype become assigned to the user.

System Architecture

The following figure shows the architecture of the AVANTI system:



In the following, we will focus on the functionality of and the cooperation between the main architectural components of the AVANTI system, namely the *User Interface* (UI), the *Hyperstructure Adapter* (HSA), the *User Model Server* (UMS), and the *Multimedia Database Interface* (MDI) within the scenario of a request for a hypermedia page. The numbers refer to those in the figure:

① The user requests a hypermedia page. The UI forwards this request to the HSA.

② The HSA fetches the requested hypermedia page from secondary storage. The markup language used within this page is a subset of and an extension to HTML [22] named 'Information Resource Control Structure' (IRCS). Apart from static elements, an IRCS page may contain optional and alternative hypermedia objects, and also groups of hypermedia objects with an associated layout like a page header, toolbar, etc. An example for an optional element is supplementary information on wheelchair accessibility. Examples for alternative elements are technical vs. non-technical descriptions and a picture of a painting vs. its textual description.
The processing of these optional and alternative elements

is controlled by *Adaptation Rules*, which can take information from other system components into account, namely assumptions about user characteristics (e.g., knowledge, interests, preferences) from the UMS, and content-related information about multimedia objects from the *Content Model* (CM) via the MDI. Information about the current user's session (e.g., previously requested IRCS pages, previously provided input) is available as well. A second group of rules that may be contained in this IRCS page are *User Model Construction Rules*. They control the formation of so-called primary assumptions about the user (i.e., assumptions which are directly derived from the user's interaction with the hypermedia page). Primary assumptions are directly reported from the HSA to the UMS.

The HSA interprets the requested hypermedia page and the Adaptation Rules, generates an adapted page (which is compliant to standard HTML) and hands it over to the UI for presentation.

③ The UI interprets the hypermedia page, retrieves multimedia objects from the AVANTI databases transparently via the MDI, and finally presents the requested hypermedia page to the user. [1]

The communication between all active components is carried out via the HTTP protocol [2]. On top of it, a restricted and slightly enhanced version of KQML (Knowledge Query and Manipulation Language [8]) for user modeling purposes is used for communication with the UMS [13].

The main advantages of this architecture include the following:

- Already existing software in the area of the WWW (e.g., communication libraries, browsers, servers, proxies, web development environments, and database gateways) can be partially or fully used for the development of AVANTI components. This allows the developers to focus on adaptivity and adaptability, and on the evaluation of these concepts in several field tests.
- Most WWW browsers available today can access the AVANTI system and take advantage of the individualization features that are based on user-oriented adaptivity and adaptability.
- All active components within AVANTI can be fully distributed according to organizational and technical requirements. This is achieved by employing an HTTP-based name service for resolving symbolic references at run-time [9].
- Certain content adaptations may be dynamically delegated from the HSA to the UI, if the necessary environment for the execution of (mobile) Java code [5] is present there. Delegated adaptations relieve the server-based HSA and allow for a more scaleable architecture, avoiding the inherent limitations of a purely server-based approach.
- Widely used security standards [4] like SSL (Secure Sockets Layer) and SHTTP (Secure HTTP) may be used in the communication between the HSA and the UI. For this purpose, the HSA takes advantage of certain HTTP servers like those from Netscape Corporation [14].

The HSA and the UMS are central constituents of the AVANTI architecture. Their development does not have to be started from scratch since already available software can be employed as a basis, including 'WebObjects' [15] for the HSA and 'BGP-MS' (Belief, Goal and Plan Maintenance System [12]) for the UMS.

[1] As pointed out before, the UI is able to perform additional adaptations (e.g., use alternative I/O devices, visual and non-visual interface objects and associated interaction techniques) which are not further discussed here.

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