Designing an Adaptive Virtual Guide for Web Applications

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Abstract. Most applications accessible through the Web suffer from a noticeable lack of support for adapting to the different information needs that different users may have regarding a certain topic. However, completely automatic adaptive support can still be confusing for users who may not understand the reasons for the dynamic change in the behaviour of an application. In this paper, we present a possible solution to provide adaptive support that does not disorient the user. Such a solution integrates a virtual assistant able to provide adaptive support in an adaptable application. We discuss an example of application of this approach to support Web visits to museum information.

1. INTRODUCTION

The advent of the World Wide Web (WWW) has introduced a new and powerful communication tool that allows people to easily access information related to any type of event, activity or interest. But, it was soon recognised that different people can be interested in receiving different information concerning the same topic because they have different goals and different background knowledge. This raised the issue of furnishing different information with different presentation and interaction styles at the user interface level and has stimulated interest in user interfaces able to adapt to external factors (the user, the tasks to support, the available devices, and the context of use).

Adaptation has been used in a number of application areas, for example learning systems, on line help systems, multimedia information retrieval systems, and personalised views. Adaptation is traditionally classified into adaptivity, where the application is able to automatically modify its behaviour depending on the user interactions, or adaptability, where the application changes its behaviour according to a small set of predefined options. Adaptable interfaces are easier to implement for developers and to understand for end users whereas adaptive interfaces are more flexible because they can react in a wider set of modalities depending on the user interactions. This gives adaptive interfaces the possibility of supporting the needs of users in a more tailored way. However, there are two main risks. Wrong deductions can be inferred so that the tailored reaction does not match the user interest or the user does not understand the reasons of the change of behaviour and has a sense of disorientation and frustration. Thus, currently a strong interest has risen in how to provide adaptive support that is still under full control of the user.

An application area where adaptive techniques can be particularly suitable is the museum field. Museum web sites can benefit from the introduction of adaptivity because they address a wide set of types of users. One of their goals is to improve learning of related concepts and they usually have a large mass of information with consequent risk of disorientation for end

users. However, most current user interfaces of museum applications are not adaptive at all and they provide the same support for every type of user and every user interaction.

A few research prototypes have been developed to use adaptive support in museum applications. An example is in [KNSM98], a work that addresses the problem of how to find information interesting for the user. It allows users to express interest on a set of topics. Then, using a predefined network that associates the topic according to their semantic closeness, a mediating agent identifies further information that can be interesting for users, although at the beginning they are not explicitly aware of it. Hyperaudio [SS98] provides audio comments in a palmtop. It takes into account the physical position of the user and the time he spends in a position as an interest on the pieces of works that are close to it. Hippie [SO99] is a prototype that aims to implement adaptive support for nomadic applications. In ILEX [CDO99] there is a system that dynamically generates text labels for exhibits in a museum jewellery gallery, even if its evaluation has found no particular learning benefits for users.

In this work we propose a solution where we integrate both adaptable and adaptive support. The adaptive support is given by a virtual guide whose purpose is to enrich the visit by supplementing the information on the works of art. In the paper we introduce the logical dimensions that we have identified for the information provided by the virtual guide. Next, we discuss how to activate the virtual guide and its underlying architecture. Then, we discuss how such dimensions are applied to our case study and we provide some concluding remarks and indications for future work.

2. THE DESIGN CRITERIA

Adaptive techniques are flexible and able to overcome some limitations of previous approaches, especially when they are supported by agents oriented to provide interactive support. However, a completely automatic adaptive support can be rather confusing for end users who may find a system changing dynamically its behaviour without understanding the reasons for such changes. Thus, when designing adaptive support it is important to allow users to clearly understand:

- When the adaptive support can be activated;
- How the adaptive support provides information;
- Which criteria determine the generation of information provided by the adaptive support.

In this work, we aim to design a virtual assistant considering museum systems as application domain. The main goal is that the adaptivity of the resulting environment should be easily understood by users and it should enrich and facilitate the navigation in the available information. To this end, users must have full control on when activating adaptive navigation. Then, users should be supported, during their visit, by a virtual guide using a number of techniques. More precisely, we want that the information delivered can be adaptive according several logical dimensions [PM00] in order to obtain a behaviour similar to that of a real guide:

- *Introduction information*, whenever a new topic or aspect is accessed the agent should provide introduction information on that topic;
- *Summary information*, the system should be able to provide some summary information concerning the items that have been accessed in the current session;

- *Comparison information*, where the purpose is to compare the current information with that previously accessed for some common aspect;
- *Difference information*, in this case the purpose is to indicate an attribute that was not present in the previous information;
- *Curiosity information*, indicating specific related information that can raise the interest of the user.

The set of logical dimensions for the information given by a virtual guide aims to make the user's visit more interesting and pleasant. Previous work in this area has considered rhetorical structures [NZ00] which can give useful background but need to be tailored for the specific application considered or has focused [M97] on an articulated set of comparisons (illustrative, clarificatory and direct). In our case we want to propose a support similar to that provided by real museum guides using similar techniques to involve visitors and make their visits more interesting.

We have used this approach to design a Web application where there are two main components in the user interface:

- One part is dedicated to providing the information on works of art in an adaptable manner (at the beginning users select one user model or specify their preferences, and this determines the type of information presented and how to access it);
- In the other part, there is the adaptive support provided through a virtual assistant that supplements the information presented with additional information belonging to the categories previously introduced.

This structure helps users in navigating through the information available because they know that in one side they will find the basic information and that there is another part dedicated to giving additional adaptive information. The adaptive support should take into account the current user model because different types of users can be interested in different types of additional information and different ways to group the information that is analysed.

3. THE VIRTUAL GUIDE

We are introducing adaptive support into an application we developed beforehand. The application that we have considered is an adaptable virtual museum [PM99] that was designed following a model-based approach [P99]. The application supports either pre-defined user stereotypes (tourist, student, expert) or models derived from user preferences. At the beginning of the session, preferences can be explicitly indicated by the user among a set of predefined options that are displayed when the user-defined element is selected (Figure 1). These preferences can be updated during a session taking into account the user accesses. According to the user model, the application provides different support mainly for three aspects: access to the information available, presentation of the information selected, modality of navigation.

To give users full control over the adaptive support, when the initial choice of the user model appears we have added the possibility of selecting how adaptive support should be activated. Users can choose from three options: activation of the virtual guide, keeping the virtual guide disabled, on-demand activation of the virtual guide during the navigation. If the last option is selected, when a work of art is presented the user is allowed to activate the virtual guide at any time.

Fig. 1: User choice of possible stereotypes or preferences.

When the agent associated with the virtual guide is activated, beside the presentation of a work of art, there is a part of the main window dedicated to the comments of the virtual guide (Figure 2). The additional information provided through the virtual guide aims to make the users' visit more interesting and pleasant.

Another goal is to provide additional dynamic information that helps users link the standard information associated with each work of art in a manner similar to when a visitor is accompanied by a real museum guide. Thus, at any time we have both standard information associated with the work of art selected, and the agent-based support that provides additional information taking into account the user model and the interactions performed.

Fig. 2. The space dedicated to the adaptive support.

The virtual guide provides the types of information introduced before with a content tailored for the application considered, thus in our system we have:

- *Introduction information*. When the user accesses some new aspect (for example a new artist or a new section) then the system provides information useful to introduce it.
- *Summary information*. After having displayed a number of works of art, it can be useful to provide the user with a summary to highlight the most important aspects that have been considered, supplemented by some related information. For example, if the user visits several works from the same historical period this can be interpreted as a strong interest in works belonging to that period. Then, a summary of the most important aspects of that historical period can be provided.
- *Comparison Information*. They allow users to relate works of art or compare them, for example comparing dimensions, chronology.
- *Difference information*. In this case, the purpose is to highlight the difference between a work and those previously accessed. This information is useful for the user to better learn and remember the descriptions of the works of art.
- *Additional curiosity information*. They are additional peculiar information that can increase the involvement of the visitor highlighting the features of the work that can raise the user's interest.

For each of this type of information, it is important to clearly identify when triggering their availability; how to retrieve the necessary information; and how such information should be presented. In addition, the actual information provided depends also on the current user model. In order to avoid annoying users, replications of comments of the virtual guide are avoided (for example, within a session a certain comparison or curiosity is given only once).

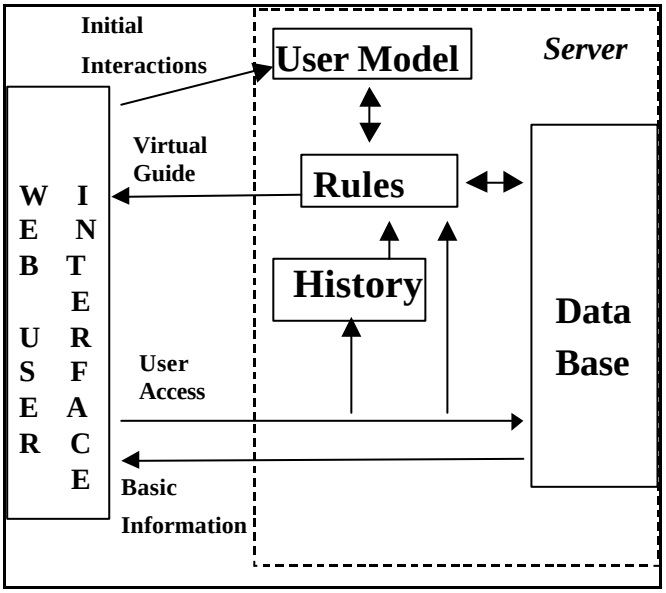

Fig. 3: The architecture of the system.

In Figure 3 the basic architecture of our system is represented. Users interact with the web interface. Their requests are sent to the database, are stored in the history part and are analysed by the agent. This agent has a set of rules that analyse the current request, the history of accesses and the current user model and, depending on this information, it decides what information to generate in addition to the basic information provided. Such information is generated using several techniques and it mainly consists of textual descriptions in natural

language. In some cases there is information associated with a specific transition in the navigation (for example moving from one room to another room). In other cases, we use templates that are pre-defined structured that are filled with dynamic information depending on the user accesses and the current user model.

4. THE APPLICATION OF THE LOGICAL CRITERIA FOR THE ADAPTIVE SUPPORT

In this section we describe more precisely the information given by the virtual guide, considering each logical dimension that we have deemed useful in this context.

4.1 Introduction information

Introduction information is generated when the user accesses a piece of information that for some aspect is completely new during the current session. For example, when the user accesses the work of a new artist, the system is able to provide some information on that artist taking into account the current user model and the works previously accessed.

In the case of the tourist user model, the information generated should also be useful for organising a future real visit. Thus, it should help users to remember a new element in terms of location, so that the user can create a mental model indicating where it is possible to find works of a specific artist, material, or historical period. Thus, the introduction of a new artist highlights how many works of that artist are contained in the museum and where they are located, specifying whether in a single or multiple rooms and the name of such rooms. Historical periods and materials are handled in the same manner. Another element considered when the tourist user model is active, is access to a new museum room. In this case, the system generates an introduction to the main features of the works of art considered in the room.

When the student user model is active, the system generates introductions mainly in terms of definitions, thus helping users to create the association work-definition. Whenever a student accesses a new definition the system provides general concepts, describing materials used to process that definition, the artists that worked for that definition and the historical periods when it is possible to find them.

In the case of an expert user model the introduction of a new artist has to take into account that the user is interested in a detailed search among the information contained in the museum. In this case, the user should have already a good background so it is preferable giving additional information concerning chronological motivations, observations, critiques, and historical notions.

4.2 Summary Information

The purpose of this information is to highlight the most important aspects common to the works of arts visited. The summary should help a further assimilation of notions already exposed to the user. This type of information is available after a certain number of accesses to the system and it depends on the current user model. Thus, for the tourist the summary will be related to the museum rooms visited whereas in the case of expert and student users will be related to the historic period considered.

More specifically, in the case of the tourist the analysis first checks for each museum room which and how many works of arts have been visited (Figure 4), and in which order. Additional comparison comments and links to the list of works visited can accompany the summary. Thus, the movements in the museum are analysed trying to identify the user's interests. The basic assumption is that tourist users of the virtual museum want to gather information useful for a future visit and, in any case, they want to memorise the museum in terms of rooms and works contained in them. Whereas, in case of student or expert users, the aim is to enrich a personal research, thus the summary in terms of historical periods help them to relate works of arts to their historical period.

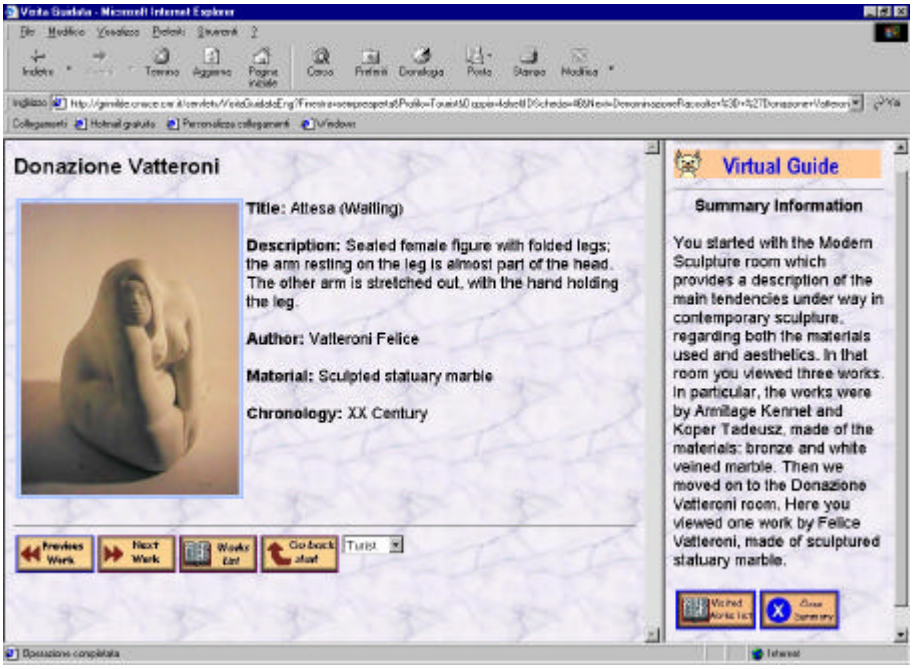

Fig. 4. Example of summary information for tourist user.

4.3 Comparison information

The purpose of the virtual assistant agent is to stimulate the user to spend more time on the application receiving information more effectively and thus improving learning. To this end, when the adaptive comment is generated it is important to take into account what the user has already seen and the current user model.

After having introduced a new subject with general information, the system links the new work of art with the previous works taking into account both the user model and the works previously accessed. There are different ways to connect a work to those previously seen. Comparison is a good tool for supporting learning and can be easily memorised by the user. When new works are accessed, we want to give additional information allowing users to relate the current work with those previously seen. More specifically, aspects concerning artist, historical period, and material used are considered for each user model. Additional aspects, more specific to the user model will be considered in the following.

When there is a change of artist, before comparing two artists, the system considers the works previously accessed and the current user model to identify the topics that the user is familiar with. Based on this analysis, the system decides whether to apply the comparison, if there are aspects to consider in comparing the two artists, which parameters to use for the comparison. If the comparison between the two artists has already occurred in the session

then it is not repeated. Regarding the aspects to consider in the comparison, the system has to identify the main features of the artist (techniques used, preferred material, …) by analysing the information contained in the application. The access to a new artist can occur along with the access to a new material, historical period, or definition. Thus, the additional comments have to consider all the changes occurred.

The agent retrieves information inquiring the knowledge base at each user access to a work of art. Thus, for example, if the only new aspect is the material then the system has to compare the two materials. Thus, the knowledge base is inquired to obtain all the works elaborated by the previous material and all the works obtained by the current material to compare the related information. If the user goes often back to works previously visited, this is interpreted as a strong interest for comparison information and thus this type of information is provided more frequently.

All the information concerning the introduction of a new subject or comparisons between items are presented in the space reserved for the virtual assistant. Summary information can include comparison information as well. In Figure 5 there is an example of comparison information. The current user model is the tourist model and the user has moved from one room to another room of the museum. Thus the system provides some comparison information between the previous and the new section.

When comparing works of art, the system is able to discuss aspects that have associated quantitative information for example it can give comments such as ("these two works have similar dimensions but have been made in rather different periods").

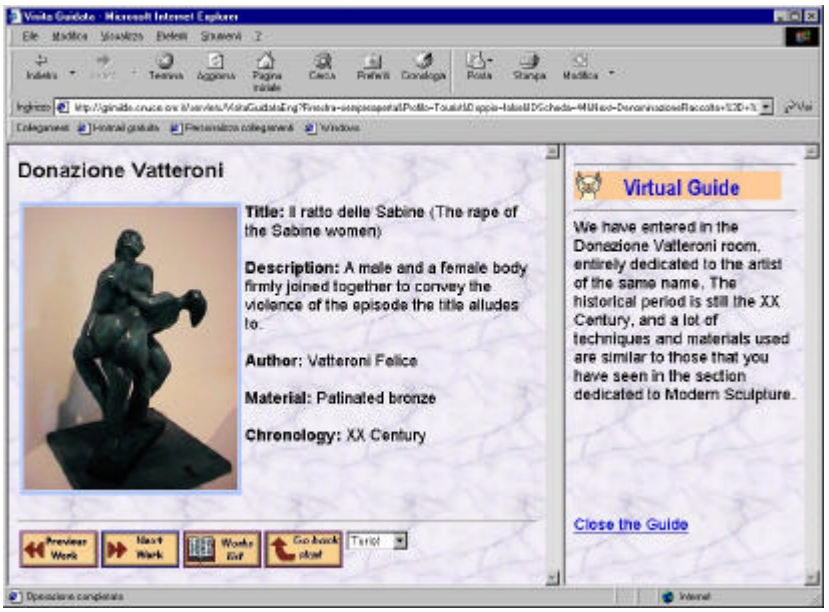

Fig. 5. Example of comparison information.

4.4 Difference information

Another type of information that can be furnished is the difference information. It can be triggered for two types of reasons: after the user has accessed some works then, when there is a work of art that completely differs for some aspect from all those previously visited, this is reported by the virtual assistant. For example, when there is a work of art made with a material that was not used for all the previously visited works. Otherwise, when there are works of arts that differ for some aspects that some virtual visitors may not catch then the difference is highlighted. For example, if after having accessed a high-relief the user selects a

bas-relief then the virtual guide indicates the difference between these two techniques in order to avoid misunderstanding that can occur as they produce results that are visually similar (Figure 6).

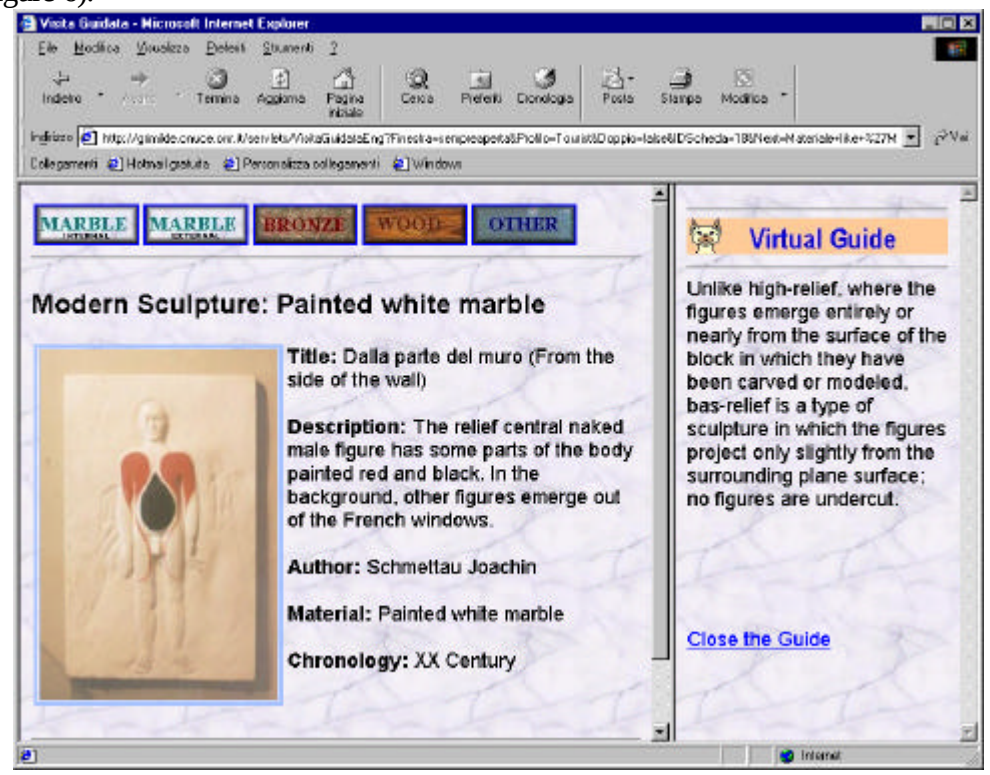

Fig. 6. Example of difference information.

4.5 Curiosity Information

The purpose of the curiosity information is to increase the interest and the attention of the user. This type of information is generated whenever a work that is unique under some aspect is accessed (Figure 7). For example, if the current work of art was made with a material that has not been used for any other work included in the application then the system highlights this feature. The uniqueness can concern the material, the artist (the unique work done by a certain artist), the historical period, in case of all the user models. When available anecdotal information is given.

Even this type of information is generated when there is a change of work accessed and, as its purpose is to raise interest from the user, it is introduced at the beginning of the additional information.

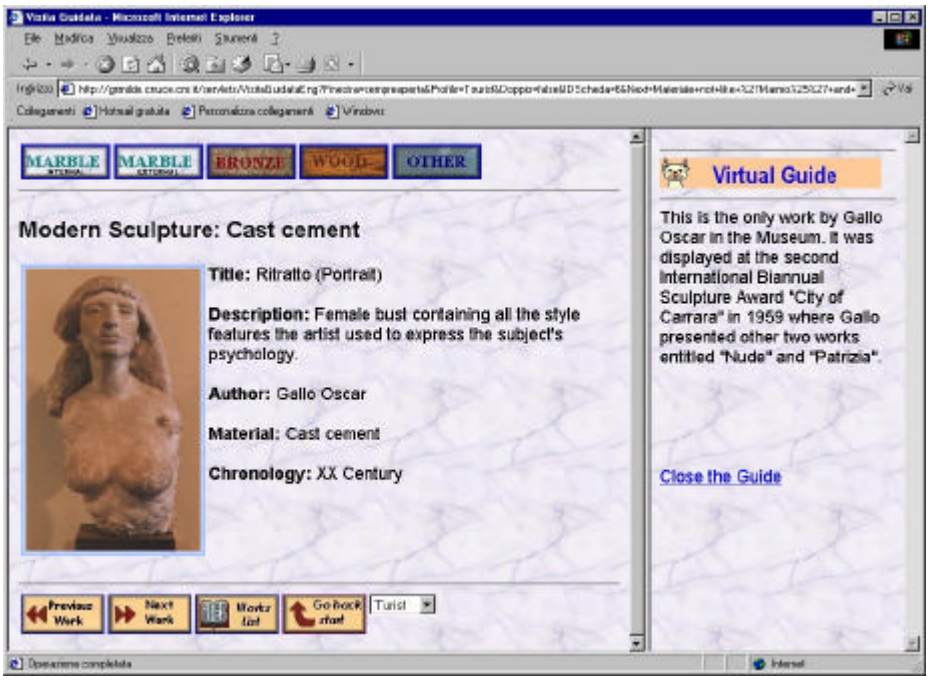

Fig. 7. Example of curiosity information.

5. CONCLUSIONS

We have described an approach to providing assistance to web visits through integration of a virtual guide with adaptive behaviour in a previously adaptable application. This allows us to obtain a flexible environment with a virtual guide able to adapt its behaviour and the information provided to different types of users depending on the interactions and goals of the users.

The adaptive support has been designed to be under full control of the user, who can determine when to enable or disable it. This support follows a set of clearly comprehensible criteria, and the information supplied corresponds better to users' interests, thereby helping to make their visits more pleasant and increase their involvement. The current system prototype that we are developing following the criteria presented is available at http://giove.cnuce.cnr.it/Museo.html.

Our first experiences with users of the application were positive, and we plan to carry out a formal empirical evaluation study to better understand to what extent the usability of the application has been heightened with this solution and if it can be improved with other techniques (such as animated agents). We also plan to apply our approach to applications supported by mobile devices.

The example provided is specific to the museum field but the approach can be applied to other application areas that share similar features as well.

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