An Approach for Personalisation and Content Adaptation for Accessible Internet Services Based on User and Device Profiles

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Abstract

The use of user profiles in the design and development of information systems and Internet applications is quite extensive. They are mostly used to maintain personal user information for administrative and security purposes. However, the information that these types of user profiles contain is not sufficient for resolving issues related to systems adaptability/adaptivity and accessibility. This paper introduces an approach for personalisation and content adaptation for accessible Internet Services based on the collaboration of user and device profiles and discusses prototype implementations. The approach emphasises dynamic aspects of personalisation and content adaptation which may be transparent to users, and identifies issues to be further explored.

1   Introduction

Designing for universal access requires that software systems accommodate a diverse set of users and needs. This raises 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, such as the user, the tasks, the available devices, and the context of use.

An essential requirement for such an adaptive system is to monitor the user's activity patterns and adjust the interface or content provided by the system to accommodate user differences as well as changes in user skills, knowledge and preferences. This paper presents an approach for enhancing personalisation and adaptation of Internet Services based on the employment of user and device profiles.

In this approach the user/device profiles are created, updated and utilised in a process which both requires and allows for explicit user intervention as well as autonomous and systematic collection and interpretation of information regarding user actions. This paper briefly describes the profiling mechanisms for users and devices, their characteristics and the process by which they are generated, (Section 2). The following section describes the way the two types of profile are used for personalisation purposes, while section 4 discusses design alternatives with regard to content adaptation. The final section (section 5) presents conclusions and current work.

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2   The User/Device profiling mechanism

The proposed approach for user profile specification based mainly on the IRIS project (Koutsabasis et al., 2001), offers an adaptive infrastructure for translating general user interaction functionalities to Internet based technical characteristics of communication channels, with respect to findings from accessibility and usability guidelines. The user profile specification builds upon open recommendations such as Web Content Accessibility Guidelines (Chisholm et al., (eds), 1999) and P3P (Cranor et al., 2002), which address, at a general level, accessibility and usability requirements of Internet services, and is mostly neutral with regard to application requirements so as to be easily extensible towards application-specific needs. These requirements are related to personal information, generic human modalities and to interaction patterns.

The IRIS user profile consists of three basic classes of information: personal information, user interaction preferences and IRIS-related user interaction. The personal information is based on the W3C P3P recommendation and contains information such as 'login', 'physical contact', 'online contact', 'demographic data elements', etc. The user interaction preferences are described in terms of human modalities and user interaction patterns that are of interest to the system. The human modalities can be mapped to communication channels that estimate the 'ability' / 'preference' of users and may also provide linguistic, 'fuzzy' values for these 'abilities' / 'preferences'. The user interaction patterns refer to interaction elements that are related to the technical characteristics of Internet services relevant to user-system interaction, and may include navigation, search, information presentation and other elements. These technical characteristics estimate the 'ability' / 'preference' of users with regard to interaction patterns specific to Internet services. The interaction patterns are estimated from raw data, such as log and history files, by a rule based multi-agent system so as to assign linguistic, 'fuzzy' values to them. Finally, the IRIS-related user interaction preferences currently consist of classes of information that are related to aspects of the IRIS Design Support Environment.

The device profile specification, based mainly on IRIS project, addresses the issue of content delivery-presentation that is tailored to the capabilities of different web enabled devices, and is relevant to any Internet-based system. The main recommendation that is related to describing device capabilities and user preferences to guide the adaptation of content presented to that device is Composite Capabilities / Preferences Profiles (CC/PP). According to the CC/PP Structure and Vocabularies (Klyne et al. 2002), a profile is constructed as a two level hierarchy: at the top level there are the profiles components and each component has a number of attributes.

Currently, the only implementation of CC/PP is the UAProf (User Agent Profile) by the Open Mobility Alliance (formerly the WAP-Forum), which unlike CC/PP specifies a vocabulary with a specific set of components and attributes to describe the characteristics of web enabled devices (tailored to WAP phones). This Device Profile Specification is based on the latest version of UAProf (UAProf-20010530) and uses components and attributes that are related to access characteristics of all kinds of personal computers.

In terms of the proposed approach, the acquisition/generation of profiles happens the very first time that the user interacts with the system, during a process termed 'user enrolment' process. Typically this enrolment process has two-steps, and each of these steps is related to acquiring information related to access device and user-related preferences and characteristics respectively. Normally, user enrolment starts as soon as a user connects to the system. At this point, the device

profile is retrieved using a software application, the Profile Handler, which must be downloaded and executed on the clients' device. The Profile Handler is a Java application that automatically retrieves the device profile, and sends it to each web server by incorporating it into the browsers' HTTP request headers according to CC/PP (UAProf) specifications. The user profile may be generated either explicitly by the user ('manually', with system help) or by the application, based on interaction with the user, leading to the inheritance of a modifiable predefined stereotype

3   Collaboration of User and Device profiles for personalisation

The combination of the acquired user and device profile data, represents a particular user's interaction preferences for the respective environment. In order for the information delivery to be fully accessible, the presentation of the information content must be shaped based on these user characteristics. The latter should be expressed in a format suitable for translation in accordance with the technological platform used. As a result, stereotypes describing a certain user category are created. Each stereotype describes a certain user/device profile category, in terms of the characteristics of the respective communication channels that fits better for a specific user, while in parallel, it associates these specific user characteristics with the respective representational parameters of each content, such as: formatting, scaling, timing and geometry parameters.

In terms of the proposed approach, various modifiable stereotypes have been implemented using template/style sheet combinations, and agent based mechanisms have been employed in order to decide which basic stereotype matches the acquired user/device profile information. The stereotype has to be selected on the basis of system knowledge about users' preferences. This knowledge is represented in a form of rules which map generic profile characteristics to presentation vehicles. A formal example of these rules (used in IRIS) is as follows:

If $\{(X \in [x1, x2])$ and $(Y \in [y1, y2])$ and $(Z \in [z1, z2])$ and $(…)\}$, then suggest strtypeN

where $X, Y, Z \in$ user/device elements, x, y, z are their respective values and strtypeN is one of the basic stereotypes. Since the mapping is not one-to-one the decision mechanism will return all the stereotypes satisfied by the existing rules as regards the submitted user/device profile information. The number of the stereotypes suggested by the system is N, which can be ranged from 1 to all the existing stylesheet/template combinations, based on the level of the system's functional complexity. Therefore, N will be the number of suggestions being made by the system to the user for previewing the selected stylesheet/template combinations. In general, the user/device profile can be gradually built transparently, on the basis of user interaction with the system, by inheriting one of the abovementioned stereotypes. More specifically, in IRIS, the later is implemented by the usage of accumulated statistical information regarding the profile_type/template_index pair.

In the long run of the system, this should create an association of the rules that are used to match particular users with the stereotype instance (template/stylesheet combination) that they finally choose to use. As the users can change their profile and use a new stereotype instance any time they want, this process is a dynamic. The results of this statistical processing are used by the system, which as soon as it filters the newcomer's profile information is able to suggest the stereotype instance with the greater usage for the respective filter.

The adaptation mechanism is implemented by a multi-agent system. The total number of agents used is five: the Profile Management Agent, the Logfile Agent, the Stylesheet Management Agent, the Interpretation Agent and the User Agent. A short description of their individual role and their functionality follows:

- **Profile Management Agent** is responsible for: receiving user profile information, deciding if a 'significant change' has taken place, triggering the Interpretation agent by sending it the transformed information, receiving the newly contracted/created template (URI) from the Stylesheet Management Agent (SMA) and updating the respective database, and keeping statistical information regarding the profile_type/template_index pair
- **Logfile Agent** is responsible for: receiving logfile information which is relevant to the user's preferences in respect to the IRIS Design Support Environment's presentation issues, deciding if a 'significant change' has taken place (concluded from user actions), and triggering the Interpretation Agent (IA) by sending it the transformed information.
- **Stylesheet Management agent** is responsible for: receiving notification on user's decision and the respective information from the User Agent (UA) to create the newly contracted template, creating the newly contracted template and saving it in the database, and sending the URI of the newly contracted/created template to the Profile Management Agent (PMA).
- **Interpretation agent** is responsible for: receiving User/Device profile and Logfile information from the PMA, creating the newly contracted template and saving it in the database, deciding which basic template to offer to the user, sending the selected basic template to the User Agent (UA), and receiving a notification from UA in case of user's rejection of the suggested basic template.
- **User agent** is responsible for: receiving the URI of the selected basic template from the IA, informing the user about the suggested basic template, and giving the user the choice to either previeiw the template or reject it in advance.

4   Content adaptation

With regard to content adaptation and the current state of technology, there are two basic scenarios to implement such a system, depending both on user and device profiles. One scenario considers having many versions of the original content on the server and delivering the appropriate one, while the second scenario considers dynamically transforming the original content as appropriate. Implementing a content adaptive framework by following the first scenario is theoretically possible and efficient in many cases but the need to provide the huge quantity of server content in many variants makes it inefficient for certain systems and potentially unproductive, an unscalable. On the other hand, the second scenario is more appropriate to a real world situation, since it eliminates the problem of multiple versions of content. The weight of the problem in this case shifts to the need to have the content in a format that can be easily transformed to the 'appropriate' form for each client according to user and device profile properties.

The approach proposed in this paper is based on the combination of both scenarios. The basic idea is that the profile mechanism generates a set of triggers that correspond to communication channels' characteristics. These triggers force internal or external agents to decide if the appropriate preferred predefined form of content is available or whether further processing has to take place. In the case where further processing is necessary, agents are triggered to search for available mechanisms to fulfil the required transformations. 'Web services' technology (W3C workshop on Web services, 2001) has been used to implement this functionality. Portlet-based applications have also been used to include this kind of functionality (internally), replacing thus the need for external processing.

The design and implementation of a portlet-based calculator, used for the portal of secondary education in the Aegean embodies a set of functions that respond to external triggers and restructure accordingly its form and its interaction behaviour. The aim is to match the needs that

correspond to the characteristics of the communication channels defined by the user and device profile mechanisms.

5   Conclusions and further work

Two applications that implement the proposed approach, namely the IRIS system and a portal of for the secondary education authority are currently under evaluation. The aim is to obtain user data and to estimate and calculate the degree of adaptation of the system, according to user requirements. Additionally, the evaluation process will analyse the behaviour of the user/device profiling mechanism. For efficiency reasons (in terms of speed), a cache mechanism has also been proposed and is under implementation.

Finally a research study regarding the classification of triggers that correspond to characteristics of communication channels is under development. The results will be critical for the content adaptation according to the proposed approach.

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