User Modeling and Adaptivity in Nomadic Information Systems

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Abstract: Mobile/wearable computing and wireless multimedia communication enable new forms of user adaptive applications becoming popular in these days. In the following paper the hippie system as a prototype for the class of adaptive nomadic information systems is presented. The system builds a model about users preferences, knowledge, interests, and movements in physical space from the users movements and their usage of the interface. Beside the forms of adaptations already known from adaptive hypermedia, the system can adapt to the current user location. Furthermore the system can keep track of activities distributed over time and space, e.g., the preparation of an exhibition visit from home, the execution in the museum, and the evaluation of the visit from home again.

Keywords: Nomadic Activities, Mobile Computing, Contextualisation, Cultural Heritage Access, Adaptive System, Museum Information System

1. Introduction

Mobile and wearable computing and wireless multimedia communication enable new forms of user adaptive applications becoming popular in these days. Users of nomadic information systems either have connected devices with them all the time or can use arbitrary stationary devices to access a nomadic system personalized to their needs. Adaptive nomadic information systems support both settings, i.e. they can be accessed at any time, from arbitrary devices and can adapt information to the user and his/her current context. This class of applications brings up new challenges for user modeling and adaptivity of which some issues will be discussed in this paper.

We will discuss some extensions of adaptive methods from adaptive hypermedia [1, 2] for nomadic applications in respect to the information available for user modeling, the application features that can be adapted, and the goals of the adaptations. Prototypical implementations of adaptive methods for nomadic information systems will be shown with the system hippie [3], which is an exhibition guide realized at GMD[1]. Currently hippie supports one art exhibition (Art at Schloss Birlinghoven) and one fair (Parts of hall 26 at CeBIT 99).

2. User Modeling in Nomadic information systems

Adaptive hypermedia systems mostly adapt the information selection and presentation to the user's goals, preferences, knowledge, and interests. In most cases the user model acquisition is driven by monitoring the activities of users in the information space or by an analysis of their connection and

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[1] The prototype Hippie was developed by GMD in the context of the project "Hyperinteraction within Physical spaces" (HIPS), an EU-supported LTR project in ESPRIT I[3]. The partners of the consortium are University of Siena (co-ordinating partner), University of Edinburgh, University College Dublin, ITC, SINTEF and GMD, CB&J, and Alcatel.

device characteristics. Additionally nomadic information systems can make use of localisation technologies (GPS, DGPS, Infrared, and digital compass) to adapt to a richer context model of the user's current situation. Beside an identification of the user's current position these technologies allow for user tracking in the physical space and his/her movements within.

The hippie system models the user's preferences, knowledge, interests, and movements in physical space. The user's preferences are acquired by explicit user dialogs where the user can set language, select auto-started or manually controlled presentations, and configure the interface. The user knowledge model is built by monitoring the user's interaction with the user interface. Positive evidence for gaining knowledge about exhibition objects comes from listening or watching presentations. Negative evidence comes from skipping or stopping presentations.

The interests of the user are the most difficult part to model, especially because they are highly dynamic. On the one hand we are assuming an underlying relatively stable interest trait structure of a visitor, on the other hand we take into account the current situation and a multiplicity of environmental factors that have an impact on the actual activation (the state) of the interest structure. In the hippie system we currently use different approaches to model the user's interest trait and state.

- Learning with domain taxonomies: With a rule based approach the system learns from all interactions of a visitor with the information system. Based on several taxonomies of the domain objects and information types about these objects the system tries to identify preferred types of objects of users (the user is interested in paintings), preferred type of information about types of objects (for paintings the user prefers the artist information), and preferred instantiations of object characteristics (the user prefers a painting when Vincent Van Gogh is the artist). *Example*: In the object taxonomy the class artwork has the subclasses painting, sculpture, and installation. Each of these three classes inherits common attributes from the class artwork and has additional specialised attributes. Depending on the information requests from a user the system computes a value for the user's interest in a class, i.e., if a user requests significantly more information about paintings than about the other classes the system infers that the user is currently interested in paintings.

- Keywords for implicit user categories: With a keyword based approach we try to identify clusters of objects that are not represented by the object taxonomy. In this approach we try to identify similarity between objects that are not captured by the categorisation in the domain taxonomies, i.e., for describing exhibits on a fair not all exhibits can be easily classified into a category especially research projects often contribute to several research areas and questions, for solving this problem the system allows the

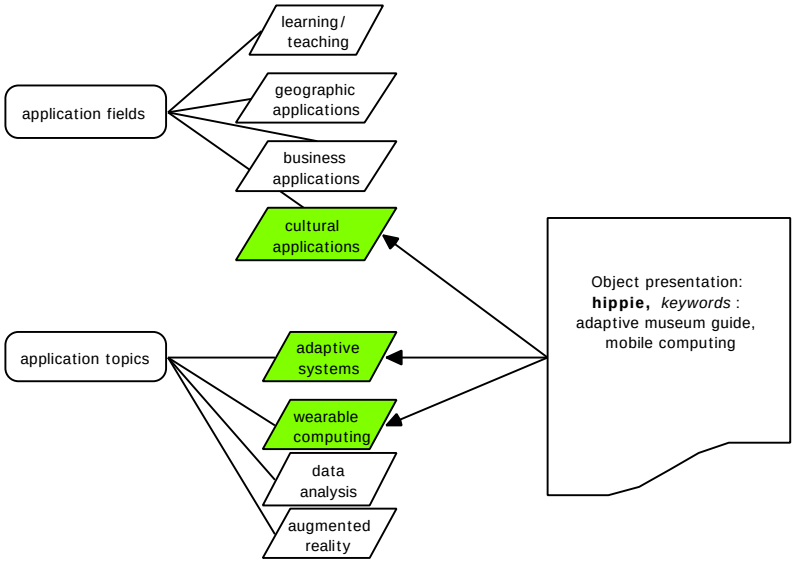

Figure1: An object presentation about hippie activating several application topics and applications fields by the associated keywords.

author of an exhibition database to specify keywords with each instance he/she creates. In a taxonomy of domain interests these keywords are associated with an interest field. Every instance that is presented to the user triggers these interest fields by way of the associated keywords. Comparing the values of the interest fields allows estimations about the users preferred interest fields and the user's interest for an object depending on the associated keywords. For future work we will expand this with a semantic analysis of the text information associated with domain objects in the sense of [4]. An example can be seen in figure 1.

- Interests of population: With a collaborative filtering approach we take into account the previous routes of other visitors and object characteristics explored by them. With this approach we are able to identify points of main interest and commonly used paths through physical space and information space. With the main points of interest and routes for the visitor population the system can propose tours and object information to the individuals. The visitor can be perceived as a typical member of the visitor population (the beaten path paradigm). Or the visitor can be regarded as an individual characterised by a significant deviation from the standard tour (the eccentric paradigm).

Especially the interest model can be refined by data of the movement model. In the movement model we store the whole track of the user within the physical environment of the exhibition. In our current hippie system we mainly use IR emitters and receivers and electronic compass to identify the current user position. With the current user position and the information about the exhibits in this area we are able to identify the artwork context a user prefers, e.g.; if a user spends a lot of time in rooms/areas with sculptures the system triggers an update of the interest model for sculpture interest. If the user passes of certain type of objects without stopping this behaviour can give negative evidence for user interest in this type of object.

3. Adaptive methods in nomadic information systems

Beside the forms of adaptations already known from adaptive hypermedia [1], nomadic information systems can adapt to the current user environment and the support functions commonly needed in these environments. Furthermore the system can keep track of activities distributed over time and space, e.g., the preparation of an exhibition visit from home, the execution in the museum, and the evaluation of the visit from home again.

In the hippie system we currently apply several types of adaptive methods:

- Adaptive navigation support: We support the navigation of the users in information space and in physical space. Adaptive annotation gives the users feedback about the objects they have already visited and those which are currently close to their physical position. A special tour module allows the users to prepare own tours or select predefined tours from a menu. If a user selects a tour the navigation support in the information space is given with a “next” button to jump directly to the next object, navigation support in the physical space is given with a “map” button that displays a map with the user’s current position and the next tour object with a “target” annotation.

- Adaptive maps: Adaptive maps contain the user current position and annotate exhibits in the exhibition to support user’s navigation in physical space.

- Adaptive presentation: Object presentations are adapted by the user’s preference, knowledge, interests and movement model. In the preferences model the users can specify if they want to have an auto-start presentation or if they want to control the presentation manually. The knowledge of a user has an impact on the information selected about this object and tries to reduce information redundancy. If a user selects a presentation about a painting and has already

seen a painting from the same painter the system will just mention the name of the artist and will not present the artist details again to this user. The user interest model is used to adapt the information selection and sequencing to users. The selection of available information about an object is adapted to the user's interest in certain information types about the class of the object.

- Adaptive recommendations: Depending on the objects a user selects by navigation in the information or in the physical space the system learns about the interests of the learner. The interest model is used to generate adaptive tour recommendations. These tours can consist of objects from the same type or of objects that have the same value for a certain characteristic, e.g., they are of the same painter or belong to the same genre. Furthermore the system alerts the user if an object of interest is in his/her closer physical area, these can be hotspot objects defined by the user or objects of interest computed from the system.

- Adaptive interface: On the one hand the user interface can be adapted by the user, on the other hand the user interface is dependent on the context a user who accesses the system. Different presentations and functionality support the user by default. When accessing the system from a desktop the main output modality will be visual (video, graphics, text) when accessing the system with a mobile device with position recognition the main output modalities will be audio (speech, audio alerts). Furthermore with a mobile device the interface will be optimized for controlling audio streams while in the desktop interface the system will be optimized for browsing data.

By the combination of features described above hippie makes use of Weiser's vision, called calm technology by ubiquitous computing [5]. (The equipment used in the museum and the information and communication interface is designed to let the visitor walk in the physical space of the museum getting access to a contextualised information space tailored to the individual needs and the current environment. Contextualised information presentation takes into account more than just the user's location (for contextualisation see [6]). A contextualised information space is defined by an information repository adapted to the location, the user and the task. In the case of a museum visit as an instance of self defined activities the task can be replaced by the visitors interest.

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