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Enabling Customized & Personalized Interfaces in Mobile Computing

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ABSTRACT

Providing an intuitive and ubiquitous interface to those services aimed at the mobile computing community continues to pre-occupy both service providers and certain sections of the research community. In this short paper, we present a snapshot of a system that is under ongoing development and reflect briefly on the initial results of some user evaluations. Based on these, we identify some critical problems with the current implementation and present a design orientated towards significantly improving the end user experience and making the interface more adaptable such that it meets the expectations and requirements of the user.

Categories and Subject Descriptors

H1 [Models and Principles]: User/Machine Systems – Human Factors; H5 [Information Interfaces and Presentation]: User Interfaces – Graphical User Interfaces.

General Terms

Design, Human Factors.

Keywords

Mobile computing, interface agents, personalization, customization.

1. INTRODUCTION

As users roam about their environment, their expectations and requirements continuously change, sometimes quite radically. Delivering services to such users in an appropriate and timely manner is difficult as a whole spectrum of possibilities must be considered. Emphasis in recent years has focused on issues relating to the actual mechanics and practicalities of delivering services to mobile users. Efforts in diverse areas such as context-aware computing, ubiquitous computing, wearable computing as well as the whole communications infrastructure are testimony to this. Though research in these and other related areas will continue for the foreseeable future, sufficient progress has been made to enable some researchers to consider some of the other issues essential to the actual use of such services, for example,

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Human Computer Interaction (HCI) issues, user modeling, adaptivity and so on.

Prototype mobile computing applications have been realized in numerous application domains as a casual browse of the literature will demonstrate. We have chosen to operate within the tourist domain, specifically addressing the needs of mobile tourists as they wander about some outdoor environment. Such a scenario offers a useful subset of the essential problems that arise in attempting to deliver services to mobile users. Furthermore, it provides a useful illustration of the difficulties and situations such users encounter while going about their normal activities. In choosing the tourism domain, we are not alone as a number of other groups have developed mobile guides as part of their research. Chief amongst these is the GUIDE project [1] undertaken at the University of Lancaster. A more recent effort in this area, CRUMPET [2] investigated the use of agents as mediators to those services a roaming tourist might need. Other efforts that focus on issues such as user modeling and adaptivity are documented in the literature [3][4]. In the following section, we introduce Gulliver's Genie and present some of the pertinent issues that arose as a result of evaluations performed on it.

2. Gulliver's Genie

Gulliver's Genie [5] is an electronic tourist guide developed in part as a result of investigations into the broad issues concerning the delivery of services to mobile users as well as issues relating to the actual implementation of software solutions on computationally lightweight devices, namely PDAs. From the tourist's perspective, the Genie focuses on two fundamental services:

1. Navigation – Enabling a tourist to successfully navigate an unfamiliar environment ensures a positive experience. The Genie achieves this through the provision of an electronic map and the continuous highlighting of the tourist's position and orientation upon it. What level of detail the map should support is an open question but at a minimum, it should show all major routes, relevant attractions as well as some standard civic services including bus stops, hospitals, police stations and so on.
2. Cultural – One popular pursuit of tourists when visiting some location is to explore any cultural attractions that area has to offer. The Genie enhances this experience by providing multimedia presentations on any attraction that the tourist encounters during their exploration. Such presentations are triggered when the tourist comes within a few metres of the

attraction in question. All presentations are customized to coincide with the perceived interests and general profile of the tourist in question.

2.1 Essential Characteristics

The Genie is distinguished by two essential characteristics. The first is the strategy it employs to disguise the bandwidth limitations inherent in cellular telecommunications networks. The second is its adoption of the intelligent agent paradigm. The Genie employs a strategy that we have termed *intelligent pre-caching* which works as follows. The tourist is continuously observed as they explore their environment. By comparing their position with a known model of their environment, their future behavior can be estimated with a reasonable degree of certainty. The Genie can therefore make informed decisions as to which attractions the tourist is likely to visit and arrange to download a presentation in such a manner that the tourist has full access to it by the time they reach the attraction. In this way, network bandwidth limitations are minimized, the limited available memory on the PDA is maximized and the tourist's satisfaction is maintained. Lest there be any doubt about the necessity for such a strategy, recall that the data rates supported by current wireless networks average about 30 kb/s in our experience and that it could take some minutes to download a multimedia presentation of only a few megabytes.

Intelligent agents are fundamental to the operation of the Genie and it may be regarded as a Multi-Agent System (MAS) comprising a suite of agents all collaborating to deliver services to the tourist. However a particular feature of the Genie is its use of strong intentional agents that conform to the Belief-Desire-Intention (BDI) stance [6]. Such agents are computationally demanding and it has only become feasible in recent times to actually deliver such agents on computationally light devices such as PDAs. Other noteworthy efforts in this area include microFIPA-OS [7] and LEAP [8]. Recall that in the BDI scheme, software is modeled and implemented in what are termed *mentalistic* notions. Such concepts differ radically from traditional methods based upon Object-Oriented (OO) techniques and the Genie has successfully demonstrated that BDI agents offer an attractive and viable alternative to traditional approaches when designing and developing mobile computing applications.



Figure 1. A snapshot of the Genie's navigation screen.

2.2 Architecture

Gulliver's Genie is designed around a standard client-server architecture. The client component, hosted on the PDA, comprises of a number of agents that continuously monitor the tourist's behavior and actively monitor the status of the PDA. The server component consists of a number of agents all collaborating to ensure that the model of the user's environment being considered at any given time is up-to-date and that presentations are prepared in anticipation of forthcoming requests from the agents on the PDA. A database, augmented with geospatial and multimedia components, completes the server component.

2.3 Implementation

The Genie has been hosted on an IPAQ. GPS is used for determining the tourist's position and approximate orientation. For wireless data communications, the General Packet Radio Service (GPRS) is used. The entire system is implemented in Java. In designing and realizing the BDI agents, we used the Agent Factory toolkit [9].

2.4 Evaluation

To obtain independent feedback, we carried out some user trials, a detailed description of which is beyond the scope of this paper. The evaluation focused on navigation support (Figure 1) and the provision of cultural information (Figure 2). In summary, practically all users expressed satisfaction with the system in principle and declared that they would use such services subject to availability and cost. All appreciated the potential of the Genie to deliver information at the correct place and time. However, a number observed that the Genie was somewhat slow and expected it to respond and update its display much quicker. Initial investigations suggest that some code optimization is necessary. In the following sections, we focus on issues relating to the interface and how this might be improved in response to users' observations.

3. TOWARDS A NEW GENIE

When implementing the Genie, the emphasis was naturally placed on practical and technical issues regarding the efficient, effective and timely delivery of services to the tourists. Having achieved this to our satisfaction, we are now in a position to reflect on issues that arose during the development and evaluation, and to speculate as to how the system may be improved. In summary, it may be stated that the *adaptivity* exhibited by the Genie needs considerable improvement. Current work on the Genie aims to address this through effective user modeling and the consideration of device context.

3.1 User Modeling

User modeling is a fundamental component in the realization of adaptive user interfaces [10]. Though the initial version of the Genie employs user modeling to successfully filter out information that would not be of interest to the tourist, this concept can be extended considerably to enhance the end-user experience. Feedback from the evaluations indicated one way of proceeding, at least initially. In the case of navigation, users expressed conflicting opinions as to how best display the map. Some were happy with the status quo. Others thought the map should dynamically rotate so as to continuously match their orientation. One of the reasons for this, we believe, may be found

in the strategies people adopt when navigating and we address this issue further elsewhere [11]. To improve the user modeling capability of the Genie, we are introducing an additional agent that controls the PDA's interface. In addition to managing the interface for the device in question (described in the following section), it personalizes the interface such that it conforms to the user's needs and expectations. For example, as well as taking the user's preferred navigation strategy into account, it might also replace the sound medium with an equivalent scrolling text commentary, should the user have hearing difficulties.

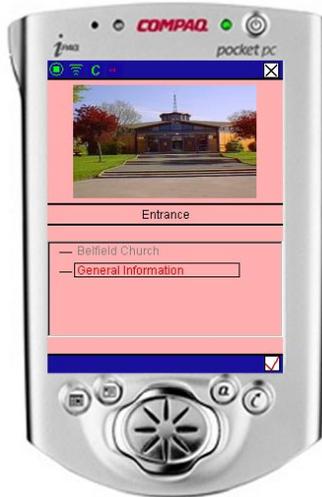


Figure 2. A presentation about the church on campus.

3.2 Device Context

During design, the issue of hosting the Genie on a different platform was considered. In principle, the Genie will operate on a device that supports Java and contains both GPS and GPRS modules. However, in its present form, the interface is rigidly designed for a 320x240 screen. This is a critical limitation of the Genie and we are currently altering the Genie's architecture such that it can dynamically adapt to the characteristics of the device on which it is deployed. It is our intention to use the inherent agent characteristic of mobility to realize this feature. The client component on the PDA consists of an agent that can determine the nature and characteristics of the device upon which it is hosted. This information is then sent to the server where it may be augmented with additional information if necessary. An agent is then dynamically constructed and infused with some essential facts pertaining to the target device. This agent then migrates to the relevant PDA, introduces itself to the other resident agents after which the initialization sequence is complete. The Genie can now proceed to deliver the required services, personalized to the tourist's profile and customized to the tourist's device. Of course the process may be optimized by maintaining a number of pre-built agents for the appropriate devices on the server. Such a scenario is feasible if the number of target devices is small.

4. CONCLUSION

In this short paper, we presented a brief description of a classic mobile computing application, namely an electronic tourist guide.

In response to the user evaluations, we have presented a revised design that sought to remedy some evaluation-driven deficiencies by focusing on customization and personalization of the interface thus increasing the overall adaptivity of the Genie.

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