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Addressing Mobile HCI Need through Agents

Gregory O'Hare, Michael O'Grady

Practice & Research in Intelligent Systems & Media (PRISM), Dept. of Computer Science, University College Dublin (UCD), Belfield, Dublin 4, Ireland.
{gregory.ohare, michael.j.ogrady} @ucd.ie

Abstract. Addressing the needs of the mobile computing community in all its guises is one of the critical challenges facing the research community in the coming decade. Given the constraints under which mobile computers must operate, significant effort must be expended to ensure that the end user's experience is satisfactory. In this paper, the selective use of intelligent agents as a means of augmenting the user experience through interfacing with the physical environment and anticipating user requirements is proposed.

Introduction

Mobile computing has dramatically changed the way users view and use computers. It has also raised serious technological challenges for the research community. From a potential user perspective, it has raised questions about security and privacy. Addressing these issues and concerns will be amongst the most import challenges facing researchers in the near future.

Context-aware computing [1] has been the subject of much research in recent years and has been extensively described in the literature. One of the core premises of context-aware computing is that the computing device should be aware of the user's circumstances and should be able to interpret any interaction in an appropriate manner to these circumstances. It has already been demonstrated that context can form a key component in mobile HCI [2].

In this short paper, the use of agents for interpreting captured context and using this to anticipate user's needs is proposed. An example based on a mobile context-aware tourist guide used to demonstrate feasibility.

Modeling Context via Agents

Though the benefits of incorporating a context-sensitive component into a mobile computer application may be immense, the actual practicalities of doing so present some difficult design and implementation problems. From a design perspective,

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identifying the user's context with a reasonable degree of certainty at any given time may prove difficult or even intractable. Even assuming that the users context has been determined, identifying what action, if any, should be taken can be difficult. Presenting the user with information at an inappropriate time, or information that is based on false premises, will quickly lead to user dissatisfaction and poor user confidence in the system. The potential for such a scenario is high, and for this reason, context has tended to be used conservatively. However, the successful deployment of applications that seamlessly capture and interpret context will mark a milestone in mobile computing and offer significant scope for further research in mobile HCI.

Intelligent agents have been deployed in a multitude of settings with the goal of addressing some of those problems that traditional computer science find difficult to handle. Agents by definition are autonomous entities, can monitor and react to changes in their environment and are proactive in attempting to fulfill their objectives. If agents are considered from an AI perspective and endowed with mentalistic attributes such as beliefs and commitments, various scenarios can be modeled in a highly intuitive manner including the capture and interpretation of a user's context.

Implement Agents on a PDA

One of the results of the massive strides that have been recently made in handheld technologies is that the deployment of sophisticated Multi-Agent Systems (MAS) on such devices is practical. Though inconceivable a few short years ago, a number of MAS have been successfully deployed on mobile devices. One example of particular interest is Agent Factory [3]. This MAS provides an environment for the design, development and implementation of agents. Though originally developed for a networked workstation environment, an Agent Factory runtime environment has been recently implemented for PDAs. This environment was developed in Java and can be deployed on any PDA or laptop that supports a JVM that complies with the PersonalJava specification. If the PDA is equipped with wireless communications facilities, agents can migrate to other PDAs or servers should they require additional computational resources.

Agent-enabled HCI: The Gulliver's Genie Story

Gulliver's Genie is a mobile context-sensitive handheld tourist guide. The modus operandi of the genie is quite simple: as the tourist wanders a city, they online access to a large repository of information that is customized to their location and personalized to math their interest profile. To elaborate further, each tourist is equipped with a PDA, a GPS receiver and a mobile phone with data transmission capabilities. As the tourist approaches an attraction known to the Genie, a multimedia

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presentation is requested from a server. Once it has been downloaded successfully, it is shown to the tourist. After monitoring the tourist's interaction, a record is dispatched back to the server and the user model is updated.

While there are obviously a number of technological challenges that must be overcome before deploying such a system, for the purposes of the discussion, just two are focused on. The first concerns the problem of capturing context and broadcasting it to other components. The second problem concerns using this in some meaningful way to augment the tourist's experience.

Interpreting Context

In this case, those elements of context that are of particular interest are the location and orientation of the user. Output from GPS devices usually adhere to some international standard, for example NMEA. Capturing this output is not particularly difficult. However, interpreting it can be a more subtle process. For example, is a particular reading consistent with previous readings? Is the quality of the readings varying? And if so, what can be inferred from this? If the tourist's orientation is changing rapidly, is it safe to deduce that the tourist might be lost and would welcome some navigation hints? Or is he/she just avoiding obstacles? Given the computational limitations of PDA devices, how often should data be broadcast to the system? Obviously, a lot of issues need to be considered. Dynamically reconciling the different objectives and priorities that a simple tourist based scenario may give rise to poses difficult challenges for designers and implementers.

Just-in-Time Information Delivery

One of the key issues that a mobile tourist information system must address is that of ensuring that information is delivered in an appropriate spatial and temporal setting. The use of GPS aids the resolution of the spatial element but ensuring that information is delivered at the appropriate time is a challenging task. In this case, one of the principle obstacles to be overcome is that of poor network bandwidth, which is a characteristic of most cellular wireless networks. For example, GSM supports a standard data rate of 9.6kb/s. Though the deployment of 3G technologies will improve the situation, bandwidth will remain an issue for the foreseeable future. Traditionally, one of the standard methods of overcoming these limitations has been through the implementation of a pre-caching/pre-fetching strategy when deploying mobile computing applications. However, given the limitations of standard PDA devices, particularly memory and disk space, the implementation of such a strategy requires an intelligent and adaptable software solution. Indeed, the nature of the data i.e. multimedia reinforces this requirement

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Deploying Intelligent Agents on a Mobile Device

Two agents have been designed and implemented for Gulliver's Genie:

- Spatial Agent: This agent monitors the incoming data from the GPS receiver. After ensuring that the quality of the data is adequate, it extracts position and orientation readings. Having checked that both are consistent with previous readings, it then deliberates about broadcasting them to the relevant components of Gulliver's Genie. For example, it must consider factors such as the current user activity, the distance traveled since the last reading and how much time has elapsed since the last update.

- Cache Agent: Having obtained a list of tourist attractions from the server, the Cache Agent, using information from the Spatial Agent, continuously monitors the tourist's proximity to these attractions. Once the agent is satisfied that the tourist is approaching a certain destination, it calculates a zone of activation for that attraction. Once the tourist is inside that zone, a presentation is requested from the server. After downloading the presentation to its cache, the agent ascertains that conditions are still valid for showing the presentations i.e. the tourist is still within the activation zone, and if this is the case, it arranges for the presentation to be displayed. Once the user has finished listening to the presentation and moved outside the activation zone, the contents of the cache are removed in anticipation of another presentation being required in the near future.

Future Work

An immediate priority is to continue refining the agent's behavior through the addition of extra rules and to perform some user evaluations on Gulliver's Genie. A second priority is to make the agents mobile so Gulliver's Genie can summon them from a server when required.

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