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Re-appearing interfaces of objects (Summary)

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Abstract

This paper describes a set of issues that we were confronted with when trying to specify people's interaction with a ubiquitous computing application. In such an application, the computer "disappears" and computing services are made available to users throughout their physical environment. Thus, objects in the environment, which become enhanced with new capabilities because of the computational power they acquire, re-appear in the task models of people. Issues here are presented from the usage level.

Summary

The last few years there has been a growing interest in ubiquitous computing environments. Although ubiquitous computing is not a new notion (ref. Weiser), in the light of two European funded FET initiatives of the Disappearing Computer (DC and DC2), in the last few years there has been an interest and acceleration in the technological as well as human side of the research in the area of the Disappearing Computer.

The view of the most of the disappearing computer artefacts stretches further than information appliances, as they involve interfaces that differ from the traditional area of computer, as we know it. The computer is no longer treated as single powerful processing object, but instead, as a collection of tangible objects. These objects maybe varied in shape, materials, capabilities, but they are able to communicate with each other through an invisible network, and share the processing capabilities they may individually have. Collective functionality emerges within a group of such artifacts that can work synergistically together in an environment, through invisible links. Such artefacts have a dual nature: a tangible self and a software self; they may be enhanced, additionally to processing, with sensing or actuating capabilities of their own.

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People can then act upon their environments, be it physical or enhanced Ubiquitous Computing environments, by setting goals, forming plans and perceiving results. At the cognitive level, the disappearance of the computer forces people to form new mental models about their tasks that involve objects and environments (that now may start to involve using hidden IT capabilities). On the other hand, if the appearance and function of everyday objects / environments change (or new objects appear into our everyday life), then people will have to adapt or form new models of tasks involving these objects.

Interaction in a ubiquitous computing environment takes place in two levels:

- Device-to-device
- User-to-environment. The user interacts a) With any single device b) With a collection of co-operating devices.
- Usage issues

Each object that participates in our everyday world has been designed with certain tasks in mind. The ways that we can use an ordinary object (sometimes implied by the "object's affordances") are a direct consequence of the anticipated uses that object designers "embed" into the object's physical properties. This association is in fact bi-directional: not only the objects have been designed to be suitable for certain tasks, but also their physical properties constrain the tasks people use them for. As everyday objects are "enhanced" with computing and communication capability, the user has to learn the new ways that they can be used (indicated by designing new affordances) and the tasks they can participate in.

Thus, the ubiquitous computing paradigm introduces several challenges for human-computer interaction. Firstly, users will have to update their task models, as they will no longer interact with a computer but with a computationally enabled object. Secondly, people will have to change their habits and form new models about the everyday objects they use.

The human-computer interface will transcend the limits of the computer and enter the physical world, as computing starts being distributed in objects around us. In such a world, the direct manipulation paradigm will have to include metaphors describing interaction with tangible objects. Unlike Weiser's vision it may not be appropriate to the nature of many artefacts to have screens added to them. Such interface approach applies to the more specific category of information appliances, and although convenient for interaction it is not always fit in the nature of objects and environments of the disappearing computer. The design of the object's form and physical properties will also affect the interaction. In fact the design of objects, -which constitutes their interface-, may have to be reconsidered so that their new capabilities can be promoted to the user (indicated by *appropriate* elements for the nature of each object). In this broad picture, information appliances as we know them are only a subset of these objects.

A result of the disappearance of the computer into everyday objects is that the conceptual models people have of these objects will have to evolve. In fact, they will have to:

- Remove the computer as a physical object from several task models
- Replace the computer in other task models with a new object
- Update the usage models and redesign the physical affordances of several objects to include the new possible use/functions

Objects will be able to process and/or gather data and to communicate with each other. People will interact at the same time with individual objects and with their configuration. This may be complex initially, but it also enables them to carry out more complex tasks that involving such enhanced objects and environments.

In terms of people's interactions with DC artefacts, the following issues will be addressed in more detail:

- How can the user tell whether an object has additional processing/communication capabilities?
- How can the user understand the state of the object?
- For how long will the people have to think explicitly about the objects, before they adopt them in their task models?
- In addition to existing skills for physically using objects, would people will have to develop skills for explicitly use the computing properties of their new environments as well?
- What are the motivating factors to make people willing to take all this trouble this vision entails?

Sample Scenarios

In order to demonstrate the concepts underlying the eGadgets-related research, we attempt to implement various everyday activities using eGadgets. As an example, consider a student living in a dormitory , which contains a study desk, a desk lamp, room lamp, clock and a collection of books, some of them on the desk and others on a self. When studying, the student will use the desk as a convenient study place and will use the available books, lights and other objects manually based on his requirements, to make his study experience comfortable.

Inside a GAS enabled student dormitory, the collective functionality of these objects (which have to be eGadgets) can be enhanced to serve the student needs better. At first, the student has to establish a GW among the books, desk lamp, room lamp and desk. When the student opens a book on the desk (wanting to start studying) and the ambient light is too low, then the desk lamp lights up. If the book that is being read moves away from the light source, the light becomes brighter so that the student can still read. When the student closes the book, the light goes off after a short interval. If another book is used for study, the lamp still lights up. In the case the lamp is broken or off the power supply, an alternative light source like the room lamp joins in the GW to provide the required service - ambient light.

More simple or complex scenarios can be supported by the concepts underlying eGadgets, all of which include the intuitive association of eGadgets' services in order to perform a collective function. For example, an alarm clock which gets the daily timetable from a PDA and rings an hour before the lecture, water boiler which starts as the student gets out of bed, lights which adjust to the ambient levels and also to the comfort of any partner who may be sleeping along, etc.

Conclusions and Future Work

The eGadget project is also looking into the role of intelligent agents, which give the eGadgets the smartness to form gadgetworlds independent of human control. Considering the scenario again, let for some reason the desk lamp go faulty resulting in no light for the student to study. The desk eGadget needs to locate some other eGadget, which provides the same kind of service that is light service. Hence somehow eGadgets need to understand what a service is in terms of its utility and experience for a human. This brings Artificial Intelligence or more specifically machine understanding into the domain of the project. In this new and smart GAS, Agents will function as the brain of the eGadget. The networking module can utilize the services of mobile agents for the route discovery and resource location making it inherently intelligent. How and in what ways this can be of any benefit to the GAS is a matter of future research.