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AN INFRASTRUCTURE FOR EXPERIENCE CENTERED AGILE PROTOTYPING OF AMBIENT INTELLIGENCE

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ABSTRACT

The user experience of ubiquitous environments is a determining factor in their success. The characteristics of such systems must be explored as early as possible to anticipate potential user problems, and to reduce the cost of redesign. However, the development of early prototypes to be evaluated in the target environment can be disruptive to the ongoing system, and therefore unacceptable. This extended abstract reports on an ongoing effort to explore how model-based rapid prototyping of ubiquitous environments might be used to avoid actual deployment while still enabling users to interact with a representation of the system. The paper briefly describes APEX, a framework that brings together an existing 3D Application Server with CPN Tools. APEX-based prototypes enable users to navigate a virtual world simulation of the envisaged ubiquitous environment.

INTRODUCTION

Ubiquitous computing poses new challenges for designers and developers of interactive systems. Because these systems immerse their users, the effect they have on the users' experience is an important element contributing to the success of a design. Technology enhancement has the potential to have a profound impact on a built environment, transforming a sterile space into a place that is in harmony with its purpose. The experience of checking into an airport can be improved by providing information to travellers when and where they need it. Frustrating delays could thereby be removed through the appropriate use of personalised information. Experience therefore becomes an additional characteristic of interacting with ubiquitous systems, to be explored in addition to more traditional notions of usability.

Experience is difficult to specify as a requirement that can be calculated and demonstrated of a system. It is difficult to measure and to obtain early feedback about whether a design will have the required effect. Currently, there are no techniques that can be used to analyse specifications against different notions of experience (for a discussion, see Harrison et al. 2008). An important barrier is the difficulty of developing prototypes that could feasibly be used to explore issues of experience.

The current work limits attention to ubiquitous environments envisaged as enhancing physical environments. In the envisaged designs, “spaces" are augmented with sensors, public displays and personal devices. Of particular interest in these systems is the way that the user interacts with the environment, as a result of both explicit interaction with the system, and implicit interactions that arise through changes of context. Here context could include location, or the steps that have to be taken by a user to achieve some goal (for example check-in, baggage screening, passport control, boarding card scanning).

THE APEX FRAMEWORK

The APEX framework is designed to satisfy three requirements. The first is that it should enable the rapid development of both prototypes and target systems. While there are several existing platforms for ubiquitous computing, (Garlan et al. 2002; Harter et al. 2001), a software tool is required that facilitates the development of prototypes, while simultaneously providing the hooks for the target system.

The second requirement is that a 3D environment can be used to construct simulations that can be explored realistically by users. 3D Application Servers, such as SecondLife or OpenSimulator, provide a fast track to developing virtual worlds. OpenSimulator, in particular, has the advantage of being open source.

The third requirement is an approach to modelling ubiquitous computing. A benefit of this approach is the integration of the modelling approach with analytical approaches, to provide leverage on properties of ubiquitous environments that are relevant to their use.

An architecture was developed based on these requirements (see figure 1).

Using APEX, prototypes can be rapidly built to represent the interaction between users, devices and services, as users move within ubiquitous environments. To avoid unnecessary development cost, early designs are explored in this proposal through model-based prototypes deployed within a

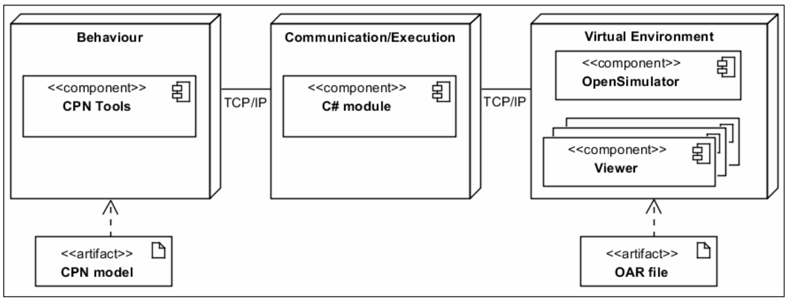

Figure 1 – Architecture of the APEX Framework

virtual environment. The developed prototyping framework (APEX) uses Coloured Petri Net (CPN) (Jensen et al. 2007) models. APEX binds a CPN model to a 3D application server – OpenSimulator (http://opensimulator.org).

The Petri nets modelling language, being an expressive and graphically informative notation, allows the description of the envisaged design. OpenSimulator provides support for exploring the design based on the Petri net description. Their integration thus allows rapid prototyping of ubiquitous environments, enabling users to navigate a virtual world simulation of the environment to evaluate usability issues, including user experience.

CONCLUSIONS AND FUTURE WORK

This extended abstract described a simulation-based prototyping framework for ubiquitous computing systems. The framework brings together the expressive and analytic power of Petri nets, with the possibility of exploring a 3D virtual simulation of the modelled system. Development of the models and 3D environments is accelerated by the use of the CPN base model, and pre-defined devices. By enabling potential users to explore the simulation of the system before deployment, it becomes possible to have a low-cost approach to the prototyping problem.

Ongoing work on the development of the framework is addressing a number of technical issues in order to better support developers and users. One goal is to reduce the amount of information exchanged by CPN Tools and APEX to a minimum. This is relevant both to prevent CPN Tools from running out of resources, and because it is envisaged that simulations will be deployed via the web. Connecting the simulation to user devices via Bluetooth is also being addressed. This will encourage a more immersive and realist usage experience by allowing mixed reality. It also allows the possibility of moving progressively as part of the design and implementation process from a simulated system to a real system. Exploring the formal analysis of the models is also being considered. Hence, combining this feature with the previous one, progress will be made towards a mixed economy of simulated and actual components of a proposed design. This will also support exploring how different levels of abstraction can be accomplished and supported. For example, supporting and enabling the migration of devices at the physical level via Bluetooth, at the virtual level as virtual devices in OpenSimulator, at the model level as CPN models.

Further development of the framework will involve its evaluation with users and developers. User evaluation concerns the fidelity of the results. Developer evaluation is concerned with the approach's agility.

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