A Framework for Building Reality-Based Interfaces for Wireless-Grid Applications

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ABSTRACT

The pervasive adoption of wireless technologies is creating a growing demand for seamless interaction with wireless services. By sharing resources across devices such as PDA's, sensors and cameras, Wireless Grids provide the opportunity to allow users seamless access to services via anew generation of user interfaces. These interfaces draw upon users existing skills of interaction with objects in the real physical world thus, we refer to them as reality-based interfaces. Although these interfaces offer the promise of ease of use, they are currently more difficult to build than traditional ones. The aim of this research is to simplify the task of developing reality-based interfaces and adapting them to a changing landscape of resources. This goal will be accomplished by providing developers with a high level user interface description language (UIDL) and a user interface management system (UIMS) which describes and enables to develop these interfaces given the uncertainty of the input-output devices they will employ.

Author Keywords

Reality-based Interaction, User Interface Management System (UIMS), User Interface Description Language.

ACM Classification Keywords

D.2.2 Tools and Techniques. H5.2. User Interfaces

INTRODUCTION

As the use of wireless technology becomes widespread, the demand for seamless access to wireless services is on the rise. By sharing resources, information and services across devices, Wireless Grids provide an opportunity for creating a virtual pool of informational and computational resources[4]. The integration of devices such as sensors and cameras into the Grid, creates the opportunity for the development of a new generation of user interfaces to applications provided in this environment which draw on users' skills of interaction with real physical word rather than with traditional IO devices. This next generation of user interfaces encompasses a diverse range of emerging interaction styles. Among these are tangible user interfaces, physical user interfaces and lightweight interaction. Common to all of these is that they change the interaction with computers from a segregated, specialized activity to one more closely related to the real physical world. Thus, we refer to them as reality-based interfaces.

By leveraging experience, knowledge and skills that users already possess, these interfaces offer the promise of interfaces that are easier to use. However, these interfaces are currently more difficult to build than traditional ones. The current generation of static, event-based, models and software tools fail to explicitly capture characteristics of reality-based user interfaces such as the existence of parallel digital and physical output channels, the combination of discrete and continuous interaction as well as the concurrent interaction of multiple users across variety of computational devices. Furthermore, within the context of a Wireless Grid, there is a need to dynamically adapt user interfaces to the same application semantics to fit a diverse range of contexts of use while employing available input-output devices. The current lack of appropriate models and tools combined with the constantly changing Wireless Grid environment makes the development of dynamically adaptable reality-based interfaces to Wireless Grids application very difficult in comparison to traditional user interfaces.

This research attempts to simplify the task of building dynamically adapted reality-based interfaces by **providing UI developers with a high level user interface description language (UIDL) and a user interface management system (UIMS) for describing and programming these interfaces given the uncertainty of the input-output devices they will employ.**

RESEARCH DESIGN

This research is designed as an iterative cycle which consists of four stages: 1) Identifying the challenges in the development of reality-based interfaces to Wireless Grid applications 2) Developing a UIDL for describing these interfaces 3) Implementing a UIMS that will build on the defined UIDL to generate dynamically adapted reality-based interfaces. 4) Evaluating, reflecting and redesigning.

Identifying the challenges of building reality-based interfaces to Wireless Grids applications
Based on a literature survey, observing students in physical computing classes and the experience of our lab in building such interfaces, we identified a set of challenges unique to the development of reality-based interfaces. Among these are the

combination of concurrent, continuous and discrete interaction and the lack of standard IO devices. A more comprehensive discussion of some of these challenges can be found in [5]. To gain concrete understanding of the challenges which stem from the dynamic nature of the Wireless Grid environment, we intend to analyze running prototypes of Wireless Grids applications.

Laying the Foundations for a UIDL

Our goal is to develop a new model and language for describing and implementing reality-based interfaces. Such a language will enable to directly specify dynamic adaptation to a variety of input-output devices, concurrent dialogues between multiple users, combination of physical and digital states as well as concurrent, continuous and discrete interaction. Though existing techniques could be extended in ad-hoc ways to address some of the aspects of reality based UI's, they would fall short of producing a comprehensible specification at a high level abstraction, which captures the dialogue from the user's perspective.

In order to lay the foundations for a UIDL for reality-based interfaces, we began with identifying a set of core constructs sufficient for describing tangible user interfaces (TUIs), a key interaction style included in the reality-based interaction category. This set of constructs is introduced in the Token and Constraint (TAC) paradigm [5]. The TAC paradigm approach is based on describing a TUI as a set of relationships between two types of physical objects: tokens which represent digital information and constraints which provide the context for token manipulation. The relationship between a token and a set of constraints is called a TAC. Similar to widgets, TAC objects encapsulate the set of manipulation actions that can be performed upon a physical object in a TUI. Our initial hypothesis is that the TAC paradigm can be extended to capture the essence of reality-based interaction as a set of concurrent relationships among abstract interaction objects that encapsulate a set of meaningful interaction actions (continuous or discrete) for a given context. These relationships might be engaged concurrently by multiple users intentionally or passively.

Building a User Interface Management System (UIMS)

The proposed UIMS is intended to provide developers with a development environment and a run-time component. The UIMS enables to specify interfaces utilizing the proposed UIDL, which in turn is compiled into code. The runtime component, which monitors changes in the environment, will dynamically adapt interfaces to changing conditions. To facilitate the implementation of interfaces using a variety of sensing mechanisms, we intend to develop lexical modules for multiple sensing technologies.

Evaluation Plan

In this research, there are two evaluation domains: machine centered and user-centered. In the former, the formal domain, we will test the correctness, expressiveness and performance of the proposed UIDL and UIMS. In the latter we intend to evaluate the usefulness of the proposed system with developers and the usability and robustness of generated interfaces with end users. This research use an iterative design process Our first iteration identified challenges for building tangible interfaces, proposed a model and a language for these interfaces and built a prototype UIMS. In our next iterations we will address additional reality-based interaction styles, build a UIMS that supports a variety of sensing mechanism and dynamically adapt interfaces.

RELATED WORK

Related work includes two segments. The first, declarative languages for creating user interfaces that target multiple devices (e.g. UIML[1]). These languages focus on generating GUIs for a variety of self contained devices. The second, toolkits which support interaction with the physical world such as Papier-Mâché [3] provide APIs for alternative sensing mechanisms. However, to date they do not provide means to directly describe properties of reality-based interaction. Jacob's et al. work on a UIDL forde scribing non-WIMP interfaces [2] is the closest to ourwork. However, it focuses mainly on virtual reality. Thisresearch is aimed at providing a UIDL and a UIMS that directly capture the unique aspects of reality-based interfaces and support their generation and adaptation.

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