CHI 2003 Demonstration Cover Page

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Personal Universal Controllers: Controlling Complex Appliances With GUIs and Speech

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ABSTRACT

We envision a future where each person will carry with them a *personal universal controller* (PUC), a portable computerized device that allows the user to control any appliance within their environment. The PUC has a two-way communication channel with each appliance. It downloads a specification of the appliance's features and then automatically generates an interface for controlling that appliance (graphical, speech, or both). In this demonstration we present a working PUC system that automatically generates graphical and speech interfaces, and controls real appliances, including a shelf stereo and a Sony camcorder.

Keywords: Handheld computers, remote controls, appliances, Pebbles, Universal Speech Interface (USI), personal universal controller (PUC)

INTRODUCTION

Common home and office appliances, such as copiers, camcorders, thermostats, and VCRs, are becoming increasingly complex. As these devices become more computerized with more functions, their user interfaces become more difficult to use [1]. At the same time, people are increasingly carrying portable computerized devices, such as mobile phones and personal digital assistants (PDAs) such as the Palm and PocketPC. Speech recognition is also becoming practical and successful. We are investigating how handheld devices and speech interfaces can be used to improve the interfaces to home and office appliances with an approach we call the *personal universal controller* (PUC).

A PUC provides an intermediary interface with which the user interacts to control an appliance. Instead of being preprogrammed with a set of controls at the factory or requiring laborious manual programming by the user (like today's "universal remotes," such as the Philips Pronto), the PUC engages in two-way communication with the appliance to download a specification of the appliance's functions. This specification, written in a language that we have developed, is used by the PUC to *automatically generate* user interfaces for the complete functionality of the appliance. The user can then use the interface to control the appliance and receive feedback on the state of the appliance. Our preliminary studies suggest that users may be able to use the generated interfaces on handhelds in *half the time* with *half the errors* for simple and complex tasks compared to the manufacturer's interfaces [5].

Our demonstration of the PUC system will show the automatic generation of graphical and speech user interfaces, demonstrate how our interface generators use our appliance specification language to create interfaces, and show the interfaces controlling real, commercial appliances.

RELATED WORK

There are several related projects, but they differ from ours in key ways. The V2 standard group has demonstrated AAIML, a language that specifies the functions of an appliance, and interpreters that build working interfaces from this language [9]. Our system is more novel than V2's because we have built PUCs that can generate both speech and graphical interfaces from the same abstract appliance specification language. The graphical interfaces generated by the PUC also have more intuitive and interesting layouts than those generated by V2. Furthermore, the PUC is able to control a variety of actual complex appliances whereas V2 only demonstrated control of X10 and prototypes simulated on a desktop computer.

Other related systems include ICrafter [6] and the Total Access System [8]. ICrafter is capable of automatically generating interfaces on a limited level, but this was not the focus of the research. The Total Access System is similar, but focuses on creating interfaces for disabled persons.

ARCHITECTURE

The PUC system has four parts: appliances, controllers, a communication protocol that allows the appliance and controller to talk, and a specification language with which the

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appliance describes its functions to the controller. An important goal of our project is to control real appliances, which may not support our PUC communication protocol. To solve this problem, our architecture also includes "adaptors." Adaptors are pieces of hardware and/or software that translate from an appliance's proprietary communication protocol to our PUC protocol.

AUTOMATIC INTERFACE GENERATORS

We have built automatic interface generators that can create graphical interfaces on a PocketPC and speech interfaces using Universal Speech Interface (USI) techniques [7]. The graphical interface generator is written in Java 1.1.8 and runs on desktop computers in addition to the PocketPC. The speech interface generator uses the Sphinx speech recognizer and is designed to run on a desktop computer. The algorithms used for generating these interfaces have been described elsewhere [3]. Both of these generators work from descriptions written in our specification language.

SPECIFICATION LANGUAGE

Our XML-based specification language abstractly describes the functions of an appliance. We believe that this language contains enough information to build a usable interface for any appliance, because we designed it based on an examination of several hand-designed controller interfaces. From this we derived requirements that our specification language must satisfy in order to generate high-quality interfaces [4].

ADAPTORS

We have created adaptors that allow our PUCs to control many different real appliances. These adaptors consist of software and occasionally custom hardware that translate the appliance's proprietary protocol to the PUC protocol. We have also created two classes of adaptors: those specific to a particular appliance, and those that function across a wide-range of appliances that use the same protocol.

Audiophase Shelf Stereo

The Audiophase shelf stereo has no built-in communication protocol, so a custom adaptor hardware was needed to translate to the PUC protocol. Our hardware mimics the IR codes of the stereo's remote control to send commands to the stereo, and then interprets the configuration of its LCD front-panel to determine the appliance's state.

Sony Camcorder

The Sony Camcorder has an IEEE 1394 communication port and supports the standard AV/C protocol for controlling media devices. We built a software adaptor for this device.

HAVi Devices

Home Audio Video Interoperability (HAVi) is an emerging standard for controlling A/V equipment in the home. We have built an adaptor that uses HAVi to control a Mitsubishi VCR, and we are working on a general HAVi adaptor that can use the information that HAVi provides about an appliance to generate a PUC specification. This would allow a PUC to control any appliance supporting HAVi.

Software Media Players

We also have built adaptors to control the WinAmp media player and Windows Media Player, two popular applications for playing MP3 files. Although these applications are just software and do not have physical boxes, we believe it is valuable to control them because they are increasingly being used as components in stereo systems.

CONCLUSIONS

This demonstration shows how a personal universal controller could be used every day by people to control the appliances within their environment. We demonstrate PUCs that automatically generate graphical and speech interfaces, and show that our architecture and specification language are complete enough to control appliances that exist today.

ACKNOWLEDGEMENTS

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Personal Universal Controllers: Controlling Complex Appliances With GUIs and Speech Proposal for a CHI 2003 Demonstration

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WHY A DEMONSTRATION?

We would like to give a live demonstration of our Personal Universal Controller (PUC) technology that allows a computerized device to remotely control complex appliances, such as VCRs, stereo equipment, thermostats, and telephones. A PUC differs from current remote controls because it is *self-programming*. This means that the PUC engages in two-way communication with an appliance, first downloading a description of the appliance's functions and then *automatically generating* a high-quality user interface. The user can then interact with the interface to remotely control the appliance and receive feedback on the appliance's state. A key part of this process is the automatic creation of user interfaces. Unlike previous systems, the description of functions is highly abstract and contains no specific information about layout or structure. This demonstration will allow us to show how our systems can generate graphical interfaces with complex layouts and structured speech interfaces for a wide variety of appliances.

We would also like to do a demonstration of the PUC technology at CHI 2003 in order to show how PUC devices interact with real appliances. Our PUCs currently control a growing number of actual devices including an Audiophase shelf stereo, a Sony Camcorder, and a Mitsubishi VCR. This is different than previous systems [5, 6] that controlled only X10 or devices simulated on a PC. None of these systems engaged in two-way communication with the appliances they were controlling. Furthermore, a demonstration provides the best forum to show the *dynamic* aspects of the PUC's control of appliances, and how the PUC's user interface dynamically changes as the appliances' states change.

We will use our time to show how our specification language abstractly describes the functions of a particular appliance and then show the PUC controlling this appliance and many others. The demonstration would be an opportunity for us to present many of the physical devices that we can control, something that time would not allow in previous presentations of this work. We have written several papers about

the PUC, but the audience will better understand how appliances are described and how the PUC interacts with them from a live demonstration.

RELEVANCE TO HCI

The goal of this research is to improve the usability of complex appliances that people use everyday. Many of these appliances, such as VCRs or telephones, are simple in concept but have become greatly complicated by the inclusion of many new features, such as programmable play lists or speed dial memory. Adding these features to an appliance is becoming increasingly cheap for manufacturers because of the declining cost of computing power. Unfortunately the cost of designing a good user interface has not declined, and actually becomes more expensive as the complexity of the interface increases. Most manufacturers do not seem to have the money or inclination to ensure that their devices have good user interfaces for all of their complex features. In fact, employees of several major consumer electronics manufacturers have confirmed this [1]. The PUC technology improves usability by separating the appliance from its interface, and moving that interface to another computerized device that is dedicated to providing high-quality interfaces, such as a hand-held computer. We have presented work that shows users can complete tasks in *half the time* and make *half the errors* when using a handheld to control an appliance as opposed to using the manufacturer's interface [4].

PUC technology can also help handicapped users interact with their appliances more easily. Instead of using a standard handheld computer, PUCs could run on assistive computerized devices, such as interactive Braille surfaces for blind users or special customized devices built to help people with muscular disabilities. This is the goal of the V2 group [6], and we are now collaborating with them to reach this common goal.

COMMERCIAL STATUS

The PUC technology has not been released for free public download, but we anticipate that it might be by the time of the conference.

PRESENTERS

The presenter will be Jeffrey Nichols, the primary Ph.D. student working on the PUC project. Jeffrey has presented at conferences in the past, and will present work related to the PUC at the ICMI [3] and UIST [2] conferences in late 2002.

AUDIO-VISUAL NEEDS

We will need to project from a laptop at XVGA resolution. Most of the devices have some mechanism for projecting their state through the laptop screen, but it would be nice if some kind of camera were available to show the panels of the actual devices as they are controlled by the PUC.

SCRIPT OUTLINE

The presentation will start with a brief outline of the problem and an overview of how the PUC solves this problem (3 slides). The architecture of the PUC system will be briefly described (2 slides), and then we will demonstrate graphical and speech PUCs in action controlling our Audiophase shelf stereo (5 minutes). We will then examine the details of the generated interfaces for the stereo and other devices, and examine how the graphical and speech interface generators made these decisions based upon the information included in the abstract specifications (6 sub-topics, 8-10 minutes). During this portion of the talk, graphical and speech PUCs controlling other devices will be used, such as PUCs controlling a Sony Camcorder and the WinAmp media player. Afterward we will demonstrate other appliances that we can control, and then talk briefly about future work and credits.

1. The Problem
2. The Solution
3. Personal Universal Controller
4. Presentation Overview
5. Architecture – Adaptors and Clients
6. Architecture – Communication and Specification
7. Demonstration – Audiophase Stereo (GUI & Speech)
8. Specifying the Functions of an Appliance (stereo & others…)
    - 8.1. State Variables (Stereo)
    - 8.2. Hierarchical Types (Camcorder, VCR, & Stereo)
    - 8.3. Commands (Stereo)
    - 8.4. Dependency Information (Elevator example)
    - 8.5. Labels (Stereo & Camcorder)
    - 8.6. Grouping (Stereo, Camcorder, & Elevator)
9. Further Demonstrations
    - 9.1. Summary of Other Appliances (Camcorder, VCR, & Elevator)
    - 9.2. WinAmp Media Player (play lists)
    - 9.3. Custom Alarm Clock
10. Future Work
11. Funding and Credits

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