UbiControl: Providing New and Easy Ways to Interact with Various Consumer Devices*

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ABSTRACT
This paper describes a system for using a PDA to easily control consumer devices found in our environment. By attaching a laser-pointer to the PDA, the user can simply point to a device in sight and request a user interface description. The user can then control the selected device in a web browser like fashion that facilitates spontaneous interaction with consumer devices.

Keywords
Interaction, consumer devices, user interface description, virtual counterparts, home-automation, X10, Slink-e, selection by pointing, laser-pointer, solar panel

INTRODUCTION
We assume that most consumer devices like TV sets, VCRs and stereos will still exist as separate devices in the near future. Each of those devices comes with its very own remote control that in principle requires reading the manual or spending some time to figure out how to operate the device. A standard PDA could often provide a better and user-friendly interface to those devices [3].

In this paper we want to show how a PDA can be used to interact with consumer devices in our environments as depicted in Figure 1. The user points with an attached laser-pointer to a device she wants to control. By doing this, the device is selected for further interaction.

The concept of device selection by pointing was proposed before in [2]. We used that concept to build a home-automation system that allows the integration of various different consumer devices that are controlled over a central server through a PDA. The real world device the user points to with the laser-pointer is used as a reference for the server to know which device to control.

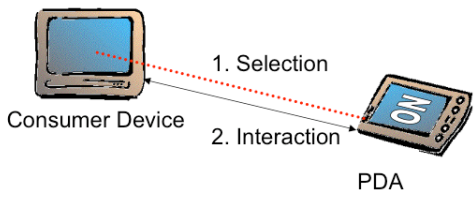

Figure 1: Selection and interaction with a consumer device by use of a PDA

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SELECTION
Interaction with a previously unknown device requires finding this device first. This might seem simple at first, but much has been done in recent years to provide a middleware that allows device discovery like Jini [8] or Salutation [7]. In those systems, devices have to register with a central lookup service to allow other devices to be found.

When the user enters a new room, her PDA could register with the discovery system and get a list of all available devices that provide some kind of service. But for the user to control any of them, she mentally needs to connect the physical device to its virtual representation. This is not an easy task as the list doesn't contain any location information, so even finding out what devices are in the same room as the user is usually not possible. Even if the physical location is known to the devices, and the list of available devices could then be reduced to all devices in the same room, this approach still leads to problems if there are multiple instances of the same type (e.g. two TV sets) in one room, requiring the user to figure out what symbolic name belongs to which device to access it through the PDA.

Using a laser-pointer to point to the surface of a device is a straightforward and out-of-band solution to the device discovery problem, allowing us to do without a discovery service.

USER INTERFACE
To allow interaction with new consumer devices without any previous setup of the PDA, a user interface description for every device is stored on the server. After device selection through the laser-pointer, the interface description is downloaded to the PDA.

Much work has been done on how to specify a user interface that abstracts from the presentation device [1]. Common to those is the separation of functionality and presentation.

For the user interface description, we have used a structured text file to describe the attributes of the actual device and its control widgets to get started. The attributes for a TV set could be power mode, volume, current channel number and current channel name. The control widget should then be a power button, channel number label, channel name label, volume plus/minus buttons and channel plus/minus buttons. In those files, the layout is fixed for a PDA form-factor. The graphical user interface is rendered using the current state of the device on the PDA.

Interaction with the device happens in a web-application-like fashion. If the user presses a button on the PDA, a request with the encoded command is sent to the server. This command is processed and a result is sent back to the PDA that triggers an update of the displayed interface. The current state of the device is always displayed on the PDA as an indirect feedback to the user action.

Figure 2: The Visor prototype

INTEGRATION OF EXISTENT CONSUMER DEVICES

As most consumer devices do not have a network connection, we chose a server based approach to control them using existent home-automation systems. This allows the PDA to communicate with the server instead of the real devices.

To abstract from the used home automations system, we used virtual counterparts for all consumer devices. Those virtual counterparts live on the server. As the real devices do not provide any status information by themselves, we used the virtual counterparts also to keep track of the real device's state and to integrate some control logic. For example, a TV set counterpart could support symbolic station names in addition to the actual channel number.

THE IMPLEMENTATION

For the control PDA we used a Handspring Visor and added a Xircom 802.11 card for wireless connectivity. A standard 802.11 base station was used in infrastructure mode to provide TCP/IP access to the Visor. We used HTTP for the communication between the PDA and the server. The laser-pointer is connected over a one transistor driver to the serial transmit pin on the HotSync connector. The power supply of the 802.11 card was used to power the laser-pointer. Figure 2 shows our extended PDA.

We used a Dell PC with a 800 MHz Pentium 3 processor and 256 MB memory running Windows 2000 for the server. To control the consumer devices, we connected the PC to a X-10 system [9] and a Slink-E device [4]. The X-10 system is a home-automation system that is able to send on/off commands to a device over the power-line. We used it to control the lighting. The Slink-e device can record and play back infrared signals like those used for consumer devices like TV sets, VCRs, DVD players and stereos, so we installed infrared transmitters in all rooms to control those devices.

To allow the selection of the consumer devices, we attached a solar panel as a receiver for the laser beam to every device and connected them to the server.

For the virtual counterparts, we used the Context Toolkit [6] and implemented them as Context Widgets.

For a more detailed version of the UbiControl system see [5].

DISCUSSION AND FUTURE WORK

We have shown that a PDA with an attached laser-pointer is well suited to select and control existent consumer devices. To achieve this functionality we used a server and provided virtual counterparts for the consumer devices. Those counterparts run on the server and can control the real devices over several proprietary home-automation systems. We further demonstrated a way to utilize a user interface markup language to provide a user interface on the mobile device.

As this approach requires a server and the wiring of those devices, we will investigate ways to build a distributed system wherein the PDA can communicate directly with the devices and no server installation is necessary.

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