Spontaneous Interaction with Everyday Devices Using a PDA

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Abstract. This paper describes a way for using a PDA to easily control everyday 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 which facilitates spontaneous interaction with everyday devices.

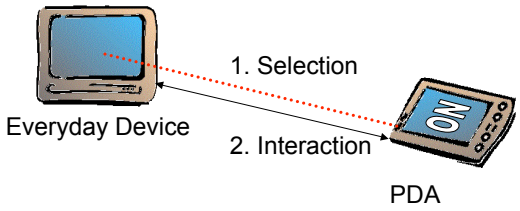

Fig. 1. Selection and interaction with an everyday device by use of a PDA

1 Introduction

We expect 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 unit that typically requires reading the user manual or spending some time to figure out how to operate the device. A standard PDA can often provide a better and more user-friendly interface to those devices [Nich01].

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In this paper we want to show how a PDA can be used to interact with everyday devices (Fig. 1). The user points with an attached laser pointer to a device she wants to control. By doing this, this device is selected for further interaction.

The concept of the device selection by pointing to a device was proposed before in [Beig99]. In previous work [Ring01] we used that concept to build a home-automation system that allows the integratation of various different and heterogeneous consumer devices which are controlled over a server through a PDA. The real world device the user would point to with the laser pointer was used as a reference for the server to know which device to control. However, this solution requires a server and an initial setup before using the system. This paper now focuses on future devices that contain a wireless network connection and can be controlled without any initial setup or a central server.

The remainder of this paper is structured as follows: Section 2 describes how the user's PDA can discover the device the user is pointing to. Section 3 shows how the user interface of this device is used on the PDA. A running prototype is described in Section 4. In Section 5 we mention improvements and possibilities for such a system.

2 Establish a connection with a device

Interaction with a previously unknown device requires finding this device first. This might seem simple at first, but much work has been devoted in the last few years to provide a middleware that enables device discovery. Examples of such systems are Jini [Sun00] or Salutation [Salu02]. In those systems, devices have to register with a central lookup service to allow other devices to be found.

When the user turns on her PDA, it 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 usually doesn't contain any location information, so even finding out what devices are in the same room as the user is not possible. Even if the physical location is known, and the list 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 a device is a straightforward and out-of-band solution to the device discovery problem, allowing us to do without any discovery service or central servers. The PDA can transmit its network ID to the device by modulating it onto the laser beam. The selected device then opens a connection to the PDA using any available wireless communication technology and allows the user to use the PDA as a control unit.

3 Providing a user interface

To allow interaction with new devices without any setup, the device's user interface description needs to be stored on the device itselfit. After the 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 [APBW+99,NMHH02]. Common to those is the separation of functionality and presentation. How to render the user interface on an actual device in an usable and aesthetic way is still an open research issue.

For the user interface description, we have used in our prototype 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 specific handheld device. The graphical user interface is rendered on the PDA using a Java application.

With our prototype, interaction with the device happens in a Web browser like fashion. If the user presses a button on the PDA, a HTTP-GET request with the encoded command is sent to the device. This command is processed on the device 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 available on the PDA as a indirect feedback to the user action.

4 Implementation

We used a Handspring Visor PDA [Hand01] and added a Xircom 802.11 card [Xirc01] for wireless connectivity. We also used a 802.11 base station in the normal infrastructure mode, so the Visor could automatically get an IP address from it. The IP address is transmitted via the laser beam to the device.

The laser pointer is connected over a one-transistor driver to the serial transmit pin on the HotSync connector. By doing this, we can easily transmit serial data over the laser beam. During the selection of a device, the IP address of the PDA is constantly sent. We encode the data in the Manchester coding scheme, so that the laser pointer is turned on at least half of the time.

To receive the laser beam signal on the device, we use a solar panel of the size 10 cm x 3 cm as depicted in Fig. 3. We chose the solar panel because of its bigger reception area compared to a photodiode, so the user is able to point the laser pointer on the solar panel from a higher distance. Even though the environment lights create a much higher voltage than the laser pointer, ambient light is either static or has a low frequency of about 50 Hz if fluorescent lights are used in the room. Using a standard high-pass filter, all ambient noise can be cancelled and the remaining laser peaks are amplified to get the serial data back.

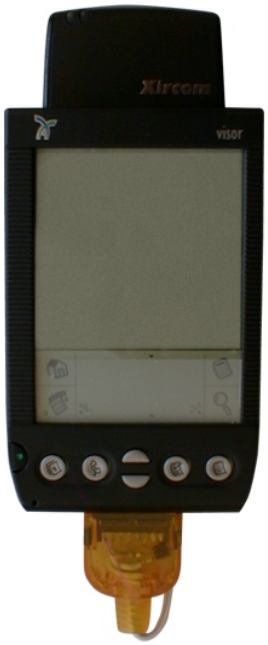

Fig. 2. The augmented PDA with wireless connectivity and an attached laser pointer (on the backside).

For our experiments, we used a normal desktop PC to decode the laser beam, communicate with the PDA and control the actual device. This functionality could easily be integrated into the everyday device as it doesn't rely on much computing power. We think that this can be accomplished by common micro-controller nodes like a Berkeley Mote [KaKP99] or a Smart-It [Smar01].

5 Outlook

As the next step, we would like to equip most of our lab devices with Smart-Its, so that hey can be controlled with the PDA, to gain a better understanding of what kind of interactions are required and what proves to be useful.

Using the laser pointer for selecting devices can simplify the setup of two or more devices that are connected together like a VCR and a TV set or projector. When trying to use the VCR for the first time, the VCR would know that an output device like a TV set or a projector is required and ask the user to point to such a device. Then both devices can exchange their profiles and work together. So the VCR could control the volume and set the channel of the TV when showing a video, or the TV could tell the VCR to record a specific program.

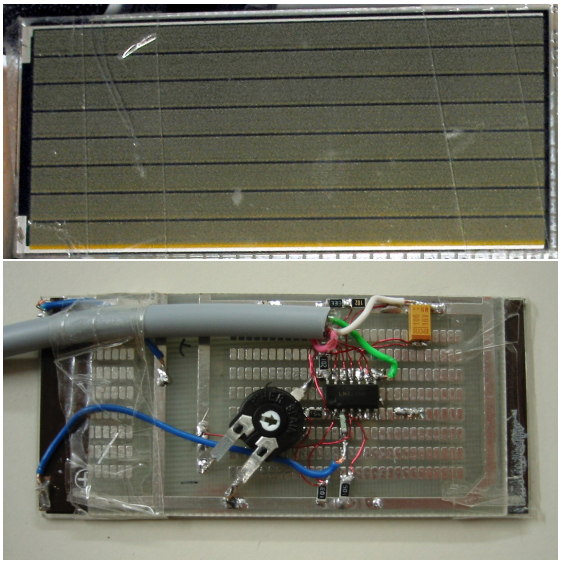

Fig. 3. Solar panel that is used as a receiver for the laser beam. On the back is a high-pass filter.

Staying with the TV set example, it would be nice to have the same user interface for all TV sets one might encounter. This can be accomplished by putting devices into categories and specifying a standard API as it has been done in the HAVi specification [Havi00]. The user interface for the TV set would then be stored on the PDA and could be customized to the user's needs such as the favorite TV stations. An agent [Früc97] could be used to build up a TV usage profile of the user, allowing the PDA to select the TV station of her favorite soap if she turns on the TV.

Other usage scenarios for the laser pointer equipped PDA would be information retrieval systems. It could be used in tour guide applications [DMCB98], where information regarding a specific location is displayed to the user. A good example might be a museum information system, where the user can get information about a specific exhibit by pointing the laser pointer to it, similar to work in the CoolTown project [KBMB+00]. Another usage might be at the train station, where pointing to the arrival board could download the timetable to the PDA and allow ticket reservation.

6 Conclusion

A PDA with an attached laser pointer is well suited to support spontaneous interaction with everyday devices in the environment. By having the PDA communicate directly with such a device, no initial setup is necessary besides pro-

viding a power supply. The required technologies already exist, they just have to be assembled in a useful fashion.

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