Personal Mobile Controller for Blind People

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ABSTRACT
We are moving towards a future where people will be surrounded by technology and multiple appliances, allowing the creation of a truly intelligent environment. However, this multitude of devices raises several issues to the HCI research area. Our preliminary studies confirmed that most devices are difficult to use by blind people, due to inappropriate interfaces. The approach described in this work tries to deal with this problem by moving the user interface from the appliances to an intermediary device, which users are familiar with and can fully control. Additionally, we propose an interface generation algorithm, which provides consistent user interfaces to all appliances in the environment.

Categories and Subject Descriptors
H5.2. [**Information Interfaces and Presentation**]: User Interfaces – *Prototyping*.

General Terms
Design, Human Factors, Algorithms.

Keywords
Blind, Controller, Interface Generation, Mobile Device.

1. INTRODUCTION
If we think about it, we usually interact with many computerized devices on our everyday live, at our homes, offices and public spaces. During the day we can easily use more than 10 different devices: microwave oven, washing machine, television, DVD player, alarm, stereo, copier machine, coffee machine, mobile phone, vending machine and mp3 player. Furthermore, recent advances on ubiquitous computing are leading us to the "Internet of Things", where digital and everyday objects can communicate with each other and the users, creating a truly intelligent environment. This scenario is particularly interesting due to the multitude of devices that users can control.

Unfortunately, all these devices have different interfaces, even for similar functions. This means that users must spend time learning all devices' interfaces, even if they are similar to other that they already know how to use.

This problem gains higher relevance for people with impairments, particularly for those with a visual impairment. While sighted users can learn how to use new devices through available visual affordances, blind users cannot access these essential cues. Furthermore, as no alternative interaction modalities are provided, the learning process is severely hindered.

Our approach consists in moving the user interface from the appliances to an intermediary device [1, 2], which is aware of users' capabilities and needs. In our work we are using mobile phones, as these have become personal objects that we use on our everyday life, and have the potential to fill the gap between technology and the target population.

2. PRELIMINARY USER STUDIES
We performed a set of interviews to assess the difficulties visually impaired users have when using electronic devices. The participants were all blind, i.e. they needed an assistive interface in order to access visual information on screen. Twenty participants at a formation center for visually impaired people volunteered for this study. Our group was composed by seven males and thirteen females with ages between 31 and 66 years old.

Figure 1 illustrates what electronic devices blind users have more difficulties controlling. While home appliances are the most used, participants stated that they can only perform a limited set of tasks with them. Because no alternative interaction modalities are provided, they had to adopt *workarounds*. The most common one was to memorize the interaction steps in order to perform a given task. However, if participants make one mistake, or an exception occurs, they may not recover from that error.

Other common *workaround* was to stick labels on the devices. This allowed participants to create tactile affordances and thus

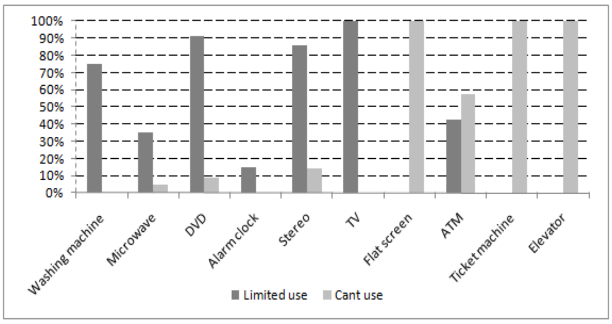

Figure 1. Interview results.

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enabling them to use those devices. As the first *workaround*, users need help from siblings or friends, at least once, and still, they are not able to fully control their devices. Participants also stated some concern about current trends on user interface design, particularly the use of touch surfaces, since this interaction modality does not provide any tactile feedback.

3. PERSONAL MOBILE CONTROLLER

The approach followed in our work can cope with all previously described problems, by moving the appliances' user interfaces to an intermediary device, which is aware of users' capabilities. When he enters an intelligent environment, his device would download the respective specification, from the server, and automatically generate an interface for controlling all appliances.

3.1 Description Language

Our server uses the DomoBus technology [3], which provides a description of all available appliances in the environment. Each appliance is described by a set of properties and each property has a type (enumerated or scalar), a value, and an access mode (read-only, write-only, and read-write). One important feature of the description language is that it does not include any specific layout information, allowing each interface generator to make its own decisions about the most appropriate interaction style (e.g. graphical or speech).

3.2 Interface Generator

The interface generator is responsible for creating the user interface. For our prototype we implemented a rule-based algorithm (Figure 2) that creates a menu hierarchy based on the environment description. Therefore, users can navigate through available appliances and respective properties and adjust their values.

If the property is an enumerated and has read-and-write access, then it is a regular property and a radio menu is created. A typical example is the power property, which is an enumerated (on and off), and only one of the options will be available for selection. If the property has read-only or write-only access, then a regular menu is created, where all options are always available. If it is a read-only property (e.g. a sensor) then a menu with no options is created, and users would only have access to the property value. Write-only properties correspond to what Nichols et al. [2] called "commands". A command is a parameter-less function that will alter the internal state of an appliance but whose result cannot be known in advance (e.g. fast forward on a DVD player).

On the other hand, if the property is a scalar, and has read-and-write or write-only access, then an edition menu is created. This menu consists of two buttons, increase and decrease, and a text box, allowing users to sequentially change the property's value or set a specific value.

```
If (property.type == enum) //enumerated
Then    If (property.type.access == RW)
        Then CreateRadioMenu()//RW
        Else CreateMenu() //RO or WO
Else    If (property.type.access != RO)//scalar
        Then CreateEditionMenu() //RW or WO
        Else CreateMenu()//RO
```

Figure 2. Pseudo-code of the generation algorithm.

All user interfaces, independently of the environment description, are generated based on the previously described set of rules, offering consistent interfaces and navigation methods for all appliances.

4. ONGOING AND FUTURE WORK

In order to validate our approach, we built a mobile prototype. It was developed in C# for the Windows Mobile platform and we used a speech synthesis package provided by Loquendo. The mobile phone used was the HTC S310. The implementation of our interface generation algorithm allows blind users to navigate the menu hierarchy using the mobile device's joystick, and provide auditory feedback (speech and non-speech). Additionally, in order to validate our approach, we develop an appliance behavior simulator.

Preliminary results showed that users can easily explore the environment and control the appliances, using the mobile device. However, minor adjustments will be made. Particularly, the appliances' description language [3] will suffer some improvements. We will add information about the relationship between the appliances' properties, thus enhancing the application usability (e.g. when a stereo is turned off, all options would be disabled except the turn on option).

Also, we intend to build a fully functional system, which will allow our server to communicate with real appliances. The last, but most important, we will evaluate our prototype in a real life scenario, with the target population. This will allow us to assess the robustness of our generation algorithm in coping with multiple appliances' descriptions and its overall usability.

5. CONCLUSIONS

The approach presented in this paper consists in moving the interface from appliances to a mobile device, which users are familiar with and know how to use. Our preliminary studies confirmed the usefulness of this approach with the target population. Moreover, we built an algorithm for automatically generate menu-based user interfaces from DomoBus appliances' specification, and developed a prototype that takes into account blind users' needs and capabilities, providing auditory feedback.

6. ACKNOWLEDGMENTS

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7. REFERENCES

[1] Emiliani, L. and Stephanidis, C. 2005. Universal access to ambient intelligence environments: Opportunities and challenges for people with disabilities. In IBM Systems Journal No. 3, 605—619.

[2] Nichols, J. and Myers, B.A. and Rothrock, B. 2006. UNIFORM: automatically generating consistent remote control user interfaces. In Proceedings of the SIGCHI. ACM Press, 611-620.

[3] Nunes, R. 2003. DomoBus – A New Approach to Home Automation, In Proceedings of the 8^{th} International Congress on Electric Engineering, Portugal, 19.