Using Handhelds as Controls for Everyday Appliances: A Paper Prototype Study

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ABSTRACT
Everyday appliances, including telephones, copiers, and home stereos, increasingly contain embedded computers which enable greater functionality. If the interfaces to these appliances were easy to use, people might benefit from these new functions. Unfortunately, it is rare to find a well-designed appliance interface. This study shows that existing appliance interfaces could be improved by using a remote control interface on a handheld computer.

Keywords: Handheld computers, remote control, appliance, Pebbles

INTRODUCTION
The problem with many appliances is that they are too complex. Some appliances need thirty or more buttons to cover all of their functions. This complexity can even make relatively simple tasks, like setting the clock on a VCR, so difficult that people avoid them.

Most appliances do not provide unambiguous feedback to users. Indicators of appliance state can be confusing. For example, on a stereo that combines a CD and tape player, it may be difficult to decide whether a circling arrow means that the CD will repeat, the tape will repeat, or both. Feedback also must be given in response to operation so that the users know exactly what they are doing. As an example, it can be difficult to tell if a single beep is intended as positive or negative feedback. These problems can be corrected with careful design, but appliance manufacturers seem to be unwilling to spend the money to build quality interfaces.

Consistency of the interface is also an issue for users of many similar appliances. A few standard conventions have been developed, the telephone number pad for example, but for most appliances each manufacturer sets their own interface conventions. These conventions can be very volatile, sometimes changing with each new model. Users waste needless time at unfamiliar appliances learning to perform tasks they already understand on a different appliance.

Some of these problems may be solved using personal handheld computers as intermediary interfaces to our appliances. Complex interfaces could be divided into functional chunks that are displayed as separate panels on the handheld with text to explain confusing features. Wizards or dialog boxes can ease complex step-by-step tasks. Using the same interface for appliances of the same type could solve the problem of consistency, although minor modifications would be needed to ensure functional completeness on every appliance.

This paper summarizes a study which shows that hand-designed interfaces for handhelds can outperform existing interfaces for two common appliances: the Aiwa CX-NMT70 shelf stereo with its remote control and the AT&T 1825 telephone/answering machine. We chose these two appliances because both are common and combine several functions into a single unit. We have designed interfaces for the Palm handheld computer that cover all the features of these appliances. Here we present data showing that our Palm interfaces perform better than what currently exists.

STUDY
Our study is a between-subjects comparison of a Palm handheld interface with the interface to an actual appliance. Paper prototypes [4] are used instead of Palm devices because a software implementation has not yet been completed. Subjects were asked to work through one list of tasks for the stereo and another list for the phone. One set of subjects worked on the actual stereo and the prototype interface for the phone, while the others worked on the actual phone and prototype for the stereo. We recorded the number of missteps and the number of times external help was required while the tasks were performed.

We anticipated that some subjects would not be able to complete some of the more difficult tasks. If a subject gave up while working with the actual phone or stereo, they were given the user manual and asked to complete the task. Subjects working on the paper prototype were required to press the “help” button, available on nearly every screen, to get a verbal hint of how to proceed.

Thirteen Carnegie Mellon graduate students, five female and eight male, volunteered to participate as subjects. All subjects were enrolled in the School of Computer Science. All had significant computer experience and seven owned Palm devices at the time of the study. Only one subject had no Palm experience and the remaining five had exposure to Palm devices in class or through friends. Everyone in the group had some experience with stereo systems. Only two did not have a stereo. Four subjects happened to own a stereo of the same brand used in this study.

RESULTS

The results of the study indicate (all $p < 0.001$) that subjects made fewer missteps and asked for help less using the prototype handheld interfaces than using the actual appliances (see Figure 1). This indicates that the prototype handheld interfaces were more intuitive to use than the actual interfaces.

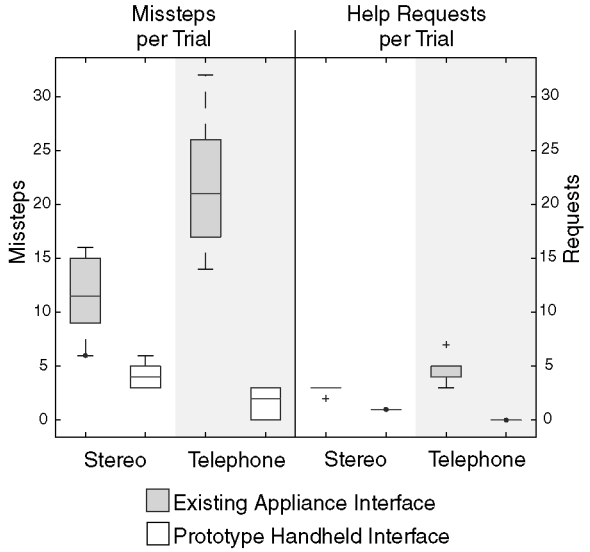

Figure 1. Box-and-whisker plots showing the range of missteps and help requests for each appliance and interface type.

DISCUSSION

The problems that users had with the existing interfaces were mainly due to poorly labeled buttons and inadequate feedback. The worst examples of poorly labeled buttons were found on the AT&T phone. This phone has several buttons that can be pressed and released to activate one function and be pressed and held to activate another function. There is no text on the appliance to indicate this.

A similar problem is also encountered on the stereo. Setting the timer requires the user to press a combination of buttons, each button press within four seconds of the last. The stereo does not display an indicator to warn of this restriction, and often users were confused when a prompt would disappear when they had not acted quickly enough.

The phone also suffered from an underlying technical separation between the telephone and the answering machine. None of the buttons on the phone can be used with the answering machine. Even the numeric codes must be set using arrow buttons rather than the keypad. All but one subject tried to use the keypad buttons to set the code. The one exception read the user manual.

In general the prototype handheld interfaces were more intuitive. Informal measurements of time indicate that subjects needed half as much time to complete tasks on the prototype interface. This difference can be accounted for in part by the large number of times subjects needed help with a task using the existing interface versus the paper prototype. With the exception of one situation, subjects never asked for help using the paper prototype.

The one exception was that all subjects asked for help once while using the prototype stereo interface. This interface places 'global' setup, such as for the clock and audio settings, in the Palm's built-in menu system. A Palm user accesses this system through the "menu" button, which is located near the Graffiti pad. None of the subjects in our study found this feature without pressing the "help" button and being prompted. This may be because the test was conducted on a paper prototype and the subjects were not considering the rest of the Palm, even though it was shown as a part of the interface.

RELATED WORK

There are several groups working on controlling appliances from handheld devices. Researchers at Stanford have explored several methods of integrating handheld devices into the iRoom [1], an interactive workspace. Handhelds are used to control information screens that are displayed around the room. It is also possible to control the room itself through a web browser installed on a handheld. Projectors and lights can be turned on and off, for example.

A part of the Xweb [3] project is working to create technologies that can create customized interfaces that are appropriate to the interests of the user. The goal is to separate the functionality of the appliance from the device upon which it is displayed.

FUTURE WORK

Our next goal is to create an interface generator that can build high-quality user interfaces as good as the paper prototypes that we have tested. This generator will be built in a general way that flexibly handles different screen dimensions and input mechanisms. Unlike previous work in interface generation, we will create a specification language based on observations from our hand-designed interfaces. This will ensure that the information needed to create a high-quality interface will be embedded in our specification language. If we can generate interfaces that are as good as our prototypes, this study shows that the interfaces will be better than those used on existing appliances.

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