Designing a Perceptive Smart Room Interface

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Recent interest in perceptive user interfaces has included the idea of sketching as a natural form of interaction between a user and a computer. My work seeks to extend the sketch metaphor to allow control of a smart room through a sketch interface.

Introduction

When designing interactive environments for co-located collaboration, a number of challenges present themselves. One particular challenge facing designers of such interactive environments involves interaction to control the behavior of these environments. The process of controlling these environments must not place a burden on users. Many authors note that if control is burdensome, then the environments become less usable, and the affordances provided by a computationally enabled environment are not accessed by the users. Users, instead, choose to use traditional devices (whiteboard and paper) which are easier to control [2, 1].

One approach to solving this problem, promoted by Tandler et al., is the creation of a set of devices, specialized to a collaborative environment, which automatically perform control operations, specifically connecting to and disconnecting from each other to create dynamic shared workspaces based on proximity [2]. This approach allows a user to avoid involvement in control processes for devices that are specifically designed for the environment and contain sensors; however, devices which are added dynamically to the environment (such as laptops computers, PDAs, tablet computers, etc.) are neglected. Another problem with this approach is that physical proximity is often not the only cue to collaboration. In larger groups, an individual wishing to place information on a wall sized display may not be closer to the display than other participants.

A second approach is to create specialized user interfaces for the environment, but this often creates a barrier to usability. Guimbretiere et al. note this in the design of their interface for wall-sized displays. Users were given a one hour training session, and it was not enough time for them to master the interface [1]. The need for training is a significant barrier, particularly for occasional users of interactive environments.

Obviously, there is a need for a better solution to the problem of interaction with and control of an interactive environment, be it a building or a room. The solution

proposed here seeks inspiration from work done in Perceptive User Interfaces (PUIs). A number of different types of these interfaces exist, including speech interfaces, computer vision interfaces and sketch-based interfaces. There are characteristics of sketches that recommend sketch-based interfaces as a means of interacting with a smart room.

Why Sketches?

There are three reasons which lead me to examine sketches as a means of interaction. The first reason is historical. A significant body of work exists in sketch recognition, and this work can be leveraged in an interface. In recognition of formal sketches (those created with a specific diagram notation), systems have been designed for UML, Math, Engineering diagrams, and others [3, 4]. In informal sketches (those sketches created without strong notational constraints), techniques such as perceptual organization are gaining favor as a means of performing low-level structuring operations which can be used as a basis for extracting meaning [5].

The second reason is pragmatic. When we discuss collaborative environments which contain wall sized displays, tabletop displays, and PDA devices, we see that many of these devices have pen interfaces. This naturally leads to sketching as a form of interaction. It is a natural activity to which a pen interface is well-suited.

Finally, speech and computer vision interfaces face significant barriers. In meetings, speech interfaces are awkward. They are public, which is inconvenient if you want to form a private group surreptitiously, and it is difficult to separate control commands from regular group discussion. Computer vision, particularly in the area of tracking, still needs refinement if it is to be accurate enough to control an interactive environment with a large number of participants. There is also a risk with computer vision based interfaces of not correctly interpreting a user's intentions. For example, consider the problem mentioned earlier using proximity as a measure of interest in collaboration.

Status of Research

My research is admittedly at a very early stage. There are a number of problems to address in my research, including:

1. Is sketching a natural form of interaction for users of a smart room?
2. What type of sketches do users draw?
3. Are the sketches drawn by users recognizable even if the users are untrained?
4. Can we design recognizers to interpret these sketches?

Whether sketching is a natural form of interaction is an open question. My motivation for exploring sketches is based on an academic interest in the recognition of both formal and informal sketches. However, there is reason to believe, from user

trials we have conducted, that sketches are a form of interaction which users are able to grasp [6].

We also note similarity between users in how they draw sketches. Over ¾ of our user population drew connector and container diagrams. This is admittedly influenced by the tasks that are available in our smart room. Tasks include the connecting of devices together to create shared control displays, the transfer of information between devices, and the control of environmental elements such as lights and speakers. The fact that connector and container diagrams were drawn without prompting is still significant, as these sketches are much easier to recognize. Three of our twenty-eight users drew icons to describe actions, which creates a more significant recognition problem if we choose to support this type of sketching [6].

Biographical Sketch Including Research Activities

Edward Lank is an assistant professor of computer science at San Francisco State University and a consultant with the Perceptual Document Analysis Area in the Systems and Practices Lab at the Palo Alto Research Center, Inc. He received his Ph.D. in Computer Science from Queen's University, Kingston, Canada, in 2001. His research interests include pen-based diagram and sketch recognition, the application of pattern recognition techniques to pen input to create more natural forms of interaction, and the novel use of sketches as input to computers.

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