Moving Data and Interfaces in an Interactive Workspace

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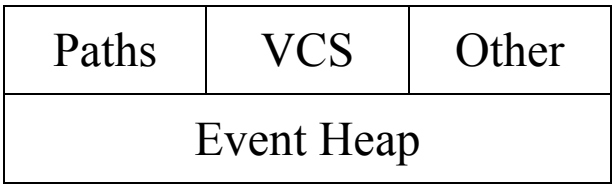
Overview

The Interactive Workspaces Project at Stanford is investigating a world in which people will interact with rich environments with many computing devices. We imagine spaces filled with large high resolution displays with touch input, video cameras, speakers, and microphones as well as more traditional input devices like mice and keyboards. People will also carry with them a variety of mobile, wirelessly connected devices. These spaces will need to be dynamically configurable. Displays and speakers may be shifted around, or new devices added to the environment at the users discretion, and mobile devices will be constantly entering and leaving any given area. Further, to allow the use of existing devices and software, the infrastructure driving these spaces must allow the integration of legacy hardware and software.

We believe three metaphors will define such a world: the ability to dynamically compose both legacy and new single device applications together to form workspace wide interaction environments, the need to move information freely between devices, and the need to move interfaces for applications onto the most convenient device. The first metaphor might be needed to coordinate the highlighting of information within a spreadsheet on one display and a related 3d model in a custom application on another. An example for the latter two metaphors: a user should be able to display a 3D model from their PDA on a large high resolution display nearby, and control it using direct touch manipulation, voice or their PDA as they see fit.



Component Interaction Model

The Interactive Room in Use

While most research into ubiquitous computing addresses either devices embedded in the environment or portable computing devices, our infrastructure attempts to address both modalities simultaneously. The system is designed to be a development environment that allows individual devices and applications, both new and legacy, to function together as an interactive workspace, and allow the easy implementation and investigation of new ways of using Interactive Workspaces. The infrastructure consists of three main parts, the Event Heap which is an underlying communication mechanism used for coarse coordination in the workspace, and Paths and the Virtual Controller System (VCS) which use the Event Heap and allow for the

transformation and movement of information and interfaces (see figure). The three metaphors are supported by one or more of these infrastructure pieces.

Dynamic Application Composability Through the Event Heap

The first infrastructure piece is the Event Heap, which is a tuple space based model of communicating between devices. Since an intermediate space is used for communication, devices need not know about each other ahead of time, and the addition or removal of devices from an Interactive Workspace does not cause failure in the workspace as a whole. This mechanism provides for the dynamic environment that we foresee.

Applications which use the Event Heap can be composed together easily if they use the same event types. State information can be broadcast by posting an event which will be picked up and used by all other applications in the workspace that understand that event. Event types generated by older applications can also be snooped upon by newer applications which can use the information they see to coordinate applications in a workspace.

Moving Data with Paths

The second infrastructure is data transformation paths [1], which were presented earlier in a HUC 2000 paper session. This system allows a user to specify any piece of data, then automatically constructs a set of transformations which will allow that data to be viewed (or output, if sound) on another specified output device. The Event Heap may be used at various points in the transformation path to provide feedback for data which is being dynamically manipulated.

Moving Interfaces with the Virtual Controller System

The final piece is the Virtual Controller System, which provides functionality similar to the data paths for interfaces. Given an application that can be controlled, the virtual application controller will display the appropriate interface for a given input device which is specified by the user. If a custom interface doesn't exist for the desired device, a basic one is created according to pre-specified rules for the given output device. The Event Heap is used to advertise controllable entities and for the actual controlling of the entities by constructed interfaces.

Conclusion

We have identified three major metaphors for how Interactive Workspaces will be used: composing multiple single device applications together, moving data, and moving information. In order to investigate these metaphors and how they will be used in real scenarios we have developed three key pieces of infrastructure to facilitate implementation and experimentation. The Event Heap provides a coarse communication mechanism that is robust to failure. Data paths allow the transformation of data for display on different devices without custom coding. Finally, the Virtual Controller System makes it easy to construct scenarios which put the interface to an application on any of a number of devices someone in a workspace might desire to use.

References

1. Emre Kiciman and Armando Fox. *Using Dynamic Mediation to Integrate COTS Entities in a Ubiquitous Computing Environment*. To appear in Second International Symposium on Handheld and Ubiquitous Computing (HUC2k), Sep 2000.