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A Single Display Groupware Widget Set

Ana Zanella
Department of Computer Science
University of Calgary
2500 University Dr NW
T2N 1N4
+1 403 220-7686
azanella@cpsc.ucalgary.ca

Saul Greenberg
Department of Computer Science
University of Calgary
2500 University Dr NW
T2N 1N4
+1 403 220-6087
saul@cpsc.ucalgary.ca

ABSTRACT

Our research concerns the design of a widget set that directly supports Single Display Groupware (SDG) applications that have Multiple Input Devices (MID). In this paper, we present some of the issues related to SDG development and describe why existing widgets and interface components are not appropriate to SDG application. Because this work is still in its early stages, no solutions are presented in this paper. Rather, we present a research proposal that describes the specific problems we will be dealing with as well as initial steps to solving the problem.

Keywords

Widget design, single display groupware, multiple input devices, computer supported cooperative work

1. INTRODUCTION

Single Display Groupware is a class of applications that supports multiple simultaneous users interacting in the same room on a single shared display, ideally using multiple input devices [24]. While SDG is not new — we see SDG systems in commercial use for entertainment, education, and software engineering — it is still only lightly explored as a research area within Computer Supported Cooperative Work (CSCW). Instead, CSCW researchers concentrate on supporting people working together from different locations.

SDG deals with applications in which people are sharing the same screen and therefore the same visual screen components with other people in the environment. Of course, we can do this now with conventional computers: people can sit around a display (whether a large screen or projected image) and use a single mouse and a keyboard to input data to the computer. The problem is that the input device has to be shared, and people have to take turns, perhaps even moving around and changing places. This can be awkward and difficult when people are trying to cooperate and interact with the system. For example, researchers have noted that children in a group who are playing a game on a shared computer may sometimes resist sharing by hogging the input device [6] [12] [24].

Sharing single input devices has more subtle aspects to it. For example, it can change the notion of 'who is in control'. Some researchers have observed that when several people are working on the same computer, the person who is operating the input device is not the person in charge [14]. Often, what happens is that this person usually follows orders, where they perform activities requested by people seated close by. Consequently, when the person operating the input device is executing a task on their own it is because others have lost interest in it and are doing something else [24].

The basic problem is that conventional computers and operating systems have been designed to give support to only one user on each machine. Small screens are difficult to gather around [9]; the single mouse and keyboard are passed around only with effort; simultaneous input is almost impossible. At the systems and hardware level, there is little or no support given to co-located people who share a display.

What makes SDG truly different from the above situation is that:

- every person has their own input device that they can use to interact with the application:
- the software is aware of this: it knows who is doing what, and responds accordingly.

As examples there are several systems that provide a large electronic shared display (e.g., the size of a whiteboard) that people can use to review software design solutions: different members can write down notes, brainstorm ideas, or modify the design simultaneously using multiple input devices [23] [19] [7] [14]. Similarly, two or more children can simultaneously play a game on the same computer using several mice or joystick (this is now done with many specialized computer hardware devices for games, such as Nintendo 64), edit a story or a draw a picture together [24].

From a human factors point of view, there is nothing unusual about this situation. Tang, for example, noticed that people sharing visual displays such as tabletops and whiteboards often gesture and make marks simultaneously over the surface [26][27]. The 'multiple input devices' in this case are, of course, people's hands and their pens.

In summary, the main objective of SDG applications is to support the way people work on the same computer at the same time. SDG should make it easy for people to share information, and to collaborate over a task. It should let people interact in a simple and effective way, which includes simultaneous input. To do this, SDG must provide multiple input devices (MID), as well as interaction techniques (or widgets) that afford simultaneous input. Before exploring how this can be done, we will first provide some background on SDG applications (Section 2). Section 3 will list several issues that appear when specifying and implementing SDG. We then rephrase the problem as a research area, and close by describing our initial forays into it.

2. TYPES OF SDG APPLICATIONS

Research in SDG has been performed in areas such as children's applications, meeting tools, shared editors and multiple input device systems.

Perhaps the largest body of SDG research is on systems supporting interacting children, typically educational applications or games and entertainment applications [1] [6] [12] [3] [4] [24] [25] [13]. For example, educational editors enable children's cooperation by supporting drawing while games often encourage competitive rather than cooperative interaction. Various studies found that children using a single mouse application tend to fight for the control of the device, where the one not controlling the mouse usually gives orders to his or her partner regarding tasks to be executed [24] [25] [12] [6] [3] [4]. However, holding the input device affects the feeling of involvement. When one child stays without the input device, he or she shows more off-task behavior than the child holding the device.

Tang studied how people use traditional shared displays such whiteboards and tabletops. He observed that small groups working co-located gesture simultaneously the majority of time [26] [27]. Also informal talking and face expressions are other important actions observed in the process. Gesturing, talking and observing other's expressions are difficult actions to support in computer systems.

Stefik [23] and Tatar [28] studied the use of multiple and single displays in meeting systems. The studies show that when people are working together in the same room and sharing a single output device they concentrate more on the task than when the users have their own separate display. Even when users have to take turns to input data, sharing a single display enhances the collaboration.

SDG editors allow co-located people to edit data simultaneously through multiple input devices [11] [14] [16] [20] [21]. For example, MMM (Multi-Device, Multi-User, Multi-Editor) [2] was one of the first SDG environments. It emphasized the use of up to three mice, where people could simultaneously interact with the editor and input data. The users shared a single display. MMM supported editing of text and rectangles and used object colors to distinguish between different users.

Specific support for formal meetings activities is another focus of research on SDG. These applications emphasize the idea of people creating some material or reviewing shared information via structured or semi-structured process[8] [9] [11]. Examples include software diagrams and brainstorm sessions. Davis [5], for example, presents a system that maintains notes taken during a meeting using Palm Pilots, which are then stored and made available to others through a WWW based repository.

Research on software supporting multiple input devices is based on hardware and architecture issues for connecting extra input devices to a system, such as multiple mice, keyboards or personal digital assistants (for example, Palm Pilots and Windows CE Devices). Robertson uses Palm Pilots to control a TV[22]. Myers used Palm Pilots as a input device to aid the user in repetitive activities such as scrolling the screen or controlling PowerPoint presentations [17] [18]. Studies show that providing multiple input devices enhances the collaboration and the interaction among the users [1] [16] [17] [2] [24] [12] [11]. However, in most of this systems provide one type of input device, even though all agree that having different types of devices could be even more beneficial to the whole cooperative process. This is because in different situations one type of device can be more appropriate than other. For example, a keyboard is more appropriate than a mouse when there is massive text input on the application; using a PDA the user has an extra and private display and can maintain private information.

3. SOME TECHNICAL ISSUES IN SDG DESIGN AND IMPLEMENTATION

Several technical issues appear when specifying and implementing SDG applications with multiple input devices. These include: identifying users' devices and users' work, providing widgets that recognize and respond to actions of different users; providing interface elements that avoid interference in others' work and displaying the global status of all users of the system. A secondary problem is how to adapt conventional groupware applications so they can support SDG and multiple input devices.

3.1 Identifying users' device and users' work

SDG assumes that every person has his or her own input device. An obvious implication is that the system should be able to support multiple devices, that the software must be able to identify individual devices, and that (at some level) a user can be associated with particular devices and its input data. Another fundamental requirement is that the system has to control and handle simultaneous inputs by several users. While some systems get around this by insisting on turn taking, we believe it would inhibit natural social interaction that includes simultaneity [26] [27].

While there are systems that use a homogeneous set of input devices (e.g., multiple mice [1]) we expect that an effective SDG system will allow different people to use different input devices. Each person may have at their disposal different combinations of mice, keyboard, joystick, and even a personal digital assistant (such as a Palm Pilot or a Windows CE machine). Consequently, the system should be designed to handle and support heterogeneous devices working concurrently. There have been some attempts to address this: some SDG systems support several mice [2]; others enable input to be done using Palm Pilots [14]. We are aware of only one system that allows both mouse and PDA [17].

3.2 Providing widgets that recognize and respond to actions of different users.

In SDG applications users are not only sharing the same display but the same interface components as well. This may include widgets such as menus, buttons, dialog boxes, etc.

Widgets in single user applications can be selected only one at a time. It is not possible to select the drawing tool and text tool at the same time. Also, some widgets can only be accessed in a certain order; for example, paste is only possible after copying or cutting actions. Besides, some buttons can not be pressed in some situations, such as, changing the font type if the user is drawing.

This is a problem in SDG because individual users may be in different modes and using different functions of the application at the same time. For example, multiple users of an SDG drawing editor who choose different tools, colors and styles as they work will be in different drawing modes. One user may want to be in a mode where he can draw a red circle, while another may want to write text using a different color. Problem can also happen if one user selects and copies a part of the drawing and other user selects the button to paste it, so the widgets selected must correctly identify which user has selected it and respond accordly..

In this sense, the widgets must be designed for several users and the system has to identify and handle the mode each user is in, for example drawing a line in red, inputting text in black, adding a comment in green, suggesting a change to the information, etc. Existing tool palettes don't support the multiple modes required, because there is only one 'global' notion of mode. Similarly, they cannot provide feedback that shows how different people are in different modes. Thus new interface techniques must be developed for SDG applications [2]. While these may be inspired by conventional interface widgets, we expect that they will have to be completely redesigned.

3.3 Designing displays to avoid user's interference

Another problem related to SDG interfaces is that several types of interface widgets can, when used by one person, create interference in another person's work. If one person raises a menu, for example, another person is blocked from seeing or working on whatever is behind it. Similarly, dialog boxes (especially modal ones) may block others from continuing their work. Thus the use of some classical interface widgets can be distracting and confusing during collaborative work,. These too must be redesigned (perhaps quite radically) to make them work within SDG applications.

3.4 Providing awareness of the other users' work

People should be able to maintain awareness of other users' status, such as their current mode and preferences, in order to better understand the overall collaborating process. Having every user in the same room is not enough to understand the cooperation and the involvement of each user in the specific activity being performed; so designing the system to handle this can improve the users awareness of the task.

3.5 Redesigning conventional applications

Another important issue is related to the significant changes that have to be done in conventional applications in order to support SDG. For example, we would have to add functionality to a drawing editor for multiple selection of drawing tools and different drawing modes. In a presentation system, it should be possible for every user to annotate slides simultaneously, to identify each user's annotations, and so on.

Innovative interface techniques must be developed for MID based SDG applications. While these may be inspired by conventional interface widgets and conventional CSCW interaction model, we expect that they will have to be significantly redesigned.

4. AREA OF RESEARCH

The main objective of my research is to design and develop MID-based SDG that naturally and effectively support people in both their individual and collective work. Specifically, we will define and implement a set of interface techniques (or widgets) that are appropriate to SDG applications. At its most basic, the task scenario for this design includes a group of people working together on a task, where the task will involve them moving between their individual and collaborative group work as warranted by the situation.

This is still early work, and much has to be done to develop the detailed methodology necessary to achieve this objective. However, there are three obvious steps that must be done to begin and carry through this work.

1. Build or use an already developed architecture that supports multiple input devices;
2. Build a device-aware widget set that addresses the human factors of SDG and that can be used to rapidly prototype SDG systems;
3. Evaluate various widgets by studying how people use these widgets and multiple input devices in different kinds of applications, and how they affect the collaborative process as a whole.

My primary research interest is in the development of device-aware widgets, where I expect to propose and investigate different widget designs based on real user needs. However, the first topic is important, as it will provide the architecture necessary for rapidly building different widget designs. The second and third topics are very related to each other, because the evaluation of the widgets will be made observing people using the widgets. Problems reported by the users and feedback about the usage will be used to improve the widgets.

4.1 Architecture to support multiple input devices

A serious technical problem is that conventional operating systems and applications only supply a single input device, which is inappropriate for SDG. The solution is to create or use an already developed architecture that supports multiple input devices, which can give better support for SDG applications development.

Research goals are to define how different input devices should communicate to and from the SDG system, how the SDG system should deal with these devices, and how we can encapsulate any solutions into the architecture. The overall goal is that the architecture should make it easier to build general SDG applications.

The architecture should have the following characteristics:

- Appropriate support of different kinds of input devices such as mice, PDA's, touch screen, etc. to work together simultaneously in the same application;
- Effective interaction between several input devices and the SDG system, and vice-versa;
- Easy to program API for SDG development.

Fortunately, there has already been some work in this area [2] [11] [16]. Because architecture is a secondary interest in my research, I will evaluate existing platforms. We will develop or modify an architecture from scratch only if existing platforms are inadequate for our research purposes.

4.2 Widget Set

The second part of my research will concentrate on developing a widget set that support multiple input devices, that are device aware, and that supports expected human behavior over a collaborative space. Some of the aspects that should be addressed are:

- Recognizing different types of input devices in the system;
- Assigning input devices to a user in the system and managing them;
- Appropriate management of widgets and interface components such as menus, icons, shortcuts, etc. so users do not interfere in others' work and cooperate in a natural way;
- Managing simultaneous input by several users and devices;
- Dealing with personal and public information in the system [10];
- Most importantly, supporting people's typical behaviors when collaborating together over a shared visual surface.

This is the most important part of the research, and several design solutions should be used to develop the widgets. The developed widgets should be tested during the next phase of my research, based on the evaluation of people's behavior using the widgets.

4.3 Study the behavior of people when using multiple input device applications

Evaluating widgets is crucial for understanding design deficiencies, as well as for knowing if we have developed effective solutions. We will study how people behave when they use SDG and multiple input device applications, implemented using the device aware widgets described in the previous section. We will look for patterns of collaboration, problems related to SDG application use, and different kinds of reaction people have to them. We will compare the use of classical systems and SDG systems to see how people change their behaviors, their collaboration and their interaction.

The main objective is to test the widget developed, and to find out people's behavior when interacting with each other using different kinds of SDG. Observing people's behavior can produce feedback for redesigning the widgets, in order to make them more natural to use. Example systems to be used by people include design review tools, editors, meeting tools and games.

The kinds of reaction/behavior we expect to observe are:

- How people collaborate using multiple input devices;
- How people interact to each other in the SDG system and outside the system, that is how much the system enhance the collaboration process;
- The quality of the collaboration and how it affects the results of the process;
- How different SDG systems affect the collaboration process.

5. CURRENT PROGRESS

Our research in Single Display Groupware is just beginning. To prepare ourselves, we are pursuing the following activities:

- Complete a literature review;
- Analyze current SDG applications in different areas;
- Analyze current SDG architectures;
- Develop Windows CE programming skills in order to program CE devices to be used as input device;
- Develop device-aware widgets for SDG applications;
- Identify SDG applications that use multiple input devices, and build them using a SDG architecture;
- Test SDG applications that use the developed widgets, in order to analyze people's behavior.

6. CONCLUSIONS

Collaboration benefits when participants are co-located, as opposed to distributed, because people tend to gesture and talk more, face and body expressions are easily percept by others, and people tend to interact more since they can see each other. Existing hardware and software systems were designed with individual usage in mind, and so fail to adequately support co-located collaboration.

Research studies concentrate in problems related to the interface design and the usage of multiple input devices. It is important for an SDG system to provide: an interface that can respond appropriately to several users doing different activities; identify and distinguish between different input devices; display modes that particular users are in; and, display the global status of all users of the system. In this sense, adapting conventional groupware applications to SDG requires substantial changes.

Our research will focus on developing a MID-based SDG that naturally and effectively support people interacting while engaged in co-located activities. We will define and implement a set of interface or widgets that are appropriate to SDG applications. To achieve the objectives we will define or use and already existing SDG architecture, that would allow fast building of different widget designs. We also plan to test and evaluate the widgets observing how people use them in order to refine the design solutions and provide appropriated support for SDG applications.

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