The next digital desktop environment

New methods and tools for integrating digital and physical elements in meetings, informal collaboration and other workgroup activities

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Abstract: We designed and developed an environment based on a digital desktop that provides computer support for desktop activities while respecting the traditional tools, workflow and habits of these environments. As the desktop is an essential collaboration space, we especially focused on enhancing the collaboration and sharing of information between co-located and remote users in an environment that integrates their personal devices and tools. We are not trying to create an experimental platform or a sandbox for testing new features, but to create a consolidated standard environment easily usable for every day activities around the desktop.

Key words: Natural interface, computer supported collaborative work, interaction design

1. Introduction

1.1 Research concept

There are desktops in most of the workspaces of modern human activities. In these workspaces the desktop is also frequently a platform for collaboration, because it is the main space in which we meet and work together or share information. With today's technologies, even when the users are in different locations we can use audio or video communications for interact with remote partners or interchange files, always by using a computer system. But though this omnipresence in the workspaces, the desktop is usually a passive element around where we use other physical and digital tools. For example, the simplest exchange of information between users, independently if they are co-located or not, usually requires complex interactions with computers, scanners, and cameras.

We propose a digital desktop (a traditional desktop which detects user interaction and projects information on its surface) as a support system for enhancing the activities performed around the desktop with computer features, focusing on the collaboration and information exchange. The support features were designed or improved after a field research in traditional desktop environments and provide support for increasing the productivity, the efficiency and improving the users experience in global.

We did not try to modify how the activities are performed around the desktop but to create a support system adapted to the traditional workflow, tools and customs.

1.2 Background

The current version of our environment is the result of the evolution of a digital desktop system that we are developing [13] [2] in our laboratory. Early in the development, we acknowledged the importance of the integration of physical documents and tools with digital information on tabletops; therefore we included a customizable set of physical tools in the workspace [1] and the possibility of interacting with real documents.

Studying the background of tabletops environments, some researches include systems that try to mimic the experience of a real desktop [4], support co-located or remote collaboration [6][7] or add new features as document management [10].

More recently, systems as SketchSpace [3] or ReacTable [8] explored ways of interacting with physical objects in a tabletop for testing prototypes and music creation respectively. ToolDevices [11] are physical tools, often similar to real tools, for manipulating digital information directly in a tabletop environment.

Using traditional external devices with a tabletop system to input text or pointing has been also researched in studies like [5]. The system described in [9] also uses a small tabletop environment combined with personal devices and remote collaboration oriented to a specific task. Steimle [12] studied how digital and physical documents are arranged around the workspaces, demonstrating that users can work flexibly with both types of elements in the same workspace.

McAdam studied how to use smartphones in tabletops for typing or interacting in the workspace [14]. Our system uses a similar approach for external devices as we provide a similar connection, but more open (not limited to smartphones) and complete (full access to the system functions).

Summarizing, most of these systems are designed for specific tasks (music creation, painting, etc.) and some are only suitable for research or experimental purposes. In contrast, we are trying to create a system for generic use, valid for everyday tasks. Another common point of most of these systems is that the available workspace is small compared to those of the traditional desktops, being usually even smaller than a personal desktop. Also tabletops that allow the users to place arbitrary objects on them are not so common.

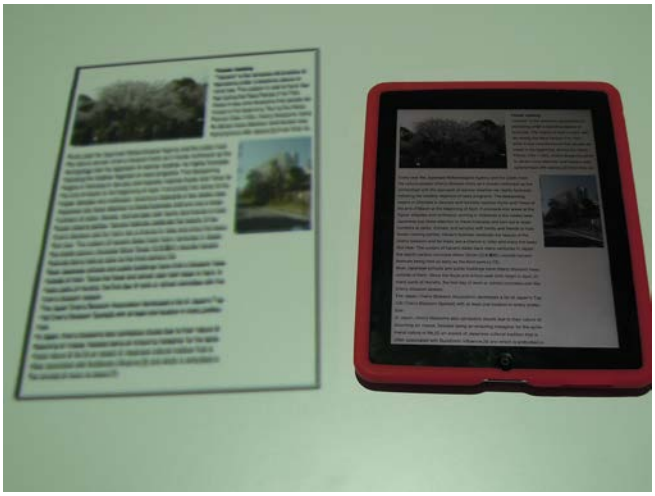

Figure.1 Zooming-up the contents of the digital desktop in a connected device for easier visualization

2. Theory

2.1 Philosophy and targets

Our target is to design and develop a digital desktop that provides computer-based support to the activities that are performed around the desktop. This support should not interfere with these activities; our system has to simplify complex or repetitive tasks and to provide new features that are not possible with the use of a computer. All these enhancements should be integrated in the environment and as transparent to the users as possible.

In the development of the system, we use the following design considerations:

- The system must provide support, but integrated with the traditional environments, tools and workflows. Users will work with their personal tools (pen and paper, laptops, etc.) and with the information in the digital desktop at the same time.
- Collaboration support. The system should support different collaboration processes and the sharing of information.
- Minimal user interface, adapted to the desktop environment.
- Automation of tasks. Some tasks that can be performed by the computer should be integrated in the system.
- Support for different situations. The desktop environment should be open to very different activities, as personal work, brainstorming, discussion, meetings, etc.
- Customization. The system should provide customization tools in order to support new tasks or activities.

Figure.2 Traditional tools and digital information coexist in the same environment

2.2 Field research

In order to provide appropriate support and refine our requirements, we studied the environment we want to support. We studied real work situations around a desktop, focusing on the interactions, the information and the tools that are used in a traditional environment. We covered situations ranging from individual work to brainstorming session and meetings. The research included direct observation of different desktop environments (meeting rooms, workgroup areas and personal work spaces), a questionnaire responded by 17 graduate and post-graduate college students and personal interviews.

We discovered that the users feel satisfied or very satisfied (90%) with their current digital and physical tools when working in the desktop, but only a very small percentage is satisfied when these tools are used for collaboration, especially for remote collaboration (only 33%).

We also identified some tasks that disrupt the workflow as when a printed documents needs to be shared digitally. The most common action in this case is to interrupt the work session and utilize a scanner to digitalize it. Other more time consuming alternatives (as typing the document text in the computer) were also very common.

From this study we conclude a more refined set of targets and features to be implemented for the desktop system, as the support for many independent groups of users, easily digitalizing and sharing of information, tools to store and recover workspace information and connection with external devices.

2.3 The workspace and the representation of information

The digital desktop provides a workspace that the users can utilize as a traditional desktop environment, with notebooks, laptops, pens, etc. During the observation of desktop activities we discovered that the users would need as much space as possible even when working alone, as they usually distribute and organize documents and tools around the available space. Therefore we provide a very wide workspace distributed in two desktops (total practical workspace is approximately 3.8 m. x 1.5 m.) and a vertical screen. The workspace is wide enough to allow many users to sit around it and work independently or in groups.

The system projects digital information on the desktop surface and the vertical screen that can be manipulated by direct touch or by pointing to the vertical screen, even when physical objects are present in the workspace. This digital information can be of three different types: text, images or groups of these basic elements. The way in that a group of elements is displayed can be altered in order to create complex elements, but internally all digital objects are based in these three basic types. For example, grouping elements in a white background for creating a document, and then by grouping documents build a book.

This simple representation of information on the desktop is enough to represent all the domain of information that is usually manipulated on a traditional desktop.

2.4 The tool system

The user can interact with the system directly by touching the digital information. This interaction model is natural and very convenient for many situations, but it is not adequate for all the activities. So the system provides an extensible set of tools, as stationery set, for interacting with the desktop digital objects.

Some of these tools take the form of physical tools similar to existent stationary objects while other are adapted to the action they perform. The simplest tools are colored pens for writing, an eraser for deleting, a cutter of dividing documents, a stamp for duplicating, etc. Other tools provide access to not so evident features as to the automated scanning, automated layout generation for documents or access to previous states of the desktop and achieved contents. To implement these tools we used different approaches and metaphors. For example, for returning to previous states, we use physical keys that provide a video-like control to rewind or fast-forward the contents of the desktop.

The tool system is not limited to these system physical tools; personal devices that the users bring with them can be used as tools inside the system (100% of the users studied bring some kind of digital device to the desktop). For example, a device with a keyboard (like a laptop computer) can be used for easily writing text or a tablet can be used to read comfortably a digital document on the workspace while holding it (figure 1).

The user can define how to use their devices depending on the activities. They can also add new physical tools or customize existent ones to perform different tasks.

3. Implementation

3.1 The system

Our environment consists of a large interactive desktop (figure 2), which supports groups of users working at same time as a traditional desktop. The information is projected using two projectors on the top, and a third one working as a vertical screen. All these three screens form a wide connected workspace. Three Kinect depth cameras provide information of the interactions of the users and the physical tools. Independently, two high-resolution cameras are used for image capturing for the auto scanning features (figure 3).

In the software side, the system is divided in three components. The interface component, which manages the presentation of the information and the interpretation of user interaction, is written in C#. The recognition system written in C++ uses the depth cameras to detect the user interactions and tools positions. The last component is the database with the contents of the desktop, using MySQL. All previous states of the desktops and users interactions are also stored in the database. Independently to these three components we developed an HTML5 application for connecting external devices to the system. Any device with a HTML5-compliant web browser should be capable of connect to the system and interact with the desktop digital contents.

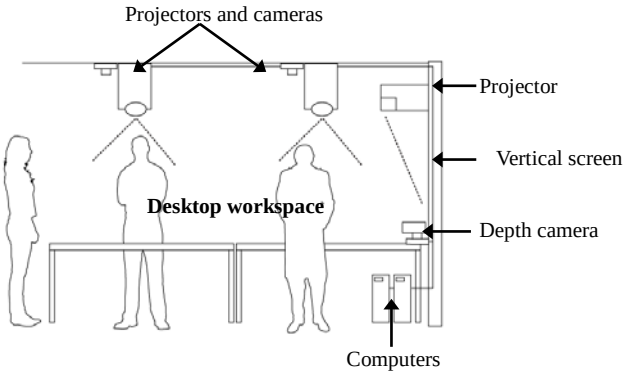

Figure.3 Scheme of the digital desktop

3.2 The experiments

In order to test our digital desktop we are performing three different types of experiments. First we perform small evaluation of each new tool or feature. In these experiments 1 or 2 users utilize and evaluate the new element, usually after the finalizing or modifying the implementation, in order to use these feedbacks to improve it. About 15 users participated in these small experiments.

The second type of evaluation is performed by groups of 3 to 4 users and tests a wider set of features (figure 4). After an introduction of the system basic features, we first let the users “play” with the system to get used to these features and then we ask them to perform a simple task, as classifying information or simply to share some pieces of information between them.

These tasks include co-located and remote collaboration. For remote collaboration we prepared a different room with a computer connected to the environment and other basic tools. We moved one user of each group to this room and ask them to perform the same task again, with the information needed to solve the tasks divided between the two locations. We also compared these activities with the same tasks performed in a traditional desktop environment. For this experiment 18 university students collaborated.

The third and last type of evaluation we planed is the use in a near “real world” situation, as the meeting in figure 2. We still did not perform successfully a formal experiment of this type, because the system is still not enough stable to support so many users and it is very difficult to guide them during the experiments.

The preliminary results of the experiment were mixed. Some users did not understand the system usage at first and felt deceived later when interacting with the digital information on the desktop because they were trying to use some functionality available in tablets or smartphones that are not represented equally in our system (as using two finger interaction for resizing). In other side, the users considered fun to use some of the physical tools as the pen or the cutter, and claimed to enjoy the overall experience.

When comparing with groups using a traditional desktop environment, the proposed tasks took more time when using our digital desktop. But even with this lack of efficiency, the users were confident that the system would be usable in the future. The main reason of this time difference is probably that the users are not familiarized with the system usage, so they misuse the provided tools and make mistakes very often. We expect that these problems will cease when they utilize the system for a longer period of time.

Figure.4 Utilizing a physical tool during one of the experiments.

4. Conclusion and future directions

During the development of the system and the experiments we detect some system flaws and failures in the design of some tools. We have to correct these problems to allow the system to support generic work situations in a real world context, one of ou r main targets. We are considering to focus in improving the touch / object detection system, in increasing its precision and in reducing the “shadow areas” where the system does not detect interactions correctly.

The mixed positive and negatives results of the experiments also shows as that we still need to improve the users support features and the way the users interact with the system. We need to establish a more convenient and long-term plan for teaching the users how to use the system in order to reduce the confusions or wrong uses of the system features.

We also discovered that, as the touch-capable smartphone and tablets are becoming very important tools, users expect a similar interaction model on the digital desktop, so we are going to integrate some features of our system in order to attend to this situation. We are especially optimistic in using physical tools for interact with digital information as the users considered they were useful and especially fun to use.

Our final target is to make as transparent as possible the existence of a computer supporting the work in the desktop from the user point of view, so they can work as usual while accessing the enhanced digital features, improving productivity and the user global experience.

5. Citations

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