Large Displays for Document-Centric Meetings

Philip Tuddenham and Peter Robinson

University of Cambridge Computer Laboratory
Cambridge CB3 0FD
<firstname>.<lastname>@cl.cam.ac.uk

Abstract

We analyse the problems of supporting meetings in which remote participants discuss text documents. We present a proposal and initial work towards a large tabletop display that addresses these problems.

Introduction

The benefits of large displays are self-evident. For co-located collaboration, large tabletop displays allow participants to work together while adhering to social protocols of personal space and without formal turn-taking. For remote collaboration, large displays provide a shared view of the task in which participants can see each other's gestures and actions. In both cases, each participant is aware of the actions of others through their peripheral vision.

It is therefore not surprising that the literature abounds with large tabletop display projects for a diverse range of applications ranging from planning room layouts to sorting photos. However, for many workers, an important daily task involves reading, annotating and discussing draft documents [1], in what we refer to as document-centric meetings. Example scenarios include meetings to discuss draft reports, design briefs, or students' homework assignments. Very few large display projects have addressed these application areas. Furthermore, the widely-adopted meeting-support technologies, such as video-conferencing and electronic whiteboards, are designed to support brainstorming and decision-making, rather than these document-centric meetings.

This shortcoming in current research is not an oversight but, as we shall explain, is due to the difficulties of creating a large display suitable for the task. In this position paper we present our designs and initial work towards a large tabletop display to support both co-located and remote collaboration around documents containing text.

Collaborating over Paper and Electronic Documents

Our work is motivated by the problems of collaborating over electronic and paper documents. Two studies [5, 6] compare reading from paper and from a conventional computer screen. Subjects who read from paper used bimanual actions to navigate and organise documents effectively, while subjects who read from the screen had difficulty determining their location in the document, found the scrolling and annotating processes disruptive to reading, and could not use both hands to interact with the document. Furthermore, many tasks require reading from multiple source documents. The authors observe that paper documents on a table support this by

permitting, for example, frequent shifts of attention and side-by-side comparison of documents, while electronic documents on a screen do not. Electronic documents offer a few benefits: they support up-to-date interactive content; they allow more complex interaction such as hypertext, alternative visualizations, and keyword searching; and they are easy to store, access and distribute securely and quickly.

Paper documents are therefore the superior medium for document-centric meetings in which the participants are co-located. They provide a shared visual workspace that all participants can see and in which participants can easily navigate documents and make gestures and annotations. However, geographically-separated participants cannot use paper in this way, and they can achieve a shared workspace with electronic documents only by using a conventional computer screen with an application-sharing system such as Microsoft NetMeeting. These systems suffer the problems of electronic documents described in the studies above.

Virtual Paper on a Large Tabletop Display

We aim to use a large tabletop display to create a system that allows users to interact with electronic documents in a way that overcomes the shortcomings identified in the studies above. Our system will support document-centric meetings involving co-located and remote participants by providing a shared workspace in which participants can interact effectively with electronic documents. The design we describe here is motivated by findings from our preliminary work and the studies described above.

Electronic documents will be projected on the display as life-sized sheets of virtual paper. Documents will show two pages at once, rather like an open book (Figures 1, 2 and 3). As with real paper documents, participants will use bimanual hand gestures to flick through pages one at a time, to move documents around the table surface for side-by-side comparison, and to add bookmarks. Each participant will have their own stylus with which they can add free-form digital annotations to the documents.

Remote or mixed-presence collaboration will be possible between two geographically-separated groups. Each group will collaborate around its own display, and the two displays will be linked so that both show the same shared view of the task. Thus each participant will be able to navigate the documents and create annotations for the other participants to see. Telepointer traces or some other form of embodiment will follow each participant’s hand and pen positions (Figure 4) allowing participants to gesture remotely to each other and to parts of the text. An audio channel connecting the two sites will allow the participants to hear each other.

As preliminary work, we have implemented a system based on the Escritoire project [2] to support virtual paper documents and hand input for remote but not co-located collaboration (Figures 1 to 4). Our early observations indicate that participants are comfortable using hands and a stylus to gesture to remote participants via telepointer traces, and that hand gestures are likely to be an effective way to navigate long documents if the gesture recognition system is reliable. We are currently implementing the full system proposed here.

We shall evaluate the display in two ways. Firstly, the usability of the document navigation and annotation system will be evaluated using an individual benchmarked reading task, such as a comprehension. We will compare our display to both paper documents and a PDF file reader on a conventional computer screen, examining effectiveness, efficiency and user satisfaction.

Secondly, a more qualitative evaluation will examine the collaborative aspects of the system. The task will be a small tutorial session in which a tutor discusses annotated homework assignments, lecture notes and exam questions with a small number of students, some of whom are remote. Such a task would normally involve a co-located group and many paper documents.

We believe the key issues for remote collaboration will be in resolving the disparity in information orientation and display form-factor between the two sites and in choosing an embodiment to convey presence.

Related Work

The Escritoire [2] presents virtual sheets of paper on a tabletop display for remote collaboration, though it provides no way to navigate long documents or to discuss several documents simultaneously, and provides no support for co-located collaboration. Many other projects augment paper documents on a desk with projected graphics to support interactive content [4,8] or for remote collaboration [7,9].

However, none of these projects have the capability to present pages of dense text and annotations on a large display as we propose. Many use only a single commodity projector over an entire tabletop and thus the display resolution is too poor. Other projects use multiple overlapping projectors in a tiled array. In this case, image warping techniques are normally applied to the individual projector outputs to create a single contiguous display [3], but unfortunately these techniques severely disrupt high-contrast features such as dense text and thus are not suitable for our display. The Escritoire suffered from this problem.

Hereld and Stevens [3] describe a technique to perform warping for multi-projector displays without disrupting dense high-resolution text. We have improved and evaluated their work, and found that users prefer this new warping technique over traditional techniques. We aim to incorporate this work and use multiple overlapping projectors to create the proposed large display capable of displaying dense text at high resolution.

Acknowledgements

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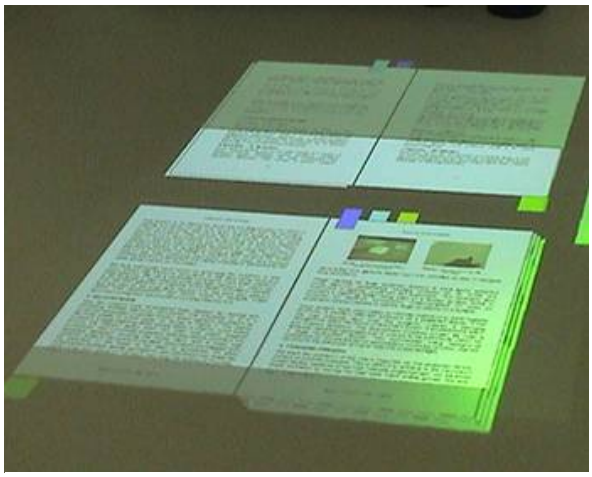

Figure 1. Virtual paper documents on a large display.

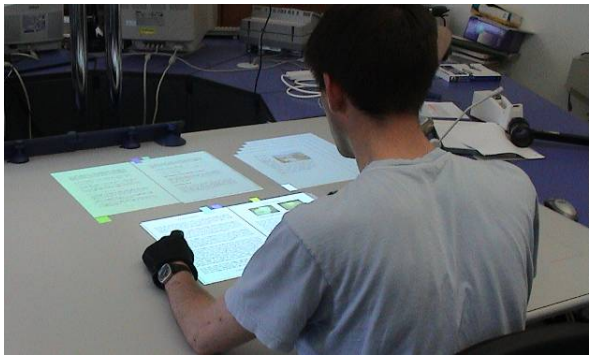

Figure 2. A user interacts with virtual paper documents on the large display.

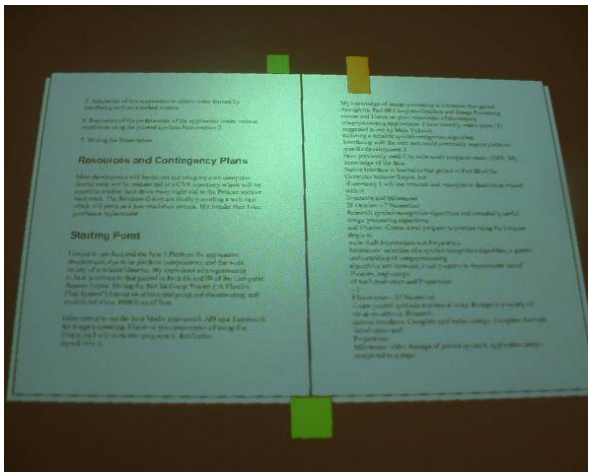

Figure 3. Virtual paper, showing two pages and bookmarks.

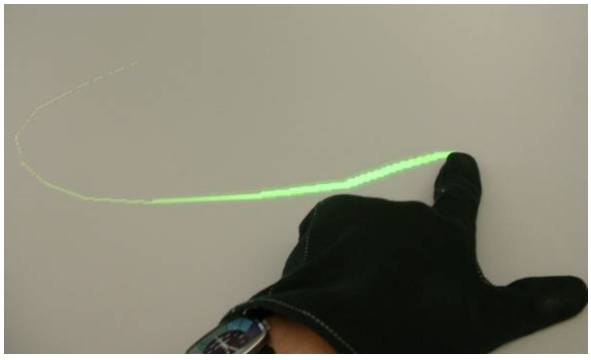

Figure 4. A telepointer trace follows hand gestures.