LARGE SCREEN INTERACTION AS A SUPPORTING TOOL FOR COLLABORATION

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SYNOPSIS

This thesis deals with the utilization of large screens to support collaboration. An introduction to the topic leads to a research question which is divided into three sub questions. Each of these is addressed through an individual research paper.

The first paper documents a literature survey and presents an overview of the field within Single Display Groupware and offers a resource for practitioners to consult when designing a system utilizing large screens.

The second paper presents a quantitative experiment on touch sensitive displays. This shows large screen touch sensitive displays to afford an advantage in completion time.

The third paper presents an empirical study of coordination mechanisms as employed at a hospital ward. This conceptual design is evaluated through a focus group interview. We conclude that coordination mechanisms have served us well as a tool to capture important collaborative practices in this case. Our overall conclusion is that large screen interfaces have the potential to support collaborative practices within communities of work, and that this may serve as collaborative support tool.

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Resume

This master thesis presents three individual research contributions to the field of large screen interaction and collaboration. These three contributions represent an exploration of the field of collaboration, supported by large screen interaction and firmly grounded within the field of human-computer interaction. The initial paper [2] can be categorized as explorative research and serves to documents a survey of literature which provides an overview of research on how large screens have been utilized in Single Display Groupware and the associated design challenges. A total of 30 papers, each detailing a SDG system utilizing large screens, were categorized by their combination of input devices and system level interface. We conclude that there is a tendency towards utilizing touch screens in pervasive systems and remote input devices in ubiquitous systems while there is a lack of research regarding the combination of remote and direct input devices for ubiquitous systems. The main challenges which researchers report relates to issues of concurrent interaction with the system.

The second paper [3] is a quantitative study which compares two touch sensitive screens differing in size to quantify differences in performance, when employing two "traditional" forms of interaction, namely direct manipulation and menu based interaction. An experimental design setup was constructed and executed in a usability lab. Eight persons from a homogenous group were selected as test subjects and each performed the same three tasks on each of four distinct interface configurations. We conclude that large screen as input device for both interaction styles provided generally quicker completion times than both configurations with PDA as input device. Furthermore through the qualitative data captured it was found that user preference for a given interface configuration is not necessarily convergent on the one providing the quickest completion time.

The third paper presents a conceptual design of a system indented to support collaboration during staff meetings at a hospital ward. The design is grounded firmly upon the coordination mechanisms which were identified through observations of staff meetings at the hospital, and the possibility of supporting these. The design is composed of two interfaces; a large touch sensitive screen and a PDA. A paper prototype was evaluated through a focus group interview; with two would be users of the system. Based on this a set of design specifications were constructed along with a brief proposal of a redesign.

Our overall research question addressed the potential of large screens for interaction as well as a supporting tool for collaboration. Our survey of literature reveals a tendency to focus on interaction with large screens through an embedded interface, more specifically by direct manipulation of the screen using technology of touch sensitiveness. Experiments concerning remote interaction with a large screen, e.g. through a PDA is also being performed. Overall this indicates flexibility when choosing means of input to a system utilizing a large screen, which is a potential strength. Only few papers address the solution of both direct and remote input devices in conjunction for interaction with a large screen, and as a result not much can be concluded regarding the potentials in that regard.

We have argued an advantage of large screen interaction compared to PDA interaction in regard to completion time through our experiment. Though very limited this is also a measure of the potential of large screens for interaction.

The potential of large screens as a supporting tool for collaboration has been argued through previous research reports on benefits and drawbacks and design challenges has been listed with references to papers dealing with possible solutions.

This report is structured in two distinct parts; the first part serves as an introduction and explanation of our topics of research which leads to an overall research question; *What are the potentials of a large screen interfaces with regard to interaction as well as a supporting tool for collaboration?* Three distinct sub questions are presented to answer this. These three sub questions are addressed through the three contributions presented in this thesis. This leads us to a combined conclusion, which is presented along with a discussion of the limitations encountered and topics of further research.

The second part contains the actual papers, each dealing with one of the questions presented.

Introduction

The advent of large screens in computer system is currently in its infancy. Large screens are used as information boards in campus environments, and large touch screens facilitate navigation amongst shoppers in large malls. As these large interaction surfaces become a technically feasible solution to implement within organisations new questions arise and as these screens also have a very large screen area, new forms of computer supported collaboration may present itself. An obvious question in this regard is how can we support such collaborative practices and what are the potential benefits of advancing to a large screen. We can also consider if traditional forms of interaction as known from the world of desktop computing is sufficient or even usable on this form of display.

Collaboration

As screens grow in size new forms of interaction may become possible, an important factor of this is grounded in the collaborative aspects of such displays. These displays offer a significantly larger screen real estate, and allows for more "eyes on the screen" as well as concurrent interaction among multiple users. This offers a number of benefits for collaboration but introduces new challenges for system design.

CSCW

Computer Supported Collaborative Work (CSCW) in general is defined by Bannon and Schmidt [1] as: "CSCW should be conceived as an endeavour to understand the nature and characteristics of cooperative work with the objective of designing adequate computer-based technologies." CSCW is an essential area of research to explore the dept of the potential for large screen collaboration. Much research has been performed within this area in the past, and it continues to afford new and exiting problems for the researchers employed within this field. Within the field of CSCW the particulars of Coordination Mechanisms [2] are seen as a important element of this particular community of work. When developing a system to support collaboration these coordination mechanisms, when identified for a given domain, might provide a reasonable foundation for the design and facilitate an interesting and above all useable system.

Large screen interfaces

Large screen interfaces has recently become an economic and technically feasible solution for presenting an interface to a computer system. The introduction of large and even wall size computer screens provides new possibilities for presenting and interaction with the electronic media and underlying IT systems. How can we expect the user to relate to the large screen? We might expect a quite different manner from the traditional interface on a stationary computer and as such novel behaviour may become manifest. Also the active screen real estate increases dramatically and allows for much more information to be presented at one time. These new possibilities are not as yet fully explored, and some questions arise. Which form of interaction is most efficient and usable on such large displays? What are the benefits and drawbacks to such screens as a whole? The traditional forms of interaction associated with medium sized displays such as the conventional PC are not necessarily sufficient to accommodate the new possibilities afforded by these displays. As these screens have a size that allows concurrent actions for multiple users the concept of collaboration becomes an obvious area of application; but how could large displays support different collaborative practices?

We define a large screen interface as an interface designed for a large computer based display system, this is includes solutions on how to interact with the system and possible utilization of the screen space. We do not necessarily restrict these solutions to those that have been implemented in an actual prototype but require that the conceptual designs they embody are based on a large screen interface.

Small screen interfaces

Small screen interaction, such as can be found on a PDA or a cellular phone is not per se a new area of research. Much research has already been performed within this particular field. When these small devices are connected to a network they present interesting possibilities for granting access to information while on the move. The users will be able to access sensitive data while retaining a high degree of privacy. The limitation of these displays is the limited estate of the display which requires considerable consideration when designing the interface. In a case such as the healthcare sector, more specifically in a hospital, where a nurse may have access to the patient records through a small screen device such as a PDA it becomes very important what information is displayed on screen and the structure of this information. This could be seen as a very general goal for all HCI research, but the very limited screen real estate available on a PDA makes this

statement paramount for this class of device. One might also argue that they offer the unique potential to give the nurses access to important information in the patient records where they need them and relieves them from having to find a physical copy of a given patient record.

After the previous brief introduction to our areas of interest we now propose our research question.

Research question

Initially we present our overall research question.

> *What are the potentials of a large screen interfaces with regard to interaction as well as a supporting tool for collaboration?*

To answer this question we have devised three sub questions. Initially a survey of literature on large screen collaboration and interaction is seen as a solid foundation to ground our exploration of this area. This is proposed answered by the following question;

> 1. *How can we categorize collaborative systems utilizing large screens to create an overview of the field and which design experiences emerge from this?*

To discuss the potential of interaction with a large screen interface a comparison between different input devices and interaction styles is addressed through a second sub question.

> 2. *How can we argue about the difference in performance between large and small touch sensitive interfaces?*

To argue about the potential of a large screen to support collaboration an empirical study of an application domain and a design proposal of a system to be evaluated therein seems suitable. This is addressed through a final sub question.

> 3. *How can we identify relevant collaborative practices within a given domain, to assert possible uses of large screen collaboration?*

The three sub questions are addressed through three distinct papers, which are summarized through an explanation of their contribution in the following section.

Contributions

This section presents the three individual research contributions to the field of large screen interaction and collaboration. The three contributions explore the field of collaboration supported by large screen interaction based within the field of human-computer interaction. Each contribution is represented by a corresponding research paper.

Contribution 1

Bisgaard J.J., Heise, M., Steffensen, C: A literature survey of Single Display Groupware interaction for large screen collaboration (*2005*)

The first paper explores previous research on Single Display Groupware systems utilizing large screens to support collaboration. This is done in order to identify general practices and shortcomings, as well as general design challenges for such systems. The findings reported originate from a literature survey of scientific papers, which were picked through a six step selection process. A total of 30 papers, each detailing a SDG system utilizing large screens, were categorized by their combination of input devices and system level interface. Through our exploration of this field of research we also identify five general design challenges related to collaboration and system design.

We conclude that there is a tendency towards utilizing touch screens in pervasive systems and remote input devices in ubiquitous systems while there is a lack of research regarding the combination of remote and direct input devices for ubiquitous systems. The main challenges which researchers report relates to issues of concurrent interaction with the system. With this paper we contribute an overview such that a would be designer of this particular type systems could consult with the purpose of gaining an overview of how other researchers have been experimenting with large screens for collaboration. Additionally it is possible to obtain a combined view of the main design challenges associated with references to papers detailing possible solutions to these challenges.

Contribution 2

Bisgaard J.J., Heise, M., Steffensen, C., Comparison of interaction styles on large and small touch sensitive interfaces (*2005*)

The second paper details a comparative study of interaction on both large and small touch sensitive interfaces, employing two "traditional" forms of interaction, namely direct manipulation and menu based interaction. An experimental design setup was constructed and executed in a usability lab. Eight persons from a homogenous group were selected as test subjects and each performed the same three tasks on each of four distinct interface configurations. The results of the test were analyzed to determine significant differences.

This is done with the intention of discovering the issues related to differences between large and small screen interaction. We conclude that large screen as input device for both interaction styles provided generally quicker completion times than both configurations with PDA as input device. Furthermore through the qualitative data captured it was found that user preference for a given interface configuration is not necessarily convergent on the one providing the quickest completion time. Our comparative controlled experiment and the preceding data analysis is a way of arguing the difference in performance between large and small touch sensitive interfaces, which were our research question.

With this paper we contribute a comparison of interfaces, touch screen vs. PDA, in regard to completion time performance, which has not recved much investigated in the field of HCI.

Our results include a few significant differences in performance and some additional indications, which is an opening for other researchers to perform similar experiments and compare the results for better reasoning about their validity.

Contribution 3

Bisgaard J.J., Heise, M., Steffensen, C., Conceptual design of a large screen collaborative system through analysis of coordination mechanisms at hospital staff meetings *(2005)*

The third paper presents a conceptual design of a system for supporting collaborative practices during staff meetings at a hospital ward. The paper is based on an empirical case. The Danish healthcare sector is currently in the process of adopting an electronic health records system. When data is stored digitally new possibilities of displaying information arise, e.g. through a large screen. As the healthcare sector is a domain characterised by a large amount of collaborative efforts between staff, we find it interesting to investigate possible implementations of large screen interfaces to support this collaboration. As a case for research we have cooperated with the nurses at the ophthalmology bed ward at Aalborg Sygehus syd. One of the current collaboratively grounded efforts which exist at the ward is a daily morning meeting in which every nurse participates. Every morning the nurses participate in a meeting were they browser the information added to the patient records during the past shift. During this meeting tasks and responsibilities for the upcoming shift are likewise coordinated. These meetings offer an interesting setting for an empirical study of collaboration.

The design is grounded firmly upon the coordination mechanisms which were identified through observations of staff meetings at the hospital, and the possibility of supporting these. These coordination mechanisms serves as a very useful tool for grounding the empirical data gathered in a computational context. The coordination mechanisms identified serves a very real purpose in the current work environment, and as such they provide a useful objects which can be employed in a computer supported collaborative system.

The design is composed of two interfaces; a large touch sensitive screen and a PDA. A paper prototype was evaluated through a focus group interview; with two would be users of the system. This evaluation provides us with a foundation for a redesign of this system based on these results. In general the prospective users were positive with regard to the system suggested, although some usability problems were identified. The nurses perceived the conceptual design as being in accordance with their work practices. After this review a new set of requirements were constructed along with a brief proposal of a redesign.

With this paper we contribute with our experiences in regard to using coordination mechanisms as a modelling tool of collaborative aspects in a specific application domain. This has been a feasible

solution in our case, based on user response and our own judgement. This might provide an interesting design premise for those interested in modelling collaborative aspects of working communities.

Method

In this project we have employed three different research strategies to answer our proposed research questions as shown in Figure 1.

1) Explorative research
A literature survey of Single Display Groupware interaction for large screen collaboration

2) Quantitative research
Comparison of interaction styles on large and small touch sensitive interfaces

3) Qualitative
Conceptual design of a large screen collaborative system through analysis of coordination mechanisms at hospital staff meetings
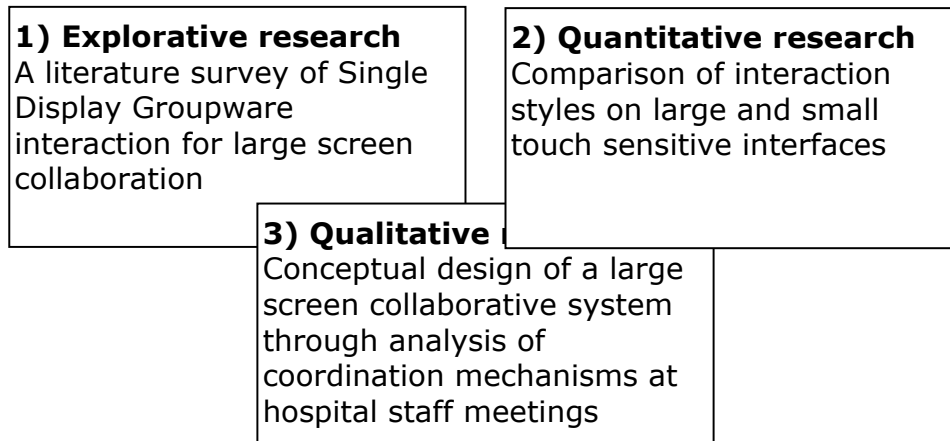
Figure 1 – Three papers on distinct types of research

The three papers differ in regard to which type of research is conducted as shown in Figure 1. The first paper [2] can be categorized as explorative research and documents a survey of literature which provides an overview of research on how large screens have been utilized in Single Display Groupware and the associated design challenges. The second paper [3] is a quantitative study which further investigates the field by comparing two touch sensitive screens differing in size to decide upon differences in performance. The third paper [4] is a qualitative study where gathering of empirical data serves as foundation for a conceptual design, which is evaluated with users.

Our literature survey which we label as explorative was performed by a six step selection and categorization method which reduced the initial number of found papers from approximately 900 to 30 relevant papers. Despite the formally described process and the criteria used this is not necessarily an easily replicable experiment as the number of articles is in a state of flux with new additions arriving constantly. Upgrades in search engines might produce slight variations in the returned results. In addition these criterions are perceived and applied by humans and as such a certain level of variance must invariably exist.

Through the second paper an experiment is presented. This was conducted in a usability lab where a simulated touch screen and a PDA were used to facilitate an empirical study of the differences among four distinct configurations. This second paper presents a quantitative study of two different interaction types each tested on two different devices. The significance of our results

allows us to generalise some of our findings and we are able to point out which method of interaction performed best according to the method we used.

Our conceptual design and the evaluation of it is detailed in the third paper was conducted in three steps; initially a prototype was developed, after this an on site evaluation was performed at the hospital with two nurses through a focus group interview. After this process a redesign was proposed. The third paper presents a qualitative study of the design and evaluation of a system for supporting collaboration in meetings. All of these papers have a contribution to the research field but our ability to generalise on behalf of these papers differs in strength. The results of the third paper allows use to make a statement about the effects of introducing this type of system to this setting and point out some tendencies which might be tried out in a similar setting by another research team. But we are not able to generalise anything on behalf of these results. So why is the third paper just as interesting as the second? This is because this paper tells us something about how people react when such technology is introduced into their work domain, and we are able to gain some experiences concerning the methods and tools we have used to develop the prototype.

Conclusions

In order to conclude on our overall research question we will first answer the three sub questions.

First question

In order to create an overview of the research field we have chosen to categorise the systems we have found according to the input devices applied and the system level interface. This revealed a tendency towards utilizing touch input for pervasive systems and remote input devices for ubiquitous systems while there is a lack of research regarding the combination of remote and direct input devices for ubiquitous systems. Our explorative survey also uncovered five general design challenges as identified through our studies of the body of research. One of the primary challenges pertains to issues of concurrent interaction with the system. This paper presents an overview that a would be designer of this particular type systems could consult, and additionally it is possible to obtain a combined view of the main design challenges found along with references to papers detailing possible solutions to these challenges.

Second question

To argue about the differences in performance between large and small touch interfaces we have performed a controlled comparative experiment. This experiment addresses the performance in regard to task completion time, and user preference. We conclude that large screen interfaces applying either of the two interaction styles, WIMP or Wizard, are quicker in overall performance than both PDA based configurations. Regarding specific types of tasks a large screen interface regardless of interaction style performed best for a "Search and compare" type of task. A "search and find" type of task, though with slim justification, was best performed on a large screen wizard configuration. Finally a "Search by comparison and compare" type of task indicated a WIMP style of interaction, whichever interface is chosen, to provide quickest completion time. Finally we found that user preference for a given interface configuration is not necessarily equal with the one providing the quickest completion time.

Third question

We have utilized the concept of coordination mechanisms to identify collaborative practices within the healthcare domain. I order to assess the possibility for using large screens for collaboration we have performed an empirical study as the basis for a conceptual design which has been evaluated

through a focus group interview. With this paper we present our experiences in regard to using coordination mechanisms as a modelling tool of collaborative aspects. We have found them to be a useful tool for modelling the practices for this case.

Overall question

Initially we proposed that large screens and collaboration on these might present the would-be designer of such a system with a new set of challenges in comparison to the traditional desktop setting. We have found that this is indeed the case as described through the initial paper presented herein. Our overall research question addressed the potential of large screens for interaction as well as a supporting tool for collaboration. Our survey of literature reveals a tendency to focus on interaction with large screens through an embedded interface, more specifically by direct manipulation of the screen using technology of touch sensitiveness. Experiments concerning remote interaction with a large screen, e.g. through a PDA is also being performed. Overall this indicates flexibility when choosing means of input to a system utilizing a large screen, which is a potential strength. From our first article we found that large screens have the potential for afford concurrent user interaction while still providing an overview for co-located users.

We also speculated on the potential differences between large, small and traditional computing environments, and through our second contribution we find that large screen interaction does offer a higher speed of interaction when compared to small screens. We have argued an advantage of large screen interaction compared to PDA interaction in regard to completion time through our experiment. Though very limited this is also a measure of the potential of large screens for interaction.

Our third paper represents a take on a possible method of uncovering the structure of work and the artefacts employed in coordinating this work and present a conceptual design of such a system. The potential of large screens as a supporting tool for collaboration has been argued through previous research reports on benefits and drawbacks and design challenges has been listed with references to papers dealing with possible solutions.

As evident through the results presented in this theses large screen have the potential of supporting collaboration. Paper one shows large touch screens as proffered by the researchers within the field. Paper two shows a distinct advantage for large screens in interaction speed when compared to small screens and test subjects expressed preference for interacting with the large

display. Paper three presents a conceptual design of such a system which is evaluated through a focus group interview.

Discussion

The conceptual design developed for the hospital ward will invariably display personal information about patient as this serves as the foundation for the collaborative practices employed within this domain. This information is given protection by the Danish law and is very personal in nature. We do not explicitly deal with this problem as visitors are prevented from seeing this information on account the intended deployment in the private staff meeting room, which is not open to the general public. Despite this we believe that if the system is to be implemented as a fully working system at the ward, it would be necessary to deal with this particular problem. There are also numerous ethical rules which must be taken into account in order to guarantee the integrity of both the patient information and perception of nurses as trustworthy care takers.

One of the features which the nurses themselves suggested was to use the large screen as an overview of patients and where they are bedded could be a fine solution for what could occupy the screen while nurses were away from the meeting room.

The success of our system closely linked to the quality of the EPR system which is going to be the backbone of this system and it is very difficult to perform a proper implementation and testing of the system without having a working EPR system. So until this database system becomes operational we can only perform dummy tests of the system which may indicate how it will function when implemented in the working environment. But based on the evaluation of our conceptual design we believe that this system will aid the nurses in many aspects of their work, even beyond the morning meetings.

It could also be interesting to perform a second experiment with the comparison of different interaction styles but with twice or triple the amount of test subjects. It could be interesting to investigate what the results might reveal and which results could be proved significant if we increased the sample size. It is our theory that this is because the users experience is somewhat dependant on esthetical satisfaction and personal preferences. They perceived the WIMP interface on the simulated touch screen as a efficient and pleasing form of interaction.

References

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