

Proceedings of the 2nd Workshop on
**Distributed User Interfaces:
Collaboration and Usability**



DUI 2012

In conjunction with **CHI 2012 Conference**

Austin, Texas, USA
May 5th, 2012

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DUI 2012: Usability and Collaboration

Nowadays, the low cost of mobile devices and large displays has made **Distributed User Interfaces** (DUIs) an attractive paradigm to develop highly interactive applications. However, there are some topics affecting the **Human-Computer Interaction** (HCI) that still remain wide open while developing DUIs. The goal of this workshop is to promote the discussion about two of the most relevant topics: collaboration and usability.

The discussion about these topics generates some questions: for instance: how can collaboration be improved using DUIs? When are DUIs suitable to perform collaborative work? How can usability standards be employed to evaluate the usability of DUIs? How do DUI concepts influence regarding collaboration, usability and cognition?

The answer to these questions is presented in this publication as a set of articles that explore different views, alternatives and applications that deal with usability and collaboration issues regarding DUIs. These articles were submitted to the 2nd Workshop on Distributed User Interfaces: Collaboration and Usability that was held on May 5th, 2012 in Austin (Texas, USA) as part of CHI 2012 conference.

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TwisterSearch: A distributed user interface for collaborative Web search

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ABSTRACT

Although Web search is typically regarded as a solitary activity, collaborative search approaches are becoming an increasingly relevant topic for HCI and distributed user interfaces (DUIs). Today's collaborative search systems lack comprehensive search support that also involves pre- or post-search activities such as preparation or sensemaking. We believe that post-WIMP DUIs can help to better support social search and have identified four design goals that are critical for their successful design. In consequence, we present TwisterSearch, an interactive DUI prototype that meets our four design goals.

Author Keywords

Post-WIMP, distributed user interfaces; surface computing.

INTRODUCTION

In the recent years, research in HCI has increasingly focused on collaborative search [1,7,8]. Collaborative search approaches can support activities and decision making such as travel planning, purchasing products or literature search and could become important tools for users' information practice in future. Consequentially, Morris identified a great need for better tool support for collaborative Web search [6].

We believe that distributed user interfaces (DUI) are particularly appropriate for supporting collaborative Web search, especially when assisting users in the three search phases *before search*, *during search*, and *after search* as they were identified by Evans and Chi in their canonical model of social search based on everyday searches [2].

While most present-day systems for collaborative Web search focus on the *during search* phase, they lack support for other phases that are more collaborative and are often distributed in nature and require a division of labor. For example, a survey conducted by Morris showed that 22.0% of the respondents cooperated by brainstorming or suggesting keywords to each other for generation and refinement purposes before search [6] – a process that is currently unsupported.

Furthermore, we believe that DUIs based on post-desktop computing systems such as tabletops and tablets are important for a natural collaboration and for supporting different working styles. For example, Jetter et al. provide collaborative faceted search and flexible working styles using a hybrid visual-tangible user interface on a tabletop that users perceived as fun to use and that was equally effective as traditional Web interfaces [5].



Figure 1. TwisterSearch: a post-WIMP DUI supporting collaborative Web search.

Our goal is to achieve a similar result for collaborative Web search based on a Microsoft Surface tabletop, Apple iPad tablets, and Anoto digital pen & paper. In the following, we first propose design goals for systems supporting collaborative Web search based on the canonical model of social search by Evans and Chi [2] and implications for design of Morris [6]. Then we present TwisterSearch¹ (see Figure 1), an interactive prototype that we designed and implemented to meet these design goals and describe its interaction design using a scenario. We conclude with a brief summary and our planned study design as future work.

DESIGN GOALS

We have formulated four design goals (DG1-4) based on the canonical model of social search by Evans and Chi [2] and design indications given by Morris [6]: 1. *Strategic Planning and Coordination*, 2. *Amplify Collaboration*, 3. *Intensify Discussion and Simplify User Input*, and 4. *Traceability*. We consider all of the four DGs as critical for the successful design of a post-WIMP DUI for collaborative

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¹ TwisterSearch Video – <http://youtu.be/ILLWV6Nx91s>

Web search. Therefore, our prototype TwisterSearch was designed and implemented with regard to these DGs.

DG1: Strategic Planning and Coordination

Morris describes two search strategies that occur in cooperative search tasks: *divide-and-conquer* and *brute force* [6]. The first is a coordinated division of labor whereas the latter is uncoordinated and tends to evoke “Google races” or “competitions”. These races possibly duplicate search results and thus increase search effort. Therefore, we argue to provide tool support for explicit coordination and planning of an ongoing search towards a structured-search. Users should be supported in pre-search activities (e.g. *context framing* and *requirement refinement*) and post-search activities (e.g. *organize and distribute search results*). Thereby, *context framing* defines and shares the boundaries of an intended future search task and establishes information needs and motives among the group members. *Requirement refinement* is a stepwise concretization of an information need by consulting other sources such as colleagues. Later structuring and distribution of search results takes place in 72.0% of the reported search experiences and is a pre-condition for embedding search into real world activities and decision making [2].

DG2: Amplify Collaboration

Evans and Chi categorized *during search* into three different behaviors: *navigational*, *transactional*, and *informational* search [2]. Based on their survey, the latter accounts for more than a half (59.3%) of the search intentions and includes various steps from information foraging to sensemaking. The *informational* search behavior, furthermore, features both solitary tasks (e.g. read and extract information) as well as information exchange with others. A Web search system, therefore, should best offer a smooth transition between loosely-coupled parallel work and tightly-coupled collaboration similar to Jetter et al. [5].

DG3: Intensify Discussion and Simplify User Input

Conventional WIMP interfaces with their single point-of-action are inappropriate for creating shareable user interfaces for co-located collaborative work. In these cases, simultaneous user input is indispensable. In contrast, Geyer et al. show the feasibility of a post-WIMP tabletop and tangible user interface combined with digital pen & paper for creative group work [3]. Furthermore, touch interfaces such as tabletops allow users to communicate more efficiently with the help of deictic references to create a joint reference and substantiate arguments. Although touch input is the dominant input on tabletops, a study conducted by Morris et al. also discovered issues when using virtual keyboards for search term input and propose the integration of physical keyboards instead [8]. We acknowledge these issues and thus suggest a digital pen & paper interface that provides a well-known interaction style for text input where

users build on pre-existing knowledge of the everyday, non-digital world [4]. We further believe that collaborative Web search systems enable verbal and non-verbal face-to-face communication and more natural gesturing to intensify discussion and to yield superior outcomes. Besides these effects on communication, a simplified user input also allows users to focus on the primary search task instead of being busy with secondary tasks such as text input.

DG4: Traceability

Gathering results and additional information automatically *during search* allows users to trace the directions of search and the keywords used to find the results. Morris [6] writes that “*this information helps collaborators understand what techniques have already been tried and how to interpret the authoritativeness or appropriateness of the results*”. Thus, we consider traceability as an important aspect, especially if Web search is carried out in several sessions.

SYSTEM DESIGN

Based on the four design goals, we designed and implemented our prototype TwisterSearch. TwisterSearch is a distributed user interface running on a shared display and multiple private displays. The shared display is used to collaboratively collect search results in a visual workspace. This workspace is provided on a Microsoft Surface multi-touch tabletop that also recognizes physical objects (tokens). Private pad-sized displays (Apple iPads) are used around the table to individually search the Web and publish findings to the shared display. The following scenario provides an example for a typical usage situation.



Figure 2. Three TwisterSearch sets, each consisting of an Apple iPad, an Anoto pen, a token, and several paper snippets.

In the beginning of a history course, three students are requested to do research about the history of *Switzerland*. They are asked to collect facts about culture, topology, and politics and, further, they need to write an essay about their findings until the end of the term. They are allowed to do this as a group. The group meets at the library where a workroom is equipped with TwisterSearch. The three students sit around the tabletop and each user takes a TwisterSearch set consisting of an Apple iPad, a digital pen (Anoto), a small pile of paper snippets, and a *tablet token* (see Figure 2). This token is a tiny acrylic glass block with

a colored frame. Each set and thus each user has a unique color (red, green, blue) that is also visible as the color of the iPad's cover, the ink of the pen and the frame of the tablet token. Before the group members start individual search activities, they first frame the topic (DG1). For this purpose, all users write relevant keywords they can think of on their paper snippets with the digital pen (see Figure 3) (DG3).



Figure 3. TwisterSearch supports natural hand writing for text input to collect keywords.

All ink strokes that are written on a paper snippet are automatically converted to a text string that is internally attached to the snippet and can be used as keyword by the system from then on. Collecting keywords is either done in parallel or in joint work recommending keywords or consulting other group members for relevant terms (DG2, DG3). This process leads to a framing of the search's context and results in a collaborative construction of a skeleton of keywords, which is filled with search results in the next step. Since all pens have different ink colors and each color is assigned to a single user, a great degree of traceability is given (DG4). The keywords are collected on the tabletop surface or the surface rim. It is possible that a user starts clustering keywords according to their semantic coherence while the others are collecting further keywords. However, clustering can also be done in joint work supported by discussion (DG3).

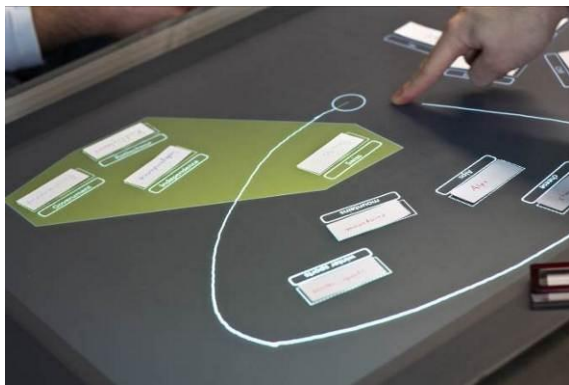


Figure 4. Touch input is used to cluster keywords.

Clusters are created and become visible by encircling one or more keywords with a finger. Furthermore, clusters can

overlap to convey the search topic (e.g. Switzerland) (see Figure 4). Since requirement refinement often occurs in social search, users can change clusters and cluster content at any time. For instance, add new keywords, rearrange keywords to different clusters, or split clusters. Moreover, keywords can be removed and put aside tentatively on the rim of the interactive surface for later usage. After students agreed on clustering, the group members are assigned to different clusters by putting users' corresponding tablet tokens on different clusters (DG1). The token indicates the search responsibility so collaborators know who is searching information for a specific cluster. This highly increases the overall awareness. Moreover, cluster keywords are transferred to the linked Apple iPad if a token is put on a cluster.



Figure 5. The search interface on the Apple iPad featuring relevant keywords (left) and a Web browser (right).

Now, individual search is performed on private displays. This can be done either loosely coupled in parallel (no 'backseat driving' [6]) or tightly-coupled in collaboration (DG2). Moreover, novice searchers can learn vocabulary and syntax from experts when searching in close collaboration [6] and apply their knowledge instantly. On the private display, received keywords are displayed in the left column and a Web browser is displayed in the right column (see Figure 5). A user selects one or more keywords by tapping on it. Then, pressing the 'Google' or 'Wikipedia' button opens the corresponding webpage with results matching the selected keywords. Users can navigate to included links or adjust search manually. The browser is operated as known from the Apple iPad Safari app. A complete website or parts of it can be selected by touching and holding the information until the selection rectangle shows up. By pressing the *Publish* button the selected information including search paths taken and user id is transferred to the shared display. The result is displayed immediately in the result view of the cluster on the shared display (see Figure 6). Each cluster has its own scrollable result view. Users can hand over private displays to show and exchange interesting information before publishing. All results can be reviewed on the shared display and private displays at any time. Tapping a result on the shared display opens the corresponding result on all private displays linked

through tablet tokens, which is useful for discussion and especially important to argument the final outcome (DG3).



Figure 6. Tapping a result in the result view (shared display) triggers the result view on the private display.

We implemented most of the design goals, however, it is not yet possible to distribute or organize results from a collaborative Web search session (DG4). This will be future work and can be implemented easily since required data is already persisted in a database.

IMPLEMENTATION

The application on the shared display (server) is implemented in C#/WPF with the .NET 4.0 framework and the application on the private display (client) is implemented in iOS 5. The cluster visualization on the Microsoft Surface displays a convex hull to indicate encircled objects. A Windows Communication Foundation (WCF) web service and OSC is used for client/server communication. The clients communicate with the server via WCF web service, which will be opened on the Microsoft Surface on application startup. Multicast OSC messages distribute keywords and object IDs of existing results to the clients. The implementation of TwisterSearch supports theoretically unlimited clients, however, the table size constrains the number of collaborators to a maximum of four. All paper snippets have an Anoto pattern on the front and a visible marker on the back. Strokes are analyzed and transformed to machine readable text with help of MS Windows 7 SDK. The recognized text is, then, assigned to the corresponding paper snippet. BaseX² persists session data, all results including search paths and the user id, all connection data, and the interaction log. Latter will be used in future to evaluate the system in a controlled experiment.

CONCLUSION AND FUTURE WORK

Based on the canonical model of social search by Evans and Chi [2] and implications for design of Morris [6], we identified four design goals for the emerging topic of DUIs for collaborative search: 1. *Strategic Planning and Coordination*, 2. *Amplify Collaboration*, 3. *Intensify*

Discussion and Simplify User Input, and 4. *Traceability*. On this basis, we presented the design and implementation of our interactive prototype TwisterSearch, which uses post-WIMP interaction with a tabletop and tablets to distribute collaborative Web search across device boundaries. In a next step, it will be important to evaluate to what extent our design meets the design goals and enables efficient collaborative Web search for typical users. Therefore, we plan to first conduct a qualitative and less formal user study similar to WeSearch [8]. After this, we will make TwisterSearch accessible to a broader user population in the library of the University of Konstanz to recruit participants for a controlled experiment with real library users and students in our lab.

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² BaseX is a light-weight XML database – <http://basex.org>

³ <http://hci.uni-konstanz.de/blendedlibrary/>

Collaborative Social Authoring Technology

Using Web-based Distributed User Interface (DUI)

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ABSTRACT

This paper describes collaborative social authoring technology using web-based distributed user interface. In view of collaboration, web is one of the most common user environments on various systems of desktop and mobile devices (e.g. smartphone, tablets, laptops). One of the features of our system includes collaborative social authoring method using various metadata information (e.g. mood, weather, time, location) of each uploaded media for the collaborative authoring. Our system also provides the recommendation function for referring and adding the related media from the participants' Facebook account during the authoring process, based on some recommendation rules. This paper presents an extension of our previous social authoring system, which is based on the concept of Distributed User Interfaces (DUIs) to be adaptable when the users collaborate using various kinds of devices like mobile devices or desktop systems.

Author Keywords

Collaborative social authoring; Distributed user interfaces; Social media recommendation; Mobile devices

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Human Factors; Design;

INTRODUCTION

Today's trend in device usage is that a person has multiple devices (e.g. smartphone, tablet and digital camera) that they use during daily life in home, office or during the moving time. Often, a person uses these devices to capture some multimedia files (such as images, video and audio), and uploaded the content into social networking service. Photos and videos shared in social network service often have deep personal meaning to the user. Using the photo

and videos uploaded, the users can collaboratively combine and create a content that has personal values with their friends.

There are some online collaborative video authoring tools that currently available for collaborative content editing. However, these current collaborative online video authoring tools do not support the usage of multiple devices. The adaptability of a UI into different display and devices are becoming more important due to the fact that many users tend to use multiple mobile devices in their busy-commuting lifestyle. Portable devices have small screen size. Users tend to feel uncomfortable by the features that they see on their devices' small screen. It is cumbersome to navigate during authoring process in mobile devices. This issue, which is related with distributed user interfaces, has not been addressed by current collaborative video authoring tools.

During authoring, a user might have many audio resources, or the user has certain skill for audio editing process. This user might want to focus on audio editing part, so he wants to have specific UI for audio editing. Hence, the system will provide the specific UI for editing certain part of the projects; in this case, audio editing. The system will also provide dedicated UIs for video or images editing and text editing.

Another consideration is although today we have personally meaningful multimedia data in our social networking sites, these authoring tools are incapable of recommending multimedia files from our social networking sites, such as Facebook.

In this paper, we focus on developing web-based collaborative content authoring intended for multi-device environment and utilizing metadata provided in uploaded media, as well as proposal for using metadata provided in the users' Facebook account to provide recommendation based on some rules provided later. In our proposed system, we are considering a distributed user interfaces (DUIs) for collaborative authoring, which is based on the concept of UI component adequate for the physical device characteristics and social media recommendation scheme from SNS such as Facebook.

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BACKGROUND

Although the term “Distributed User Interfaces” has been getting more popular in the past few years, yet there is no official definition for the term. Based on previous informal definitions, [1] synthesizes the DUI definition as *a user interface whose components are distributed across one or more of the dimensions input, output, platform, space and time*.

In our proposed authoring system, the system can be run on a single computational device or several different devices (input dimension), the graphical output is tied in a single devices (output dimension), the authors can use the system in either same location or different location (space dimension), the authors can use the system in either same or heterogeneous operating system, networks and architecture (platform dimension), and the user can use the system asynchronously (time dimension).

A concept of UI plasticity defined by Thevenin and Coutaz [6] is the capacity of a UI to withstand variations in both the device and its physical environment while preserving usability. Here, we implement the plasticity concept into our collaborative content authoring so that the usability during content authoring in mobile device is preserved. Our system provides plasticity to the video content creation users, so that the authoring tools’ UI can be adapted according to the device in which the users are currently working on.

In Current DUI definition, the distribution of hardware device is stronger than the software distribution. Especially, there is no consideration about the input content distribution, such as how to use social media in DUI based social authoring. We believe that social media application can be used as distributed input sources. Therefore, we consider content input from social media for our collaborative content authoring tool.

DIRECTIONS

In our current work [2], we have implemented a collaborative authoring system that utilizes metadata information provided by the users. When the user uploads the media to be used in the authoring tool, the user is asked to provide additional metadata. A collaborative authoring metadata (CAM) is proposed to enable authors sharing authoring intention and situation of each resource.

Our previous authoring system did not consider Distributed User Interfaces. The authoring system did not adapt its UI according to the device it currently runs on. If the authors use the system through mobile devices such as smartphone and tablet, the authors might not be comfortable by the interfaces available in the device view because they are provided with many complicated features in a small screen. Another consideration is the authoring system did not have the capability of adapting the UI according to specific editing part for the user. Some authors might be expert to

provide audio enhancements on the project (audio authoring), while the other authors are excellent in narrative visual storytelling (video authoring), and, the other users might know many things that could be used to provide textual information on the project (textual authoring). In this case, we need to provide adaptability of the interface based on the users’ intention (or expertise). In this case, we develop three interfaces, Audio Authoring User Interface, Video Authoring User Interface, and Textual Authoring User Interface.

Also, in current system, using social media account such as Flickr for recommendation source seems to have less “personal” value. Instead, content from social networking sites such as Facebook tends to have deeper personal meaning in view of content creation. According to [3], *social networking* sites (e.g. Facebook) have higher self-presentation/self-disclosure than *content communities’* sites (e.g. YouTube, Flickr). Therefore, in this case, Facebook is better content source than Flickr to provide deeper personal content to be recommended into the content being authored.

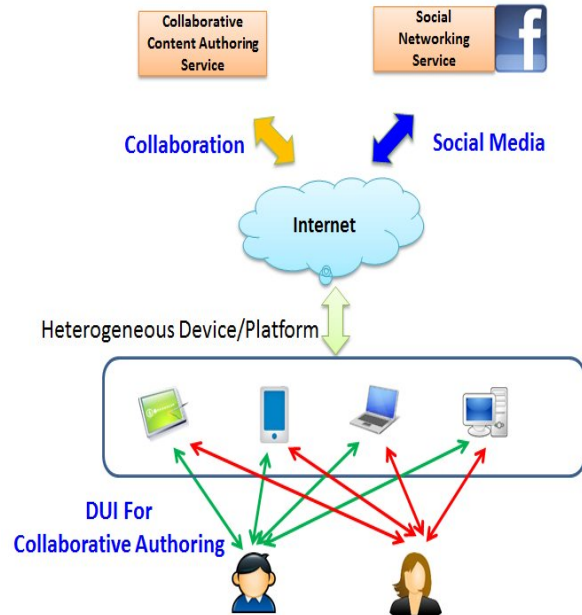


Figure 1. General direction of the proposed system.

Our general direction can be seen in Figure 1. The users have multiple devices (e.g. tablets, smartphones, PCs and notebooks) with different display size, computational resource, and features. Every devices connected to the internet, and the internet connects the users to several services, such as mobile messaging service, collaborative content authoring service, and social networking service. The users can create a content using collaborative content authoring service anywhere, using any devices that connected through the internet. Since the user might not feel convenient using the UI developed for desktop in their mobile devices, we develop specific UI for mobile devices.

In view of DUIs for heterogeneous device/platform, we use a concept of UI component which is used or downloaded to devices according to the authoring purpose and device's physical characteristics. In other words, each functionality of collaborative authoring can be divided into component. For example, the authoring of multimedia contents handles several media, such as image, video, audio and text. In the desktop environment, the authoring tool provides all the functionalities for multimedia in one application. However, in case of mobile devices, it is not possible to provide all multimedia contents authoring functionalities in small screen and low computational capability mobile device.

In our system, we provide user intention oriented component UI for the collaborative authoring. Currently, our users' intention-based UI is now being developed to reduce UI complexity during authoring process.

Proposed Architecture

To extend our current system, we propose an extended architecture which can support the concept of DUI and links with SNS like Facebook. This architecture is provided in Figure 2. The proposed architecture is based on our current collaborative authoring system[2], which is web server and web browser based client system.

The proposed system consists of web-based DUIs, web server and social database. Web-based DUI provides a space to create project, publish the content, and manage authors' accounts. Authors can store their resources (audio, photos, and videos) and CAMs in the social DB. The web server links web based DUI and social DB, and includes the modules for collaborative authoring system.

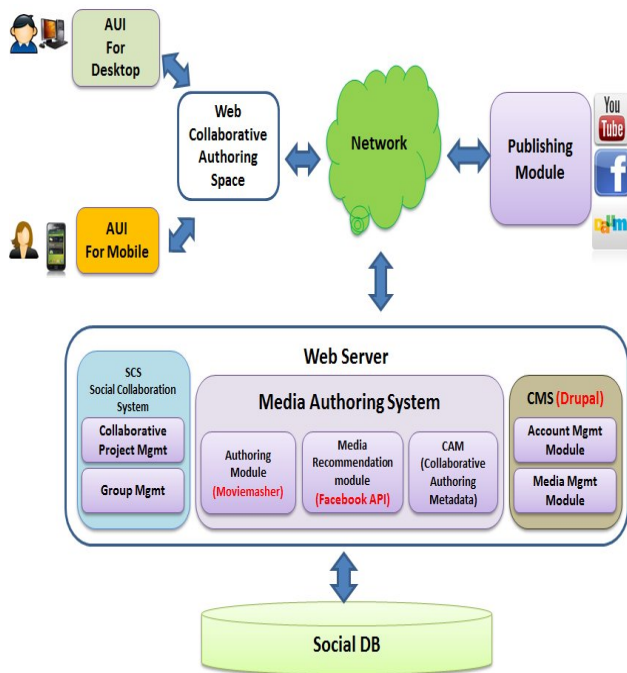


Figure 2. Newly proposed architecture of the system.

Web-based DUI can be composed according to the user's device. In case of desktop PC, we can use web browser in which all the authoring functionalities are provided. However, in case of mobile devices, user can select the DUI component according to the user intention. For example, the audio authoring user can only download the audio AUI and perform the collaborative authoring. Here, the pre-authored video and text content is provided as a reference in the timeline. However, the detailed image/video files are not provided.

The web server consists of SCS (Social Collaborative System), MAS (Media Authoring System) and CMS (Contents Management System). The SCS includes collaborative project management module and group management module. These modules implement collaborative function on the web. When a user searches for co-authors, group management module requests author's information at the social DB and provides appropriate author information to the requesting user. The collaborative project management manages group of the project.

The MAS includes authoring module, recommendation module and CAM module. The authoring module provides editing capability and preview of edited content. The CAM module creates CAMs, analyzes created CAMs and displays this information systematically for collaborative authoring. Using these CAMs, authors can exchange their authoring intention and information of each media. CAM is provided by authors during media (image, video or audio) upload. We define and store CAM using XML.

In case of creating narrative story using images, the authors need related images or videos about certain topic. Our recommendation system can help the authors by providing the appropriate image or video from Facebook. The recommendation module is a novel method for media authoring. The recommendation module searches related images from Facebook based on the keyword of the analyzed CAM. During the authoring process, each author can have a recommendation with related images and sound from Facebook based on this CAM. For example, the author can be recommended with some Facebook photos that were taken by other participants which include similar metadata.

CMS includes an account management module and a media management module. We use open source video editing tool (Moviemasher [4]) for implementing authoring module and Drupal [5] for implementing CMS.

CAM & Facebook Photo metadata

This paper also addresses the coordination of our collaborative authoring system and current Social Network Services such as Facebook, Flickr etc.

In Facebook, each user has many friends and shares several kinds of contents with one's friends. So, when we want to

create collaborative UCC, it would be also useful to use our friend's Facebook album as a social database. For this, we want to coordinate our collaborative authoring system and Facebook photo album.

Here, Participants' Facebook photos are accessed using Facebook API.

Our system supports the collaborative authoring based on the CAM. In Facebook album, each photo can have several metadata information such as time, location, and so on. So, this metadata of Facebook photo can be used as CAM for our collaborative authoring. Using this Facebook photo metadata, we can search and collect the related photos of our friend from Facebook album and create social UCC using these searched photos.

Currently, we are developing collaborative UCC authoring system while coordinating Facebook album as a social DB.

CONCLUSION

In this paper, we consider DUI for developing web-based user interface into collaborative social authoring. We develop web-based collaborative media editing environment and adapt CAM to communicate authoring intention and comments among collaborative authors, and coordinate with Facebook photo album. We add new

consideration that arises from current system and propose DUI for collaborative authoring, which has adaptability of the system to be used in multiple platforms and space, and content recommendation scheme from Facebook.

ACKNOWLEDGMENTS

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Towards Better Support For Collaborative Research By Using DUIs With Mobile Devices: SocialTV Navigation Design Case Study

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ABSTRACT

Due to the increasing importance of usability and privacy evaluation (e.g., for SocialTV), an identified challenge in our case is to support multi-disciplinary research activities related to it (e.g. rapid prototyping or interaction design evaluation) in a collaborative way. In this paper, we propose extending a collaborative system in order to flexibly allow for react on change requirements with respect to realistic SocialTV situations for different research purposes (usability and privacy requirements identification and evaluation etc.). Thereby a high-fidelity prototype that remains flexible for future extensions with reduced realization costs, becomes crucial. We concretely target this by means of a DUI based prototype that enables involved people to use their own mobile devices for navigation in a selected SocialTV scenario.

Categories and Subject Descriptors

H.5.2 [User Interfaces]: Graphical user interfaces (GUI);
K.6.m [Security]: Privacy;

Keywords

Distributed user interfaces; usability testing and evaluation; security and privacy; HCI; mobile devices; WallShare;

1. INTRODUCTION

Ethnographic research considers SocialTV as a social experience [6] since it has shown that people enjoy TV watching as a part of socializing with friends and family when co-located or geographically distributed. Considering the development of social and collaborative software/hardware with respect to the media consumption tendencies, one can notice that SocialTV is gaining in importance.

SocialTV mainly targets the integration of software/hardware to support social activities for either synchronous real-time

interaction schemes or those of asynchronous nature. For synchronous real-time interaction, a good example is allowing chatting with friends or family while watching the same TV content. Asynchronous interaction for instance is mostly represented e.g. via comments or ratings related to a TV episode or movie. Thus the SocialTV presents a completely different scenario where new multi-user requirements related to media consumption have to be fulfilled while considering usability and privacy aspects.

Based on lab and field tests as well as surveys that were carried out with the help of Web based prototype we identified various usability and privacy requirements as well as a need for a high-fidelity prototype. Thereby we involved more than 32 people of various ages and expertise. To meet the identified requirements, we propose in this paper an extension of the WallShare system to support collaboration at different time and space. In this contribution, the presented extension addresses a specific scenario concerned with navigation design in SocialTV. The extension introduces new mechanisms to support the organization and navigation of TV resources by using the mobile devices of the involved people.

The remainder of the paper is structured as follows. First we address our requirements analysis. Then we present our approach. Finally we present our conclusions and future work.

2. REQUIREMENTS ANALYSIS

In an interdisciplinary SocialTV research cooperation at our University, different people from various faculties and institutes (Media Science Faculty, Marketing and IT Security and Privacy Group from the Information Systems Institute, and international HCI researchers) are working together in order to develop innovative concepts for identified requirements and needs. Our research proceeding is mainly based on following different ethnographic approaches. For instance, by enabling people of various ages and expertise using different SocialTV solutions in different lab and field tests. These tests are accompanied with questionnaires for different phases (e.g. two-phase evaluation with the help of one questionnaire at the beginning and another at the end). The collected data (based on usage observation and questionnaires) is later analyzed by involved researchers.

In the context of this work we focus on lab and field tests carried out for selected SocialTV interaction scenarios by means of a Web based prototype to stimulate SocialTV situations. Latter primarily focused on evaluating potentials of SocialTV in the light of usability and privacy. Lab tests observations were carried out using usability testing software while field tests observations were performed in a real room allowing for a lean-back situation. In both situations, researchers are also present to observe and assist the testers. Figure 1 shows the Web based prototype used which is an online environment for supporting different collaborative SocialTV interaction scenarios. The prototype divides into four different areas (A, B, C, and D in Fig. 1). The main frame (A) shows the content on top of the chat area (B). The navigation menu (C) including the room structure was placed on left side. The general content of the prototype is arranged in rooms that can contain video material, different page types (e.g. wiki pages for text), communication channels (e.g. room-related chats and/or threaded mail) and so on. Further on this menu bar (D) contains synchronous presence awareness indicators (online users in the SocialTV platform). Awareness information is also shown in the navigation tree (C). So, users can see who else is currently in the same room watching the same video or TV content (by showing the picture of the user next to the room node in the navigation tree).

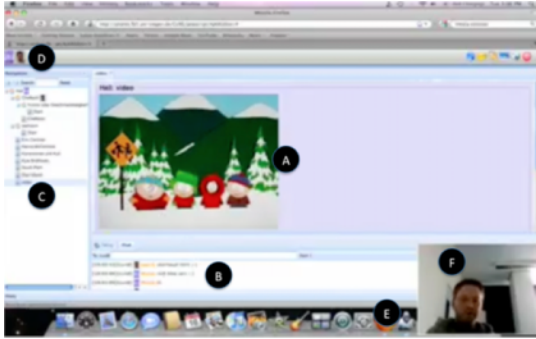


Figure 1: Screenshot from a lab test using a SocialTV Web based prototype for synchronous and asynchronous collaboration

For accuracy, the used Silverlight's Gorilla usability software (s. Fig. 1-E) allowed to capture the actions carried out in the SocialTV environment as well as the testers' interaction in audio and video (e.g. Fig 1-F). The results of lab and field tests involving more than 32 people are presented in Figure 2. While the different colored problem areas in Figure 2 are mainly related to usability and interaction design problems, security and privacy concerns analysis were identified with the help of the questionnaires. The analysis of the collected data based on the PET-USES (Privacy-Enhancing Technology Users' Self-Estimation Scale) method [2], which considers usability aspects. The main research proceeding consists in solving identified problem areas. In this paper we focus on the crucial navigation problem (red in Fig. 2) for space reasons.

The main problem area is related to the navigation in a SocialTV environment in general. In further discussion with the testers, we observed that rapid prototyping with the

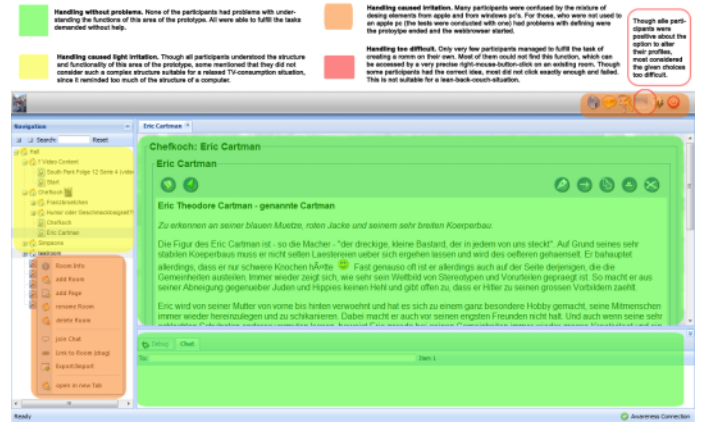


Figure 2: First evaluation results

help of other methods (e.g. charts) was not efficient enough to simulate the real situation. The development of further prototypes was expensive in terms of development costs and also brings some restrictions with it. Furthermore, the Web based realization does not reflect a high-fidelity prototype. For instance, researchers want to observe groups watching the same TV content while being geographically distributed. For this, shared displays (similar to real televisions), which are flooded with the same TV content (e.g. introduced by the users themselves) are needed and so on. In summary and since a hardware solution could also be very expensive and not adequate for reacting on emerging changes in our case: A collaborative tool allowing for rapid prototyping as well as usability testing by considering other research needs (in our case mainly related to security and privacy) was needed. This tool should reflect realistic SocialTV situations (R1), allow for flexible parallel interaction of the involved people (R2), and be flexible in terms of costs emerging from adaptations to new situations and tests (R3).

3. THE WALLSHARE PLATFORM BASED APPROACH

To fulfill our requirements R1-R3 we extended the WallShare platform [8]. WallShare provides users with a collaborative multi-pointer shared desktop that is projected on a wall, or displayed on a big screen (R1, R2). Pointers are controlled through mobile devices, such as PDAs, smartphones, tablet PCs, etc. using dragging gestures over the mobile device screen (R2). Here, the mobile devices act as remote controls that can be adapted easily to new situations (R3). The system allows users to upload, or download resources to/from the shared desktop using a pointer that is controlled from users' mobile devices by the means of gestures over the screen (R1). From the interactive perspective, according to the taxonomy described in [7], WallShare is a distributed user interface (DUI) represented by a multi-display ecosystem composed by Inch and Perch scale size displays that define a few-few social interaction relationship among users. From the collaborative perspective the system provides users with face-to-face collaboration, in the same space, at the same time) (R3).

Figure 3 shows a prototype realized by extending the Wall-

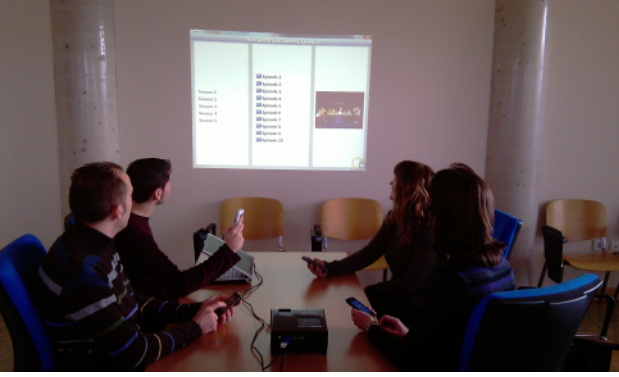


Figure 3: A SocialTV setting realized with a WallShare based prototype

Share platform. The Figure shows people navigating in a SocialTV environment by using their own mobile devices as remote controls. However, the system allows other groups to see the same content with this group together which was required in our case to better study privacy aspects (e.g. listening people impressions while carrying out the tests).

4. SUPPORTING COLLABORATION

Although this paper focuses on realizing our chosen SocialTV navigation design we want to evaluate, the Figure 4 exposes main elements of the architecture that support the different time/space collaboration among users (face-to-face collaboration was already supported by the original platform [1]). From the Intranet perspective, the **WallShare Server** is in charge of dealing with the information coming from the **WallShare Mobile Client** through a Wi-Fi connection that enables users to control the shared surface represented by the **Shared Surface Projector**. The WallShare Server is also responsible for delivering information from the Intranet to the Internet when users call Internet Services, as well as from the Internet to the Intranet when collaborative activities are performed. The **WallShare Mobile Client** is the medium employed by users to manipulate information over the shared surface by the means of gestures, as well as using services from the Internet. From the Internet perspective, the **WallShare Server** is connected to the **Idemix Server** [4] to delegate security and privacy issues. It is also connected to one or more **SocialTV Collaboration Services** to deal with different time and space collaboration. Finally, it is connected to one or more **SocialTV Video Servers** that are in charge of providing video contents.

4.1 Supporting interactive navigation

The user interface conceptual model defines the UI concepts that are part of the SocialTV UI, and how these elements are related. The Figure 5 shows these relationships. As we have mentioned, the WallShare platform implements a collaborative DUI where users employs mobile devices (Local Display) to interact with a shared display (Shared Display). For instance, if we select a video **Resource** on the Shared Display the **CommandList** in the mobile device will contain different commands according to the mobile device owner characteristics. If the owner is 16 years old, and the video is for people above 18 years, the play command is disabled.

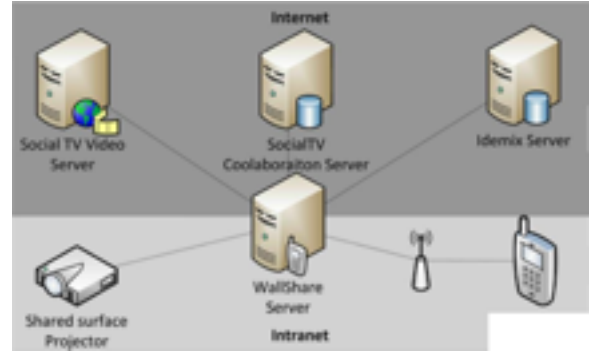


Figure 4: Extending collaboration

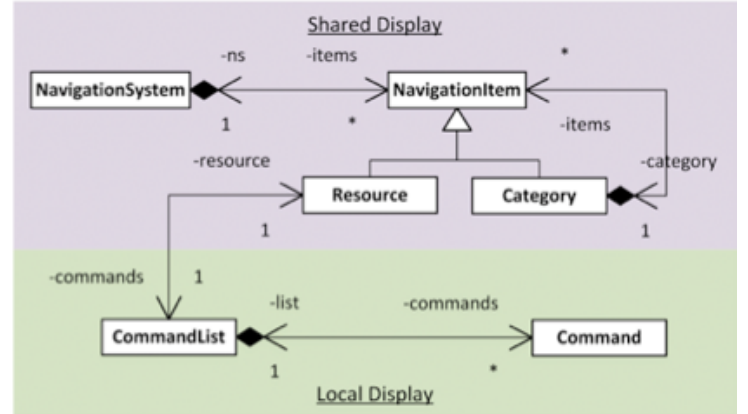


Figure 5: UI conceptual model

The aim of the navigation control is to improve the interaction between users and the shared display. WallShare is a multi-pointer platform where users are able to control cursors and perform actions on icons. However, in order to improve the navigation across categories and resources, we proposed a menu based interaction where users control the selected item position through gestures over their mobile device displays.

The navigation control proposes here two modes: the Category Navigation and Command Execution modes. The Category Navigation mode allows users to select a sub-category from a category by the means of dragging up or down the user finger over the mobile device display. In order to show the sub-category contents, the user just drag his/her finger to the right over the mobile device display. Finally, to go back to the parent category, the user drags his/her finger to the left over the mobile device display.

The Command Execution mode is activated when selecting a resource. The list of commands that are available for a resource is displayed and personalized on the local display. Thus, users are able to send messages to a conference chat, post messages in a blog, play videos, etc., just by selecting the command on the mobile device display. Note that the Exit command is an explicit option on the command list that allows users to go back to navigation model. The navigation control functionality is depicted in the Figure 6.

5. CONCLUSIONS AND FUTURE WORK

In this paper, we identified three requirements in order to reach better support for collaborative research related to SocialTV. We proposed the extension of a collaborative tool allowing for building high-fidelity prototypes that reflect realistic SocialTV situation. We showed this by means of a prototype that proposes a chosen navigation design for the Social TV system where users are able to interact with a shared display and perform social activities using gestures performed with their own personal mobile device.

As Future Work we are thinking on improving the system with social awareness. For instance, there are two people connected to the SocialTV, one of them is 21 years old, the other is 16 years old. Besides, a video for people above 18 years old is selected. The system should be able to recognize this situation. First results at modeling level could be found in [3] and in parallel evaluation work described in [5].



Figure 6: WallShare based navigation system proposal

Acknowledgments

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Two Thousand Points of Interaction: Augmenting paper notes for a distributed user experience

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ABSTRACT

We present two early prototypes of a system that couples an augmented wall of paper notes with multiple handheld devices in order to support the process of affinity diagramming. Our system allows multiple users to work together simultaneously, freely interacting with potentially thousands of physical notes directly, and with a coupled digital representation of the same notes via a smart phone, tablet or PC. We propose the affinity diagramming process as a use-case well suited for distributed user interfaces.

Author Keywords

Affinity diagram; affinity analysis; augmented paper.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Some activities are not well suited to be performed within the constraints of a traditional computer interface and context of use, and are therefore still accomplished mainly by “manual” (i.e., non-computerized) methods. Distributed user interfaces (DUIs) potentially offer new ways to accomplish these activities. In this paper we examine one such activity, affinity diagramming, and present two prototypes that create a distributed user experience using augmentation of physical objects (up to thousands of paper notes) as well as digital devices.

In the following section we explain the affinity diagramming method as it is carried out today, and discuss why paper-based processes are preferred over desktop computer alternatives. Identifying contributing factors such as support for group interaction and collaboration, tangibility, spatial awareness and interaction richness, we argue that this suggests a potential role for DUI solutions.

We then give an overview of related work, and argue that an approach based on large touch displays presents a barrier to use. Instead we propose a hybrid approach of augmenting the physical diagram and coupling it with additional

interactions on standard mobile devices. We describe our design concept for a comprehensive solution, as well as two currently implemented prototypes towards that vision. We conclude by considering the more general applications for this type of distributed user interface.

BACKGROUND ON AFFINITY DIAGRAMMING

Loose paper notes arranged on a surface are commonly used to support a variety of tasks that involve creativity, design, planning, and organizing or analyzing information. Examples include film storyboards, scrum boards in agile software development, brainstorming, studying for an exam, or planning books on note cards.

One particular process of arranging paper notes on a surface is called *affinity diagramming* (or sometimes the KJ method) [1]. In affinity diagramming, items (e.g. interview quotes, observations) are written down on separate notes, which are placed one by one on a surface (a table, or more often a wall). As the notes are placed, and in moving them around later, they are clustered based on their *affinity*: their similarity or relevance to a shared topic. This leads to the creation of groups, which are then labeled and clustered in a similar way. The process repeats until the highest level has only a few groups. In this way, affinity diagramming is a bottom-up approach to organizing unstructured data into hierarchical categories.

Affinity diagramming is used to several different ends in a number of disciplines, including CSCW and HCI as well as design, business and anthropology, and different variations of the method exist. We will focus on affinity diagramming to support the analysis of qualitative data, or the *affinity analysis* technique, as it is used within user-centered research and design.

Affinity Analysis

Many frequently used data-gathering methods for user-centered design and research (e.g., interviews, probes, participant observations, and focus groups) generate large amounts of unstructured qualitative data. In order to make sense of the information, the teams involved need to immerse themselves in the data, interpret it, and find ways to structure it. Affinity diagramming is one way to do this; other common approaches include coding the data, quantifying it in various ways, and examining and interpreting it in an informal fashion. One of the often-cited advantages of affinity analysis is that it is well suited to



Figure 1: Collaborating on an affinity diagram.

collaboration, enabling a team to efficiently generate a shared analysis together (Figure 1) [1] [5] [6].

A small affinity diagram for data analysis may consist of no more than a hundred notes, and a team of two may complete it in a few hours. At the other end of the scale, large affinity diagrams may contain up to two thousand notes, and teams of six to eight people sometimes work on them for weeks [3].

While a number of special- and general-purpose desktop applications could in principle be used to perform affinity analyses, previous research has found that users of the method still predominantly prefer physical paper notes [4] [2] [3]. Among the reasons given for this is that the computer tools do not have the immediacy, portability or flexibility of paper, that they do not adequately support collaboration through simultaneous interaction, that they do not offer the immersion, spatial awareness and tangibility of paper notes on a wall, and they limit the interaction richness to a single mouse cursor, hindering manipulation of multiple notes.

At the same time, the analog process has some definite drawbacks. The whole analysis is embodied in a single physical artifact (the diagram itself), which must typically remain in place throughout the process, and which is easily degraded (e.g., by notes falling down from their assigned places on the wall). As the amount of data increases, the affinity diagram becomes increasingly unwieldy, taking up a great deal of space, making it hard to find particular notes or get an overview of the complete structure, and becoming time-consuming to rearrange.

Once the process is complete, the results of the analysis usually need to be computerized. Also, since the diagram can only represent one way to organize the data, bringing out other dimensions requires the disassembly of the diagram; there is no straightforward way to store multiple versions or maintain a record or history of the process.

RELATED WORK

In response to the challenges of paper-based affinity diagramming and similar tasks, and mindful of the limitations of desktop applications, several previous authors have built systems based on large interactive displays.

Judge et al. [4] created an all-digital affinity system using a wall-sized multiple-display environment. *The Designers' Environment* [7] is similarly an all-digital system using tablets and an interactive tabletop.

The Designer's Outpost, in contrast, combines an interactive whiteboard with physical paper notes [6] to support design brainstorming, and Geyer et al. use a vertical display and interactive tabletop to capture and create digital copies of physical notes [2].

While these systems support collaboration, direct manipulation and spatial awareness better than desktop tools, they have their own limitations. The scale of affinity diagram they can comfortably support remains limited, they require sizable investments in dedicated hardware, and to take advantage of any of their features requires an upfront commitment to use them throughout the process, breaking with established practices.

We take a different approach, and while we don't claim our solution is better, we offer another option on the continuum between a wholly analog and a wholly computerized process.

OUR BASIS FOR DESIGN

Instead of imitating the affordances of paper on computer screens, our idea was to support the existing paper-based processes by digitally augmenting the physical notes. In addition to the literature, we were inspired by personal experiences with affinity diagramming, which the first and last author had used in previous projects.

Not only had we faced a number of the problems described above, we had also seen attempts to overcome them. One of these solutions involved having all the notes in a file on the computer, printing them out with an identifying bar code on each, and using a barcode reader to rapidly capture the structure of the diagram upon completion. Another consisted of manually photographing the entire diagram in sections after each session.

Interviews were also conducted with researchers and practitioners who use affinity diagramming and related techniques in their work (9 so far), to gather a wider range of experiences and perspectives, and for the benefit of team members who were less familiar with the affinity method. The first few of these interviews are reported in a previous publication [3].

Based on this information, we came up with the general design concept and decided which use-cases to focus on in the initial prototypes.

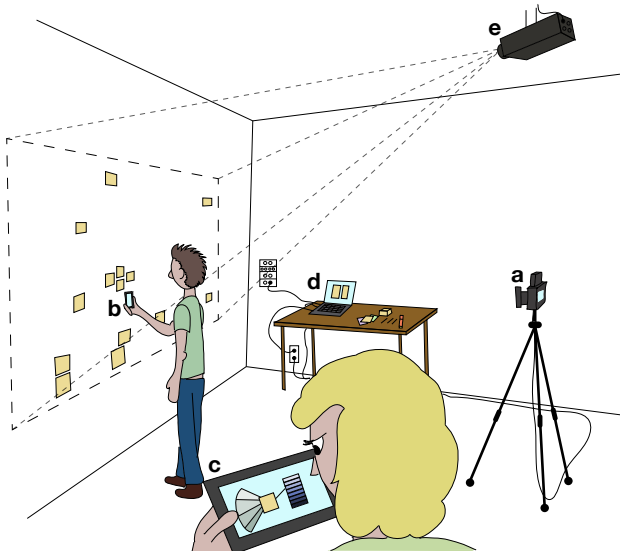


Figure 2: Sketch of the augmented paper affinity diagram concept.

CONCEPT

It was an important design goal to keep the barriers to use as low as possible, so as not to lose the simplicity that is one of the main advantages of paper. Therefore, the design concept relies on off-the-shelf hardware that is likely to already be present in many offices and labs. It is designed to be modular, so that users may include only components they have available and wish to use, and flexible, so that users can move seamlessly between the augmented system and the traditional, plain-paper process. The system will make best-effort attempts to provide as much functionality as possible given the available resources and data.

Figure 2 shows an overview of the system in sketch form. The essential element of the system is capturing the content and position of each note on the wall. In one feasible implementation, this is achieved by tagging each note with a unique ID, stored in a 2D barcode (we use QR codes). A camera pointed at the wall can then recognize the barcodes. If the notes are prepared in advance on a computer, the content of each note may simply be looked up in a database using the ID. If the database does not contain the content, the best available picture of the note taken by the camera can be used. OCR or handwriting recognition may potentially be run on this picture in order to convert the content into text form.

The system takes advantage of two types of cameras; a stationary, high-resolution camera mounted on a tripod (a) to capture the whole wall, and the handheld cameras in mobile devices such as smart phones (b) and tablets (c). The stationary camera is connected to and controlled by a computer (d), and snaps photos at regular intervals during the affinity sessions, thus providing an incomplete (due to

occlusions and barcode recognition failures) record of the locations of each note throughout the process.

If a stationary camera is not used, users of the system may instead photograph the affinity diagram manually, piece by piece. The system should stitch the photos together into one coherent representation, though in this case the temporal resolution of the digital copy will be lower. Data captured from the viewfinder when using the mobile clients to interact with the system can also be used to fill in and update the digital copy.

By moving the physical notes around, users indirectly manipulate the digital model of the diagram; in this way, the paper notes become points of interaction with the system. If they want to interact directly with other aspects of the system (for example to perform a search for a note) or view information that is not visible in the physical diagram, they can use clients running on smart phones, tablets and PCs, as described below.

Finally, a projector (e), connected to a computer running a system client, may be used to overlay output directly on the wall and onto the physical affinity diagram.

Use-Cases

The augmented affinity diagram can support many different tasks. To guide our early design and prototyping efforts, we decided to focus on some simple use-cases: (1) Locating a note on the wall based on its content; (2) Viewing the distribution of a set of notes defined by a certain characteristic; (3) Consulting additional information about a note.

IMPLEMENTATION

We have created prototypes of the key components of the system, allowing a user to interact through an Android smart phone or tablet client, using the projector to display output and getting input from a stationary camera.

We use a simple client-server architecture, where Android apps on the smart phone and tablet (and what is currently a Java client on the computer connected to the projector and camera) communicate over HTTP with a backend server, which handles any heavy processing and maintains the digital model of the affinity diagram in a database.

As part of the initial setup, the projector and stationary camera need to be calibrated to each other, in order to know where to display information that should be overlaid onto the wall. We assume the wall to be a flat surface, and so we simply display 2D barcode patterns at the corners of the projected area. By recognizing these barcodes in a photo from the camera, we can calculate the transformation between the camera view and the projector view and position overlays accordingly. Of course, if the stationary camera is moved, the projector must be recalibrated.



Figure 3: Smart phone and tablet clients; top right, notes matching a search being highlighted in green by the projector.

The current smart phone client (Figure 3) offers the ability to search for notes based on their content (use-case 1). A simple search field is used to enter queries, returning matching notes as you type. Notes selected from the results are highlighted on the wall. Through the same interface, a user may also search for categories of notes, such as all notes from a certain interview, and highlight all of them at once (use-case 2).

The current tablet client, meanwhile, is designed for viewing additional information about a note, such as metadata (e.g. the participant profile, or information about the interview or observation session the note came from), photos associated with the note, and direct access to the data in raw form (e.g. the audio or video clip that the note is based on, an unedited transcript, etc.).

The interaction is again based on a magic lens model, where the user holds the tablet up to a note she is interested in more information about, while the screen displays the viewfinder view. When a barcode is recognized, the app overlays an interactive digital version of the note on top of the image of the physical note. The view can then be frozen so that the user may interact with the digital note without having to keep pointing the tablet to the physical note.

The additional information about the note is displayed as a stack of notes hidden under the note itself, which can be expanded out to sit around it and moved around freely in the neighborhood using touch gestures. Color coding is used to distinguish different types of information.

Limitations

These early prototypes have been created both as technology tests and to test the designs. Both aspects still suffer from many rough edges. On the technology side, the biggest challenge is the barcode recognition. While the resolution of the camera is fully able to resolve the barcode pattern, variations in brightness across the image mean that

many QR codes fail to be recognized under anything other than optimal lighting conditions.

Small-scale usability tests of the prototypes have shown that participants are able to complete the intended tasks with only minor difficulties, and pointed towards some possible improvements for future iterations. The tests also indicated that the coupling of the physical notes with the digital augmentations is compelling and easily grasped.

Neither the designs nor the implementation are yet sufficiently mature to test in a realistic context, so we cannot say how well they will fit into the affinity diagramming workflow and group interaction.

DISCUSSION

The augmented affinity diagram offers multi-user interaction distributed over a number of digital devices. However, we believe the more significant aspect of the work for distributed user interfaces is the augmentation and instrumentation of mundane objects, here in the form of paper notes, turning each of them into a point of interaction with the system. This form of ubiquitous computing is a radical break from traditional computer UIs, and here we are barely scratching the surface of its potential and what it means.

Affinity diagrams lend themselves well to this kind of augmentation, as the notes can be tagged to be easy to recognize, and the activity is relatively straightforward to model. However, as different types of sensors become commonplace and computer sensing improves, the same paradigm extends to many other activities that involve distributed interaction with physical objects, such as browsing a book shelf or a shopping aisle, cooking, tidying up and cleaning, and many types of office work. These and others will provide many interesting problems for DUIs to address.

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Using Distributed User Interfaces to Evaluate Decision Making in Cloud Deployment

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ABSTRACT

In case of incidents in information technology (IT) systems of a supply chain participant, crisis teams need to quickly take steps in order to keep IT systems and therefore the supply chain running. Deploying an IT infrastructure partly or completely on cloud infrastructure is a viable solution, e.g. as in the face of technical failures and cyber attacks. Currently there is poor support of tools, which allow lay users for cloud deploying applications in a provider independent fashion and with respect to their individual security requirements. For this task we presented and discussed ESCAVISION. In this paper we propose an approach based on distributed user interfaces in order to evaluate the usability of ESCAVISION and the process of decision making in crisis teams. Furthermore the respective interaction design as well as the WallShare based infrastructure are described. We also discuss the approach and future directions.

Author Keywords

Distributed user interfaces, cloud deployment, cloud security, decision making, mission-critical situations

ACM Classification Keywords

H.5.2 User Interfaces: Graphical user interfaces (GUI), C.2.4 Distributed Systems, K.6.M. Miscellaneous: Security.

General Terms

Experimentation; Human Factors; Security

INTRODUCTION

Cloud Computing [13] has gained considerable importance, for industrial settings as well as in the personal area. Application deployment in the cloud (called “Cloud deployment” in the rest of the paper) is still a challenge, especially for lay users. While some providers offer custom

tools to ease cloud deployment, others lack such a facility. Migrating already deployed applications from one cloud provider to the other is another crucial task which requires user-friendly tools to support this kind of decision-making, especially in mission-critical scenarios. In [10] we proposed ESCAVISION, a tool which supports lay as well as experienced users with these kinds of tasks. It was motivated by an industry scenario from the ReSCUeIT project [15] which requires user-friendly solutions for lay as well as experienced users to perform mission-critical decisions such as migrating (parts) of the IT infrastructure of supply chain partners. However, evaluating the usability and the process of decision-making in ESCAVISION is mostly limited on interviewing users in the afterward.

This paper describes an approach on the basis of Distributed User Interfaces (DUIs) to track the process of decision-making and evaluate the usability of ESCAVISION live and in a minimally invasive fashion in terms of distraction of users by observers. The approach uses WallShare [18] which provides users with a collaborative multi-pointer shared desktop which can be projected at several locations on e.g. a wall. It allows us to live observe users who are performing tasks related to cloud deployment such as provider selection and security configurations while allowing for remote observations where both groups, users and observers, are not bound to any location. Live observation delivers context-related data on usability aspects of ESCAVISION which is otherwise hard to track in the afterward. The possibility to change locations of both groups on the fly adds flexibility to social experiments and also allows for observing dynamic groups in changing locations more easily.

The rest of the paper is structured as follows. In the next section we describe a motivating scenario from the ReSCUeIT project and address our requirements analysis based upon that scenario. After that we present our approach. Related works are discussed thereafter. Finally we draw a conclusion and address future works.

SCENARIO AND REQUIREMENTS ANALYSIS

Scenario

ReSCUeIT [15] is a joint German-French research and development project which focuses on increasing the safety of the food supply chain for the civil population. It integrates partners from academia as well as from industries along the food supply chain (production, retail and logistics) in order to assure that the requirements from all different stakeholders in the food supply chain are considered. In the frame of this project, one goal is to develop a software platform which supports the whole business process lifecycle from business process modeling to process execution. This platform needs to be fault-tolerant and scalable in order to keep the supply chain working, even in the face of cyber attacks on the IT infrastructure of one or several supply chain-partners. Known and well-documented threats can be detected by the ReSCUeIT platform and are responded to by means of automated process-chains. However this approach is not suitable for unpredictable and/or unique threats. In such a case a crisis team is gathered and informed by the ReSCUeIT platform. This crisis team then needs to manually take measures to face the threat. One of these measures is deploying parts of the IT infrastructure on cloud infrastructure in order to assure that the supply chain keeps working. We proposed ESCAVISION [10] for this task. As the members of the crisis team do not necessarily need to be IT experts (e.g., employees of an agricultural production facility), one design goal of ESCAVISION is to support experts as well as lay users.

Currently we are using a high-level representation for security properties (see Figure 1). For a given application (which needs to be prepared in the beforehand as an image containing a software stack) and cloud service which follows the Infrastructure-as-a-Service (IaaS) model [13], the user can determine the importance of each of the security properties confidentiality, integrity and availability on a scale with three stars where one star means “low importance” and three stars “high importance”. More experienced and expert users can define security requirements at a more fine-grained level. For instance the security property “availability” can be further divided into “response time” and “uptime”. While the “stars” representation of lay users is transformed into concrete values for more fine-grained security properties based upon security best practices, experienced and expert users can define these values on their own. These requirements are then transformed into image- and cloud service-configurations in a model-driven fashion [10].

Requirements

The usability of ESCAVISION’s User Interface (UI) is crucial for the efficiency with which the crisis team responds to disruptions of the ReSCUeIT platform. Therefore it is important to be able to evaluate the usability of the UI live, not only in simulated but also in real settings.

In order to reduce dangers of version conflicts with the UI, changes to the UI should take effect on all clients immediately. This will also neutralize the danger of collecting wrong data with regards to the usability of the UI.

As humans tend to change their behavior when being observed, a live observation facility is needed which requires as less direct or indirect interaction with the test persons as possible while giving them the freedom to use ESCAVISION from virtually any point, including their natural working environment.



Figure 1. Example for user-defined security properties in ESCAVISION.

To sum up, the analysis of the scenario yields the following requirements with respect to evaluating decision making processes for cloud deployment with ESCAVISION:

- Facility which allows to evaluate the usability of ESCAVISION live in real or simulated settings (**R1**)
- Changes to the UI of ESCAVISION should take effect for all users immediately (**R2**)
- Live observation facility from R1 should influence users as less as possible in order to assure that users behave natural (**R3**)

THE WALLSHARE PLATFORM BASED APPROACH

To fulfill our requirements R1-R3, we extended the WallShare platform [18]. WallShare provides users with a collaborative multi-pointer shared desktop that is projected on a wall, or displayed on a big screen (R1, R2). Pointers are controlled through mobile devices, such as PDAs, smart-phones, tablet PCs, etc. using dragging gestures over the mobile device screen (R2). Here, the mobile devices act as remote controls that can be adapted easily to new situations (R3). The system allows users to upload, or download resources to/from the shared desktop using a pointer that is controlled from the users’ mobile devices by means of gestures over the screen (R1). From the interactive perspective, according to the taxonomy described in [17], WallShare is a distributed user interface (DUI) represented by a multi-display ecosystem composed

by Inch and Perch scale size displays that define a few-few social interaction relationship among users. From the collaborative perspective, the system provides users with face-to-face collaboration, in the same space, at the same time) (R3).

Figure 2 shows a prototype for a SocialTV [4] setting which was realized with the WallShare platform. The Figure shows people navigating in a SocialTV environment by using their own mobile devices as remote controls. The system allows other groups to see the same content together with this group. For members of crisis teams this means that they do not necessarily have to be located together. For researchers evaluating the interaction of crisis team members with the WallShare platform it means that they do not need to be physically present in order to evaluate the usability of the UI.



Figure 2. A SocialTV setting realized with a WallShare based prototype.

One of the most important functions that ESCAVISION acquires by applying WallShare is that, the system can learn user's preferences in order to assist them. These preferences are represented by user profiles. WallShare asks the user to identify and it has an initial information about the user (e.g. name, age, language, etc.), and our proposed system acquires knowledge about user actions that are worth being recorded to determine their preferences and to model relationships between them. WallShare maintains the status of every device, with which the user makes use of the system, and activates them as per user preference. It generates a sequence of expected user's query and simultaneously activates the devices with preset preference settings.

By this, ESCAVISION facilitates its usability for the user and influences users as less as possible in order to assure that they behave in a natural way while using it.

EXTENDING WALLSHARE TO SUPPORT R1-R3

WallShare per se already offers facilities to distribute the UI. We added additional facilities for an observer UI which contains exclusive menus for observation purposes. In case that somebody from the "observer" group joins a WallShare session, the DUI turns on observer facilities. Otherwise the

UI is restricted to ESCAVISION functions. These functions include selecting applications and cloud services as well as defining security properties [10]. The functions mentioned above were integrated in WallShare by means of a sophisticated UI (see Figure 3). Crisis teams can use the UI from different locations which allows them to work distributed using their mobile phones as a remote control (see Figure 4). Observers can also be located nearby or at different locations so that their individual UIs cannot be seen by regular users. Additionally, each member of either group can change his/her location without any negative effect on the observation process. Therefore requirements (R1) and (R3) are fulfilled.



Figure 3. WallShare with ESCAVISION extension.

All UI templates are managed centrally and then served to any kind of display. Changes on the template are taking effect on the displays immediately. No update of mobile phone clients is needed. Therefore requirement (R2) is fulfilled.

The resulting system contributes to usability and collaboration in two ways:

- (1) It improves collaboration between users and observers by not dictating any mode of interaction. Members from both groups can work either collocated or distributed and are not bound to any physical location.
- (2) Awareness of users is addressed by not showing any observer functionality if no observer is present at the same location. This reduces irritations, possible wrong usage and thus increases the quality of observation data.

RELATED WORK

In [3] again WallShare was used as a DUI to support secure distributed decision making. Hence the general eligibility of DUIs for decision making was shown. However this work did not cover using DUIs as testing environment to analyze the process of decision making or to test the usability of UIs.

The approach presented in this paper is based upon work presented in [6] where a context-aware facility for



Figure 4. Controlling WallShare remote via mobile phone.

SocialTV was developed by means of a security meta-model which was transformed into a concrete UI. This transformation is context-aware and takes into consideration subscriptions of users in order to decide if certain programs should be showed on a list or not. The approach presented here adapts this idea to decide whether the observer UI should be shown or not.

Cloud deployment was the topic of several works. Here we will focus on one approach by Konstantinou et al. [12] which is quite similar to ESCAVISION. The main difference here is that ESCAVISION is more focused on different kinds of users, namely lay and expert users. On the other hand the work of Konstantinou et al. addresses an approach to build applications based upon a repository of pre-built virtual machine images which then can be deployed in the cloud.

The interplay between security and usability was formulated by Kerckhoffs in 1883 as the last of his six principles for crypto-systems and it demands that the correct application of a crypto-system should be easy to use and not expect the user to know “a long series of rules” [11]. The exact modalities of this relationship are however still a matter of research (e.g. [1, 7, 8]). Research in the field of model-driven service security was done by e.g. Satoh et al. [16] and Menzel et al. [14]. In both works however the focus is on service-oriented methodologies to develop new applications whereas ESCAVISION is an approach to outsource existing applications.

In this paper we present a distributed asynchronous system which allows remote evaluation of users submissions; it works in real-time and off-line, calculating and showing the

current potential maximum score for each proposed challenge. Through the distributed architecture of the system, many deployment scenarios are possible. Applying this tool, multiple scenarios can be arranged and mixed easily, increasing the range of problems variety, evaluation methodologies and, hence, raising the possibilities and potential utility of this system.

In order to support the decision making process at different physical locations, it largely depends on having all relevant information at hand immediately and being supported during the discussion of the information independent from their actual geographical location. For our system, we propose the use of a common multilaterally secure distributed UI to support the decision making in geographically distributed groups of users.

CONCLUSION AND FUTURE WORK

This paper presented a system offering an approach based on distributed user interfaces in order to evaluate the usability of ESCAVISION and the process of decision making in crisis teams.

The system allows observing users live while performing tasks related to cloud deployment such as provider selection and security configurations. At the same time, none of the groups is bound to any location but can move freely in order to allow for a more natural behavior of test persons which thus leads to an increase of the quality of observation data.

Results from current and future evaluations which are going to be performed with the extension of Wallshare presented here are intended to be used to further improve the usability of ESCAVISION, especially for collaborative settings.

Features planned to be integrated are direct manipulation techniques for navigating through the menus as well as sophisticated tailoring capabilities (e.g. drag and drop support for access rights assignment). ESCAVISIONs new functionality for the so-called visual tailoring [5] and navigation will be complemented by new forms of visualizing synchronous awareness information and supporting communication.

These days, almost all users make use of the internet with their mobile devices, so the next version of ESCAVISION, which is now being developed, will also directly support mobile devices by means of an App to be more dynamic and to offer the user more flexibility to use it. The UIs are being developed by applying Model Driven Architecture (MDA) methodology, to obtain the highest interface quality and to be standardized.

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Enhancing the security and usability of DUI based collaboration with proof based access control

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ABSTRACT

Resource access control is at the heart of many collaboration platforms. Thus the usability of used techniques is crucial for projects with high expectations to response times in the collaboration process. The special case described in this paper is using the anonymous credential system Idemix in a such a project basing in its turn on distributed user interfaces (DUIs) to enhance decision making in disaster situations. We show the potential of using Idemix to enhance the usability of decision making in crisis related social interaction by using DUIs. Idemix and proof-based credential systems in general could ease transparently performing authorization, e.g. without any user intervention at the level of the user interface. We present this exemplary with means of a developed prototypic mobile application for supporting collaborative scenarios for the BMBF RescueIT and projects along with the WallShare System. Further, we present the IdeREST implementation of Idemix in order to support non-Java devices such as Windows Phone 7 used for the developed prototype.

Author Keywords

distributed user interface; access control; anonymous credentials, Idemix, WallShare, IdeREST

INTRODUCTION

When working in collaborative settings, the use and disclosure of personal information for private and business life is a must. Thereby applications gain strength from leveraging efficient, secure privacy-respecting interaction and communication between individuals as well as seamlessly supported interaction in terms of enjoyable user experience.

On the one hand security and privacy are one of the most-cited criticism for pervasive and ubiquitous computing [10]. On the other hand usability is a prerequisite for security and

privacy. Therefore, it is part of a major effort to balance and improve security and privacy design of applications by considering usability aspects especially in collaborative systems using shared workspaces. One of the most disregarded and critical topics of computer security has been and still is, the understanding of the interplay between usability and security [6].

One of the means to enhance privacy in communication of individuals and services is to use partial identities, consisting of selected user data to be disclosed for a particular purpose and context. Privacy-enhancing systems and applications supporting collaboration have to allow for user-controlled identity management (IdM). With respect to the different capabilities of modern mobile devices (e.g. smart-phones and tablet PCs), addressing security and usability aspects becomes crucial. Experts from various research communities believe that there are inherent trade-offs between security and usability to be considered [6] [13] [3]. These general requirements are based on ongoing work in various projects targeting to leverage advantages of distributed user interfaces in various scenarios.

In this paper, we present our approach for enhancing the usability of end-user controlled access rights management in privacy-respecting collaborative settings. Our approach makes use of the anonymous credential system Idemix in order to provide complex access control functionality for a collaborative RescueIT prototype. The usability-related requirements result from using Idemix in complex mobile collaborative scenarios in the context of RescueIT in first prototypes.

The reminder of this paper is organized as follows. An overview of the state-of-the-art is given in Section 2. In Section 3 we present the requirements derived from scenarios of the RescueIT project. Section 4 we propose our evaluation approach, before we finally conclude with our conclusions and presentation of ongoing and future work in Section 5.

STATE-OF-THE-ART

Collaborative settings need some degree of user information disclosure in order to achieve the intended goals as Palen and Dourish mention in [12]. Mostly, end-users have to balance functionality and security as well as privacy preferences by

using several mechanisms. Access control is a main mechanism the system has to achieve, ideally without affecting the usability of the application. Usability issues are also discussed by security researchers in [6] and [7] from theoretical and practical perspectives. Especially in social settings where mobile devices with restricted capabilities and new possibilities (e.g. screen size, ease of localization) are used, there is an increasing need for privacy-respecting mechanisms and solutions by considering trade-offs related to usability.

A fairly large number of research work is focused on making access rights management usable for end-users. An overview on existing approaches for access rights management in collaborative environments has been provided by Bullock and Benford in [4] as well as in Haake et al. in [8]. Latter work reviewed the state of the art especially by focusing on group formation and access control in shared workspace systems concluding that *"in today's shared workspace systems access rights management by end-users is insufficiently supported, either due to too complex role models, access control parameters and user interfaces that end-users cannot easily understand, or due to insufficient functionality"*. From the security point of view, different practices are used to enhance access control. The widely used password authentication is in general a good approach under the prerequisite that a secure password is used. In general passwords are notoriously weak, mostly because of limitations of human information-processing and/or limited capabilities of the respective mobile device. A contribution from the usability field to enhance authentication is e.g. the usage of graphical passwords. An example is the usage of graphical authentication in Android smart-phones to unlock the main screen. However also those approaches have been proven to be not secure enough e.g. due to the smudge traces that can emerge on the screen surface [1]. Biometrics also allows for enhancing authentication but are still *"classified as unreliable because human beings are, by their very nature, variable"* [6] [11]. The challenges increase if (lay) users are asked to set access rights for others, delegate rights, or manage their own security and privacy preferences. In the context of this work, the EU Project PICOS¹ represents a good and current example. Security and usability research for developing usable (psychologically acceptable) security mechanisms is a young research field which depends on the context usage [6]. Because of this and many facts cited above, we argue that security and privacy design by considering usability is specific to the project context, and thus we analyze in this paper requirements of user-controlled access right management. Those are based on concrete RescueIT requirements by considering lessons learned from previous projects and good practices cited in standard literature.

PROBLEM AND REQUIREMENT ANALYSIS

In this section, we first present background information about Idemix and about the RescueIT project on which our requirements gathering is based. We summarize thereby requirements from lab tests with previous prototypes that resulted

in change requirements primarily related to usability aspects, before we address further requirements we derived from the selected scenario in scope of this paper.

Idemix in a nutshell

Idemix is an anonymous credential system, developed by the research group led by Jan Camenisch at IBM Research Zurich. It enables to perform anonymous authentication between users and/or service providers and as well supports accountability of transactions [5]. An Idemix credential is obtained from an issuing authority, attesting to the users attributes such as birth date or access rights and allows for various protocols and mechanisms cited in standard literature (i.e. property proofs, usage limitation, revocation of credentials, revocation of anonymity, verifiable encryption). During the issuance protocol the user and a certificate authority (CA) interactively create a credential. In contrast to privacy enhancing technologies sending pseudonym certificates to a given verifier, Idemix based solutions only send proofs (such as I am older than 18 or working in the automotive industry). It allows for un-linkable, selective disclosure of such attested credential attributes while not revealing others. When the user shows this credential to another entity (another user or a service provider), the credential itself is never revealed. Since Idemix enables involving the user in the personal data disclosure process, the user can decide which attributes to disclose [2]. All these strengths make it well suitable for realizing an user-controlled IdM supporting digital faces in RescueIT for both; collaboration of users with each other as well as collaboration of users with a given service.

RescueIT background information

ReSCUEIT² is a joint German-French research and development project which focuses on increasing the safety of the food supply chain for the civil population. It integrates partners from academia and industries along the food supply chain (production, retail and logistics) in order to assure consideration of requirements from all stakeholders. One goal within the scope of this project is to develop a software platform supporting the whole business process lifecycle from business process modeling to process execution. This platform needs to be fault-tolerant and scalable in order keep the supply chain working even in the face of cyber attacks on the IT infrastructure of one or several supply chain-partners.

Summary of the requirements from earlier prototypes

Earlier work related to this paper is based on the previous objectives described above. The full presentation of the RescueIT requirements goes beyond the scope of this paper. Instead of this, we cite the concrete main requirements which were identified related to security as well as usability-related performance evaluation with respect to a potential Idemix integration in RescueIT:

- Developing a prototype reference implementation of an IdM system for mobile devices
- Support of changing end-user requirements while building as well as evaluating developed prototypes and concepts

¹The PICOS Project: Privacy and Identity Management for Community Services. <http://picos-project.eu>

²Robustes und vErfgbares SCM - UntErstztzende IT-Plattform: RESCUE IT (BMBF). <http://www.sichere-warenketten.de>

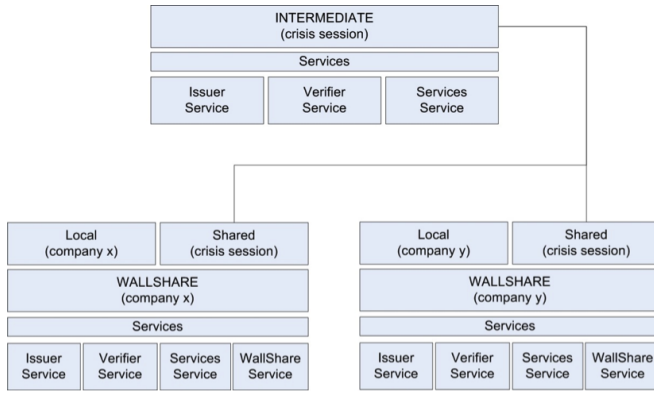


Figure 1. Architecture of two wallshare instances communicating via an intermediate

As part of a previous work an Android prototype has been implemented and analyzed [9]. The main focus laid on general feasibility and performance evaluation, but lab tests with end-users also identified several usability requirements. An additional analysis of selected RescueIT scenarios identified the need for usability enhancements in access rights management mechanisms (authentication and authorization). In summary, the evaluations identified the following (change) requirements:

1. the IdM has to be deployable on mobile platforms without affecting usability acceptance (**CR1**),
2. and an usable (and intuitive) interface to define complex access rights (**CR2**).
3. the Idemix protocol needs to be performable by non-Java clients, like e.g., a Windows Phone
4. RescueIT needs to support dynamic, distributed crisis management, so a realistic scenario implementation has to be provided and evaluated for CR1 and CR2 (**CR3**).

APPROACH

From the previous explanations, Idemix represents a perfect starting point for automating privacy-enhancing authentication and authorization in the background meeting so CR1 and CR2. By allowing for background authentication and authorization, a good performance could be reached since no user interaction is needed. The CA could provide needed acknowledgements for access permission enforcement. However, this needs a pre-defined set of attributes which are allowed to be included into automatic generated proofs.

For meeting CR3, we implemented an emergency scenario, in which different stakeholders of the supply chain, managed by RescueIT need to interact in order to find a fast solution for the crisis. To support the interaction and documents sharing during a crisis session, the WallShare [14] system proved to be an adequate approach, so we used this as a basis for our prototype and extended it to meet our requirements.

The Idemix RESTful service

In order to be as flexible as possible in terms of used hardware, we want to support many different mobile platforms, with different capabilities, and the current reference implementation of Idemix is written in Java, we needed find a way

to perform the Idemix protocols, even with platforms not supporting Java. Since the porting of Idemix from Java to C/C++ is ongoing work, we decided to provide the functionality in form of a RESTful Idemix service. To achieve this, we externalized the computation functionality of Idemix to a server offering a REST-API. With this server, we call *IdeREST* it is now possible to use the Idemix functionality even on Windows Phone, Windows server or to lower computation time for weak mobile devices.

Implementing the scenario

In the implemented scenario, we make use of the WallShare system, in order to support the collaboration in a local meeting situation. A large WallShare screen is projected in a meeting room and each user has an additional screen on his/her mobile device in order to interact with WallShare and see additional information. Each user has an Idemix credential, allowing to proof certain characteristics, like, e.g., role, age, or employer. With this it is possible to define special access rights for each shared document and also to log in to the WallShare system. If an crisis situation occurs, and multiple, locally distributed, organizations need to interact, an intermediate session is instantiated (see Figure 1. The local WallShare screen will then become split in two areas, a shared area that is the same for all distributed WallShares, and a local area, only viewable by the local team 2. Now all participants can easily exchange important documents pictures etc. by just dragging them into the shared area. The WallShare servers (Windows server), as well as the mobile WallShare clients (Windows Phone) are making use of the IdeREST service in order to authenticate each other.

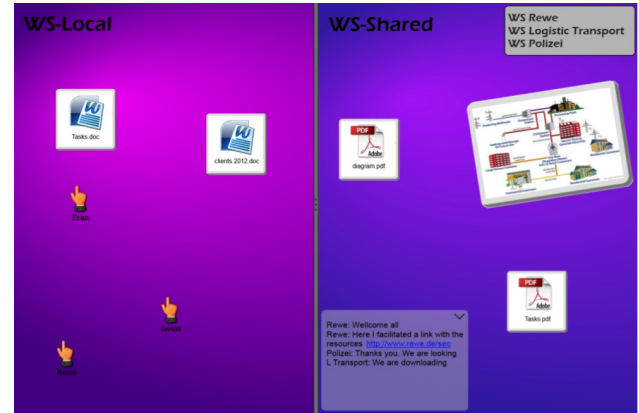


Figure 2. Wallshare showing a local and a shared area

When a new crisis session is instantiated, the creator can define special access rights for the expert team to join. Thereby it is possible to make the intermediate session only accessible to managers of a certain organization and the local police department. Third parties, like, e.g., the press, can thereby be excluded, which can be of high importance in delicate situations. The generation of the required Idemix proofs is performed in the background, hidden from the user. The issued credential (comparable to a virtual id card) is initially stored on the device and relevant attributes (and only them) can be shown automatically on demand. Code Listing 1 shows the

code of the Windows Phone prototype used to login with Idemic to the WallShare server.

```

1 private void LoginIdemix() {
2     string result = client.Connect(App.Host, ECHO.PORT);
3     if (result != "Success") {
4         MessageBox.Show("Error de servidor");
5         return;
6     }
7     App.Socket = client;
8     App.Nonce = App.Socket.Receive();
9     App.NombreProofspec = App.Socket.Receive();
10    try {
11        IsolatedStorageFile store = IsolatedStorageFile.
12            GetUserStoreForApplication();
13        if (!store.FileExists(App.NombreProofspec)) {
14            App.Proxy.DameProofSpecAsync(App.NombreProofspec);
15        }
16        else {
17            CompilaProof();
18        }
19    } catch (Exception ex) {
20        MessageBox.Show("Error con el servidor");
21        App.Socket.Close();
22        return;
23    }
24 }

```

Listing 1. Code of the Windows Phone client for login

CONCLUSIONS AND FUTURE WORK

In this paper, we showed how the usability of user-controlled access management can be enhanced by using Idemix. Since Idemix is an anonymous credential system allowing for mixing identities, it also supports automation of some scenarios by providing un-linkable anonymity. The feasibility of our approach was demonstrated by implementing the prototype which enables participants to transparently exchange data in the background without the need for explicit interaction (e.g. in UIs). This is possible since Idemix assesses that the attendees fulfill some attributes in the background (i.e. required affiliation or role) and provide access without disturbing the end-users. Our approach presents a new solution which is to our best knowledge not addressed in related work. Future directions intend enhancing the usability and security in P2P scenarios and for generating complex proofs for users without security background.

Acknowledgment

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Enhancing LACOME to Consider Privacy and Trust Issues in a Mixed Presence Meeting Environment

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ABSTRACT

The LACOME system was initially developed to support screen sharing and interaction with shared documents during collocated meetings; security and privacy needs were met through social norms. However, meetings often require the inclusion of remote participants. In this position paper, we describe LACOME and discuss the design challenges of extending it for use in mixed presence (collocated and remote) environments. Two key design implications we are addressing are privacy management in large shared display and trust management in remote collaboration.

Author Keywords

Distributed User Interface; Mixed Presence; Collocated Collaboration; Trust Disparity.

ACM Classification Keywords

H.5.m. Information Interfaces and Presentations: Miscellaneous; H.5.3. Group and Organization Interfaces: Collaborative Computing; D.4.6. Security and Protection: Access Controls

INTRODUCTION

LACOME, the Large Collaborative Meeting Environment, was initially developed at UBC (see [8, 10] for details of its architecture). It uses a client/server architecture to allow participants (clients) to connect to the LACOME server and publish their desktops on a large screen with one or more VNC servers (see figure 1). Once published, windows or even full desktops can be moved, resized, and iconified. The LACOME server is responsible for running the shared display and creating multiple VNC session simultaneously whenever requested by the LACOME clients. It allows other users to interact with the displayed information at a variety of semantic levels.

A LACOME client can be connected to the server either as publisher, or navigator or as both. In figure 1, three computer systems are interacting with LACOME. The first client is connected as a navigator, while the second one is connected as a publisher by VNC connections. The third client is connected both as a publisher and navigator. There

are two types of VNC connections shown in the diagram, a regular VNC connection is initiated by the LACOME server, while a reverse VNC connection is started by VNC server. The navigators communicate over LACOME connections, while publishers communicate over VNC connections [10].

Distributed user interfaces provide enhanced interaction capabilities to users by distributing user interface elements across users, platforms, environments and different contexts [3]. The LACOME system is an example of a distributed user interface systems as it includes the following dimensions of distributed systems:

- Multiple users: Several users collaborate at the same time
- Multiple computing environments: Collocated v/s Remote collaboration
- Multiple domains and tasks: As each user is collaborating with his/her personal machine, so users have the flexibility of performing independent tasks and can publish their work for the other participants when they deem it appropriate.
- Multiple contexts of use: Users collaborate with different machines (laptop/desktop), hence different computing powers and platforms (operating systems).

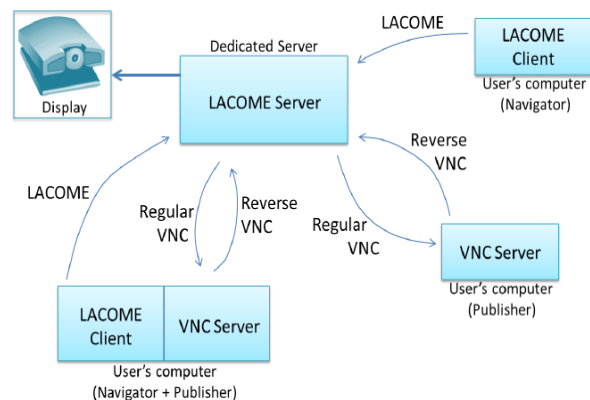


Figure1. A typical LACOME Configuration [10]

LACOME is similar to other distributed user interface system such as Wallshare [15] and Dynamo [7], and it has similar functionality (i.e., client-server architecture, large display sharing, designed mainly for collocated collaboration). WallShare [15] is a multi-pointer system based on client/server architecture that allows collaboration for face to face meetings and working groups [15]. Users can collaborate through the shared zone via their mobile devices and a usability evaluation showed effective outcomes in terms of effectiveness, productiveness, task efficiency and task time. Dynamo [7] is a large publicly accessible multiuser interactive surface that allows the cooperative sharing and exchange of media remotely and shoulder to shoulder collaboration by allowing multiple users to interact simultaneously on the same large display [7]. Dynamo and WallShare with mainly designed for displaying and exchanging information in collaborative environments, while LACOME was mainly developed to support large collaborative meetings and eliminate the need to sequentially display and interact with information on a large shared display

The LACOME system was originally designed for collocated collaboration, but it can also be used in a mixed presence scenario with the addition of conferencing (audio, video) support to provide the verbal communication necessary. The current system would only provide one way communication to remote collaborators as they could connect to the LACOME server from their remote location and share their desktops but they would not be able to see what other collaborators are sharing or to interact with the shared content. We are, therefore, extending this current system to provide equal opportunities for mixed presence collaboration.

A common concern while sharing on a large single display is the privacy of confidential information. To date, no explicit privacy controls have implemented in LACOME, instead it is relying on social privacy norms inherent in face-to-face collaboration. As we move to implement privacy and security controls more formally, we are guided by Social Translucence design principles [4] of providing visibility, awareness, and accountability in the system. We are also considering trust management and access controls, two key requirements for systems intended to support dynamic collaboration [11]. Once we finish our re-design of LACOME and implement the new controls, we will conduct a usability evaluation of the system. This evaluation will be focused on the user's satisfaction and effectiveness of the system, as well as to further identify any unanticipated security and privacy issues that will arise when it is used in a mixed presence collaboration.

We next discuss the design challenges in mixed presence collaboration before discussing their implications for the design of LACOME and our future work.

CHALLENGES IN MIXED PRESENCE COLLABORATION

Until now LACOME was designed for use in collocated settings. As we extend this system to be used in mixed presence, we must address issues of privacy, trust, and usability explicitly. We have identified four major challenges of collaborating in mixed presence settings:

Impoverished environment: We need to provide similar communication environments to collocated and remote participants for equal participation in collaboration. For example, collocated collaborators can use hand gestures to uniquely communicate significant information [14], which may be missed by remote collaborators. One for remote collaborators is that the collocated participants have the ability to control (i.e., stop or minimize) an individual's actions while interacting with the system through verbal communication, gestures, etc., while remote users have limited control when collaborating with the system.

Trust Disparity: We believe that trust is one of the biggest factors that need to be considered for efficient and productive communication. If interacting with the system with only a custom mouse cursor, remote collaborators cannot compete with the physical presence of the collocated users [12]. This unique problem is called presence disparity, where collaborators focus more on collocated collaborators at the expense of their distributed counterparts [13]. We also consider trust disparity [9], which is a similar issue in remote collaboration and is a consequence of presence disparity. It can be more difficult to develop trust in online settings than during collocated collaboration. Trust among collocated and remote participants can vary prior knowledge, credentials, and activities. We hypothesize that the collocated participants will trust each other more than the remote participants because collaborators at the same location typically have some prior knowledge of other people and can more easily determine their activities. Thus, they may have a level of while publishing or sharing their contents with others at the same location.

Access control: The large meeting environment demands different levels of access according to the requirements and authorization of the users. Access control is an essential component to ensure the secure access and is more challenging for dynamic collaboration because of limited knowledge about remote users [11]. Therefore, access control policies are not only important for remote collaboration to establish trust and secure communication, but these are also useful for collocated users for efficient and productive communication by eliminating (preventing) disturbing elements to access the system. Currently LACOME does not provide access control mechanisms.

Privacy: Privacy concerns can increase when personal and confidential information is shared on a large screen. Privacy concerns can be the greatest barricade to the long-term success of ubiquitous computing [6]. Some privacy concerns that users might have during system use involve

understanding just who can access the information and what they can do with that information.

DESIGN IMPLICATIONS FOR LACOME

We present design implications for LACOME as we extend the system with privacy and access controls to support mixed presence collaboration and overcome the challenges. We have identified in the current LACOME system the only information that the server has about clients is the IP address of their machines. The server displays two things on screen, the IP address of the server and the “return to desktop” icon. The IP address is shown on the upper left corner (see Figure 2). The server IP address is used by clients to start the communication with the server, while return to desktop icon is used to stop navigation. When a particular user wants to break navigation, it presses this icon and LACOME server send message to user’s client, indicating that user want to cease navigation [10]. When multiple users share their desktop on a large screen, they have no information about which display belongs to which user. This identification problem is exacerbated when trying to identify the users interacting during mixed presence collaboration.

Our implications for design include:

Provide enhanced information about collaborators Research suggests that richer media are better for trust building and trust maintenance [1]. We believe participants, especially remote ones, need more information about other system users. We are considering adding a user profile option; whenever a LACOME client connects, the user will be asked to create a profile that would include information about the participant (e.g., image, credentials, experience). This profile would be available on the LACOME server. This particular feature will reduce the trust disparity and also increase the communication awareness among the users. To facilitate ongoing meetings, users should have the

option of storing this information long-term.

Mirror the shared display to remote collaborators. The remote collaborators have no information cues except for those provided by the system itself [5]. Currently, the LACOME system does not provide feedback other than what is visible on the shared display except through a small control window on the user’s machine when they run a client to navigate or publish. Our implemented system will provide a mirror image of the system to its all users and groups to enhance two way communications and provide remote collaborators with more information.

Provide security controls and visibility of access control. One way to resolve privacy concerns is to define the accessibility of the system by providing information about collaborators and what information they can access, what will happen to the information that people have shared etc. The current system doesn’t use any authentication techniques except the server’s IP address. In large and confidential meetings, clients need to be authenticated in order to block interruptions from disturbing the audience. Another security technique that can be used to maintain the security and privacy of shared information is authorization. The use of authorization will allow groups or individual to be authorized for the access of shared information. The use of authentication and authorization techniques will notify the publisher about who is accessing the information and users have privilege to deny the connections if they want to. Therefore, use of access control mechanism in LACOME system will reduce the privacy concerns and trust issues.

Implement privacy gradients for shared content. Another way to resolve privacy issues may be to introduce privacy gradients through the concept of public and private desktops. The public desktop contents could be viewed by all collaborators, while private desktop contents could be viewed by only certain participants who have been provided access by its publisher. In the current system users have no option other than sharing their content to all viewing the shared display (generally the whole desktop content, unless their VNC server allows them to share individual windows). With the addition of remote users and the concept of more than one shared display in the collaborative environment (i.e., the main display and its mirrored versions), the opportunity exists to provide finer grained access control.

FUTURE WORK

Once LACOME has been extended for mixed presence environments, a user study will be required to find out how these issues will affect the users, what they will do in this situation, and how people’s sharing behaviour change with the type of meetings. Our initial plan is to develop the system using recommendations from prior research and then refining the privacy and access controls as we observe the concerns and actions of its users in the field during various meeting types and environments.

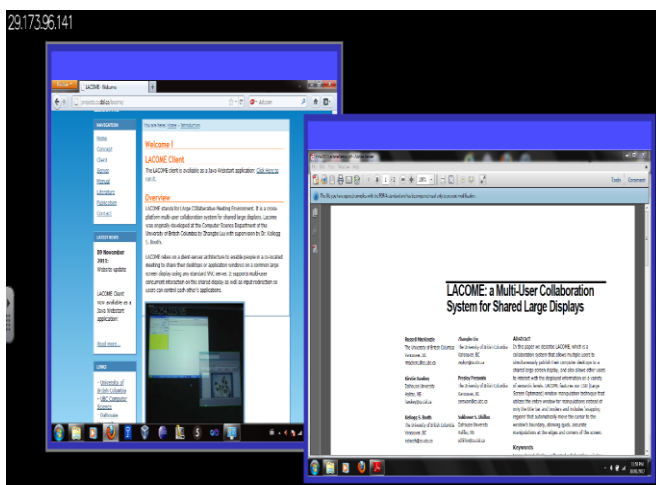


Figure2. Screenshot of LACOME system showing two shared displays on a large screen. IP address in the left corner is used by the clients to connect to the Server.

There are several broad challenges that we have to consider before designing the study. The study design will going to be challenging for two reasons: the distribution of participants during mixed presence collaboration and the difficulty of studying privacy and security due to its secondary nature. As our main objective will be to observe security and privacy issues, we should not reveal this objective to our participants as it may bias their behaviour towards the task if they know that they are being observed for particular task. Prior research has pointed out the difficulties in conducting usable security and privacy related studies because security is rarely a primary goal and most of the time it is not noticed by the users until it is broken or missing [2]. Both lab studies and field studies can be challenging. It is not an easy task to motivate users in security related lab studies if they are not using their own machines and data, and they may focus more on security than usual [2, 16]. It is equally hard to design field studies as well because participants might have concerns about the security and privacy of their tasks and not want to be observed. Additionally, we will have challenges due to the inclusion of both remote and collocated participants which will impact our ability to study the impact of the system on all the collaborators present.

CONCLUSION

In this paper, we introduced LACOME system. It is a large collaborative meeting environment system initially designed to support collocated meeting environment. We are extending the current system to be used in mixed presence. We have identified some theoretical design challenges in order to extend its use by remote participants. We proposed design implications to overcome these challenges and are in the process of implementing basic functionality and controls to allow participation by remote collaborators. Once finished, we will conduct a series of user studies to iteratively refine the system and its security and privacy controls. These studies will allow us to investigate the tradeoffs between security, privacy and usability.

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A Framework for a Priori Evaluation of Multimodal User Interfaces Supporting Cooperation

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ABSTRACT

In this short paper we will present our latest research on a new framework being developed for aiding novice designers of highly interactive, cooperative, multimodal systems to make expert decisions in choice of interaction modalities depending on the type of activity and its cooperative nature. Our research is conducted within the field of maritime surveillance the next generation distributed multimodal work support.

Author Keywords

Analysis, *a priori* evaluation; cooperation; multimodality; system design.

ACM Classification Keywords

H.1.2: Human factors; H5.2: Evaluation/methodology

General Terms

Design; Human Factors; Management

INTRODUCTION

The computer industry is on the brink of a new era. The future is not a solitary PC, but a diverse set of smart, cooperative devices interacting not only with its end users but also with each other while fully integrated in their environment. The interaction with these systems are multimodal where the tools become extensions of the human sensor and motor systems supporting the end users' cooperative execution of actions while trying to solve problems. The computer is thus no longer a system that just determines something by mathematical means, brings order (Fr. 'Ordinateur'), handles data (Swe. 'Dator'), count information (Hun. 'Bilgisayar'), or is a machine full of knowledge (Fin. 'Tietokone'). It is rather an infrastructure for multimodal human-computer interaction and cooperation. However, are we as designers equipped to meet the rapid evolution within the computer industry? In

this short paper, we suggest that we need to find a way to minimize the gap between analysis and design to be able to continue delivering optimized and satisfactory systems to our customers and end users at a reasonable price.

THE DESIGNERS' CHALLENGES OF TODAY

The vast majority of today's expert designers are still novices within the design of highly interactive, cooperative, multimodal systems. However, they are still supposed and demanded to deliver intuitive, useful systems of high quality to a reasonable cost. The technology necessary to create these systems are mere a mash-up of existing technologies, but the design field is quite new. Model-driven languages, methods and tools are continuously being developed and enhanced to meet the demands of the industry on adaptive, flexible and robust [8] systems designed and developed at a low cost. One example of such a project is the pan-European ITEA2: UsiXML project which is based on the $\mu 7$ concept, i.e. multi-device, multi-platform, multi-user, multi-linguality/culturality, multi-organization, multi-context, and multi-modality. However, due to the designers' lack of experience and know-how in designing these new complex systems, and due to the intended end users' and customers' inability to clarify and articulate their cooperative and multimodal needs in a comprehensive way, the designers often face infoglut resulting in poor choices in interaction modalities. Some of the most common challenges are:

- The intuition and decision-making of the designers regarding computer supported cooperative multimodal systems are biased by previous experiences of single-user system design
- The complexity in group interactions and activities pose great challenges:
 - Group logistics of data collection
 - Number and complexity of variables
 - Validation of re-engineered group work
- It is time and money consuming to perform evaluation of multimodal cooperation even though

one focus on a smaller set of activities and well defined user groups (even for a one-user application)

- The lowest common denominator is “easily” validated for single user systems, but not for multimodal cooperative systems with a big variety of end users
- There is a disparity in activity objective and needs between who does the work (the end users) and who gets the benefit of that same cooperative work (the management team/the customer)

One way to aid the designers would be to provide a framework that can alleviate the transition from analysis to design. Today, this is a tedious time consuming work biased on deficient mental models by the designers and without any promise of quality delivered. Therefore, our intention is to help novice designers of cooperative multimodal systems to make expert decisions in choice of modality or combinations of modalities. We believe that this will not only enable the creation of new, for the end users, adequate intuitive systems supporting their cooperative work, but it will also optimize the projects’ ROI. In the following paragraphs we will present an *a priori* evaluation framework being developed based on our understanding of human behavior and cooperation and how multimodal interaction can be approached to solve these issues. Our research is being conducted in the context of ATOL (Aeronautics Technico-Operational Laboratory), a joint enterprise between TELECOM Bretagne, Thales and Ecole Navale (the French Naval Academy), where we study multimodal computer supported cooperative work within the context of maritime surveillance missions.

HUMAN BEHAVIOR AND COOPERATION

One of the strongest assets of human beings are their ability to interact with each other in quite complex ways in order to fulfill a great number of simultaneous tasks initiated from a wide variety of intentions [7], an ability paramount for the execution of maritime surveillance missions. These interactions take place within a group of people, i.e. two or more participants, who can be considered to cooperate to the extent that they 1) consider each other cognitively in interaction, 2) have a joint purpose, 3) consider each other ethically in interaction, and 4) trust each other to act according to 1-3 [1]. Novices and experts meet in different groups and teams within which they take on passive, active or expansive roles, while belonging to different communities of interest and practice at the same time [4]. Their interactions can be collective or dispersed and they can be direct, i.e. interpersonal, or indirect, e.g. mediated by computers. Furthermore, depending on their level of involvement, one can consider them to engage in no interaction, lightweight interaction, information sharing, coordination, collaboration or cooperation. Evidently, the complexity of human interaction together with the challenges posed on the designer regarding choice of

interaction modality demands a comprehensive framework to avoid infoglut in the moving from analysis to design.

Based on the work of prominent scientists during mid and late 19th century, such as Charles Robert Darwin, Gustav Theodor Fechner and Mikhaylovich Sechenov, the Russian psychologist Lev Semyonovich Vygotsky founded cultural-historical psychology, thus closing the gap between the natural sciences and the mental sciences of human behavior. He approached behavior not as a result but rather as a process in motion and in change, i.e. by studying behavior as interaction. Vygotsky’s research on activities bridged the gap between the mental and the physical contexts of human behavior and consciousness [10]. Activity Theory, an evolution of Vygotsky’s research, provides a basic framework for human interaction and a useful basic unit of analysis; the activity.

The Activity Theory concept deals with a set of fundamental types [5], which are:

- An object – Activities can be distinguished by their objects. It is the object and the transformation of that set object that drives the activity.
- A collective phenomenon – The activity does not take place in isolation but is always a collective phenomenon.
- A subject (agent) – The activity has a subject or a collective of subjects who understands the motive of the activity. In our research we refer to the subject as an actor or a role.
- A material environment – The activity exists in and transforms its material environment.
- A historically developing phenomenon – The activity is a process that has a shared memory.
- Contradictions – The force behind the development of an activity are contradictions.
- Actions – Participants realize an activity through conscious and purposeful actions.
- Culturally mediated relationships

These fundamental types can easily be illustrated in a diagram together with their individual relationships. Kuutti’s research [5] on Activity Theory and its fundamental types has resulted in a useful framework for research on computer-supported cooperative work. Cadier [2] extended the Activity Theory framework of Kuutti to manage both negotiation and execution of cooperative work (see Figure 1 and Figure 2, below), thus enabling analysis of cooperative activity.

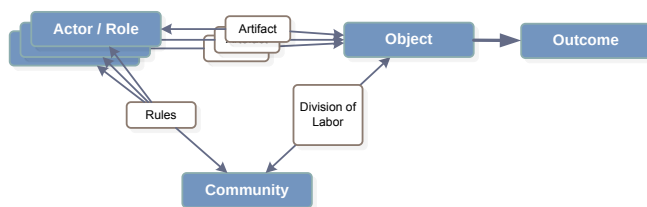


Figure 1. Basic structure of a cooperative activity [2] with its properties visualized and given a relation to each other with mediating artifacts, rules and division of labor being multimodal in their character.

The model in Figure 1, above, depicts the ‘playground’ of an activity, whereas the model in Figure 2, below, illustrates the actual execution process of an activity and its sub-activities/tasks and operations. Furthermore, this model also illustrates the cooperative steps of an activity where the negotiation of division of labor is the starting point, but also the result.

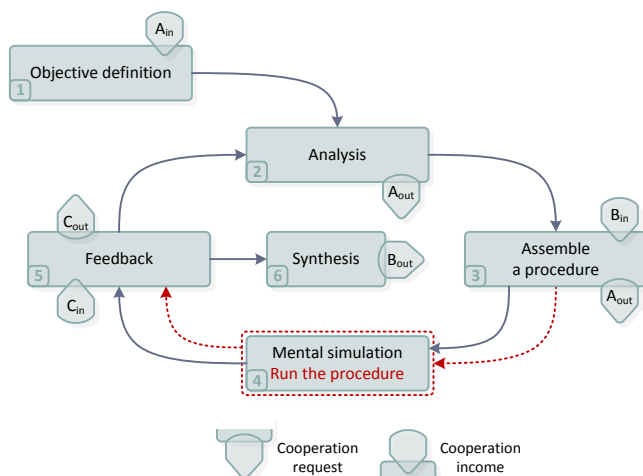


Figure 2. An iterative cooperative activity process [2] where cooperative requests are multimodal acts of negotiation and decision whilst the rest of the process is multimodal (internal as well as external) actions.

Based on this knowledge we can conclude that cooperation is heterogeneous where contradictions force activities [5], that it is culturally and contextually situated and that it makes use of internal as well as external communication [10], both verbal and non-verbal [1], to organize the same activities. These activities the users later execute with the help of mediating artifacts such as computers. We can also conclude that the level of verbal versus non-verbal communication depends on the social context of the actor/role, which are mediated via social rules and norms and the activity's division of labor. This would suggest that no person act in isolation and that one could consider all activities, if taking into account the different levels and types of human interaction and work support, as cooperative as well as multimodal.

Based on this understanding of human interaction and computer supported cooperative work we can look closer at

what implications this has on the choice of interaction modalities and how we can develop a framework suitable for designers.

A SOUND CHOICE OF INTERACTION MODALITY

Human behavior, interaction and cooperation are multimodal by origin. Activity Theory provides, as shown above, a comprehensive high-level framework for organizing cooperative activities into manageable entities. However, in order to be able to provide any insight into preferred choice of multimodality for any specific context we need to enhance and develop it further. To be able to manage the cognitive aspects of the actors/roles in cooperation we can make use of Endsley's Situation Awareness model [3], which, in combination with our understanding of the human sensor and motor system provide a mind and body description of human capabilities (see Figure 3, below). The actor/role has been given a physical interface in his/her motor and sensor system as well as a detailed description of his/her mental capabilities, which both take part in transforming the object mediated by an artifact, e.g. a computer system, and vice versa. The same goes for the mediated interaction with the community via cultural rules and norms. Together, the mind and body define the activity process from situation awareness via decision to execution of the activity, either alone or in cooperation with other actors/roles. The actors'roles' mental capabilities and properties are affected by the community's social and cultural rules and vice versa and the actors'roles' use of artifacts to transform the object of interest into sought for outcome also transforms the actor/role in that same process.

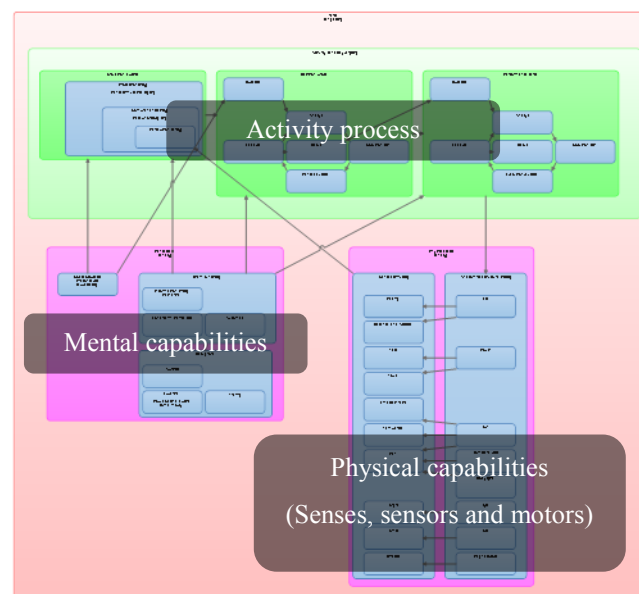


Figure 3. Enhanced actor/role model based on work of [2], [3], [4] and [5]

A computer system also has a physical interface towards the outside world and an inner “mental” core based on the

intentions of the system creators as well as its users' use and re-work. The physical aspects (input and output devices) together with the logical interaction language make an interaction modality which together with e.g. CARE properties can be combined into multimodal interactive systems [6] while providing *plasticity* [8] (see Figure 4, below) to correspond to the changing context.

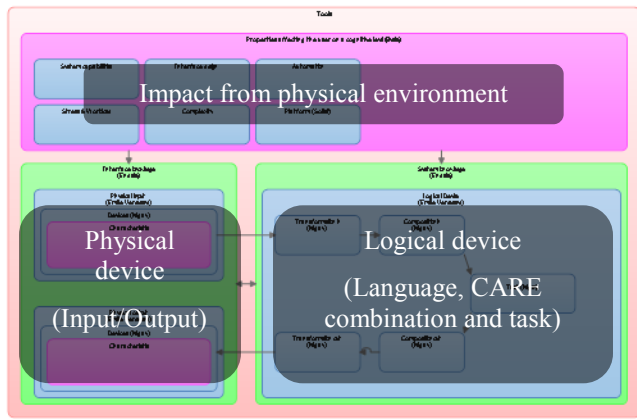


Figure 4. Our latest artifact model of the computer interface based on the work of [6], [8], [9] and [10].

The understanding that human interaction with computer systems and other humans varies depending on if the actor/role is acting alone or in cooperation with other humans or computers as well as on the context of use is crucial. By comparing the actors'roles' mental capabilities and objectives with the logical device and its intended task support of the computer system one can evaluate the mental aspect of the activity. By comparing the physical capabilities of the actors/roles with each other and with the computer system one can find constraints as well as possibilities of interaction modalities. The actors'roles' negotiation with the group and the community regarding division of labor while executing tasks aided by a computer system changes the way a task is conducted and what interaction modalities that are suitable for the overall activity as well as the execution and negotiation of the tasks.

The continuous development of our models based on our cross-disciplinary research proves very promising. Our research on the next generation work support for tactical commanders and sensor operators within maritime surveillance, who work closely within highly specialized teams, while making use of different kinds of interaction

modalities or combinations of modalities to execute their work, and who negotiate their division of labor, are well suited for our research. We hope that our results will shed some light on the impact of cooperation on the preferred choice of interaction modalities. Our framework will be a welcome help for novice designers of cooperative multimodal systems when making expert decisions in choice of modality or combinations of modalities.

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CSchool: DUI for Educational System using Clouds

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ABSTRACT

In this research paper we describe the conceptual process of the CSchool system, to support the administration of schools educational process in the cloud by applying Distributed User Interfaces (DUI). CSchool encourage the use of new technologies by students, teachers and parents, in the classroom within the entire educational environment making use of amicable distributed interfaces between its users. This system appears as a result of the "Escuela 2.0" project. This project contains high number of schools, and start with the need to create collaborative characteristics to communicate the users of these.

Author Keywords

Distributed user interfaces, cloud deployment, educational systems, web services

ACM Classification Keywords

H.5.2 User Interfaces: Graphical user interfaces (GUI),
C.2.4 Distributed Systems.

General Terms

Design, Human Factors, Educational System

INTRODUCTION

In schools, the daily work of teachers and students is focused in the educative sessions and the collaborative work (face-to-face and offline sessions). In the other side, the new technologies put more and more tools at its disposal (moodle, Atutor, Blackboard, Calorina, etc.), but these technological systems do not use education as a key element; instead, they are based on the advantages that teachers and students can find in managing these models, through online and distance education [1]. From here, we start the development of the CSchool (Cloud Services for Schools) system, as a distributed system that facilitates the interaction between the different users of the educational communities (schools, teachers, students, tutors, etc.), by making use of the cloud services, and at the same time by presenting an educative process of quality.

In the last 2 years, we presented the first steps of this work, TabletNET [2] eLearnXML [3]. These learning platforms make use of services and resources such as communication, collaboration, cooperation and evaluation (Agenda, discussions, email, exercise, libraries, forum, chat, test, etc.) to create a comprehensive education environment, in the classroom or distance learning, between students, peers and teachers. These tools have been developed to manage the students of a school or a particular class.

The idea of the paper will merge TabletNET and eLearnNET to the cloud, and to make use of the current economic benefits of cloud computing, which is being impossible to be avoided now days. With CSchool, schools can identify their core competencies that define the differentiated service provided to those involved in it [4]. Some services are offered by public providers (google Cloud, Amazon Cloud, Azure Cloud, etc.) and others come from shared capabilities with other relevant users from other educational systems. For this, the consolidated services are an important lever engine. From one side, this will reduce the costs in the educational system, and from the other side, it will help in facilitating wider access. With CSchool students can access to technology, and they will not depend on any technical charges, human and financial costs that an institution can support. Students from a state or region can expect that common services are provided through the "cloud education" provided by the system (see Figure 1). The model of interaction between these users will notice message passing and distributed system interfaces.

This paper consists of 6 sections: First, a brief introduction is given. Second, we review the concept of cloud computing and the advantages of making use of it in the educational environment. Third, we go through the cloud services that will support these users. Fourth, we describe the system of charging for these services. Fifth, we present a case study of the application by presenting an example of XML messaging between different clouds and a user interface prototype, and how the devices can access this distributed system in the cloud. And lastly, we end the paper with the conclusions and future work.

CLOUD COMPUTING

The term cloud computing is a new phenomenon that appears to be linked to Web 2.0. The origin of the term refers to the collection of different services stored on servers that users access them only through Internet. That

is, the user has access to a number of files and programs stored in different, undefined, or virtual places (this is the reason why the term cloud is used), which are permanently available to us wherever we are [5]. Our documents are not physically hosted on our computer and we can have them from anywhere with just an Internet connection. So, working in the cloud means that users don't have the need to depend on a particular program or even an operating system any more. And, the only need to start working in the cloud is a device with Internet connection.

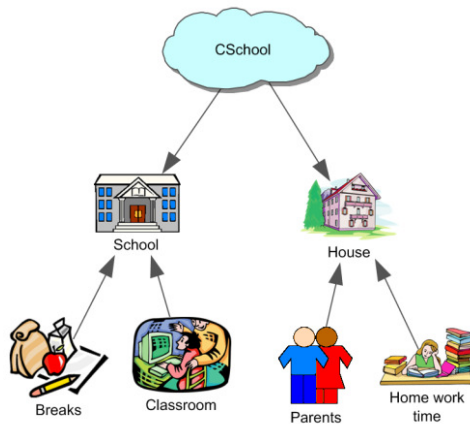


Figure 1. System Scenarios

Cloud computing applied for education

The great advantage of “the cloud” is information sharing, in a real way. With a local area network multiple users can use the same file, but it gets more interactive with, for example, a document shared online by several students. Similarly, they can simultaneously view exercises, view and edit home works on the web and organize all the information shared in a presentation, using data from different sources [6]. All this, is based on collaborative and communicative environments. Our educational cloud is composed of information, academic process data; those are linked together with other Web 2.0 applications that support the students’ interaction with each others, managing by this, their own academic process. As we indicate before, in our research group, ISE Research group, we are building a new platform, CSchool, which make use of all these resources to create an adequate educative environment to students and teachers to improve the teaching / learning process in the secondary schools by means of Cloud services and distributed user interfaces.

CSCHOOL SERVICES

Being the cloud systems the accommodation place for the users’ interaction within the services of the system, push the distributed user interface to incorporate into the cloud as a service, and in which this service will be available to support the user devices in a hidden way. Since our scenarios are schools, first we studied how the CSchool services are divided, taken into consideration the school organization. From here we can extract the necessary

actors, in addition to the scenarios where these actors act, and the distributed interfaces in which they will be screened. The school schedule is specified following a procedure established by law, for the management and academic organization [7]. If this is accompanied with qualification, evaluation, monitoring and communication, and finally to support distributed user interfaces, we can define the necessary CSchool services (see Figure 2):

- **Program Services:** provide the necessary structure for the teacher to conduct an educational program according to a specific structure established by the education law.
- **Services of teaching units:** provide structure for the creation of teaching units and establish the organization of these teaching units to be taught within distributed user interfaces.
- **Services of collaborative learning:** collaborative learning tools or application that encompasses all these needs distributed within multiple user interfaces.
- **Service learning languages:** distribute the multimedia character reinforcement, audio and video for students and teachers between several user interfaces.
- **Communication services to parents:** with this service, schools and teachers can communicate with parents or tutors, in one way communication, this communication is developed to support distributed user interface.
- **Distributed user interfaces:** supports Web Services 2.0.

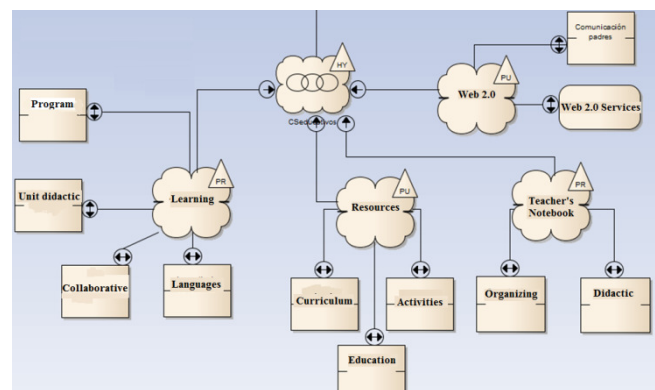


Figure 2. CSchool Services Grouped by Clouds

These services are grouped in different clouds, and at the same time those are grouped by the scope of the services from the educational point of view, which can be public or private clouds, but it also includes hybrid clouds that provide services to external entities. In Figure 2, there is a cloud structure SMOF [8] following the methodology in which the services are grouped by IAAS [9], in which each cloud offers full service.

CSCHOOL ARCHITECTURE

In the conceptual model of the system architecture we distinguish two distinct parts, first we define the different types of pricing and its architecture, which should cover the different possibilities of a cloud with the services mentioned above. On the other hand we consider the conceptual architecture of the distributed user interface, allowing the system users to establish collaborative relation.

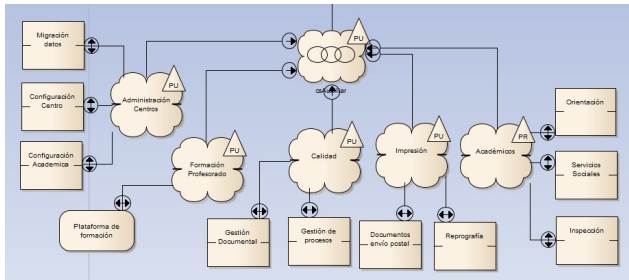


Figure 3. Other Auxiliary CSchool Services Grouped by Clouds

CSchool Charging Architecture

The charging architecture [10], define the different types of pricing proposed for this system, as the following types: prepaid charging, bid rate charging; constant charging; Variable charging, etc. As an example of this conceptual architecture, we show how the charging scheme in the SCschool is included, taking into account the access to files and data.

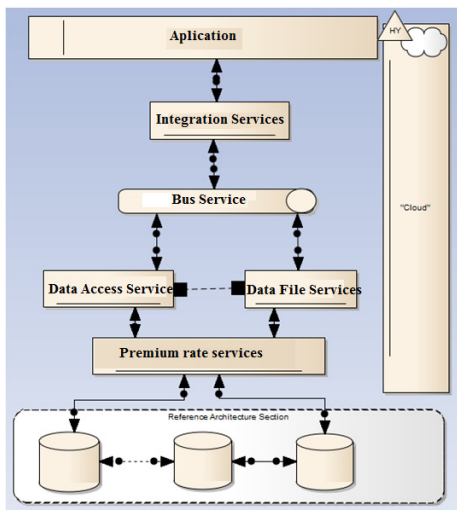


Figure 4. CSchool Charging Service

Elements under the CSchool charging are:

- Users of the system, constant charging.
- Files hosting, charging for lodging.
- Reprographics, constant charging.
- Postal sending, bidding charging.
- Multimedia services, video and audio stream.
- Activities and resources for creating lesson plans.

To set and store the results of the charging system as well as to consult it, XML language is used in all steps and carried out in the cloud. The XML charging system gives us a possibility to obtain a detailed bill grouped by the type of charging of the resource, providing all the details to the customer.

DISTRIBUTED USER INTERFACES DEVELOPMENT IN CSCHOOL

The scope of the project and its location makes necessary the inclusion of a distributed user interfaces support, to obtain a quality system that take into account the use of new technologies, mobile devices and multiple use of devices at the same time, on the cloud, so users can interact with the application in a dynamic way. In this scenario, the cloud provides the communication channel, the channel that users make use of to share information in real time.

For this we created specific services in CSchool, to establish the communication between users, for which the interfaces, and how to be distributed between several user interfaces, are managed in the cloud before being displayed in the user device. These interfaces are developed by using Model Driven Architecture (MDA) [11]. All resources are developed to support distributed user interfaces, share reading (viewing) and writing (editing) properties. The interface of the application is divided into several sections. These sections can be divided to be distributed between several devices, to provide the means to communication and collaboration (see Figure 5).

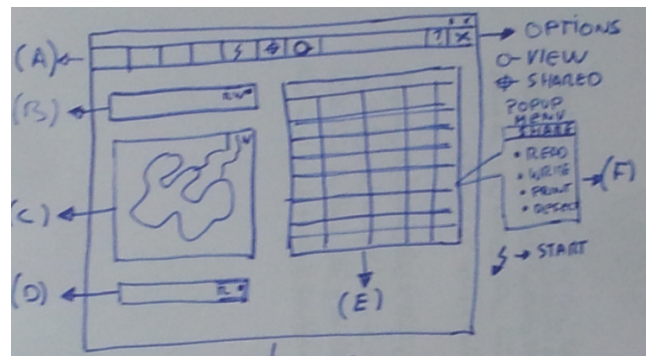


Figure 5. CSchool Distributed User Interface

In this logical design, we define the functionality of the interface where the user can select whether he want to share, his screen, with read-write properties with other users. The parties identified in the interface design, are as follow: (A) indicate the options of the menu which lists the actions to share items, add read and/or write properties. By managing the part (A), the user interface will preview these actions on the other elements [(B), (C), (D) and (E)] of the interface. These features of the distributed user interface within CSchool will facilitate the collaborative work for both students and teachers, as well as the involvement of parents in the educational process, by interacting in the scheduled sessions by the teacher. It also allows the

creation of curriculum materials and activities preconfigured for inclusion in the teaching units.

CSCHOOL CASE STUDY

Next, we present a case study with the screenshots of an activity performed in the classroom, and the user interface of the devices in the different scenarios (school, home, etc). To start the class, the teacher has to perform several steps; he creates and initializes the students' sessions, so the students' mobile applications can work, see Figure 6.



Figure 5. CSchool Teacher User Interface

Once the teacher finishes the creation of a session the student can start performing his work; the student can usually visualize and perform his school work, on his mobile or tablet devices, see Figure 7.



Figure 5. CSchool Student User Interface

The student can perform his work in a single way or monitored by his tutor, in which this can view the students screen from the TV or any other smart device has the application installed on, see Figure 8.

CONCLUSION

This paper has presented the current situation of CSchool system, an initial architecture for an information system in schools, which is part of School 2.0 project; we have defined the actors, and the scenarios given by the these cloud services, in a innovative design. We believe that, our system is a large project, and there are multiple technologies to be tested before. From the educational aspect, we should complete a study of the different laws in the educational process based on the European Educative

commission, in order to provide the necessary cloud services. For the development of the distributed user interface, to improve the collaboration in the educational process, we will design a roadmap, for both the analysis, design and implementation of the system, starting this by schedules and lesson plans, teacher's book, because it needs to operate external clouds, besides being the axis central system to facilitate the daily work of its users.

As a future work, it depends on the received feedback, from the users of the educational system, since its use will permit us to accommodate new methodological needs and educational improvements, such as promoting the CSchool integration in ERP's.

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Is the Quality in Use Model valid for Distributed User Interfaces?

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ABSTRACT

The use of Distributed User Interfaces (DUIs) provides multiple users with the ability to perform several tasks at the same time. However, the question is: What is the level of effectiveness, productivity, safety and satisfaction users reach while fulfilling their goals using DUIs? To answer this question, we have to take into account DUI characteristics that are traditional user interfaces do not have; for instance, portability, continuity, nature of social interaction, amount of screens, and so on. Consequently, this paper exposes an analysis of DUI essential characteristics that are missing in actual quality models used to measure the quality in use of user interfaces (ISO/IEC 9126, ISO/IEC 14598 and SQuaRE series of standards).

Author Keywords

HCI, Distributed User Interfaces, Quality in Use, Collaboration.

ACM Classification Keywords

H.5.2 [Information interfaces & presentation]: User Interfaces; H.5.3 [Information interfaces & presentation]: Group and Organization Interfaces.

General Terms

Design, Experimentation, Standardization.

INTRODUCTION

As result of the cost of displays has been significantly reduced [12] during the last years, conventional methods of communication that present information in a static way (i.e. advertisement posters) are gradually being replaced by interactive displays which provide people with interactive services [15].

Users usually interact with these services using a single entry point (a keyboard or touch screen display). Although this way of interaction seems to be enough to carry out anonymous single user tasks; it is not the best while

carrying out collaborative tasks.

For instance, suppose that a set of users share a multi-touch display that is used as a canvas. In order to draw on the canvas, users have to use a drawing tool and set its properties through a palette. If the multi-touch display is the only entry point to interact with the application, we have to display one palette per user; which means that we “pollute” the user interface with $(N - 1)$ palettes that are useless for each user, where N is the number of users using the drawing application.

An alternative to deal with this problem is the use of a DUI known as coupled display. Coupled displays allow users to use more than one display surface to interact with the application. Following the drawing tool example, a DUI using a coupled display would allow users to run each user palette on a separate display (i.e. a smart phone or PDA).

Thus, while each user deals with information that is not relevant to other user through a personal interaction surface/display, the shared display is used to interact with the information that is relevant to all users. Touch-based interaction is not the only way to interact with this kind of displays, gestures, body orientation, and user movements are some of other alternatives that are employed to interact with DUIs [2, 10, 11].

DUI applications behave in a different way compared to traditional user interfaces. For instance, one difference is the physical separation of the same user interface into different devices. Consequently one question arises: What is the level of effectiveness, productivity, safety and satisfaction users reach while fulfilling their goals using DUIs?

There are currently several standards defining quality models to measure the quality in use of traditional applications; for example, the ISO/IEC 9126 [6], ISO/IEC 14598 [4] and SQuaRE series of standards [5]. As result of the analysis of these standards, we have detected that DUI essential characteristics were not taken into account when defining the standard.

On the one hand, this paper presents some the set of most relevant definitions and essential characteristics of DUI in order to analyze how these concepts affect the quality in use; the other hand, we summarize all the characteristics

and attributes of the standard quality models that affect the measurement of the quality in use in a DUI scenario. Finally, as result of the analysis, we identified the shortcomings of actual quality models regarding DUI essential characteristics.

DISTRIBUTED USER INTERFACES

There are two fundamental concepts related to interactive displays that can be found in the bibliography: coupled displays and distributed user interfaces.

Distributed user interface

The definition for the DUI concept may vary according to the author.

According to [9], “a DUI consists of a UI having the ability to distribute parts or whole of its components across multiple monitors, devices, platforms, displays, and/ or users.”

Besides, [14] and [8] state that “distributable user interfaces can be split up in parts that are migrated to different interconnected (and embedded) devices in the environment of the end user that cooperate to offer functionality to ease the tasks of the user. Notice that migratability is an essential property for an interface to be distributable.”

Finally, [1] introduces the environment as an essential part of a DUI exposing that “distributed user interfaces are a user interface that distributes its components among several interaction devices available in the environment.”

As result of the analysis of these definitions, we summarize the definition of DUI as “the result of migrating a part or all the interface components of an existing user interface (distributed or not distributed) across multiple devices or platforms. The goal of the DUI should be the same as the goal of starting IU, besides the DUI should facilitate user tasks”.

Essential DUI properties

The essential DUI properties are characteristics that should be present in a DUI system in order to be considered as such. According to [7], there are 4 essential properties:

1. **Portability:** This property means that the UI as a whole, or elements of it, can be transferred between platforms and devices by the means of easy user actions. For example, a user running a graphic editor in his desktop computer may transfer an UI element (i.e. the color palette toolbar) to another platform (i.e. a portable device) with a simple action.
2. **Decomposability:** A DUI system is decomposable if the UI is composed by a set of UI elements; and one or more of these UI elements can be executed an independent UI, without losing their functionality. For example, the calculator application can be decomposed into two UI elements: the display, and the numeric keyboard. Following this example, this property can be associated to the Portability property

in order to decouple the calculator keyboard into a smartphone, while the display can be showed in a public display.

3. **Simultaneity:** A DUI system is simultaneous if different UI elements of the same DUI system can be managed in the same instant of time in different platforms. For example, two or more users can use the same DUI system in different platforms at the same time. This does not imply that all DUI systems are multiuser, as we will see later on.
4. **Continuity:** A DUI system is said to be continuous if an element of the DUI system can be transferred to another platform of the same DUI system, while keeping its state. For example, a user can be on a call in his mobile phone walking on the street, and when he arrives at home, he can transfer the call to the TV without interrupting the call.

Coupled display

A consequence of working with DUI is the need for multiple displays. And this is when the coupled display concept to come into play.

The coupled display concept was coined by Terrenghi in [13] stating that “from a functional point of view, two coupled displays must as minimum to share output and/or input components of the user interface of a single interaction task. Besides they must have some system link between their interaction states”.

Coupled displays are deployed in display environments where people is interact able to interact with multiple displays at the same time. According to [13, 3] there are a set of factors that affect these display environments: (a) users’ visual angle, (b) scale of the ecosystem defined by the coupled displays, (c) nature of social interaction, (d) interaction technique and transfer of interface elements, (e) user location, (f) screen size, (g) number or screens.

Both, essential characteristics and factors, affect the quality in use of a DUI system. Thus, we should keep in mind these characteristics and factors in the quality models in order to measure the usability of DUI systems.

QUALITY MODEL FOR QUALITY IN USE

The product specification and evaluation are vital to achieve high quality software. This is the main reason to define new quality characteristics in order to get reliable measurements based on widely accepted evaluation parameters.

The ISO (International Standards Organization) and the IEC (International Electrotechnical Commission) have developed the ISO/IEC 9126/1991 standards. These standards were divided into two related standards: the ISO/IEC 9126 standard (related the quality of the software product), and the ISO/IEC 14598 standard (related to the product evaluation).

However, this division resulted in inconsistencies between both standards due to a fundamental reason: the use of separate lifecycle for requirements, specification and product evaluation. Thus, the SQuaRE series of standards are oriented to unify these two processes using a single process to measure the software quality. SQuaRE series of standards are meant to replace the ISO/IEC 9126 and the ISO 14598 standards in the near future.

As SQuaRE standards are the most recent ones, and they have been greatly improved, this paper is focused on the quality model described in the SQuaRE series.

The SQuaRE series defines a quality model for internal quality, another for external quality, and a third one for the quality in use. The focus of this paper is on the quality model for the quality in use.

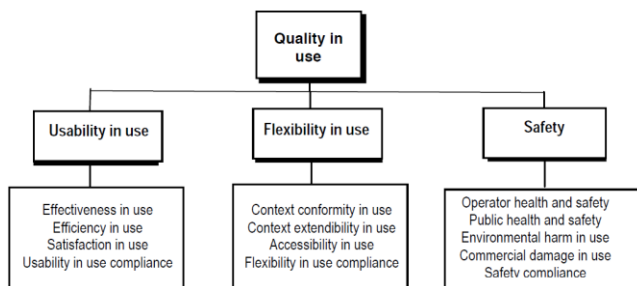


Figure 1 Relationship between the subcharacteristics and characteristics of the quality in use

DUI METRICS DEFINITION

The Figure 1 shows the subcharacteristics that are taken into account when measuring the quality of the software in terms of 3 characteristics (usability in use, flexibility in use and safety).

After analyzing these relationships, we have found that there are not metrics to measure the quality in use of DUI characteristics defined.

There are many questions we should ask ourselves when we want to evaluate the quality in use of DUI. Thus, we have detected a lack in the quality models. Some questions are the following:

Related to productivity, Does it take the same time a user to perform one task at a UI that multiple users to perform the same task on a DUI? Besides, how do we measure the time when the task is distributed across different devices with a DUI?

Regarding the essential DUI features, portability affects the quality in use due to the required time to perform a portability of the interfaces or part of it between platforms can be critical when the quality is evaluated. Another factor to be measured can be related to continuity. How long does

it take to transfer a user interface element and its state from one platform to another?

In order to answer these questions, some new metrics have been defined. These new metrics can be incorporated into the standard quality model presented in the previous section. The following paragraphs define the new metrics grouped by the DUI characteristics we have exposed on Distributed User Interfaces section.

Portability

- Interface portability time: It is the time needed to transfer the original UI from the source platform to the target platform or platforms. This time possibly will be composed by the time needed to close the UI, the time needed to do the transference among platforms, and the time needed to init the UI on the target platform.

- Portable task completion: What proportion of the tasks associated to a transferred UI is completed?

- Portability errors: It is the subset of users' errors due to portability.

Decomposability

- Decomposability time: It is the time needed to divide the original UI into one or more UIs.

- Composability time: It is the time needed to compose the original UI from two or more UIs.

- Decomposed task time: How long does it take to complete a task associated to a decomposed UI? Note that in a DUI system a task can be performed by more than one user.

- Decomposition/composition errors: It is the subset of users' errors due to decomposition/composition process.

Simultaneity

- Number of parallel tasks: It is the number of tasks that can be performed in parallel.

- Time of task synchronization: It is the consumed time due to synchronization overload.

Continuity

- Interface continuity time: It is the time needed to transfer the state of the original UI from the source platform to the target platform or platforms. This time is possibly defined as the sum of the time needed to save the state of the original UI plus, the time needed to do the transference of the state among platforms plus, the time needed to restore the state on the DUI.

- Continuity errors: It is the subset of users' errors due to the continuity process.

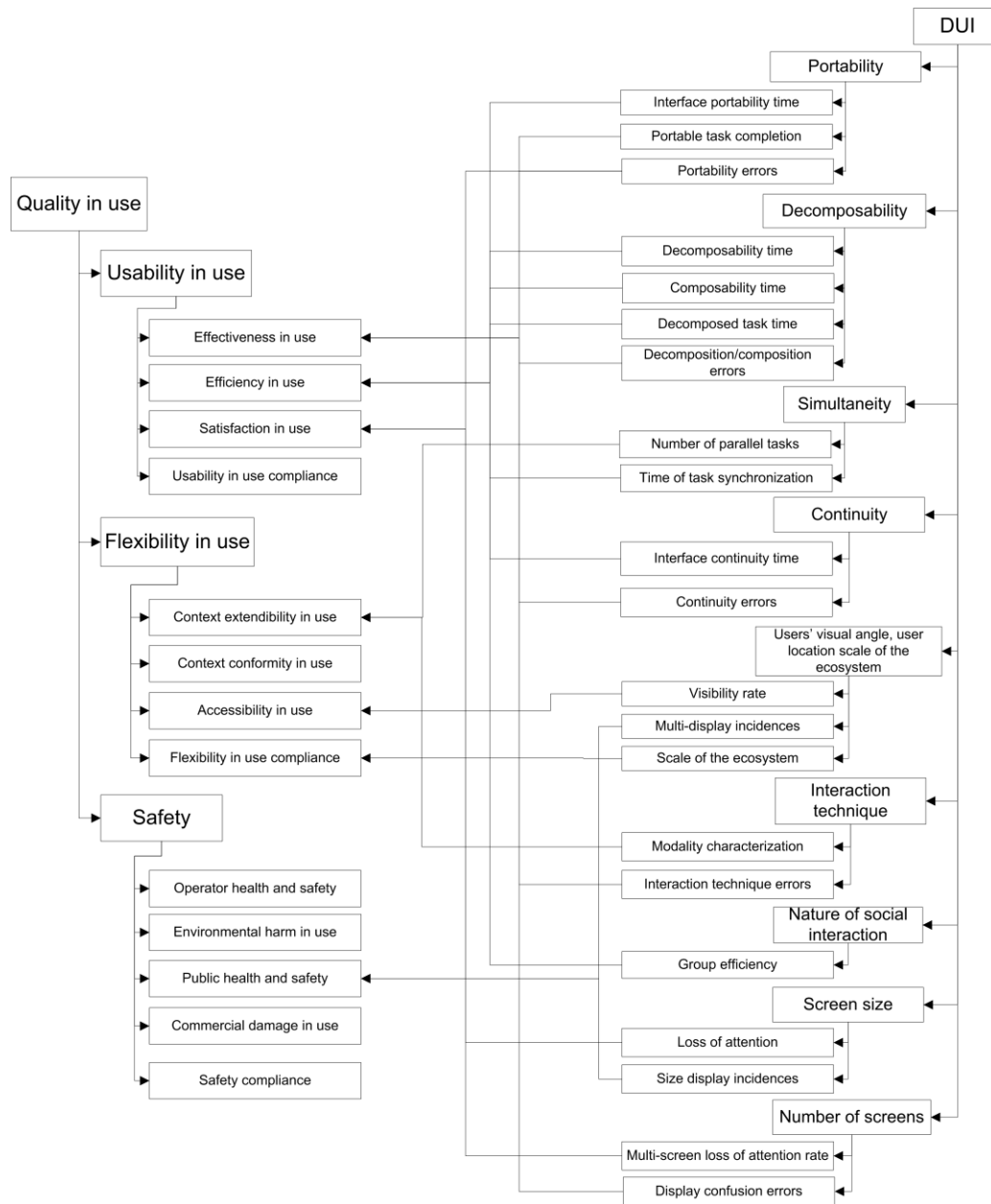


Figure 2 Mapping between metrics of DUI and sub-characteristics of the quality in use

Users' visual angle and scale of the ecosystem

- Visibility rate: It is the percentage of the total UI that can be displayed (without scrolling).
- Multi-display incidences: It is an enumerated list of health problems due to the use of multiple displays. For example we can define the percentage of users that suffered visual fatigue.
- Scale of the ecosystem: It is the measure to define the screens' size that composes the DUI system.

Interaction technique

- Modality characterization: It is an enumerated list of modalities to interact with the DUI.
- Interaction technique errors: It is the number of errors due to the use of a particular interaction technique.

Nature of social interaction

- Group efficiency: It is the measure by which a group of users is more efficient performing a task compared to a single user performing the same task.

Screen size

- Loss of attention rate: It is the percent of the time that the user losses the attention of the workspace due to the screen size.

- Size display incidences: It is an enumerated list of health problems due to the screen size. For example we can define the percent of users that have suffered visual fatigue.

Number of screens

- Multi-screen loss of attention rate: It is the percent of the time that the user losses the attention of the workspace due to the number of screens.

- Display confusion errors: It is the subset of users' errors due to confusion related to the selection of the active screen.

The Figure 2 shows the mapping between DUI metrics and the quality in use sub-characteristics. Note that each metric is only mapped to the most affected sub-characteristic.

CONCLUSION AND FUTURE WORK

This work highlights the importance of collaborative scenarios and the increased use of digital displays. The use of DUIs is motivated by the flexibility that digital displays offers to work with dynamic information, and the low price they are reaching.

For this reason, DUIs are the most suitable to work in collaborative scenarios where users interact with multiple-screens different screens. Consequently, we have to keep in mind the quality in use when developing DUI applications which will be used by many users.

However, we have detected a lack in the actual standards regarding to the quality model for the quality in use. It is because the quality model does not take into account DUI characteristics in the definition of metrics.

This paper proposes some metrics related to the DUI characteristics that should be incorporated in to the quality model in order to achieve a quality model suitable for DUIs.

As future work, we are extending the quality model for in quality in use to improve the evaluation of DUI environments. Besides, we are defining an evaluation process to check the quality in use of DUI systems.

ACKNOWLEDGMENTS

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Context Model for Distributed UI on Interactive Table(s)

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ABSTRACT

In this paper we describe an extended context model in order to take into account both interactions on a single interactive table and interactions which are distributed and collaborative. The model proposed can, from our point of view, be used to make sure that the usability of the interaction is guaranteed. Indeed, it is essential to know the interaction configuration in order to ensure the usability of the system. The model suggested is illustrated in a case study integrating collaboration and UI distribution. A conclusion gives the limits of the article before a presentation of prospects.

Author Keywords

Context; Model; Distribution; Interactive table; Tangible object

ACM Classification Keywords

H.5.2; H.5.3. Information Interfaces and Presentation (e.g. HCI): User Interfaces; Group and Organization Interfaces

General Terms

Human Factors; Design; Theory.

INTRODUCTION

In a world in which everything and everybody are connected, it is possible to envisage connecting different platforms in order to carry out remote collaborations. Our work concentrates on the connection of interactive tables on which the users interact using tangible objects. There are few works in existence relating to connected tables. Very often, some complementary devices are introduced, such as in work of Yamashita *et al.* [16] which adds a videoconferencing system in order to support collaboration. In our work, we propose the use of one or several tables and some tangible objects in order to support interaction and collaboration. In [11], collaboration scenarios were presented according to different configurations (type of source platform and target platform, distribution strategy (master/slave or autonomous entities), UI

distribution type (complete/partial), collaboration type (synchronous/asynchronous)). Afterwards, in [12], a concept of tangible objects called Tangigets is defined and illustrated, making it possible to support distant collaboration between a tangible interactive table and other surfaces. Considering that the context could be a means to ensure the system usability [13], we think that it is interesting to take the context into account in order to try to propose usable surfaces.

In this article we propose to use the context model suggested by Kubicki *et al.* [9, 7], which we widened so as to integrate the specificities of interactive tables in order then to widen it even further to integrate distribution characteristics. The following section of the article introduces the *TangiSense* interactive table as well as the architecture which enables it to manage distribution. Then, we present the proposed context model. An application of this model is then illustrated before concluding and proposing research prospects.

FROM *TANGISENSE* INTERACTIVE TABLE TO DISTRIBUTED SURFACES

This section aims to give a brief presentation of the support of our work which is the *TangiSense* interactive table. This table has the characteristic of not being tactile, unlike the majority of interactive tables present on the market or in the scientific literature. It proposes a direct interaction via tangible objects. Table 1 presents five different interactive tables, each one using a different capture technology. It shows that each capture technology has its own characteristics. That is why the current interactive tables combine technologies. For more information, see Kubicki *et al.* [9].

Table 1. Five interactive tables using different capture technologies

Capture technology	Representative example	User distinction	Object detection	Object overlay
Electrical	DiamondTouch [3]	Yes	No	No
Camera	ReacTable [6]	No	Yes	No
Touchscreen	eLabBench [1]	No	Yes	No
Magnetic	Actuated Workbench [14]	No	Yes	No
RFID	TangiSense [9]	Yes	Yes	Yes

The first part of this section presents the table while the second one presents the software architecture adopted to support the collaboration and the distribution between surfaces.

The *TangiSense* Interactive table

The *TangiSense* table is an interactive table prototype which uses RFID technology in order to communicate with tangible objects (equipped with RFID tag(s)). It was designed by the

RFIdées¹ company. For the users, the table looks like a traditional table, because it is a similar size and texture (glass) to a table for everyday use (*e.g.* due to the technology employed, the users can place their hands on the table without interfering with the system). However, the table is able to communicate via LEDs on its surface which make it possible to display texts (in low resolution) or to define zones. It is possible, according to the applications, to use an external video projector in order to provide a finer grained display and to project directly on table. The table detects the tagged objects and reacts according to them. Details on the technical aspects of the table can be found in [10]. A photograph of the table in an experimentation situation with several users is shown in Figure 1.



Figure 1. *TangiSense*, its objects and users during an experimentation

Architecture dedicated to distributed interaction

The software aspects were initially defined for a *single* table, *i.e.* even if tables were physically connected, no interaction was envisaged with other platforms (the initial architecture is presented in Kubicki *et al.* [10]. From now on, the table architecture has evolved in order to be able to connect several tables and even several platforms, and so allow distribution [4]. This architecture is based on a Multi-Agent System (MAS) which will make it possible to integrate the context adaptation rules. The architecture is fully described in [4] and allows us to consider new distributed interactions in various contexts.

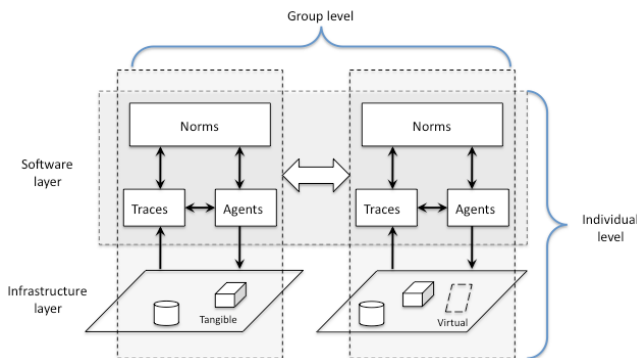


Figure 2. Functional architecture of *TangiSense* [4] (case of tables in interaction)

1. www.rfidees.fr

PROPOSITION OF CONTEXT INTERACTION MODEL TO SUPPORT THE DISTRIBUTION

Context-aware computing [15] appeared along with mobile platforms in order to adapt the applications to these new more restricted devices. In these contexts the user was alone on the platform but could switch from one platform to another (in general only one at the same time)². Since then, many definitions and evolutions have covered the concept of context-awareness. However, we chose to base our work on the Calvary *et al.* [2] proposal which defines the context as a triplet $\langle \text{User, Platform, Environment} \rangle$. From this triplet and a set of definitions from the state of the art, we proposed a context model [9]. This model was enriched to take into account the specificities of the interactive tables [7].

From a *User* point of view (Figure 3(A)), the most important modification in comparison to the other platforms is the **cardinality** between User and Platform. Indeed, the interactive tables make it possible to work with several users around their surface. The **Location** of the user relating to the platform is very important and influences the platform (display) itself. Indeed, the context will not be the same if the user *position* is on one side of the table (*e.g.* East) or on the opposite side (*e.g.* West). User *posture*, sitting or standing, is also important. Finally the interaction style is **Post-WIMP** and corresponds to competences in the use of tactile technology which can be *multiTouch* (**tactile interactions**), or in the use of objects (**tangible interaction**). The users who are collaborating together can have a **social link** which will influence their collaboration (parents/children, manager/employee, husband/wife, etc). It would also be necessary to specify which of the tasks are collaborative. It may only be a few of them (*partial* distribution) or all of them (*full* distribution).

From a *Platform* point of view (Figure 3(B)), an attribute was added making it possible to know if the platform is *multi-User* or not. In order to detect inconsistencies relating to the position of the user (criteria Location, attribute position), an attribute making it possible to know the *height* of the platform was added. One of the interactive table's characteristics is also the capacity to recognize or interact with a set of **objects**. We distinguish two object *types*: **virtual** objects (which are generally video-projected or displayed) and **tangible** objects (physical objects placed on the table). From a general point of view, the tangible objects are equipped with **tags**. These tags can be of a different *type*: bar-codes, RFID, *etc.*, often stuck under objects so as to enable their identification. According to the **capture system**, it is possible to vary the *number* of tags stuck under the object. Thus with three tags stuck under an object, it is possible, for example, to (re)form the shape of the object using software or to detect the direction of rotation of the object (*e.g.* in the case of RFID technology). The RFID Technology makes it possible to store information directly in the object. Thus the object has a *memory* enabling it to be completely independent from the table. In the case of virtual objects, it is a **videoprojector** which is mainly used. These platforms also evolve as regards the work **surface** and

2. However some works such as those of Grolaux *et al.* [5] are proposed on interface distribution between two types of platform.

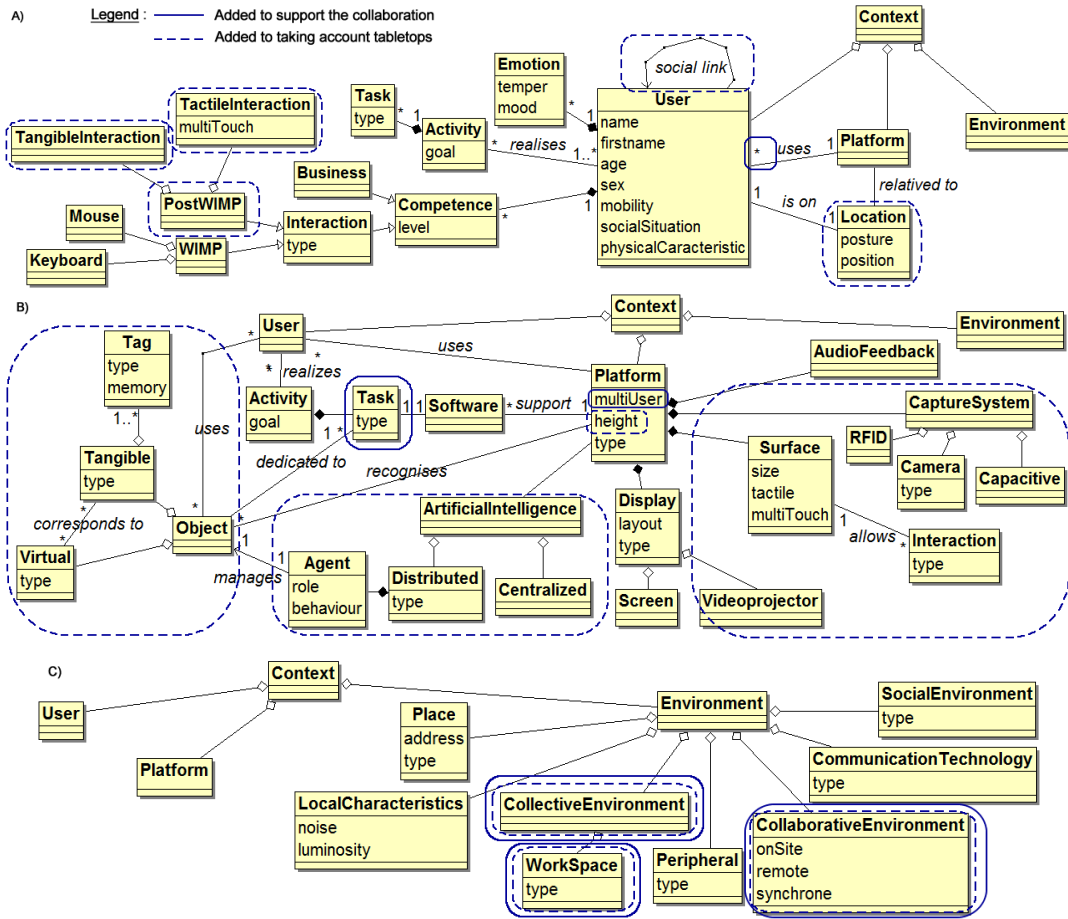


Figure 3. Context-awareness models integrating the specifications for the interaction with interactive tables, collaboration and the distribution

depend on the **capture system**. Finally, certain platforms can also carry an **Artificial Intelligence** element which can be **centralized** or **distributed**.

Concerning the *Environment* (Figure 3(C)), a criterion which was added relates to the **collective** classification of the environment: either (1) the users use the common part of the table, the **type of workspace** is then *common*; or (2) they use different parts of the table, each one having their own **workspace**, in this case the type of workspace is *individual* [9].

In order to take the collaboration into account, a **collaborative environment** criterion was added to the **Environment** characteristics. Indeed, this is the environment conditions which will possibly lead the users to collaborate. This collaborative environment can be distinguished through two characteristics which will influence the interactions. Either the users collaborate by using the table (meaning a single table), in this case the collaboration is considered to be *on site*; or the collaboration is done on several distant platforms (the users use the table and at least one other distant support such as another table and/or another platform); in this case the environment is one of *remote* collaboration. The method of collaboration must be also added to the environment in order to know if collaboration is *synchronous* or *asynchronous*.

The next section aims to introduce a simulation to show our proposition and models in real context situations.

SIMULATION

The scenario involves a child working on an amusing activity on a first interactive tabletop: Marcelino performs one or several school exercises. In particular, he is currently using the "learning and recognition of colors" application: he must associate a dominant color with a set of tangible objects "which have lost their color" [8]. Meanwhile, his parents, Renato and Sofia, interact in another room around a second interactive tabletop (used with another goal, such as family records). The human-machine interface is different on both platforms in this first context. The child may at various times request assistance (remote collaboration) from his parents. They must be based on a common support to facilitate collaboration (e.g. direct or indirect advice to be provided on the color of certain vegetables): the human-machine interface must be distributed on the two tabletops in this second context. An illustration is provided in Figure 4.

Contexte #1

- Users : Marcelino (4 years old ; child of Renato and Sofia), Renato (40 y/o, husband of Sofia, parent of Marcel), Sofia (35 y/o, wife of Renato, parent of Marcelino)

- Platforms : tabletop1, tabletop2
- Marcelino performs : "learning and recognition of colors" task (individual task)
- Renato and Sofia perform : "family records" task (collaborative task)
- Environment : non collaborative, remote

Contexte #2

- Users : no change
- Platforms : no change
- Marcelino performs : "learning and recognition of colors" task (collaborative task)
- Renato and Sofia perform : "learning and recognition of colors" (collaborative task)
- Environment : collaborative, remote

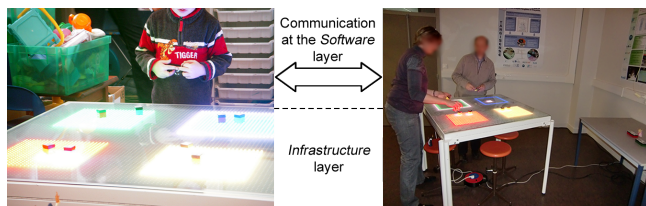


Figure 4. Illustration of the users in remote collaboration (context #2)

Such situations are under study and development. Different evaluations are also planned.

CONCLUSION

This paper has presented the *TangiSense* tabletop and its software architecture. This architecture allows UI distribution between different tabletops and surfaces in general. This distribution is possible by integrating the intelligence of the distribution in the agents of a multi-agent system (developed with JADE). Then a global context model has been described; it has been extended by taking the specificities of tabletops into account. The context model proposed in this paper considers UI distribution on surfaces. Our research perspectives are the following: to propose a set of adaptation mechanisms integrated into the multi-agent systems, based on the context model proposed; to propose explicit relations between the context model and usability criteria; to validate progressively the context model in various experiments.

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Integration of Collaborative Features in Ubiquitous and Context-aware Systems

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ABSTRACT

Healthcare environments imply changing conditions which might result in an adaptation in the agenda and in the behavior of employees. They require ubiquitous and context-aware software, which offers information and functionality based on their needs. However, employees usually have to complete tasks as part of more complex ones, creating significant dependences among them. Therefore, healthcare systems should offer users the possibility to collaborate. Furthermore, some healthcare employees need to be constantly moving around the environment. Thus, they should be able to use the same application in different devices depending on their context. The system should adapt its appearance based on the device restrictions through a distributed user interface. In this paper, we present UBI4HEALTH as a system whose main features include the aforementioned healthcare requirements. The system presents, as a differential factor in healthcare, the integration of collaborative features using the distributed user interface paradigm.

Author Keywords

Collaboration, ubiquity, context-awareness, awareness, context, healthcare, dui.

ACM Classification Keywords

H.5.3. Group and Organization Interfaces

General Terms

Design, Management.

INTRODUCTION

Healthcare environments involve situations in which employees need information and tools to complete delicate tasks quickly. Current technology allows creating healthcare systems that offer the required information and functionality based on users needs. Additionally, the system can be integrated into the environment being invisible to the

users, but functional everywhere. In this way, they just have to pay attention to their tasks avoiding being disturbed by how the system operates. Concretely, these desirable features regarding healthcare systems drive us to consider the inclusion of context-awareness and ubiquity.

Two important situations remain unsolved in healthcare environments. First, employees must collaborate in order to perform both complex tasks and emergency situations; therefore the system should offer collaborative tools. Second, a great number of employees are continuously moving around the healthcare environment using different devices according to their needs and context; thus, the system has to adapt the content depending on the device, because the visual features of each type of device are different even if the information to show is usually similar. Users must work in the same application in order to reduce the complexity of work, regardless of the device. Summarizing all these kinds of features in healthcare, distributed user interfaces seem to be a proper solution to be considered in the development of such systems.

In this paper, we present UBI4HEALTH as a context-aware [3, 4], ubiquitous [11, 12] and collaborative system with a distributed user interface. The system is applied to a residential care home, but can be used in most of healthcare centers. The main objective is to improve the management of the center helping employees in their daily tasks. The system offers to users the possibility to obtain information about their tasks and workmates, being able to communicate through messages. Knowledge about workmates is important information that permits to select who is the adequate workmate to help in every collaborative task. UBI4HEALTH has an efficient mechanism to complete tasks collaboratively. Additionally, the employees can use different devices depending on their conditions: they could use a personal computer if they do not need to be in movement; or they can use a PDA, a smartphone or a mobile device, if they need to complete their tasks moving around the environment. Anyhow, the system offers users the same application with different visual appearances.

The rest of the paper is organized as follows: a description of outstanding related works is presented in Section 2. Section 3 describes the system and the outcomes of its

evaluation. Finally, Section 4 presents conclusions and future work.

RELATED WORKS

Over the last decade, healthcare has appeared as a relevant research field and many research groups have focused their interests on it. One of the main reasons to this fact is the capacity to improve tasks to perform in healthcare environments as hospitals, residential care homes, clinics, etc. In this way, several ubiquitous and context-aware systems and prototypes have been developed in order to facilitate the realization of essential processes in medical environments. Following, outstanding related works with UBI4HEALTH are described. The study of these systems allowed us to make comparisons and to focus our contribution in healthcare.

MobileWard [9] is the oldest remarkable related work. The system is a context-aware electronic patient record, which detects the entrance of a user in a ward and automatically shows to that user, information related to the ward. In 2006, a context-aware system [1] oriented to hospitals was developed, which uses Bluetooth technology to locate employees. Concretely, the system utilizes a modified Bluetooth USB whose range of action is diminished due to the modifications. Other related work [7] centered in location information is used by its authors to show the acceptance of ubiquitous devices in healthcare. Concretely, they create a WLAN infrastructure with which they are able to locate disoriented patients. The nearest related work is iHospital [5]. The system is a vision of a highly interactive workplace, where healthcare staff can access to relevant medical information through a set of heterogeneous devices and collaborate taking into account their own context. The last two remarkable related works are an assistant to manage tasks of medical staff [10] by using a bracelet that warns with colors explicit alerts; and VERA [6], a phone-based system that increases awareness about health behavior taking medical decisions.

Described systems offer collaborative features but forget the possibility to integrate them with distributed user interfaces. Instead, UBI4HEALTH makes real this integration, offering new possibilities and commodities in healthcare environments. The UBI4HEALTH system is described hereafter stressing its collaborative and distributed user interfaces aspects.

UBI4HEALTH SYSTEM

We have developed a collaborative, ubiquitous and context-aware system for residential care homes although it could also be deployed on most of healthcare centers. The main objective is to help employees in their daily tasks knowing that it will influence on residents life, an important topic in healthcare.

Technology and Architecture

The architecture of the system (see Figure 1) has been designed to offer ubiquity and context-awareness using Wi-Fi technology. A set of Wi-Fi access points, located around the residential care home (defining relatives zones), allows users to be connected at any point of the center. Each mobile device (a PDA, a smartphone and a mobile phone) detects wireless signals, and the stronger one determines where the device is, because it corresponds to the Wi-Fi access point located in the same zone where the device is connected. It is not necessary to know exactly the point in the environment where a user is. Each zone has a maximum distance that if a workmate has to cover it to attend an urgency, it will not be a problem. Additionally, the hardware architecture incorporates RFID technology to identify users when they bring an identification card closer to their device.

In UBI4HEALTH, users can work with a PDA, a smartphone, a mobile device or a PC, using only one application. The system adapts its appearance according to the visual restrictions of each device.

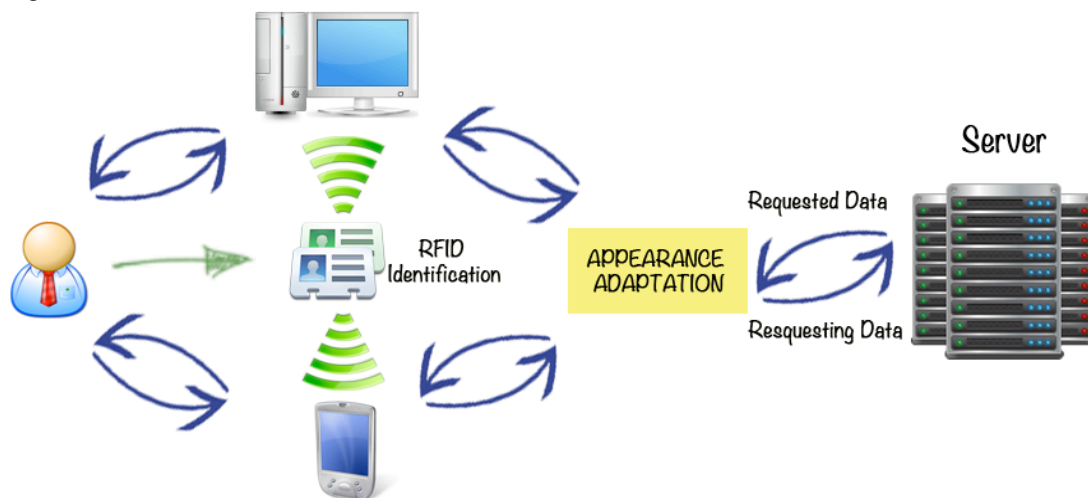


Figure 1. System architecture

Users will feel that everything is familiar independently if they use a personal computer or a mobile device, because they will appreciate only slight differences between versions. Therefore, the system uses distributed user interfaces to facilitate employees their everyday tasks. Figure 1 shows how each device adapts the received functionality or information (either to a mobile device or a personal computer) to its appearance restrictions.

Description of the System

The system has as main objective to help employees of a residential care home in their tasks. In this way, the system offers mainly information about their current and pending tasks and about the workmates who can help them.

Once a user logs in the system, it offers him the available functionality. Concretely, the system shows a menu with the following options: (1) manage advice notes, allowing to create a new one or manage an existing one; (2) manage tasks (pending or the next one); (3) communicate information to other workmates by messages; and (4) consult information about workmates, such as their location, current tasks, used resources, etc.

The management of advice notes allows employees to access to notes and notices that have been created previously. This is an efficient mechanism to remember actions to be performed. Additionally, notices let users to create notifications in order to remember or inform some workmate the necessity to achieve some unorganized task.

Employees of a residential care home must do a great number of organized tasks. They have to perform their work at the programmed time in order to facilitate the

residents' life. The system offers a complete tasks manager, in which users can see information about their current tasks, the next task or pending tasks. The manager allows employees to assign them pending and unassigned tasks that will include in their agenda. Also, users can unassign tasks if they have the adequate permissions.

In healthcare centers, employees should collaborate in a great number of tasks. The main reasons are that there are tasks so complex to be done by one employee or during their performing the employee needs help. UBI4HEALTH contains functionality that increases the collaboration of the users to obtain help from workmates. Concretely, the system offers the possibility to communicate through messages using notes, which is a synchronous mechanism. Another collaborative tool is the possibility to obtain information about workmates that is to be aware about them (see Figure 2). Each employee can see where are his workmates through a map in which is possible to know who is in each zone. Therefore, users have an important way to collaborate because they obtain more information about who can help them based on knowing who is active and where he is.

Finally, the system offers the possibility to create an urgency notice. When an urgency appears the employee may warn others searching for help. The system offers in every screen the possibility to create an urgency sending advice notes to the nearest workmates. This functionality can be seen as other important way to collaborate because users may search quickly the nearest workmates who can help to solve the urgency.



Figure 2. Workmates list and Residential Care Home map

Evaluation

The usability of UBI4HEALTH has been evaluated based on the ISO 9126-4 standard [8], focusing on the effectiveness, productivity and satisfaction in use [2]. The experiment has been performed with a group of ten volunteers completing seven concrete tasks. Frequent computer users composed the group and all of them have used touch screen devices. They completed all the tasks and a final user satisfaction test. The outcomes of the evaluation led us to the following conclusions about the system: (1) in general, the error frequency was very low, as the majority of tasks could be easily completed since users had learned how to use the system very fast; (2) they did not spend too much time to complete each task and they reduced times in every new task; (3) and finally, users experienced a good level of satisfaction.

CONCLUSIONS

Employees of healthcare centers need to collaborate in order to achieve their objectives. Additionally, in this type of centers some employees are constantly moving around, having to use different devices based on their needs and context. However, a healthcare system should offer the same application regardless of the device type, because users generally work with the same functionality and information. This feature allows employees to familiarize with just one application, reducing their learning process and the technological complexity. Therefore, the application should adapt its interface according to the device in such a way that the use of the distributed user interfaces paradigm becomes a requirement in healthcare systems.

This paper presents UBI4HEALTH, a context-aware and ubiquitous system designed for healthcare environments. In comparison with studied related works, UBI4HEALTH has as a differential factor, the integration of collaborative features with a distributed user interface. Employees can seek help from their workmates at any moment, having the opportunity to work together in order to perform unknown situations or complex tasks. To this end, the system offers a synchronous communication mechanism through messages and it offers information automatically about each workmate (current task and location). This information may be used to determine the workmate who is in the best condition to help. At the same time, UBI4HEALTH uses a distributed user interface over different devices (PDA, Smartphone, mobile device, and PC) allowing users to move around the working center. The system adapts its visual appearance according to the restrictions of the device.

The system has been evaluated based on the ISO 9126-4 focusing on the effectiveness, productivity and satisfaction

in use. The outcomes of the evaluation indicate that (1) users learned how to use the system very easily, (2) they did not need too much time to complete each proposed task and (3) a high level of satisfaction was achieved by all of them.

ACKNOWLEDGMENTS

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Improving DULs with a decentralized approach with transactions and feedbacks

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ABSTRACT

When multiple users work collaboratively, coherence is not an easy feature to guarantee. It requires an exclusive access to some part of the User Interface (UI) and needs to give some feedbacks to other users. This synchronization needs a true concurrency control algorithm. One of the most common solution is to use a server as a transactional manager. Unfortunately, a central point of control is also a single point of failure. This paper proposes a decentralized architecture based on a peer-to-peer network providing decentralized transactional support with replicated storage. As a consequence, there is a gain in fault-tolerance and the transactional protocol eliminates the problem of network delay improving the overall usability. The addition of a feedback mechanism allow the users to understand better the behaviour of the system.

Author Keywords

Distributed User Interfaces; Collaborative work.

ACM Classification Keywords

C.2.4. Distributed Systems. H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

General Terms

Design

INTRODUCTION

There are many software applications supporting collaborative work, such as drawing, text editing or software development. Collaborative work can be done synchronously or asynchronously. In the later case, the participants make their modifications on their local copy without direct interaction with the other participants. Once the changes are made, they are committed to the global state. In the former case, which is the focus of this paper, all participants are concurrently working on a shared working space. Such scenario requires continuous synchronization of the participants in order to avoid conflicts. One way of achieving such synchronization is by

letting the participants lock the part of the shared space they want to modify, granting exclusive access to that part. Since all participants can take any lock, having a single point of control make sense, resulting in the classical client-server architecture. Unfortunately, it is well known that having a single point of control also means having a single point of failure, because the whole application relies on the stability of the server.

The case study we present in the paper is based on TransDraw [5]; a distributed collaborative vector-based graphical editor with a shared drawing area. Each user runs the application and joins a server to get access to the shared area. When someone is drawing in this area, feedback is sent to other users reflecting the action. In addition, TransDraw uses a transactional protocol to allow users to make optimistic changes on the drawing with immediate conflict resolution. This feature eliminates the problem of performance degradation caused by network latency and it is a crucial property of TransDraw. The synchronization and storage of the global state is done on a server which centralizes the control of the work flow. When users modify an object on the drawing, they request exclusive access for it, which may succeed or fail depending on the behaviour of the other users. All this is reflected graphically in the shared drawing space.

A problem of TransDraw, due to its centralized architecture, is its dependency on the server. If the server crashes the work is lost, and the application will not run until the server is rebooted. Peer-to-peer networks have the nice property of being self-organized, fault-tolerant and fully decentralized. We propose in this paper to redesign the transactional protocol of TransDraw to overcome the problem of the single point of failure. In order to do that, we use Beernet, a structured peer-to-peer overlay network providing a fault-tolerant distributed transaction layer with replicated storage. Every time a user attempts to modify a graphical object, this modification will be done inside a transaction with a different transaction manager, which is replicated to allow the transaction to finish in case of failure of the manager. Unfortunately, this fault-tolerance mechanism is not free. Replication requires a higher usage of network resources increasing latency of transactions, but the optimistic approach for starting the modification of an object counteracts the latency. We consider this a small drawback because the functionality of TransDraw is fully respected and there is an important gain in fault-tolerance.

For the management of DUIs another problem comes from the needs of feedback. The initiator of the distribution must know when the distribution is over and if everything went well. The destination platform should notice the distribution and not be affected negatively by it. For this, we use a feedback mechanism in order to notify both the source and the destination for any kind of distribution. If the result of the distribution is invisible to one of them, a feedback needs to ensure the action went well. If the result is creating information or modifying the destination remotely, the destination should understand this addition or change

What follows is a more detailed description of TransDraw and related works in sections **TRANSDRAW** and **RELATED WORKS** Beernet is described in section **DECENTRALIZED TRANSACTIONAL DHT**. The core of the proposal is explained in section , being followed by conclusions.

TRANSDRAW

Description

Transdraw is a collaborative vector drawing tool created by Donatien Grolaux using transactions[5]. The toolbar provides, not only the traditional tools of vector editing (eg. lines, ellipse, rectangles), but also a pair of tools supporting collaboration. As soon as a user selects an object, a request is sent to the server for the corresponding lock. However, the user is permitted to edit the object optimistically before the server can answer the request. The optimistic nature of the operation is visually presented to the user by feedback in the form of a red selection frame. When the server grants the lock, the transaction on the object is committed and the user can continue to edit the object in exclusive mode, indicated by black selection handles until he deselects it at which time the lock will be returned. If the lock was already held by another user, the server has to refuse it to the user and the transaction is aborted. The user sees the modifications he did optimistically undo themselves and the object is deselected.

A user can also manage explicitly his locks by using the “*take lock*” tool, for example to make a complex reorganisation of the drawing, involving several individual objects. He then has to release the locks manually using the flashing “*release-locks*” button. In order to prevent starvation which could happen as simply as by a user inadvertently selecting every object before taking a rest, a lock stealing mechanism is provided. The “*steal lock*” tool make a request to steal a lock to the server which forwards it to the current owner of the lock. This user then has a few seconds to accept or reject the stealing of her locks. On timeout, the stealing is considered accepted. Once accepted, the previous owner notifies the server to forward the lock to the stealer.

Example scenario

Figure 1 presents the view of two users working on the same drawing, each in his own window. Bob, on the right, had the top ellipse selected long enough for the server to grant him the lock as can be seen by the black selection handles around it. Alice, on the left has just tried to select this ellipse. After a, normally brief, period during which she was able to do optimistic changes to this ellipse, her transaction is aborted,

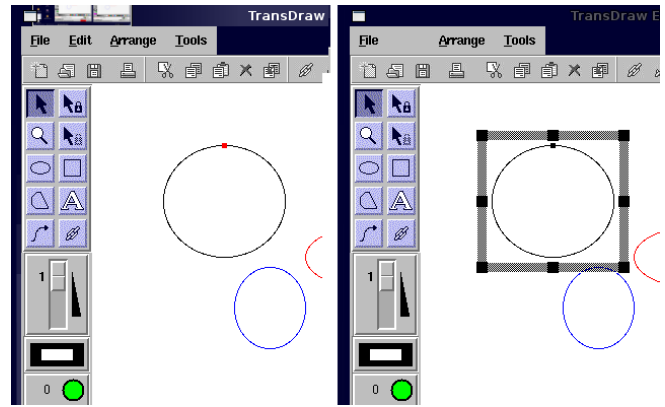


Figure 1. Alice, on the left, see a locked and non-editable ellipse while Bob has it is selected and editable.

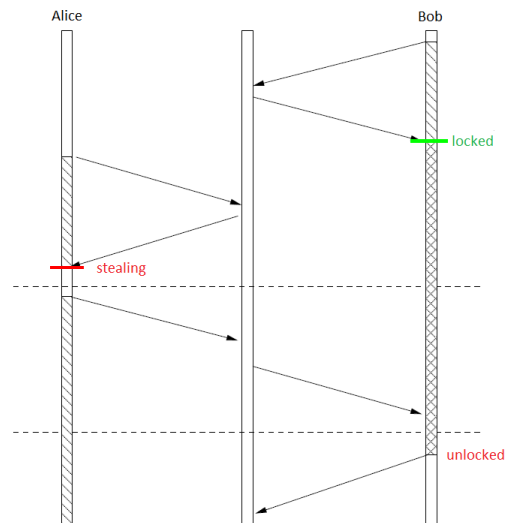


Figure 2. Scenario of complex interaction

and she is notified of it by the disappearance of her selection and the red dot on the ellipse which will blink a few times to explain that Bob is a currently editing this object.

The diagram in Figure 2 describes a possible continuation of the scenario in which Alice steals the lock from Bob to perform the update she wants. Alice ask to steal the lock to the server. Since Bob currently has the lock, the server ask Bob whether he allows his lock to be stolen or not. This is shown to Bob as two blinking buttons at the bottom of his edition window as we can see in Figure 3. If Bob allows his lock to be stolen, either explicitly or by ignoring the request long enough, he loose selection of the object and possession of the lock and the server transfer them to Alice.

All of this assumes that the server does not crash.

RELATED WORKS

There are some applications that already support collaboration in different ways. We describe and comment some of them briefly.

BOUML

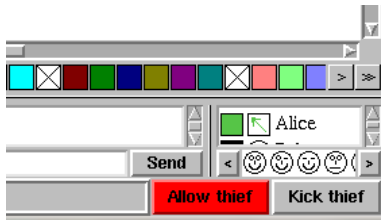


Figure 3. Bob is asked whether he allows his lock to be stolen.

BOUML[8] is a free UML tool that allows drawing diagrams and generating code in multiple languages. The tool has been developed as a multiuser application in a sequential way. Each user of the application must choose an identifier which allows working on some diagrams. The work may be done in parallel but there is not any feedback on other users work as there is no support for concurrent work. There are many problems with the tool. The lack of feedback prevents user to know what others are doing and to see their changes. It is also impossible to know which files are currently being modified or that have been modified and saved. There can be conflicts when saving the project. When users are working collaboratively, the work of a user will be saved but not all the modification of other users. This leads to irreversible lost work without any warning. Another problem is the impossibility to lock part of the work to prevent modification from another user.

Gobby

Gobby is a free text-editor that allows collaborative work [1]. It supports multiuser parallel edition on multiple documents and a multiuser chat. A user has to start a session and create the documents, he will host the server needed to centralize the information. Other users must choose a name and a color and connect to the server host. The collaboration between all the users is simple thanks to the feedback brought to users with colors. As the BOUML application, Gobby does not support any lock of some part of the text and all the users can edit what they want. There is a problem when the server crashes. The unsaved modifications can be saved but the whole process of creating a server and joining the server must be restarted.

Google Docs

Google Docs [3] is an online office suite that allows multiple users to modify the same file at the same time. One particular feature, similar to TransDraw, can be seen on spreadsheets. Once a user is modifying a cell, this one is coloured differently as in any single user spreadsheet application. When other users connect to Google servers to edit the same file, then, the cells they select will appear with a different colour on the view of the other users, and with a tag identifying the user. Instead of locking the cell, changes are save incrementally using versioning. Google Docs uses also a centralized architecture because everything is controlled at Google side. But, there is a very important difference. There is not only one server to rely on, but a set of servers with replicated information, so if a server crashes, another one takes over. Of course, these are only conjectures about Google's back-end.

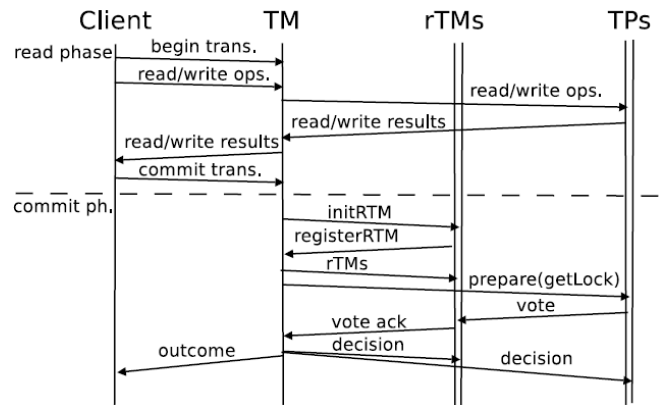


Figure 4. Paxos consensus protocol for distributed transactions.

DECENTRALIZED TRANSACTIONAL DHT

Beernet [2] is a structured overlay network providing a distributed hash table (DHT) with symmetric replication. Peers are self-organized using the relaxed-ring topology [6], which is derived from Chord [9], with cost-efficient ring maintenance and self-healing properties. Data replication is guaranteed with a decentralized transactional protocol allowing the modification of different items within a single transaction. The transactional protocol implements a Paxos-consensus algorithm [7, 4], which requires the agreement of the majority of peers holding the replicas of the items. We will focus on the transactional layer of Beernet because it will be our mean to decentralize TransDraw.

Figure 4 describes how the Paxos-consensus protocol works. The client, which is connected to a peer that is part of the network, triggers a transaction in order to read/write some items from the global store. When the transaction begins, the peer becomes the transaction manager (TM) for that particular transaction. The whole transaction is divided in two phases: *read phase* and *commit phase*. During the *read phase*, the TM contact all transaction participants (TPs) for all the items involved in the transaction. TPs are chosen from the peers holding a replica of the items. The modification to the data is done optimistically without requesting any lock yet. Once all the read/write operations are done, and the client decides to commit the transaction, the *commit phase* is started.

In order to commit the changes on the replicas, it is necessary to get the lock of the majority of TPs for all items. But, before requesting the locks, it is necessary to register a set of replicated transaction managers (rTMs) that are able to carry on the transaction in case that the TM crashes. The idea is to avoid locking TPs forever. Once the rTMs are registered, the TM sends a *prepare* message to all participants. This is equivalent to request the lock of the item. The TPs answer back with a *vote* to all TMs (arrow to TM removed for legibility). The vote is acknowledged by all rTMs to the leader TM. Like that, the TM will be able to take a decision if the majority of rTMs have enough information to take exactly the same decision. If the TM crashes at this point, another rTM can take over the transaction. The decision will be *commit* if the majority of TPs voted for commit. It will be *abort* oth-

erwise. Once the decision is received by the TPs, locks are released.

The protocol provides atomic commit on all replicas with fault tolerance on the transaction manager and the participants. As long as the majority of TMs and TPs survives the process, the transaction will correctly finish. These are very strong properties that will allow us to run TransDraw on a decentralized system without depending on a server.

DECENTRALIZED TRANSDRAW

Instead of using a big infrastructure, we can achieve replication and fault-tolerance by building TransDraw on top of a peer-to-peer network, and by decentralizing the synchronization of locks and data storage. Our proposal is to build TransDraw on top of Beernet.

The Paxos-consensus protocol as described in section **DECENTRALIZED TRANSACTIONAL DHT** is not sufficient to provide exactly the same functionality of TransDraw as it was described in section **TRANSDRAW**. The main difference lies on the moment where the locks are granted. As it is currently, locks are granted too late for TransDraw, because it is not possible to inform users about the intention of the others.

The first modification we have to do to the transactional protocol is to allow eager locking request. One idea is to request the locks when read/write operations are sent to the transaction participants during the *read-phase*. If locks are not granted, the transaction is immediately aborted. The problem introduced by this modification is that if leader TM crashes after requesting the locks, there is no rTM yet to take over the transaction, and items would be locked forever. Considering this, the registration of rTMs must also be moved up to the read-phase. After this two modifications we realized that in fact it is better to avoid the read-phase and start immediately with an extended commit phase that first needs to gather the participants.

The second modification is an eager notification mechanism. Currently, our transactional layer is meant for asynchronous access to the share state. When a peer writes a new value for item, other users are not notified unless they read the item. In the case of TransDraw, other users need to be notified not only of every modification on the value of items, but also on the intention of other users when they lock items. To achieve this, the leader must broadcast its decision to the network once it gets enough locks, and once the final decision is taken. Note that eager locking and the notification mechanism are only needed on synchronous collaborative work.

CONCLUSION AND FUTURE WORK

We have seen that several synchronous collaborative applications are currently based on centralized synchronization. This strategy is efficient but not fault-tolerant because it strongly relies on the stability of the server. Some applications achieve fault tolerance by replicating the state of the server, but this requires a more sophisticated infrastructure and it is still inherently centralized. Single point of control is a single point of failure.

We propose to implement these kind of applications on top of structured overlay networks with symmetric replication, and a transactional layer based on consensus. This strategy provides synchronization and fault-tolerance by decentralizing the control of the work flow. We present our approach by taking the TransDraw application and the Beernet peer-to-peer network.

Beernet as is, can help to decentralize asynchronous collaborative applications. In order to achieve the functionality of TransDraw, which is synchronous, eager locking and a notification mechanism need to be added to the current transactional protocol.

We still need to study in detail the new transactional protocol, implement it and compare the performance with the centralized approach. We expect to have a small degradation in performance at the level of the transactional protocol due to replication cost, but with a huge gain in fault-tolerance. There is no degradation in performance for the user in case of no conflicts, because its changes are done optimistically, eliminating the problem of network latency.

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Improving the Capabilities of People with Cognitive Disabilities with an Interactive System based on Distributed User Interfaces

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ABSTRACT

People with cognitive disabilities face more difficulties in learning and integrating into society. They need an education focused on activities that stimulate and improve their cognitive skills so they may become more and more independent. In order to take advantages of the benefits of the latest technological developments using multiples devices, displays and several connections, we have developed an interactive system that enhances the user experience by using the latest technology, such as the RFID. This paper highlights the effect in the way users interact with all kind of devices. In order to eliminate the user-computer barrier computer, a new form of interaction is proposed. The user interacts with the interfaces through the objects, such as cards, toys, everyday objects, etc. The project is based on games to motivate users and facilitate the learning process.

Author Keywords

Interaction Resources; RFID; Distributed User Interfaces; Collaboration, Intellectual disability

ACM Classification Keywords

H5.2. Information interfaces and presentation: User Interfaces. – Graphical user interfaces.

General Terms

Design, Human Factors, Experimentation.

INTRODUCTION

Intellectual disability is an impairment of the adaptive skills manifested in conceptual, social and practical areas [3], [9]. People with disabilities have difficulties in decision-making

processes which may hinder their integration into society.

The importance of support systems to improve and enhance the development of cognitive abilities of impaired users is essential. In this field technology can offer extensive benefits in order to improve these limitations.

The educational and training techniques for this collective should be approached differently, as expressed in [6], by using games impaired users can learn to explore, develop and control their physical and social skills while learning to adapt to their environment and culture [2]. Moreover, this process is performed while voluntarily participating in a leisure activity for enjoyment.

Nowadays, the existing educational games are still difficult to use. They use the classical interaction devices such as a computer connected to a keyboard and a mouse or in the case of virtual reality, the devices are even more difficult to use and expensive. This interaction is not natural for users and some previous training is required. The means of communication among the user and the computer has always been focused on traditional GUI (Graphics User Interfaces), executed on a basic computer. However at present this is changing as the computer fades into the background and the new scenarios are enriched with computing systems everywhere, as defined by Weiser in 1991 [11], computation is embedded in the environment and becoming invisible to the user. This paradigm is called Ubiquitous Computing. Nowadays multi-devices and multi-displays are found in everyday scenarios.

In new environments other kind of interfaces are required, such as DUI (Distributed User Interfaces). According to Niklas Elmqvist in [1], DUI can be defined as user interfaces whose components are distributed throughout one or more dimensions. These dimensions are input, output, platform space and time. Among the scenarios that support DUIs we can find multiple screens, multiple devices, multiple users and multiple displays, as defined by

Melchior in [4]. According to Vandervelpen in [9], the components required to interact in these scenarios are:

- IR or *Interaction Resources*: the devices that help the user to interact with the system.

- ID or *Interaction Devices*: the computing systems which manage the input or send output to IR in order to show the task executed and its results. They include devices such as: desktop computers, tablet PC, mobile phones...

This paper presents games based on collaborative environments aimed at stimulating different skills in people with cognitive disabilities. They integrate a new form of interaction where common objects are scanned and interact with displays located in the room.

RELATED WORKS

In this section we describe briefly the systems and interactive games developed for people with intellectual disabilities.

The term “Serious games”, defines the games that simulate real situations for people with disabilities, such as shopping in the supermarket. They are designed to improve abilities which can be used in their everyday environments. [5].

Some other games used are focused on virtual reality, as shown s in [7], [8]. Players are offered to wear helmets, gloves or other devices or simulators which make them get immersed in a particular setting to play the game. In [13] the devices required to facilitate interaction for people with disabilities are described.

A different RFID-based solution can be seen in [12], but it is only focused on the teacher's guide to be followed for daily treatment for children, not specifically to be used in the application by the children.

The advantages that these systems provide are numerous. It encourages positive attitudes in the user, as they are appealing, motivating and provide information quickly. However, this system presents some disadvantages, such as the following:

The user needs a minimum knowledge on computer use for this game. Not everyone has the ability to use a computer and the use of some devices like the mouse and the keyboard is not intuitive for people with cognitive disabilities. They need other people or teachers to help them.

- The system requires highly specialized and expensive hardware/software (simulators, virtual reality).

- Some games present a very specific design and some information can be difficult to find.

The system proposed attempts to solve the limitations found in current systems. This has focused on providing a simple and intuitive interaction, using everyday objects to interact with the game without requiring previous training by the user. It allows users to play both in groups and individually.

It is flexible because everyday objects can be used anywhere and at any time. RFID technology has been chosen to implement the system. One of its main advantages is that this technology is transparent for the user.

The system can be easily deployed in any place and the cost is quite low. For these reasons and considering the benefits offered by digital toys, it is an ideal solution to improve cognitive skills, also increasing creativity and encouraging the user to use it again.

The following section describes in detail the proposed system.

CASE STUDY

In this section the system developed is explained in detail. It is based on games for people with intellectual disabilities. The main objective is to improve cognitive capacities such as memory, arithmetic and auditory discrimination. In this way they learn to be more independent for their daily activities.

The interactive system is composed of a collaborative wall display projector. It shows the different games offered. These games are run inside the computer connected to the server. The mobile devices have an integrated RFID Reader which allows communication among the digitalized toys and the wall display projector. Every device is connected to the server through a wireless network. The server is responsible for generating the corresponding interfaces on each device. The digitalized toys have an integrated RFID tag. In this way they can communicate with the mobile devices and handle and interact with the game displayed in the wall. In this case the mobile device is hidden in a doll because it is more appealing and motivating for to the user.

In order to use the application, the user just has to move the digitized object with the RFIG tag closer to the reader and at that moment the collaborative interface changes depending on the tasks to be performed, if the game involves matching couples and the child is successful, it displays the message but restarts the game, allowing a new start.

Distributed User Interfaces

In order to develop the interactive system we have used distributed user interfaces as we have different types of interfaces distributed in the scenario. These are: the physical interfaces (physical toys digitized), the main interface displayed on the projector and the interface that runs on the mobile devices that integrate the RFID reader. Each has a different function but act jointly to facilitate the user interaction with the application. The interaction components and their roles in the scenario are next described.

IR (Interaction Resources): the digitized physical toys. These resources provide the interaction with the system. In

this case study, everyday objects such as toys or cards are used to interact with the system. In this way we offer users more flexibility and familiarity with the physical interfaces.

ID (Interaction Devices): the interaction devices, in this case the mobile devices. They communicate with the digitized collaborative screen and toys, thanks to RFID and wireless technology. The interface in the mobile devices in this case serves to help users to use the system.

Interaction Style

User-computer communication style simulates the user's natural way of communication when interacting with their everyday environment. Therefore no prior knowledge is necessary as the use of the system is very intuitive.

In our system the style of interaction is simple and natural (See Figure 1), it is only necessary to move the toy, card or desired object, depending on the activity being carried out, closer to the mobile device (hidden in an object). The interaction and the processes occur in the system implicitly. In this case the collaborative screen shows the game running. It may show some objects and to associate that object, the user has to interact with it, just by moving the corresponding object closer to the mobile device. From this moment all processes are run implicitly by the user. The collaborative screen displays the pictures, text and sounds, depending on the game executed.



Figure 1. Interaction way. The user moves the digitized object (interaction resource) closer to the mobile devices that contain the RFID Reader; this is an interaction device hidden in the object

System Architecture

The system is based on a client-server configuration. The implementation can be seen in Figure 2. The client system runs on the user mobile device (concealed in an object). It is connected to the server through a wireless network and it is communicated with the digitized objects via RFID. When the RFID reader, located in the mobile device, detects the tag integrated in the toys, the RFID tag is excited by electromagnetic waves sent by the RFID reader, then, the applications that is running inside the mobile devices sends

the identifier to the server. The server verifies the information and executes the processes necessary to generate the corresponding interface in the wall projector. The server communicates the information to the computer where applications corresponding to the games are being executed.

Advantages of the system

The main advantages of the system are the following:

- Easy to learn and use because the objects used to interact with the system are a simplification of reality and are easily assimilated.
- It provides a simple and intuitive interaction style, so users need no prior knowledge of the use the system. All they have to do is moving the object closer to the reader.
- It is an audiovisual game with a collaborative screen, displaying games in relation to memory, calculation and other abilities which is equipped with auditory discrimination of colors, sounds and texts designed to appeal the user and influence positively his/her creativity.
- It incorporates feedback and collaborative screen messages are displayed visually and game results are voiced. The steps to be followed at each stage are clearly shown and positive messages are displayed to encourage users to continue using the application.
- It offers a flexible alternative to play individually or as a small-group therapy.

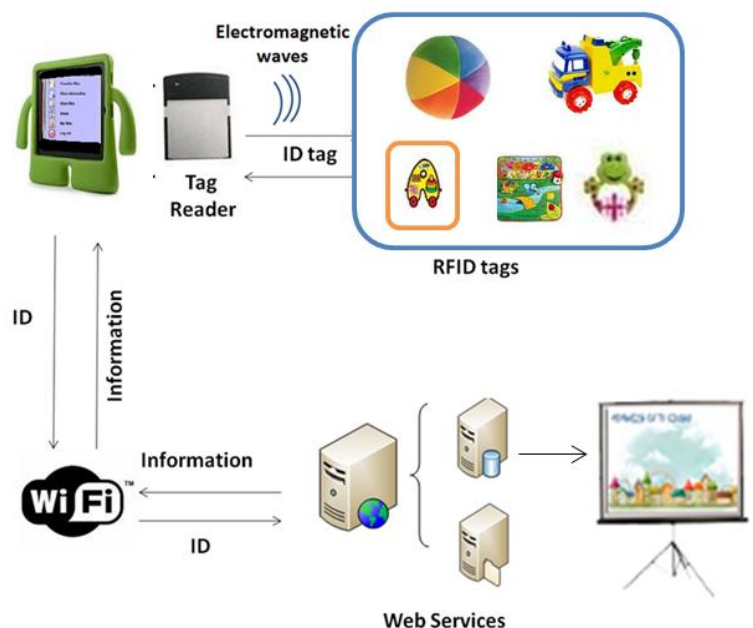


Figure 2. System infrastructure and interaction among the devices

- Dynamic, sympathetic and friendly interfaces encourage users to use the system and show the advantages it offers.
- The cost of the physical interfaces (digital toys) is very low and passive RFID cards and toys are also inexpensive.
- It is very flexible and accessible as working with objects and mobile devices it can be used anywhere without passwords or requiring any other device that may hinder its use.

CONCLUSIONS

People with cognitive disabilities have more difficulties for learning and for their integration in society. Some encouraging training activities may be useful to accompany them in their learning process. Some classic games designed for this target group may still require certain knowledge on the use of new technologies. In order to facilitate human-computer interaction to carry out activities to improve cognitive abilities with no need to concentrate on the use of the computer, we propose an interaction style based on everyday objects to interact with digital interfaces in games, so no prior knowledge is required. This new way of interaction is intuitive and attractive and at the same time it improves the user's cognitive abilities. To achieve this, we have used emerging technologies, such as RFID which facilitates interaction by means of the use of mobile devices

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