3D Collaborative Virtual Environment for Real-Time GUI Sketching
Ambiente Virtual Colaborativo 3D para el Bosquejo de GUIs en Tiempo Real

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Resumen:

El presente artículo describe los hallazgos de 3 estudios de usuario realizados con el fin de identificar los requisitos funcionales y de información de *awareness* de un grupo de diseñadores de Interfaces Gráficas de Usuario (GUI) mientras llevan a cabo la tarea de bosquejo de GUIs. Se prestó atención especial a las restricciones naturales y del software, la interacción de los participantes y la manera como estos utilizan la información sobre el entorno de trabajo, el equipo, los artefactos y las tareas. Estos hallazgos son usados en el diseño de un ambiente virtual colaborativo en el cual los diseñadores pueden llevar a cabo la tarea de forma muy natural, amigable y eficiente. El sistema construido se explica en detalle, señalando su arquitectura y mejoras funcionales comparadas con aplicaciones existentes similares. Como trabajo futuro, se describen algunas tareas desde ya programadas y se proponen funcionalidades adicionales y mejoras posibles que podrían complementar la herramienta.

Abstract:

This paper describes the findings from 3 user studies conducted to identify the real functional and awareness information requirements of a group of graphical user interface (GUI) designers while they carry out a GUI sketching task. Special attention was paid to the natural and software restrictions, participants' interaction and the way they use the information about the workspace, the team, the artifacts and the tasks. These findings are used in the design of a collaborative virtual environment in which designers can perform the task in a very natural, friendly and efficient way. The system built is explained in detail, remarking its architecture and functional improvements compared to similar existing programs. As future work, some already scheduled tasks are described and additional functionalities and possible improvements are proposed, so that the tool can be complemented.

Keywords:

awareness, sketching, prototyping, collaborative virtual environments, graphical user interfaces, user studies, collaborative real-time editors

Palabras Clave:

awareness, bosquejo, prototipado, ambientes virtuales colaborativos, interfaces gráficas de usuario, estudios de usuario, editores colaborativos en tiempo real

Introduction

One of the most important tasks in User Centered Design (UCD) is Prototyping [1]. For complex software this task is usually performed by groups of designers who get together around a table to design and choose the best graphical user interfaces for a specified set of requirements.

Traditionally, this task has been carried out using paper, markers and some other tools, but since this makes it impossible to reuse parts of the design, like the copy-paste in computers; the process requires designers to draw over and over the controls of their designs and also agree on the appearance of the drawings, making it a slow labor. Another problem of this task is that the physical artifacts produced are difficult to trace along the other stages of the UCD process since it becomes a computer assisted process.

Additionally, nowadays, many of these groups are physically separated, so the need of supporting effective communication grows and the possibility of remote collaboration among participants is mandatory.

There are lots of 2D applications that offer tools to designers so that they can increase their productivity and consistency using predefined and configurable widgets. These tools allow designers also to better manage the sketches related to specific requirements, but an intense study of the most popular of these tools has shown us that none of them offer an interaction as natural, transparent and participative as the traditional paper manner, keeping the participants unaware of what others are doing and forcing them to strive on coordination of their contributions, which causes long moments of inactivity by some designers which, in turns, makes them get bored.

The Awareness factor has been recognized to affect directly the communication, fluency, productivity and, in general terms, the experience of a group of users while they perform a collaborative task [2]. The awareness of the workspace, the artifacts, the group and the tasks are some of the requirements that applications for groups should consider.

Some of the existing tools for groups allow teams to get together in 3D virtual environments where they can work collaboratively and to be aware of what is going on. In these applications, the information about the group (identity, location, state), the artifacts and the workspace is rich, but the problem of a very restrictive coordination of contributions still remains and none of these tools offer objects like the widgets that 2D applications offer. Additionally, a new problem arises; accuracy at designing gets compromised since controlling small objects like 2D widgets in a 3D environment can be more difficult for some people [3].

As Cook and Churcher [4] announce for the collaborative software engineering case, delivery of successful collaborative design applications is challenging, and the most critical success factors are

those associated with providing effective support for aspects such as awareness and concurrency control.

Based on the functionalities, constraints and lacks we found in the 2D and 3D applications, the perceived judgement of their users, the real and specific needs of GUI designers that our studies revealed, and the existing theories about awareness and concurrency, we propose a highly competitive application for prototyping that allows physically distributed groups to perform the task in a very friendly, participative, vivid and informative way, similar, in this sense, to the traditional manual one, and as organized and efficient as the computer assisted version.

Requirements Analysis

Three user studies with different settings were conducted; all of them were video taped. The first one consisted on the study of seven groups of designers (21 designers) while they produced a group of GUI prototypes manually, using paper, markers, pens, pencils and erasers.

Before the second and third studies, eight 2D prototyping tools and three general purpose 3D collaboration environments were compared to choose the most complete 2D and 3D applications for the studies. Teleplace [5] and Mockflow [6] were the best 3D and 2D tools selected, respectively.

The second study consisted on the observation of 7 groups of designers while they tried to carry out the prototyping task using the selected 3D tool [5] which allowed designers to share a drawing panel, have visual information to be aware of what their collaborators are doing and establish a voice communication.

For the Last study we considered 17 groups of designers (50 designers) while they carried out the task using the selected 2D prototyping tool [6] which offered access to a wide set of GUI widgets that ease the prototyping task and a mechanism to share their contributions to remote collaborators via check-in/check-out revisions. Figure 1 shows the 3 studies while they were conducted.

FIGURE 1: Photographs of the 3 conducted studies. Left: Manual Study. Top-Right: Study with the 3D tool. Bottom-Right: Study with the 2D tool.

From the videos, we extracted rich information that shows the user's behaviors while doing their tasks. We focused on aspects like time invested: sketching, communicating, understanding the requested task and idle or distracted.

The next table shows the percentage of time invested on these criteria.

Study / Activity	Traditional - Manual	With the 3D tool	With the 2D tool
Sketching: Finding a widget, adding a widget to the sketch, drawing a widget in the canvas.	**60%**	**71%**	33%
Communicating: Exclusively talking, using the chat or the voice system, marking and discussing details.	10%	6%	**43%**
Understanding the task: Reading/Reviewing requested task	8%	3%	5%
Idle or distracted: Sit idle or doing something different to the task while the user gets the turn.	22%	20%	19%
Average Total Time invested	11.45 minutes	24.35 minutes	17.25 minutes

Table 1: Percentage of time invested on subtasks perceived in the users studies.

In every study, users invested an average of 1 minute understanding the requested task.

The study with the 2D tool required more time for communicating because it only provided a text based chat, so users had to invest more time writing and reading in depth instructions and details, being this task the one that required the most of the time.

The manual study and the study with the 3D tool allowed designers to communicate while they were sketching at the same time, so the exclusive dedication to this task was reduced considerably.

The manual study and the study with the 3D tool required more time for sketching because there were no already drawn widgets so users had to draw the whole widgets every time they needed them, being this task the one that required the most of the time in both cases.

The Needs

The manual studies revealed that designers really needed a tool with attributes such as:

- several consistent configurable GUI widgets
- the possibility to add or modify a widget to the sketch in any moment without obstructing other participants
- a mechanism to store the sketches produced during a design session and assign them to specific functional requirements

The studies with the 3D Application showed that designers would work better with:

- the possibility to add or modify a widget to the sketch in any moment without waiting for others to cede the turn
- more accuracy when selecting and dragging drawings around the canvas

The studies with the 2D Application showed that designers need:

- better awareness mechanisms so designers can see what the others are doing
- the possibility to merge the work they produced isolated with the work produced simultaneously by the others
- a more fluent communication like the audio based one

Satisfaction of these needs can improve the experience of the group by reducing idle times and increasing efficiency at communicating and sketching.

Proposed Solution to the Identified Needs

In order to specify a complete tool that satisfies the real needs of designers, we considered the functional and awareness needs identified by our 3 user studies, the functionalities offered by the

competitors software like Balsamiq Mockups [7], MockFlow [6], Teleplace [5] and others; the theories about Workspace, Group and Artifact Awareness [2], [8]; theories about Territorial Coordination [9]; studies about tools for Awareness in Groupware[10], Awareness Models for Collaborative Learning [11] and Success Cases of Telepresence applied to education [12].

The system developed is a common Client-Server application using Java technologies. The server is in charge of the management of the shared information used during a sketching session, transmit the awareness information from clients to clients using Kryonet [13] framework and persistence of the artifacts developed in every session using the Java Persistence API [14].
Every client is in charge of presenting the information about Awareness, the Chat and the Sketching system, broadcasted by the server. This visual information is presented using Java Swing and JMonkeyEngine[15]. The conference is started among clients using IP addresses without connection to the server using Java Media Framework[16].
The next drawing describes the developed System illustrating the frameworks and APIs used.

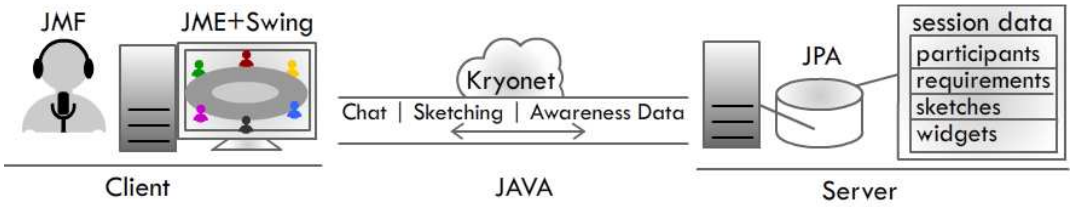

FIGURE 2: System's Description: Frameworks and APIs.

Detailed Characteristics of Every Subsystem

For the Chat System, we have provided an interface that allows designers to communicate with every participant in the design session and separately communicate with the current co-editors of a Sketch. In this way, we can simulate the behavior shown by the users while they carry out the manual face to face sketching task, in which groups are made and some discussions are private to the group and some public to the entire group. Additionally, as requested by our users, the chat informs with a Skype or Messenger like visual sign that there is a new message in any of the chats, and the chat window can be manipulated in such ways that won't affect the user's job.

The Voice-Conference System allows a selected group of participants to carry out a voice conference and add or remove participants to and from the conference in any time. A conference control frame has been provided to easily allow these functionalities. Figure 3 shows a zoom of the chat and the conference control frame.

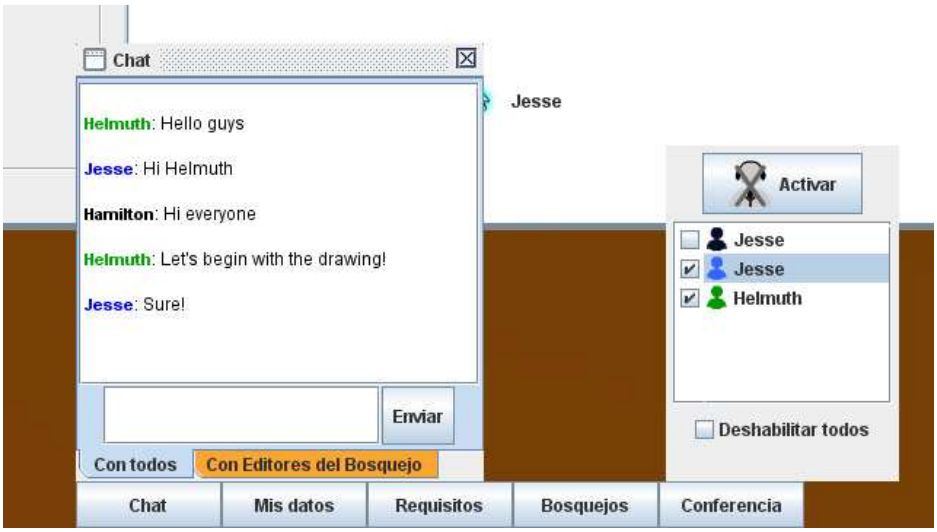

Figure 3: A zoom of the chat and the conference

The Sketching System provides a wide set of preconfigured GUI widgets, famous in most of the 2D competitors applications. In order to add a widget to a sketch it is only necessary to drag and drop one of the widgets provided in the widgets toolbar, and to edit the settings of the widgets a quick edit functionality containing the most common attributes has also been provided. The great novelty of this Sketching System is that allows co-editors of the sketch to contribute to the sketch (add/remove/modify) in any minute without turn taking and with a real time feedback of their actions. This quality deals with the problem mentioned by our users when they say "I don't know what others are doing", "I have to wait until they notify me of their changes" and "I can't participate when another one is using the shared board".

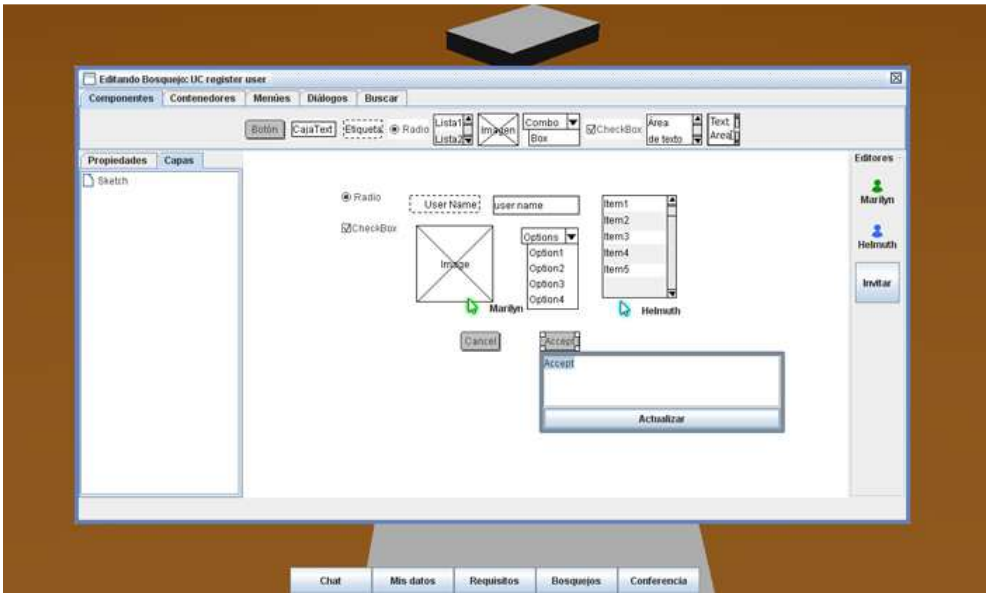

Figure 4: A picture of the sketching frame. 3 persons are editing the sketch at the same time.

The Awareness Tools provided with the system are those related to available participants and artifacts in the workspace, remote representation of participants' actions, representation of participants' state and participants' associations. The tools developed are: 2D telecursors (Figure 4), 3D telepointers, Avatars animation, Artifacts location and Territorial differentiation, as shown in Figure 5.

Considering Metaphors, in order to assure that the developed tool maps the reality and the fluency of the traditional manual sketching task, we have tried to offer a 3D virtual environment where users can sit around a round table and use their personal and shared spaces as they would manually. Te view of every user can be managed to simulate the movement of the user's heads and this movement is transmitted to the others. Since pointing at objects and details of the artifacts is also frequent during the task, users of our system can use a 3D telepointer to point at any object in the virtual environment and a 2D telecursor to indicate details in a sketch. Users can see and access the artifacts over the table as they would in the real environment, but additionally they can have an organized view of the sketches and information about their authors and collaborators.

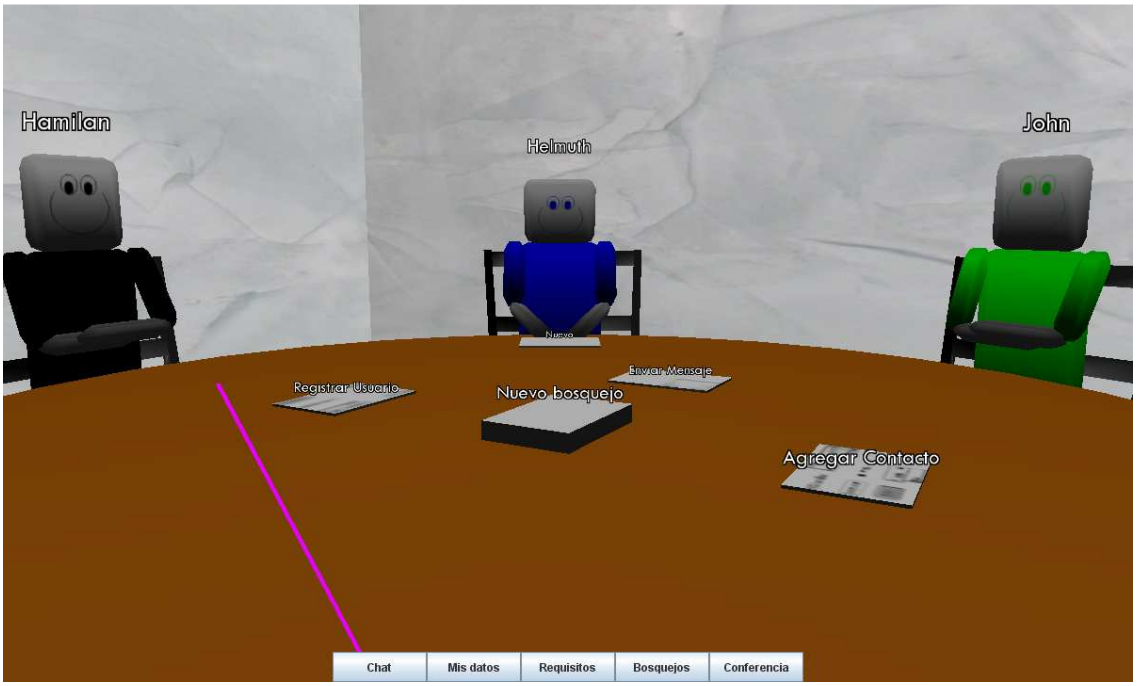

Figure 5: A picture of the Environment and Telepointer as awareness tool. Sketch in use by a participant appears close to his/her avatar (Helmuth/Blue). Unassigned Sketches appear around the white sheets pile.

Future Work

At this moment, the tool has been developed. Usability tests and the modification of the tool according to the tests findings are scheduled. We will run an experiment to validate the Hypothesis

"*The developed tool allows a small group of designers who are geographically dispersed to be more efficient and feel more motivated during the GUI Sketching task"*.

Some functionalities like allowing the users to add a personal drawing of a widget and exporting the sketches to a source code in languages like Java, C# and more has been considered and will be included in the software.

As future work the developed tool could be expanded to fit other tasks. Additionally, video transmission of participant's faces can be included to identify possible improvements in user's satisfaction, motivation and efficiency.

Currently, our system informs the union of participants to co-edit a sketch by orienting avatar's heads to the shared artifact and pointing their 3D telepointer to the sketch. We think that there may be a better solution to illustrate this, so we let this open to discussion.

Conclusion

As a result of the conducted studies we identified that many of the needs that GUI designers have while they carry out the prototyping task are not satisfied completely by the best existing applications. The identified needs and some theories related to group work such as workspace, team, artifacts and task awareness allowed us to specify and develop a tool that satisfies the most critical needs of physically separated GUI designers, increasing their productivity and willingness, but it is still necessary to conduct some experiments to validate that users can really work more pleasantly and fluently with our tool.

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