

Challenges on Distributing a Collaborative Sketching System Across Multiple Devices

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ABSTRACT

The recent popularization of touch screen devices have brought to users the opportunity to use different devices to interact and to share content, while current advances in the mobile context brought new capabilities for systems to run on many devices while maintaining the system's consistency. Those two factors combined pose new opportunities for researchers to explore how users can collaborate using an heterogeneous set of devices, that can include large tabletops, smartphones or e-readers. This paper starts the discussion on four challenges related to this context.

Author Keywords

Electronic sketching; Distributed systems; Collaborative design; Prototyping.

INTRODUCTION

The current popularization of touch screen devices and the multi-platform capabilities made possible by HTML5 might pose new opportunities for developers to build distributed interactive systems with minimum effort on adapting systems for each platform. Systems to support design activities are also included in this set of new opportunities, also giving room for researchers to investigate how designers use sketching to prototype interfaces on the current multi-platform scenario.

Multi-platform sketching is the activity of drawing with an electronic stylus at different devices while having the same system running on those different devices [13] and developed the GAMBIT system, a multi-platform collaborative tool originally conceived for User Interface design that allows users to share pictures and sketches on different devices using a virtual, spatially infinite wall.

The tool is an essential part of a research on sketching, whose goal is to investigate electronic sketching usage in current UI

design practices taking into account the multi-platform context for producing and validating interactive prototypes. The system was created to be:

1. Sketch-based - electronic sketching is supported as the main mode of interaction, it is used to quickly put ideas on an external medium, where they can be discussed, improved and stored for further reference;
2. Distributed - for it allows users to sketch using the device of their preference, and also allows the prototyping and testing of systems on the very device it is intended to run. The system was built with HTML5 and Javascript in order to run on any device with browsing capabilities, through a browser or embedded into a native application;
3. Collaborative - for it focus on group sessions, allowing not only designers to sketch and discuss together, but also to include end users in the process.

This paper is organized as follows: in the next section we motivate the research on distributed user interface together with the related works. Then we present the Distributed sketching system constructed to investigate sketching activities on a multi-platform context. And finally we present a set of challenges related to distributing a collaborative system into multiple screens.

MOTIVATION AND RELATED WORK

Although the motivation of this research work is UI development, the observations presented here can scale up to sketching systems and distributed systems in general.

To support sketching into UI design, we needed to analyze the process in which UI design is included. The tools available for UI development are usually not focused on UI **design**, in which designers usually explore different alternatives but in UI **modeling** as a final product, where designers must attend to formal standards and notations. There are many tools available for both modeling and design, however practitioners are currently forced to choose formal and flexible tools. Whichever they choose, they lose the advantages of the other, with attendant loss of productivity and sometimes of traceability and quality.

As categorized by [3] and depicted in Table 1, a Distributed User Interface (DUI) is a user interface whose components are distributed across one or more of the dimensions input, output, platform, space, and time, and can be described as follows:

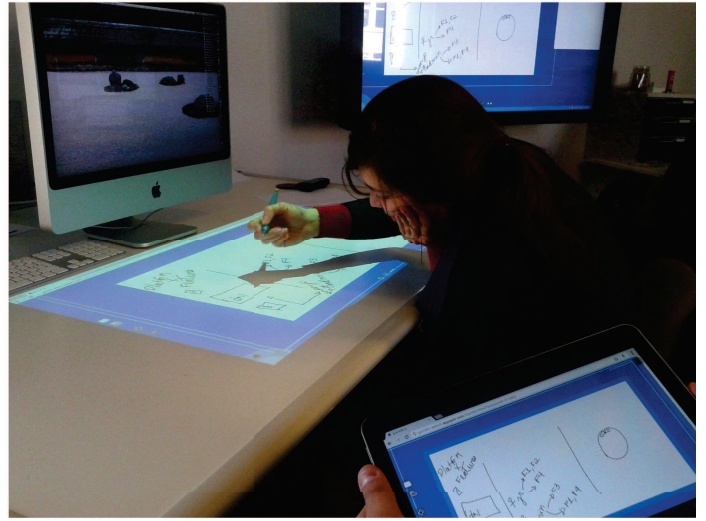
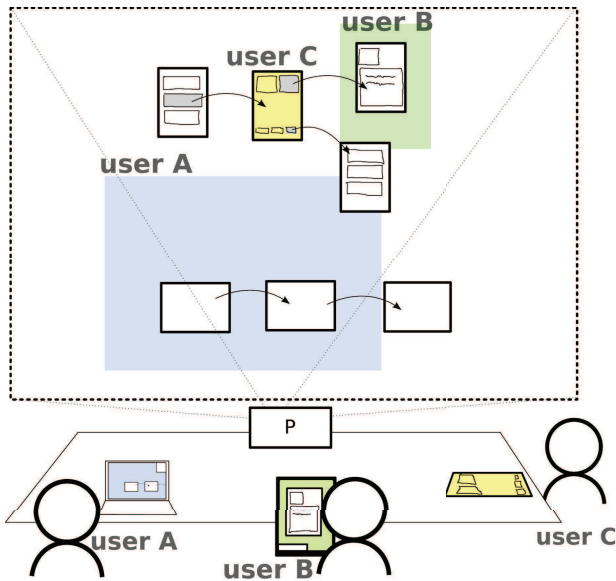


Figure 1. GAMBIT, a multi-screen distributed sketching system showing, in the right part, a session shared with tablet (front), an interactive tabletop (middle) and a TV (back).

Input: Managing input on a single computational device, or distributed across several different devices (so-called input redirection);

Output: Graphical output tied to a single device (display), or distributed across several devices (so-called display or content redirection);

Platform: The interface executes on a single computing platform, or distributed across different platforms (i.e., architectures, operating systems, networks, etc);

Space: The interface is restricted to the same physical (and geographic) space, or can be distributed geographically (i.e., co-located or remote interactive spaces);

Time: Interface elements execute simultaneously (synchronously), or distributed in time (asynchronously).

Tool	Input	Output	Platform	Space	Time
Calico	One	One	One	Single	Sync
DENIM	One	Many	One	Single	Sync
DAMASK	One	Many	One	Single	Sync
I-LAND	Many	Many	One	Multi	Async
TEAM STORM	Many	Many	One	One	Sync
WallShare	Many	Many	One	Multi	Async
Dazzle	Many	Many	One	Multi	Async
CrossWeaver	One	Many	One	Single	Async
InkKit	One	One	One	Single	Sync
SketchiXML	One	One	One	Single	Sync
GAMBIT	Many	Many	Many	Multi	Async

Table 1. Tools for UI design by sketching according to DUI systems classification.

CALICO [8], INKKIT [11] and SKETCHXML [2] are categorized as single input, single output, single platform systems despite being created for sketching in general, cannot be effectively used for designing multi-platform systems. DAMASK [6], DENIM [9], I-LAND [16], TEAM STORM [5], CROSSWEAVER [15], WALLSHARE [18] and DAZZLE [10], despite having the possibility of distributing the output across

many devices, are single-platform, which means that all the devices need to run the same computational environment.

GAMBIT is positioned as a distributed system that not only can have input and output from many devices, but also from many platforms, ranging from desktops and interactive televisions to smartphones and e-readers. In this sense, devices that are better suited for sketching input can be used for pen interaction while large displays can be used for visualization. Also, a session can have parts of the shared “wall” interface distributed in space among many projections, composing a virtual meeting room, for instance.

DISTRIBUTED SKETCHING SYSTEM

Sketching is considered to be a powerful tool for doing design. As the findings of [4] point out, the presence of ambiguity in early stages of design broads the spectrum of solutions that are considered and tends to deliver a design of higher quality. Furthermore, the very process of sketching and discussing is largely considered to have the same importance as the final product of a meeting or design session [1].

Fostering creativity is considered to be important since design is essentially a problem of *wicked nature*, i.e. the process of solving it is identical with the process of understanding it [12]. In wicked problems, the designer does not have a clear understanding of what to produce and has only a vague goal in mind in the beginning.

Design sessions were observed in two companies related to user interface development in Belgium. The people involved on those sessions were designers, project managers, programmers and frequently stakeholders. In overall, in these companies the design sessions are usually done around a central topic, about which people discuss in order to produce some artifact, usually a report with a list of requirements, wire-

frames and some session log of the decisions made around the interaction. It is important to note that this report is not produced at the site but after the meeting, for what people usually take pictures for remembering and registering what was discussed. Nevertheless, the design sessions most often proceeded with three distinct phases:

1. Sketch production - One or more participants produce sketches to express ideas.
2. Sharing: the participants normally share the drawings using a big sheet of paper and use post-its. The sheets are arranged as a storyboard on a wall for discussion.
3. Discussing: the participants refined the sketches based on what was discussed and learned on the discussion.

By creating a distributed sketching system we are willing to offer designers a flexible solution in which they can choose their device of preference to sketch. GAMBIT's basic requirements list was presented in [13] and it is developed as depicted on Figure 1: the many input devices can be tablets, mobile phones, large graphical tablets, etc. and they be used to sketch and submit drawings to a virtual wall where all the drawings are organized spatially. The roles of the devices are interchangeable – a user might request the wall's control at any time, organizing and grouping the sketches, or even creating the possibility of drawing “out of sight” (i.e. out of the public projection) and then putting the drawing for public discussion, like in the sessions observed at the IT companies.

Since GAMBIT is a web-based system, the wall might be a full-screen browser window opened on a desktop computer, a projection (P in Figure 1) or a large interactive display. Figure 1 (left) also shows *user A* visualizing a big part of the screen on its own laptop, while *user B* is focused on sketching a document on the upper part of the wall and *user C* is navigating through a prototyped interaction path.

CHALLENGES AND FUTURE WORK

GAMBIT was originally conceived as a tool for aiding UI designers to produce interactive prototypes, however it poses as an example of a general-purpose system for sharing pictures and drawings in a virtual multi-screen environment. We introduce a set of four general challenges for this distributed sketching system:

- C1** *Make users aware of each other's activities* if, at one hand we have the “out of sight” sketching activity, in which users want to sketch outside of the group for later discussing in public, on the other we would like to make users aware of who is sketching in public. Furthermore, by having such a large number of possible devices and an “infinite” workspace to work on, it is hard to keep track of which devices are observing specific parts of the wall.
- C2** *How to “point” at something remotely?* We have made some initial observations of people sketching in groups, and we have noticed the “point to” gesture were ubiquitous in all of them: the physical communication have a greater power to deliver messages than the electronic mediated one. We have observed that remotely located users (aided with video conference applications) had difficulties when trying to point to some part of the screen, for what

they used to draw upon.

C3 *Concurrency and Conflicts*: This is a classic problem of collaborative systems which we need to address and yet there is no implementation on the system to deal with the concurrent modifications and conflicts.

C4 *The right tool for the job*: Not all the devices have the same resolution or performance. We need to identify which devices are suitable for the basic activities (sketching, sharing and discussing) but also for specific activities, such as handwriting [14] [7]. Also, experienced sketchers such as architects may have different requirements than UI designers and software engineers.

The challenges posed by the novel approach presented on this paper are not completely new for Distributed User Interfaces or Collaborative Work domains, except perhaps for C4 which is specific to Electronic Sketching. C1 is discussed in [1] (in the chapter “I Know What I See, But What Do You See?”). However, classic collaborative systems are largely considering just one device (usually big tabletops) and not many devices at the same time, which might increase the problem complexity.

C2 is well covered in [17], which proposes to use a camera to capture users' arms and project a sort of shadow on the other devices. However, that would require a camera pointing at each device, and for sake of simplicity a mechanism such as a virtual laser pointer could be implemented.

Due to the popularization of touch screen devices users now have an unprecedented number of options to interact and share content, and yet there are no open standards available for making applications distributable on those devices. The list of challenges presented on this paper is intended to bring the discussion of “old” problems of collaborative systems to the contemporary context.

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