Tackling Collaborative-Design of Mobile Prototypes

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Abstract

This paper presents an application for collaborative design of mobile prototypes, covering both prototyping and evaluation stages of design. Virtual design workspaces provide designers with the necessary mechanisms to build and test prototypes. Shared versions of these workspaces along with annotation mechanisms offer the ability to not only constitute collaborative design groups, but also perform group evaluation of the created prototypes. Evaluation provided positive feedback on the approach taken for the collaborative design tool.

Keywords: Mobile Applications, Collaborative-Design, Collaborative-Evaluation.

1. Introduction

Designing applications for mobile devices is an increasingly demanding challenge. Besides the hardware constraints that are imposed by their size, interaction modalities, diversity and portability, their pervasiveness and multi-purpose functionality imply an entire new set of usage paradigms.

Consequently, new methodologies, techniques and tools have emerged recently [2][15], and amongst them, two central concepts come forward: prototyping and evaluation. It is thus of utmost importance to have tools that support each of them [5], but also simultaneously shrink their articulation, therefore covering coherently the whole prototype/evaluation cycle [1].

Yet, because of the multitude of factors to consider in mobile applications design, methodologies, techniques and tools may still fall short to offer an effective and efficient support to prototyping and evaluation. Here collaboration has a role, even more relevant than for the design of desktop applications.

Some work exists on tools for collaborative analysis of artefacts (e.g. [3] [10] [17]). However, they usually focus on the analysis and often ignore the design itself or, most notably, the evaluation. Besides, creation and comparison of alternative prototypes and its usage is often neglected. In an often exploratory-context such as mobile design, the ability to compare synchronously usage results, adjust concurrently prototypes and comment as the design/evaluation process occurs is, sometimes, a requisite for success [5][6].

As such, we propose a tool for collaborative design of mobile prototype that covers the comparative and collaborative dimensions and the prototyping/evaluation cycle in an integrated way. The tool emerged from the fusion of a framework for mobile prototyping, which includes a single user design tool, into a comparative and collaborative tool for the analysis of mobile prototypes' usage. The result constitutes a powerful framework for mobile applications design, allowing distributed and complex group collaborations.

The paper is as follows: related work is discussed; then we briefly describe our previously developed framework and the analysis system; afterwards the collaborative-design tool is presented along with some remarks about the integration approach; a basic usage scenario and preliminary evaluation results are then examined; finally, we draw conclusions and reveal some of our future work.

2. Related Work

Design methods and techniques for mobile devices, albeit being recent and somewhat immature fields of research are increasingly being addressed by researchers, leading to the appearance of different approaches for a wide range of problems [7]. There are several prototyping application proposals, such as DENIM [4], SILK [12], SketchWizard [13] or SUEDE [14] (these last two supporting alternative modalities such as pen-input or speech user-interfaces, respectively). However, although these tools have useful functionalities and features, and provide sketching and quick prototyping mechanisms, the integration with the evaluation stages is rarely addressed. Furthermore, none addresses the specific needs of mobile devices or provides usability guidelines and aids to designers while creating their prototypes. Nevertheless, the automatic support for Wizard-of-Oz prototypes and the ability to animate hand drawn sketches has shown very positive results. Regarding cooperative design process itself, Liappis [16] presents a collaborative software which covers early stages of the design process, such as idea generation through brainstorming or even sketch analysis and associated annotation procedures. However, the artefacts targeted

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by the software lack any kind of pro-activity or behaviour, focusing mostly in static artefacts such as pictures.

Regarding the analysis process, Greenberg presents SharedNotes [11], a system in which users are able to create annotations for their digital artefacts. These may be later published in a shared space while in a meeting, focusing more on the transitions between private and public notes. Notable [9] is another annotation system, focusing more on document (and respective annotations) search and on the separation of the document visualization and annotation taking platforms. These two works, despite providing valuable design cues, do not cover a comparative dimension of the used artefacts. NotePals [10] is another annotation sharing system which allows users to aggregate notes to artefacts and allow other users to access them. Unlike the other examples, there is a clear attempt at providing a certain degree of comparative analysis in addition to its collaborative facet. However, the static nature of the used artefacts does not promote the employment of the system for usage evaluation ends, thus not accomplishing the goals we propose. The Pebbles project [11] focuses more on the collaborative use of mobile devices. Users operate their PDA's connected to a PC to remotely send input data, thus enabling direct manipulation of the same display by multiple users. While this solution is a good example of a collaborative application, it doesn't integrate any kind of comparative features, hence not covering our goals.

Pinelle presents and discusses a set of design practices for groupware tools in [17]. In addition, a prototype for homecare is presented which allows clinicians and patients to share documents allowing direct access to these using a timeline. This work shows the closest features to our approach. However, no emphasis is given to a comparative dimension. The lack of annotation support is another feature in which it differs from our approach, hence not fully covering the comparative and collaboration dimensions.

3. The Mobile Prototyping Framework

This section provides a brief description of the Prototyping Framework. The Framework comprises: (1) a set of libraries for prototype construction, supporting interpreted program modification. Using the libraries, it further provides tools for: (2) prototype manipulation; (3) creation and adjustment of prototypes; (4) and basic usage analysis.

3.1. The Multimodal Prototypes' Library

Pages and rules compose prototypes. Pages nest elements of different types (e.g., text/audio/video labels, answering/recording elements and multiple-choice objects). Elements always combine visual and audible presentations, and anchors for mode-agnostic interaction, thus offering the basis for multimodal prototypes. Rules determine the prototype behaviour. Specific events, such as selecting a certain answer, a time-out or a next page request, may trigger rules that have associated actions (e.g., pop a help message, skip a set of pages, disable an interaction element).

Libraries provide the basic elements and pages but also complex and domain specific ones (e.g., ECG plotters). Besides the run-time components, the libraries support persistent representations through SQL databases (exclusive to desktop tools) or XML-files (all platforms).

3.2. The Manipulation Tool

This tool materializes prototypes and enables users to interact with them. Prototypes are loaded from one of the possible persistent representations (usually XML files). The tool then provides customizable navigation and interaction mechanisms (see Figure 1), through different navigation bars or other multimodalities (e.g. gesture, keypad - see [8] for details). The user is able to select and provide the data on each page using the available interaction mechanisms. The tool keeps a time-stamped log of the interaction commands and the altered data, and provides the user the ability to save a results' snapshot of the entered information. Results and logs are kept in persistent representations similar to those of the prototypes.

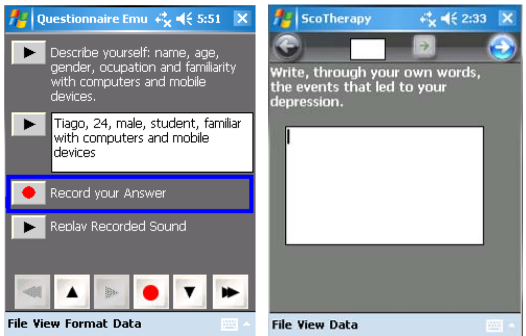

Figure 1 - MobPro: Manipulation Tool

3.3. The Builder Tool

The Prototype Builder, desktop version, provides two operation modes: a wizard-based and an advanced one. Here we briefly describe the former. A mobile device mode is also available. Figure 2 shows the wizard-based version with: an elements' Palette (left); a canvas with a Page Editor (centre); a Navigation Bar (bottom); and a Page Organizer (right).

The tool guides designers to create prototypes, page by page and organize page sequence. On each page, the designer can easily drag and drop the selected elements (e.g. labels and buttons) from the palette to the page editor. S/he can attach rules to elements or regions, which will trigger actions elsewhere (a selection of actions is available). After completion the built prototype is saved in one or both representations (for further details on the tool, see [1]).

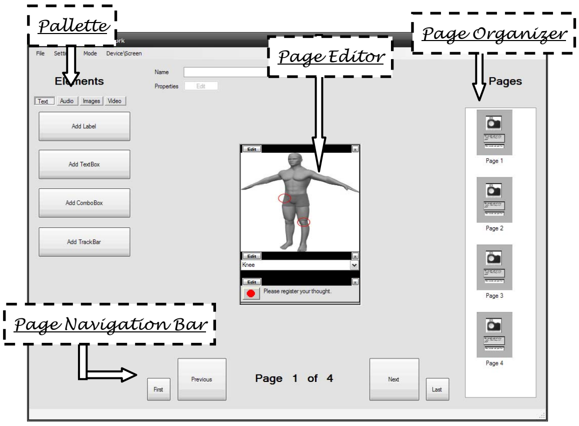

Figure 2 – MobPro: Builder Tool (wizard mode)

3.4. The Usage Analysis Tool

These tools are available for desktop and mobile platforms. Two flavors are provided: result's inspector and log player. The first is a simplified version of the Manipulation Tool and enables the analyst to browse through the results entered by the user. The second uses the information recorded in the log files and reproduces the user's interaction according to the timestamps associated with each interaction. A time-based navigation bar substitutes the structural one. The analyst is able to play, pause and stop, and to advance and recede to the time when the user changed the page. A status bar shows a timeline and the total time that the user spent when manipulating the artefact.

4. The Collaborative Analysis System

The Analysis System comprises a set of applications and a Communication Server. The latter ensures the correct flow of messages and the management of connections and groups during sessions. From the applications we will focus on CATMA (Comparative & collaborative Analysis Tool for Mobile Artefacts) and on the aspects that were relevant to integrate the collaborative design. The other tools handle authentication and planning, and a modified version of the Manipulation Tool enables its real-time monitoring within CATMA (see [5]). The system comprehends two main levels: usage analysis and collaboration.

4.1. Usage Analysis Level

CATMA (Figure 3) offers the mechanisms to annotate prototypes, interaction results and logs, analysing more than one, simultaneously. On the right, the tool provides a Query Component that permits the analyst to select the objects (prototypes with/without results or logs) from the repository. Once selected, the objects are instantiated in the Working Space, the large canvas at the middle/left of the tool, within their own Containers (the figure shows a couple of them). Each provides information about the object under analysis (at the bottom of the container), encapsulated access to the object, space-handling mechanisms (e.g. move), and local annotation management.

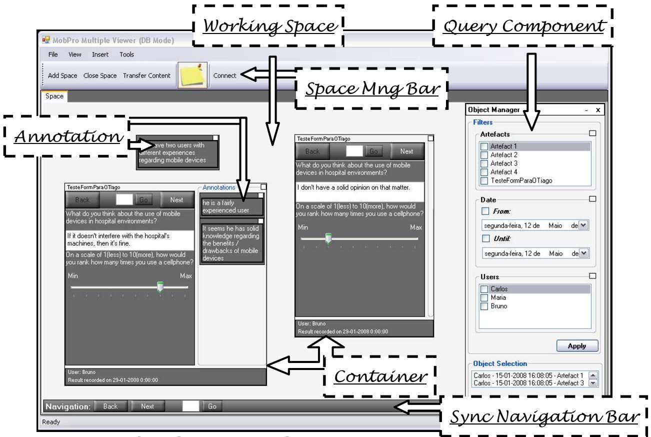

Figure 3 – CATMA: Collaborative Analysis Tool

Annotations can be global (on the working space, above the left container) or associated with a specific object or, more specifically, with a specific page/log-time (inside the left container). In this case, when the analyst moves forward to analyse the data of another page or at a latter interaction time, a new set of annotations can be added/edited. The annotation process usually starts with a global annotation. The analyst may drag it into a container if it refers to some page/time.

At the bottom of the tool, a Synchronized-Navigation bar is visible, complementing the ones inside the containers. These, at the top of each prototype instance, enable an independent navigation through each object. The synchronized-navigation bar offers a mechanism to navigate simultaneously on all the prototypes in the space. For prototypes w/o results, the analyst may use "back"/"next" to recede/advance the current page on all prototypes. When logs are under analysis, the synchronization dimension is primarily time instead of page, i.e. local navigation bar plays/stops/pauses each inspector whereas the synchronized-navigation bar plays/stops/pauses them all, simultaneously.

CATMA enables the creation of extra working spaces (space management bar in Figure 3). Primarily, extra spaces allow the organization of information, containing their own set of containers and notes and mechanisms to copy them across spaces.

At this level, CATMA offers working spaces for prototype testing, results inspection and log playback, depending on the objects under analysis. On the first, the analyst can interact with the prototype; on the last two, s/he will browse pages (results) or time (logs). A common use of this tool is the comparison of results/logs entered on the same type of prototype by the same user, on different occasions, or by different users. Both pertain to comparative analysis scenarios, though the latter aims the performance comparison among individuals, whereas the latter assesses usage evolution.

4.2. Collaboration Level

The collaboration level adds a distributed dimension to CATMA. First, a new type of space is available. The monitoring space allows the analyst to follow interactions happening in a remotely connected Manipulation Tool. Naturally, it allows analysts to annotate each monitored prototype. The synchronized-navigation bar becomes a control bar that aids the analyst to define the fulfilment pace (e.g. enable/disable page change on remotely connected manipulation tools). In this space, a component that list and enables selections of the Manipulation Tool instances connected to the same session substitutes the Query Component.

Secondly, CATMA allows the definition of sharing policies for each space: private or shared. Private spaces behave as described above. A shared space manages the replication of the annotations, containers and objects it holds through the associated spaces on other connected instances of CATMA. The protocols for the definition of the participants of a shared space or the dissemination of changes through all the related spaces are detailed elsewhere [5], and are supported by the Communication Server.

5. Integrating Collaborative Design

The collaborative-design tool derives from the integration of the MobPro Builder into CATMA. The result provides support for the whole process of design and evaluation of mobile prototypes, on a collaborative distributed strand.

The main extension to CATMA is the introduction of a design working space. This integrates adaptations of the MobPro Builder components, rearranging them into CATMA-spaces standard organization. The new space comprehends a new type of objects handled by the containers and a modified version of the Builder's palette (see Figure 4).

The new type of object, the Prototype Editor, is in fact a revamping of the Page Editor referred in 3.3. Figure 4 shows them inside the two Containers (each editing a different prototype). The main visible change is a local navigation bar, originally available at the bottom of the Builder Tool (see Figure 2), that now appears on top of the page editor. Through the bar, the prototype editor enables the browsing/loading of each page, in sequence, into page editor. As such, the navigation through pages feels similar to the navigation approach in other CATMA spaces. To edit an element the editor provides small "edit" button on the left top corner of each element. Deletion is achieved through the cross button in right top corner of each element. Both are mechanisms inherited from the original page editor of the Builder Tool.

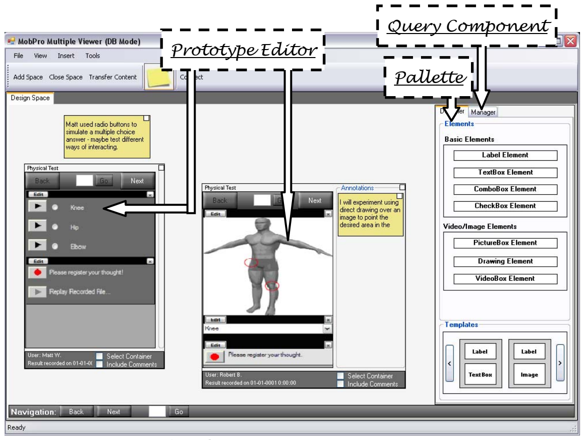

Figure 4 - Collaborative Design Tool

Figure 4 also shows the space's palette on the right. This palette offers means to select/drag the elements and page templates that will be created in the prototype editors as the user desires. Creation occurs by dropping them or selecting a creation action in the destination prototype editor. It is also visible in Figure 4, beneath the palette, the tab that holds a Query Component, similar to the one used in other spaces. This enables the loading of prototypes created in previous design sessions into the editing space.

Finally, the design space also presents a synchronized navigation bar. Again, the bar is similar to the one used in prototypes' testing and results' inspection spaces. As in those spaces, the objective is to browse the different prototypes under edition, synchronously, page by page.

An envisaged use of the design space is to build alternative prototypes, compare them and adjust them in a concertized way. For that, the abilities inherited from CATMA, namely the handling of multiple containers and the global and local annotations of the objects under work (the editors), are kept in the design space. Moreover, all the features of the collaboration level are also available. Thus, making a design space shared is straightforward for a designer: select other instances of CATMA in the same session, available on request from the top menu bar, and propose a shared design space.

5.1. Architectural Design Level

While the look and feel of the new design space does not introduce major differences from the other spaces and in specific cases from the Builder Tool, the underlying changes were much deeper. In fact, CATMA's access to the objects under work was redesigned to cope with the different types available (or others that may emerge).

Figure 5 depicts the container components. A Wrapper was introduced that abstracts the access to objects. It is responsible to:

a) Propagate the orders/changes to the object - orders, such as NextPage or UpdateContent, may come from the synchronized-navigation bar or from replicas of the object in other CATMA instances;
b) Communicate changes in the object to CATMA – these are forward to other CATMA instances, depending on the sharing policy and the participants of a shared space;
c) Manage the anchoring points (e.g. page or time stamps) for the annotations – the container will request anchoring points when it associates annotations and will be notified when the anchoring point is no longer valid (e.g. page changed or time elapsed);

The run-time creation of wrappers is the responsibility of the ObjectManager (above referred by Query Component), that is also responsible to provide any specific context to it (e.g. the Pallette in the Editors case). As such, pertaining CATMA the creation and interaction with the objects is agnostic (i.e. no knowledge about the type of object under work).

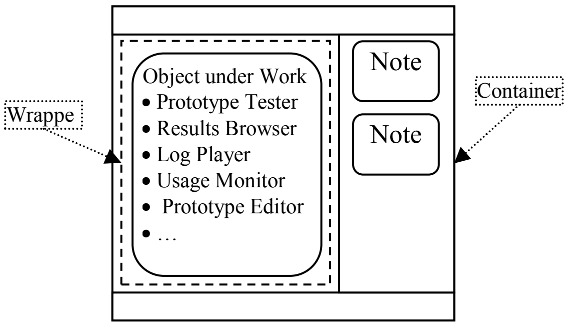

Figure 5 - Objects within CATMA spaces

The integration of objects on CATMA passes by the implementation of this protocol and the ability to have objects that communicate their changes. In the case of the prototype editor these were the major modifications, i.e. introduce in the editor the ability to generate events that convey changes on pages, elements, rules and the current loaded page.

6. Usage Example

The use of the collaborative-design tool in a collaborative design scenario is straightforward. To simplify, we present the more basic one.

- Consider two designers each with its own CATMA-design instance. Designer A creates a private design space and builds a prototype. She comments her own design using local and global annotations. Designer B does the same.
- Later they initiate a session, and decide to collaborate. Designer B creates a shared prototype testing space, inviting A, and both publish their prototypes, without annotations, in this new space. They test each other's prototype, synchronously, page-by-page, and add pros and cons notes, as they go. Designer A then decides to revamp her prototype. She creates a shared design space and rebuilds her prototype there passing the floor (access to the prototype editor) to designer B, from time-to-time. Designer B proceeds the same way with his own prototype. They jointly create a third prototype merging the other two.
- Once they reach satisfactory versions, they save the prototypes', load them in their mobile devices, and use them during a couple of days in real mobile settings.
- Later, the designers get together on a new session. They create a log player shared space, and replay the usage logs, for both users and for the three prototypes (6 logs). They account for performance and usage hesitations and comment the results.

The first design/evaluation cycle ends. A new designer is invited and the design is refined.

7. Preliminary Study

We conducted a preliminary study about the use of CATMA as a collaborative design platform. We asked four persons that have developed prototypes with MobPro to create new ones adopting a collaborative approach. Designers worked in pairs, which changed in each of three experiments. Six prototypes were attained, two in each experiment. Each pair of designers were bound to produce only one prototype in each experiment.

The level of complexity of prototypes increased in each experiment. Generally they were variations of adaptive applications used in psychotherapy. Each designer was provided with a laptop running the tool in his/her own office. All the contacts between them were through CATMA-design. Phones or other communication tools were not used.

Designers were free to use the tool for half an hour, learning how to edit prototypes and analyse results and logs. They also learnt how to create spaces, join sessions, save prototypes and load them in a PDA. During the experiments, designers were allowed to use all the features of CATMA-design they want. Each experiment started with a 10 minutes explanation about the required prototype, followed by 50 minutes of work, at most. Sessions were created, with the defined pairs for each experiment (using the session planning tool).

Generally, the creation of the prototypes included: phases of critique, where comments were used; phases of change, where elements and pages were exchanged and merged; and, for two of them, a final phase of complete rebuild. Designers used different sharing policies in different groups/experiments. Sometimes most of the editing occurred in a private design space, whereas discussion happened over a shared prototype testing space. The final prototype of each experiment/group was built on a shared design space. In the two cases where the prototypes were completely rebuilt this space was initially empty. On the other cases, one of the initial prototypes was used. Annotations were created on all spaces and all experiments. Most annotations were global.

After the experiments, designers were asked to comment on them and compare them with the previous experience they had with MobPro's Builder tool. In general, they felt that the ability to add annotations in private and particularly in shared spaces was particularly useful and very important for prototype evolution. They also referred that the ability to work in group was advantageous and that the ability to create, sometimes simultaneously, two prototypes in the same space was interesting. During collaboration, they missed, from time-to-time, a faster communication channel (e.g. speech).

They also reported some difficulties. First, the coordination of the access to the prototype editors in shared design space was felt awkward to use. The main reason was the awareness on who had the floor. Second, designers did not actually understand the behaviour of the local annotations. Initially they thought they were prototype indexed and not page indexed.

8. Conclusions & Future Work

In this paper, we presented a collaborative design tool, as part of a mobile prototyping framework. The tool was obtained from the integration of an individual prototype-building tool into a collaborative analysis system. The result provides support to the whole design/evaluation process, in a collaborative way for multiple prototypes. Designers are able to create or review more than one prototype at once, comparing their aspect and behaviour, while writing annotations regarding the decisions taken. Multiple designers, on their own tool instance, can perform design and analysis on shared working spaces. Changes and annotations are automatically replicated by the instances in a selective ordered way. Mechanisms for control of access, synchronous navigation and playback are available.

Early evaluation provided positive feedback regarding the annotation capabilities of the tool and on the possibility of simultaneously working with remote peers designing prototypes. Besides the potential acceptance, the experiment also served to understand better the policies and strategies used in an integrated and collaborative approach to the whole prototyping evaluation cycle of mobile applications' design.

In the future, we aim to deepen the above study and address the reported complains. On one hand, we will focus on new annotation mechanisms, namely direct on-screen drawing, annotation placement and organization. On the other, a stronger effort will be placed on analyzing different coordination and control-access mechanisms. Finally, we are defining tests for more complex scenarios, preferably involving multiple design teams working cooperatively in different rooms.

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