PDAs as Input Devices in Brainstorming and Creative Discussions

Lars Bollen, Guillermo Juarez, Micha Westermann, H. Ulrich Hoppe
University Duisburg-Essen, Duisburg, Germany
{bollen, juarez, hoppe}@collide.info

Abstract

In this paper we present the use of PDAs as input devices in brainstorming sessions and creative discussions using the Mobile Notes architecture and application. Mobile Notes enables heterogeneous, mobile input devices together with collaborative modelling environments to be used in different discussion scenarios, e.g. classroom discussions, seminars or lectures. Based on the conceptual perspective of assigning specific functionalities to different devices in technology enhanced learning environments, we describe the design, implementation and first experiences with Mobile Notes.

1. Introduction

The trendy notion of “mobile learning” has different connotations: On the one hand, it can be understood as “learning on the move” – often referred to as “learning any time anywhere”. Of course this interpretation relies on specific kinds of technological enabling, but the definition aims at the general setting of learning activities. Particularly, it includes informal learning settings (cf. [1]). A second interpretation sees mobile learning somewhat more pragmatically as learning with mobile devices. This may include formal learning in the classroom. Here, mobile devices may enable a one-to-one orchestration with learning devices (one device per learner, cf. [2]).

This paper is clearly based on the second view in that it explores the use of mobile devices in classrooms. The one-to-one assumption (see above) raises a couple of questions which need more exploration. Among these are the questions of ownership (who owns the personal device – the institution or the student?) and homogeneity (will one device be used throughout different subject matters?). Evidently, these questions are inter-related and the answers may depend heavily on cultural and institutional premises.

We will concentrate on the question of homogeneity. More concretely, we explore device heterogeneity even in one specific setting. This setting includes personal mobile devices (PDAs) as well as a publicly visible interactive screen connected to a PC. Similar mixed device scenarios involving tablet PCs and bigger interactive screens have been studied by Liu and Kao [3]. One of the motivations for the mixed setting given by Liu and Kao is the lack of shared visual focus with small personal devices. This lack of shared visual focus is seen as a cause of fragmented communication observed in a classroom study. The Liu and Kao study provides details about communication patterns and micro activities, such as eye contact and hand/finger pointing, leading to the conclusion that “shared displays enable group members to participate closely in shared activities and establish ideal communication patterns”.

2. Functional Assignments between Different Devices

Based on the findings of Liu and Kao, we believe that, as a next step, dedicated classroom scenarios with heterogeneous devices should be designed and orchestrated. In this context “dedicated” means an orientation towards specific types of learning activities in which different types of devices would be integrated based on different functional assignments. Evidently, the functional assignments should reflect the specific strengths and potential complementarities of the different devices. E.g., following Liu and Kao [3], public interactive displays complement the lack of shared visual focus with smaller personal devices.

In our own previous work, we have explored extending collaborative visual modelling tools to PDAs [4]. In one “light weight” version, we used PDAs to graphically annotate models without replicating the functionality (or “operational semantics”) of the modelling environment on the PDAs. The fully fledged modelling environment would run on a PC and would be shown on a big interactive display. On the PDA, an area of the visual modelling space could be selected and annotated using and hand writing and drawing. These annotations were directly transferred to the
public display. This type of interoperability could be characterised as synchronous bitmap sharing with graphical annotation. But this usage scenario also suffers from a problem of shared visual focus, due to the necessary switching between the PDA view and the public view. It is also somewhat clumsy to adjust the viewing area on the PDA.

In this paper, we focus on an application in which the function of the PDA is even more limited: It is used as an input device in asynchronous mode. The usage scenario is a brainstorming discussion in which contributions are prepared on the participants’ PDAs. When a contribution (either text based or a hand written sketch) is completed, it is sent to a database from which it can be retrieved and transferred to the public display application. This transfer can be selectively controlled by a discussion moderator. All public discussions would only refer to the public display area.

3. Technical Issues: Hardware, Operating Systems and Java

In the COLLIDE group at the University of Duisburg-Essen, we started a small scale project called “Colbedded” as a way to deploy collaborative learning applications on Linux based PDAs. This project grew and became a platform to integrate and facilitate the development of Java software for both desktop and mobile devices. It is the basis of the Mobile Notes application described later.

“Colbedded” started as a tailored operating system distribution based on OpenEmbedded for our PDAs. Later we included in the project a wider range of devices, including Windows CE based PDAs and smartphones.

A key component for the Colbedded framework is GNU Classpath. This project is an open source implementation of the Java classpath and currently features the 98% of the JDK 1.4. With GNU Classpath we can now develop and deploy full J2SE applications on mobile devices.

This is very interesting for two reasons: First, we can use a lot more complex applications on these devices, and second, we simplify future development since it is virtually the same as for desktops and requires no specific training.

Different open source virtual machines based on GNU Classpath can be found for almost every platform and operating system, but we were mainly focused on the Windows CE and Linux on ARM platforms. We decided to use Mysaifu JVM for the former and Jam VM for the latter.

All these projects are being frequently improved and actively maintained, getting better and better in every release.

These developments on a technical level made it much easier to design and implement learning environments in mobile scenarios using heterogeneous hardware.

4. Mobile Notes

Building on the conceptual background described in section 2 and on the technical background described in chapter 3, we designed and implemented an application to support classroom discussions with mobile devices and electronic whiteboards similar to what has been presented in [5] and [6].

The environment - we called it “Mobile Notes” – is based on FreeStyler [7] and Cool Modes [8][9], two applications that have been developed at the University Duisburg-Essen. These applications support interactive and collaborative modelling with heterogeneous semantics (e.g., Petri Nets and concept maps) in computer supported classroom scenarios.

Mobile Notes’ main functionality is to use PDAs to write short textual contributions, to draw sketches or to participate in a vote and submit these products to a central server in order to display and arrange them on an electronic whiteboard and to initiate further discussions and collaboration.

Mobile Notes’ main components are:

- A computer running FreeStyler with the Mobile Notes plug-in (the server).
- Mobile devices acting as input clients.
- A database as communication interface between the clients and the server.
- An interactive whiteboard used as the common output device for all the clients. This board is based on the FreeStyler application.

Figure 1 shows a typical arrangement of these components.

Following the concept of functional assignments (see above), the mobile devices is designed not to copy or emulate what is shown on the screen. Being aware of the limitations as small screens and the lack of conventional input devices as full size keyboards, our approach was to develop a custom interface that enables an easy interaction between user and system.

---

1 OpenEmbedded is a flexible linux metadistribution for embedded devices; see http://www.openembedded.org
2 GNU Classpath is a free implementation of Java’s standard libraries; see http://www.gnu.org/software/classpath
3 Mysaifu JVM is a free Java virtual machine for Windows CE; see http://www2s.biglobe.ne.jp/~dat/java/project/jvm/index_en.html
4 Jam VM is a compact Java virtual machine; see http://janvm.sourceforge.net
The mobile devices and the server are connected only through the database. This provides several advantages over a direct network connection:

- A completely asynchronous communication method, more flexible and convenient for our scenario.
- A persistent storage that can be used later to extract useful information about the behaviour of the participants.
- The technical setup is quite robust compared to peer-to-peer connection, since mobile devices still tend to lose connection in certain settings.
- The board could be implemented with different devices as long as it is clearly visible by all the participants.

4.1. Input Modes of Mobile Notes

In Mobile Notes, we support several kinds of notes. First, contributions can be “active” or “non-active”; i.e. active notes can be referred to by another note, non-active notes cannot be referred to. A note can be changed from “active” to “non-active” and vice versa by the moderator. References are represented graphically in the form of edges between contributions on the whiteboard in FreeStyler and may be parameterized with “pro”, “contra” or “question”.

Additionally, “handwritten notes” and “vote boxes” are available in Mobile Notes:

Handwritten notes are a natural input method to PDA users, since most PDAs are lacking a full keyboard but are equipped with a touch-sensitive screen. Thus, supporting handwritten contribution is extremely useful on these small-scale devices. Figure 2 shows a handwritten annotation in the PDA and its representation in FreeStyler.

Another feature of Mobile Notes is voting. Vote boxes allow a moderator or teacher to freely create votes among the participants about a specific topic. The results of a vote are collected in the database and can be displayed on the whiteboard. A vote box can be referred by another contribution if it is made “active”.

Figure 3 depicts a typical FreeStyler workspace during a Mobile Notes session; showing some of the elements mentioned above. This screenshot originates from a recent usage of Mobile Notes during the “Big Issues in Mobile Learning Workshop” in Nottingham, UK, in June 2006.

4.2. Using Mobile Notes

The basic use case in our system is the following:

The moderator of the discussion starts the system providing the required parameters.

One of the parameters is the session name, because parallel discussion could take place at the same type on different sessions. The participants hold a mobile device that will be authenticated and connected to the selected session.

After this, the actual collaborative event starts. The moderator can add a note (or a drawing or vote box) into the workspace, and these notes will be almost immediately (after having been passed through the database) seen on the mobile device of the participants.

This initial note is like the seed of the graph that will be collaboratively generated between the moderator and the participants.

Based on this information the moderator could focus the discussion towards the most interesting options.

The status of a note on the screen can be changed by the moderator at will, depending on the importance of the note at that moment of the discussion.
4.3. Moderation

Mobile Notes provides a moderation feature that allows for more control in process of discussion. This is achieved by simply having a kind of “buffer” in FreeStyler that collects incoming contributions before adding them to the public workspace. This buffer is visualised by a table in the control of the teacher / moderator; he can freely choose which contributions to put into the workspace or which contributions to discard.

Thus, the moderator is able to focus on certain parts of a discussion, he is able to reject distracting or off-topic contributions, he may enforce a temporal order of topics etc.

4.4. Selected scenarios

In this chapter, we will describe three typical, meaningful and easy to arrange use cases for the Mobile Notes architecture. One of these scenarios, the brainstorming scenario, has been qualitatively evaluated and will be discussed in more detail later.

The variety of the described scenarios shows the widespread possibilities and options that Mobile Notes provides.

Teacher presentation

In this scenario, we assume a teacher or moderator has prepared a presentation within FreeStyler and uses an electronic whiteboard. The teacher initiates a Mobile Notes session and his audience is equipped with mobile devices. Some topics of his presentation are available for referencing and can be commented, questioned or annotated by the audience during the presentation without disturbing the speaker and without distracting the audience.

After the presentation the teacher can use the comments and questions on the topics of his presentation that emerged during his talk for a smooth transition into a discussion phase.

Brainstorming

In this scenario, a moderator can open up a brainstorming session by creating an initial issue for reference. The participants can contribute their ideas without being influenced, distracted or restrained by their fellows. This important issue of brainstorming scenarios is often neglected and can be realized easily in Mobile Notes.

Test questions

In the end of a lesson, a teacher can easily pose questions using Mobile Notes’ free text input or the voting boxes to check the students’ understanding or opinion on certain topics. These results can be re-used in a later lesson to overlook general changes in understanding or opinions. Since Mobile Notes can be used in anonymous mode, students are more likely to answer these requests for opinions honestly.

5. Qualitative Evaluation

The Mobile Notes application has been qualitatively evaluated with several groups of students. After some initial test of the operational reliability and basic usability of the architecture, we conducted a small scale qualitative study in a seminar for students of Computer Science for Higher Education and students for Diploma Applied Computer Science. Nine students, one teacher / moderator and one observer participated in the study. The setup of this study is shown in Figure 3.

The first part of the study was a brainstorming session to recall the details of “binary trees”. This topic has been chosen to increase the chance of the creation of handwritten notes and drawings (since some features of binary trees can be easily described with a drawing). In a second phase, an open discussion on the interrelation of height and the number of elements was conducted.

This study was evaluated by observing the students' behaviour, evaluating the database entries and by questionnaires that were filled out by students.

The questionnaires that were filled out ranked the Mobile Notes architecture on a “System Usability Scale” [10]. The average result was 76.4/100 with the lowest and highest values being 52.5/100 and 90/100 respectively. In addition to this positive result concerning the general usability of the system, we still identified some minor difficulties in using the system in interviews with the students afterwards (e.g. low performance of one specific PDA when doing handwriting, unfavourable arrangement of certain user interface elements etc.).
It could be shown that the use of handwritten notes vs. typed text notes depends on several factors. For example, the chosen topic has an impact on the use of handwriting and sketches: Talking about e.g. binary trees increases the use of sketches, as it was anticipated. Personal preferences also had an influence on the input mode. I.e., some people are more likely to create drawings and sketches than others. Additionally, we found out that people who are familiar with PDAs tend to use the pen-based input more often than people who are not.

Another qualitative result of this study is that certain kinds of computer supported discussions are more suited to be enriched with mobile device input support than others. Brainstorming and voting worked very well in our examples, whereas a discussion with hypotheses, arguments and counter-arguments seemed to be somewhat clumsy and artificial to be conducted with the help of mobile devices.

6. Discussion

The Mobile Notes application and architecture integrates different types of devices in a specific, purposeful way. In a sense, it is a normative approach which goes beyond observing usage phenomena and preferences (as described by Liu and Kao in [3]). It is based on a specific distribution of functionality between PDAs and a public interactive display. The interoperability of components depends on loose coupling through a database. This allows for both asynchronous and quasi synchronous transfer of contributions.

However, the practical value of such scenarios will depend on more than functional distribution schemes and “local interoperability”. The embedment of local scenarios into a broader community (e.g. school) infrastructure for re-use and sharing is also necessary. On this level, it will be important to resolve the questions of device ownership and device homogeneity/heterogeneity across subject areas. This will involve institutional decisions beyond the level of this study. The exploration of mixed device scenarios is important to prepare the ground for reasonable judgements on the higher levels.

7. References