Smart Bailando

Eye controlled RSVP on handhelds

Master thesis in Computer Science

Written by:
Per Åkervall, 710510-5170, GU
Roger Granath, 671009-5693, GU

Supervisor:
Staffan Björk, Ph.D. Computer Science,
Studio Manager at Interactive Institute – PLAY.

Examiner:
David Sands, Professor,
Director of Studies at the Computing Science Department at Chalmers University of Technology and University of Gothenburg.

GÖTEBORGS UNIVERSITET

Abstract

In English

This thesis describes the implementation and evaluation of uniting gaze detection and the text presentation technique RSVP on handheld devices. RSVP is the technique of showing small amounts of text on one row and replace it with new text after a given time period. A historic review on the evolution of handheld devices is given and we speculate about their future. We also take a look at different gaze detection systems and point out their pros and cons. We then describe the prototype we developed, including the process of building it. An involved user evaluation is described and a discussion, based on the prototype and evaluation, is given. We conclude by describing the overall results and possible implications of the whole.

In Swedish

Denna uppsats beskriver implementationen och utvärderingen av sammanförandet av ögondetektion och textpresentationstekniken RSVP på handdatorer. RSVP är metoden att visa små stycken av text på en rad och byta ut den mot ny text efter en given tidsperiod. En historisk tillbakablick på handdatorernas utveckling ges och vi diskuterar lite om dess framtid. Vi tar också en titt på olika ögonstyrningssystem och påvisar för- och nackdelar med dessa. Vi beskriver sedan prototypen vi utvecklat, inklusive uppbyggnadsprocessen. Det innefattande användartestet beskrivs och en diskussion, baserat på prototypen och utvärderingen, ges. Vi avslutar med att beskriva helhetsresultatet och drar möjliga slutsatser.

Keywords

PDA, handheld, RSVP, adaptive RSVP, gaze detection system.

Preface

This Master Thesis in Computer Science at the Department of Computing Science, University of Gothenburg was a joint project between Ericsson Usability Labs, Kista, Interactive Institute – PLAY, Gothenburg, and Smart Eye AB, Gothenburg.

First of all, we would like to thank Staffan Björk at Interactive Institute – PLAY for his support and guidance, and Martin Pettersson, Smart Eye AB, Gothenburg for his help and support.

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Content

1 Introduction

For the last 20 years we have read more and more information from computer screens. This has become even more common in the last 10 years as mobile phones and personal digital assistants (PDA) have become useful tools in life to communicate and gather information. Mobile internet has made its entry and it will probably take a more active part in peoples live in the future.

During the past 5-10 years, research has been done [1, 2] and today there are several ways to improve the readability of long texts on small screens. The human is used to read on paper. In the early 1980's, research shows that you read 20-30 % faster on paper than on a large screen [1]. Later research shows that today's high resolution screens are much better and the readability is much the same as reading on paper [2]. However, most readers still prefer to read on paper.

A computer can hold many books and documents relieving the user from carrying too many things around. Usually, when using a computer it is possible to print out the text and read on paper, but this is not often possible with handheld devices. You use them in a mobile environment and you can not carry around a printer. Unfortunately, the presentation of the information in the devices is optimised for larger computer screens and not for small, handheld ones. Therefore, it has become interesting to enhance the reading of long texts on small screens to make it more pleasant and as efficient as possible.

A growing number of technology companies produce products that deliver a reading experience which is similar to a book (e.g. Cytale's CyBook, Everybook Inc's Dedicated Reader, Franklin's eBookman, and NuvoMedia's Rocket eBook, etc). Special software has also been developed for reading electronic books on computer screens and handheld computers [3]. However, such devices have not become a success. One reason might be that they forces the user to carry around yet another unit adding only a few new functions such as the ability to mark and change text with a stylus.

Computer devices has become more and more "intelligent" as some companies and universities do research on ubiquitous computing (where computational power is invisibly available where ever you are) [8] and context aware computing (where the devices adapts to the surrounding context and thereby automatically provides valuable functionality, instead of demanding the user to interact with it) [28]. One outcome of the just mentioned is eye detection technique [4, 5, 6] that together with modern text presentation might improve readability on small screens. Consider a handheld device with a downloaded book in it. Wouldn't it be nice if one could read the text from that book without having to worry about flipping pages or scrolling a current one?

1.1 The assignment

Ericsson Usability Labs has in cooperation with PLAY, Interactive Institute done research on information visualization on small screens. During year 2000, they started study Rapid Serial Visual Presentation (RSVP) technology on handhelds. The technology builds on showing many small amounts of information (text) on one row on a screen. A prototype, Bailando, has been developed and evaluated [24]. From the evaluation results, a new request to develop yet another, improved prototype arose. The primary new functionality of that prototype should be that the text is controlled by a system that can detect eye movements by the user.

In this thesis, a potential improvement of Bailando is described. The prototype controls the text presentation by starting and stopping the text flow using gaze detection facilities and is an attempt to improve usability and readability of reading long texts on mobile devices.

2 Background

Much of the development of today's PDAs comes from a project made on a technology called ubiquitous computing. This chapter briefly describes ubiquitous computing, the PDA evolution and market, as well as the difficulties in reading large amounts of text on small screens, and how different researchers has tried to solve the reading problem. Finally, context aware computing and some eye detection systems are described in a few words.

2.1 Ubiquitous computing

1988, the Computer Science Laboratory (CSL) at Xerox PARC, started to do research on a technology called ubiquitous computing (ubicomp). "Ubiquitous computing is the method of enhancing computer use by making many computers available throughout the physical environment, but making them effectively invisible to the user." [7]. In order to make such a system both distributed and invisible to the user it requires both communication and context. The system components can then share information about their status (i.e. the context in which they are operating) [8].

CSL has developed three different types of devices to play a roll in a ubiquitous environment - the ParcTab, the ParcPad, and the Liveboard. As mentioned above, much of the development of today's PDAs comes from this ubiquitous computing proj ect.

2.1.1 ParcTab

The device is a palm-sized computer (see figure 2.1) and is designed to be carried or worn at all times, much like a pager. Its size, weight, and features are intended to encourage casual computing, whenever the person feels like it. The system is intended for use in an office setting (a world of terminals, printers, hosts, devices, information, and other people) where people carry one, or a few devices, and interact with several other devices. It has no power switch. Instead, it automatically turns itself on when a user starts interacting and off when the person stops doing so. These devices leverage a simple piece of context, user location, and provide valuable services (automatic call forwarding for a phone system, automatically updated maps of user location in an office) [10].

Figure 2.1: The ParcTab mobile hardware

CSL started the development of the ParcTab 1992 and they expected to carry on through 1995. In March 1993 they released the first system for general (non-project) use. The device's operating system and hardware design have proved robustness and are still in use in new projects at Xerox PARC today [30].

2.1.2 ParcPad

The ParcPad (later called MPad) is foot-sized and can be carried around. The intended use of this device is similar to the way notebooks are used today, but not quite. It was not envisioned as a personal computer but rather as scrap paper, that can be grabbed and used easily, with many in use by a person at the same time [*7*].

2.1.3 Liveboard

The Liveboard is a large electronic display. It is not mobile and connects directly to an Ethernet. These devices are analogous to whiteboards or the home magnet-covered refrigerator or bulletin board, but with more functionality [*7*].

2.1.4 Collaboration of these devices

CSL's goal was to make these three devices to work together depending on the surrounding environment.

A ParcTab can for example be used as a pointing device. Consider the case in which a lecture is presented using a Liveboard. Each tab-user in the audience can then control its own pointer on the display by moving a finger over the ParcTab touch surface [*7*].

Another example of this powerful combination could be an employee who wants to show a set of figures to his manager. As he approaches her office, he looks at his tab telling him that the boss is alone in her office. While they are talking, the employee uses the tab to locate and printout a data file on the network server. By default the system sends his request to the closest printer and lets the user know when the job is finished. Several examples of Ubiquitous Computing are given in Mark Weiser's article "The Computer of the 21st Century" [9].

2.2 Evolution of handheld devices

Concurrently with the development of ubiquitous computing the evolution of handheld devices started.

Handheld computers are light, small computers that users can carry with them. They started out as electronic organizers similar to pocket calculators, and they have evolved into fully developed computers.

In 1989, Atari introduced the Portfolio handheld computer. Using MS-DOS, this fairly large machine only had agenda and note-taking functions, as well as some computer-like functions. In 1990, Hewlett-Packard sold a calculator, which had some agenda functions. Japanese suppliers developed electronic organizers, the Casio BOSS and the Sharp Wizard series (see figure 2.2). Their machines were small, had undersized keyboards, tiny screens, and small memories. The limitations imposed by their hardware, limited these machines to just a few functions: agenda, a contacts database of names, address, telephone numbers, an alarm, and a note taker - “They were an electronic variety of the paper-based agenda” [11].

Figure 2.2: Sharp Wizard and Casio BOSS

The year 1993 was a turning point in the evolution of the handheld market. Apple Computer released the first commercial personal digital assistant (PDA), named Newton. It pioneered with a new user interface that included handwriting recognition and intelligent user-friendly software [11]. Apple meant that this was the ultimate information source and thought it should keep one’s things in order like meetings, phone numbers, save notes and had a to-do-list. They also thought that it should be possible to send and receive messages on the PDA. The following years the sales of PDA dwindled [12].

In March 1996, Palm Inc released their first industrially manufactured PDA, the PalmPilot. It was the feature computer users had long waited for and became a success because of the functionality that Apple once thought of now was reality. The PalmPilot accounted for more than 63 percent of the handheld market in 1997, up from 51.7 in 1996, and over 1 million units were shipped in 1997 [11].

2.2.1 PDAs of today

Today there are many manufactures of PDA’s. Some of the bigger are Palm, Hewlett Packard/Compaq and Casio. In 2001, over 13 million PDAs were sold world wide. Compared to 2000, the sale increased 18%. The big battle between Palm operating system and Microsoft’s operating system, Pocket PC, lead by Palm who had 57% and Pocket PC 21%. The trend is that Pocket PC takes market shares, from 11% to 21% in one year, and Palm is loosing. The prognosis for 2002 is that sold units will be in the same level as 2001 and starts growing next year.

The average cost for a PDA slipped to $277 (2001) from $296 in year 2000. Palm based unit are not as expensive as the Pocket PC based ones [13].

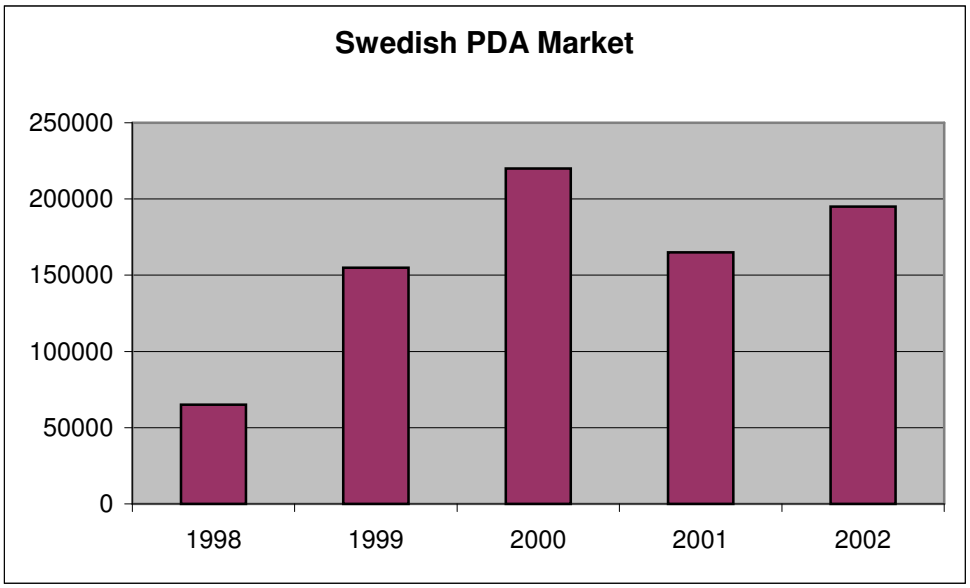

Figure 2.3: Swedish PDA market 1998 – prognosis for 2002, sold units.

The sales of PDA in Sweden have increased substantially since 1998 (see figure 2.3). The prognosis for 2002 is almost 200 000 units [12].

As mentioned, the sales of PDAs are expected to increase the coming years, much depending on better functionality such as longer use before recharging, MP3-player, etc, but also because of more memory capacity, higher CPU speed and lower prize. Another reason is that the PDAs more and more often comes with mobile phone functionality or vice versa. Either PDAs comes with a phone-application as add-on (e.g. HP Jornada 928) or cell phones are provided with the features of a PDA (e.g. SonyEricsson T68) [19]. Which constellation that will win this "war" remains to be seen. There are also examples of mp3-players with PDA functionality [20].

Today one can use a PDA for a variety of purposes. For example, service technicians and real estate managers at Väsbyhem, Sweden uses PDAs to receive missions, make time reports, order materials etc. Thanks to this, they save at least 15 minutes every day [15]. The target group seems to be people that work in the field (i.e. employees that do not have access to a desktop computer every now and then) who need to send or collect information in place. Those can be home-help services that constantly need updated information on patients they visit [16].

2.2.2 Limitations and side effects

The thought of always having a computer device with some kind of wireless connection with you surely enables the user to get or edit information at the time of its choice but still there are some negative issues.

As long as the handheld is used as a calendar and address book the memory is hardly ever a problem. However, for saving and playing music files or showing pictures with somewhat good resolution it takes quite more memory capacity. Due to that handhelds does not have an internal hard disk, all information must be stored in RAM-memory. The memory capacity normally lays between 4 Mb and 64 Mb [17]. A PDA with rechargeable batteries must be recharge after only a few hours of use (for most people, that is about twice a week), for those with single-use batteries, you have to change them every month or two [18]. Palm's consumes les s battery than, for example, Pocket PC.

Another negative issue is the fact that is quite hard to read long texts on small screens due to the limited screen space. Today's interfaces resemble the ones that can be found on desktops. They are not adapted for reading long texts on small screens. The consequence of this is decreased readability due to frequent page turning, improper margins, inappropriate line widths and awkward justification [24].

2.2.3 Future

Technical magazines of today contain a lot of articles that deals with PDAs and mobile phones. The hardware is getting better and therefore improved software can be added. Nowadays, the PDA development evolves as fast as the desktop computers and it looks like handheld devices such as PDAs, cell phones, and MP3-players will become one unit.

2.2.4 More information

For more detailed information about PDA, see Appendix D which contains information about different models, operating systems, memory, weight and more. We have also taken part of some test results and judgements that we give a review from. We want to point out that the tests and judgements not are done in a scientific way but we think that they have a value.

2.3 Readability on small screens

During the past 5-10 years there has been a lot of research to make the readability on small screens better. Today, there are several methods that have brought improvement to this area, but there are mainly two different ways to present a text on a small screen, s*tatic* and *dynamic*. The major difference between them is that the static way requires physical interaction by the user, and in the dynamic way this part is minimised.

2.3.1 Static – normal text reading

Today the most common way to read on small screens is just to read. After reading all lines displayed, you click on the screen a couple of times and new lines show up and you can continue to read. It is an easy way to read - you do not miss any text and you control the displaying by hand. There are some big disadvantages with this. First, it is quite inefficient - it takes long time to read large amounts of text on a computer screen compared to reading on a paper. Secondly, the limited screen size causes problems in improper margins and line widths [14].

2.3.2 Dynamic – Leading text presentation

When reading with leading text presentation, the text automatically moves from right to left on the screen, on one single row. Evaluation of this technique shows that it is more efficient to read this way than in a traditional way. Using leading text presentation the physical interaction with the device is reduced and the reading speed could be held at a high level, almost like reading on paper. A big disadvantage with this method is that you miss a lot of information as the text presentation moves on even if you look away [21].

2.3.3 Dynamic - RSVP

RSVP stands for Rapid Serial Visual Presentation and is the technique of continuously showing fragments of a text from a text file on a small area. RSVP differs from leading text presentation because RSVP shows a chunk of information on one row and after a while the whole chunk is changed to a new one. The physical interaction from the user is reduced since the changes are done automatically. Several evaluations have been done on the reading efficiency using RSVP technique. One conclusion is that reading with RSVP does not differ from reading on paper [22, 23]. As with leading text presentation you miss a lot of information if you look away from the screen. RSVP has two siblings - Adaptive and Sonified.

2.3.3.1 Adaptive RSVP

By calculating the appearance time of different text segments Adaptive RSVP is an improvement of the RSVP technique. When displaying a text the system tries to display as many word as possible on one row. The text is displayed for a specific time which is calculated for each row [24]. By taking the number of words and characters, sentence- and paragraph ends etc. into consideration, the flow of the text more accurately matches the way the human read – as it takes more time to read longer words and as it's normal to temporary halt at the mentioned ends.

2.3.3.2 Sonified RSVP

RSVP comes in yet another flavour. By adding tags to the text RSVP can play sounds while the user is reading, just like there is music in movies to get a richer experience. For example, if the text says “The autumn breath was cold and hard” the application gives a sound of a cold, hard wind at the time of reading [24].

2.4 Browsers for handhelds

Even if internet is a great source of information, PDAs does not provide an easy-to-read interface due to the limited screen size. Below a description of four browsers developed for handhelds is described. Only the last one presents the text in a dynamic way.

2.4.1 Static - Power Browser

Using a PDA to get information from the web it can be difficult to show a web page on its small screen. Power Browser is a web browser developed for handheld devices (see figure 2.4 and 2.5) and is designed to enhance access time. When you download a web page to your PDA the web page is broken into smaller text units that can be displayed, either hidden or summarised. When using the summarised function, the user can click on keywords or single-sentence summaries to unfold the hidden information.

Figure 2.4: Site Search

Figure 2.5: Full Text View

It has been shown that this technique enhanced the access time very much [25] but, it has not solved the problem of reading long text on small screens.

2.4.2 Static - WAP Browser

Wap Browser is the most common commercial browser for small screens. This browser uses the WML-language, wireless mark-up language, similar to the HTML used on desktop browsers. Also this browser is designed to enhance access time. When using WML, a web page is structured as a collection of cards which the user can navigate

among. This technique is today used on cellular phones [26] but even so, it has not made it convenient to read long texts on small screens.

2.4.3 Static - West Browser

Another similar way of showing web pages on small screens is used by the West Browser, developed for PDAs. Also this browser divides a web page into several cards that are displayed on the screen at the same time and is designed to enhance access time. The card that has the focus has a larger size than the others. The user can select different ways in how the card can be presented on the screen [27]. Neither West Browser has solved the problem of reading long texts on small screens.

2.4.4 Dynamic - RSVP Browser

In an effort to improve reading and accessing web pages, a browser named RSVP Browser has been developed. This browser uses RSVP technique to present different links/cards during web navigation. For example, when searching the web, the results, all related links, are presented in a RSVP manner. When you find something that looks interesting, you just click on that link and so on. You can also stop the RSVP presentation, go back some steps, and click on another link/card [26]. With this technique, you do not have to scroll among the cards - they are presented automatically. A disadvantage is that the user might miss important information as she looks away.

2.5 Bailando

Bailando is an application that uses adaptive RSVP technique to present text and has been developed and evaluated by Öquist [14]. The intended use is for reading books and long texts. It runs on Pocket PC based PDAs and since a lot of screen space was available all the application controls were implemented in the GUI. This also makes the Bailando software easier to run on other PDAs since button assignments differ between devices. The GUI contains controls to start, pause and to resume text presentation [24].

2.6 Context aware computing

One field in computing science is context aware computing. Context aware computing is when the computer reacts or adapts its behaviour (to better help the user) after input from the environment, in addition to from the user [28]. For this issue there could be several solutions that refer to context aware computing. One is cameras that focus on the object that the user is looking at instead of specific focus areas, e.g. Canon EOS 5. Another is an alert system in a car that sounds the alarm if the driver falls asleep while driving [4].

2.6.1 Gaze detection systems

Smart Eye has developed a system that can detect the point of gaze and head position using standard cameras connected to a normal PC (www.smarteye.se). Another company is LC Technologies that, just as Smart Eye, have a system that generates coordinates indicating where the user's eyes are looking on the screen. With these values, applications can be controlled (www.eyegaze.com). EyeTech Digital System has a different system where the eye movements control the cursor (www.eyetechds.com). A more sophisticated eye controlled system is manufactured by H.K. EyeCan, who has developed a system called VisionKey. The target group for this application is people with severe physical disabilities. With this application, the user can manage writing letters, play games, surf and listen to multimedia by controlling the system with the user's eyes (www.visionkey.ca).

Today's eye detection system can replace the cursor function and work as a sensor. The problem is that the systems of today are not stable unless the user is sitting still. Often a PDA is used in a mobile environment causing frequent vibrations and waggling by the hand. If an eye detection system could work in a stable way, it could become context aware and possibly improve the usability of PDAs.

3 Problem

Ericsson Usability Labs has in cooperation with Interactive Institute - PLAY done research on information visualization on small screens. During year 2000, they started studying Rapid Serial Visual Presentation (RSVP) technology on handhelds. The technology builds on showing many small amounts of information (text) on one row on a screen. A prototype, Bailando, has been developed and evaluated [14]. From the results, the evaluation gave a new request to develop a new, improved prototype. The primary new functionality of the prototype should be that the action of the text would be controlled by a system that can detect eye movements by the user.

Smart Eye is an IT-company located in Gothenburg, Sweden who has developed a software system that can follow body-, head- and eye-movements with aid of a desktop computer, equipped with video cameras (including so called web cameras). The result of the fast growing PDA market, with constantly more powerful units and extra equipments, such as cameras, Smart Eye is interested in examining the possibilities of porting their system to a PDA.

Based on the above, Ericsson Usability Labs and Interactive Institute - PLAY, with support from Smart Eye, believe that adding gaze detection functionality to RSVP is one feasible route to make reading on small devices as convenient as ordinary screen or paper reading.

3.1 The problem

As a first step toward an enhanced RSVP application we where asked to write this Master Thesis based on two issues;

- Evaluate the possibilities to port the Smart Eye System to different handheld computers with consideration to technical performance. Primarily investigate which performance criteria that are needed and examine the commercial handheld computer market.

- Port the platform to a handheld computer environment. This includes familiarizing in the differences between PC platforms and platforms for handheld devices (in the first place Pocket PC) and programming in order to get round compatibility problems. In case the available hardware lack performance the task change-over to creating a bridge enabling communication (and by that control) between the application (Bailando) on the handheld device and Smart Eye running on a desktop computer.

3.2 Difficulties

As mentioned above the porting can be the hardest problem. Even if choosing a developing environment similar to the one used to build Bailando and/or Smart Eye there could still be a lot of problems. The operating system on a handheld device are slimed and thereby not giving full support to the functions/methods as well as not containing the classes and types that might have been used in the native code of Bailando and/or Smart Eye. The processor speed and memory capacity of the handheld devices might make the efforts in vain. That Bailando works on a handheld device is a fact, but how about the Smart Eye System? In the future it should fit inside an embedded hardware according to Martin Krantz, vice president at Smart Eye AB. However, current processors for handheld devices do not have the same capacity as the ones in desktop computers so it's not for sure that both Bailando and Smart Eye can run at the same time. If faced with the fact that it doesn't work, a new problem will be confronted. Handheld devices are supposed to be used freely so the new prototype needs to work as client/server application. The response time must be held at a real-time level in order not to make Smart Bailando feel sluggish. Assumptions were made that the users expect the text to stop that instant the user looks away from it and start rolling again at the split second the user's gaze return.

3.3 Questions

1. How common is it that handheld devices have a built-in camera or as an add-on module?
2. Is the performance of today's handheld computers enough to cope with Smart Bailando or is a client/server implementation needed?
3. How precise are the values from the Smart Eye System?
4. If the values are not good enough is it possible to make them more precise?
5. Is it achievable to control start/stop of the text, presented by Bailando, on a PDA with Smart Eye technology?
6. If getting good values (one way or another) is it feasible to control/set the speed by looking at the controls for speed adjustment?
7. Can readability and/or usability increase by adding eye control to Bailando?
8. Can the text start at a lower pace (wpm) and accelerate to the pace before being stopped?

3.4 Excepted results

The excepted results can be summarized according to the following:

- A modified prototype of Bailando that can be controlled by means of eye detection.

- A documentation of the modified prototype such that it can be developed for research.
- A porting of Smart Eye's software platform to a handheld computer. In the case that the platform not can be run on a handheld computer (e.g. by means of proven bad performance) a "bridge" will be built such that Bailando can be tested towards the software platform on a stationary computer.
- A documentation of the changes between the now existing software platform and the new one.

3.5 Limitations

Due to that RSVP has undergone an intense evaluation no interest exists in evaluating it further. We just want to evaluate the functionality of Smart Eye technology together with Bailando (i.e. Smart Bailando) to see if it can add readability and/or usability when reading large mounts of text on a small screen.

The user test will not have the rigorous, scientific approach as Bailando went through. We only want to test if these technologies are compatible and if the users feel comfortable with them.

4 Method

In order to improve readability on Bailando, and develop Smart Bailando, some strategically decisions had to be made,

- Which platform
- Development method
- Evaluation method

Before taking any decisions some literature studies were made, in order to gather information to base our decisions on.

4.1 Literature study

In order to increase our knowledge about closely related issues like Bailando, the Smart Eye system and PDAs all sources of information were consulted – the web, articles, papers, help-documentation, etc.

4.2 Platform

As both Bailando and the Smart Eye System are written in C++, the selection of programming language was easy. Assumptions were made that the porting would be less troublesome by choosing C++.

Several issues spoke in favour of developing for Windows environment. First, the main target was handhelds running Pocket PC (i.e. Windows CE 3.0). Second, both Bailando and the Smart Eye system only runs on Windows based operating system. By choosing Palm OS, compatibility problems would surely be encountered.

Among the PDAs running Pocket PC, we tried to find the ones that have the most powerful CPU. At the end, a Pocket PC based Compaq iPAQ 3630 was chosen. The iPAQ had the most powerful CPU (206 MHz) available on the market.

4.3 Developing method

There are different developing techniques to choose among when creating a prototype. Prototyping resolve uncertainty about how well a design suites a user's needs and helps in making decision about,

- The necessary functionality of the system
- Operation sequences

- User support needs
- Required representations
- Look and feel of the interface

In prototyping there are some different ways to work, Rapid, Incremental and Evolutionary [29, 31].

4.3.1 Rapid prototyping

Rapid prototyping is used when the designer wants to collect information on requirements and test the adequacy of possible designs [29, 31]. It's also used to get quick response of some different design possibilities in order to reject the disliked ones.

In rapid prototyping simple tools are used without typing any code. Rapid prototyping can result in drawings on paper, detailed screen shots connected to a storyboard, or an interactive solution that simulates the properties of the user-interface. Which level that is suitable depends on which stage a project resides in for the moment. The result is quickly available, which makes it possible to develop several prototypes with different degree of details during the development process.

4.3.2 Incremental prototyping

In incremental prototyping a shell, with the essential parts, is delivered very fast and then one section at time is added to the system (brick-by-brick) [29, 31]. This allows requirements to be tested by the users at an early stage. Changes can therefore be done according to views of the users while developing the system.

4.3.3 Evolutionary prototyping

This is a compromise between real software development and prototyping [29, 31]. The initial prototype is constructed, evaluated and evolved continually. The main problem with this method is that the designers try to fix the problem with their prototype, forgetting to test other possibilities.

4.3.4 Our developing method

Our choice of method, developing Smart Bailando, was evolutionary prototyping, this because we wanted to move forward in small steps. We were not sure of what problems we could get stuck on during the development. After each progress we wanted to do some evaluation before moving on, but most of the technical evaluation not could be done by users, due to the time limit, so these things we had to test by ourselves, with help from

our supervisor and developers from Smart Eye. Finally, the improved prototype, Smart Bailando, will be evaluated by some potential users.

4.4 Evaluation methods

As with every developing project, evaluation is an important thing to do. If you do not evaluate, how can you convince any one, except yourself, that the product is good?

There are several methods to evaluate something; observations, interviews, surveys, verbal protocol, group discussion or a combination of these. The test persons should be chosen randomly and maybe also fulfil some criteria, depending on the subject to evaluate [29, 31].

4.4.1 Observation

Observation is one evaluation method where the user is observed as she uses the product [29, 31]. The observation can be done in several ways, by video filming, direct observation, record an audio tape or if for example testing an application making a log file.

An advantage with observation is that the test person acts in real life using the prototype. If not using direct observation, it is possible to go back and look or listen to the test afterwards and also observe how the test persons acted at a particular moment, over and over again.

Disadvantages with observations are that they take a lot of time – there is no possibility's letting too many persons do the test. Often the persons are aware of that they are observed and do not act normally. There can also be too much data, which can be hard to analyse.

4.4.2 Interviews

Another way of evaluating a product is to do interviews [29, 31]. There are different ways of interviewing people. Either have a set of questions or only have some set of topics to ask about.

By using interviews it is surer that the user understands the questions and thereby gives good quality answers. Some resulting questions can also be asked.

The disadvantages with interviews are that it can be hard to analyse the material. It also takes a lot of time and it may not be possible to interview that many people.

4.4.3 Surveys and questionnaires

When evaluating something by a survey the users fill in some questionnaire [29, 31]. The questionnaire has a set of question, often with some range.

With a survey, a lot of people can be reached and it's possible to make statements supported by statistics. The results can also be compared with other similar surveys.

By using a questionnaire it's not sure that the user understands the meaning of the questions.

4.4.4 Verbal protocols

Verbal protocols are when the test persons speak during or after the test [29, 31]. There are three different protocol to use, normal, think aloud and post-event protocol. The normal verbal protocol is when the test supervisor asks questions during the test and the test person answers them. Think aloud is when the test person is asked to think aloud during the test. The post-event protocol is when the users is viewing videos over their actions and are asked to comment them. Comments that are said by the test person is recorded on an audio tape or written down by the test supervisor.

The advantage with this evaluation method is that the users give information on how they experience the system while using it.

A disadvantage with think aloud protocol is that it works for some minutes. Often the test persons are so concentrated on solving a problem or testing the product that they forget to think out loud. Moreover, it's time-consuming and it can be hard to analyse. Therefore, the test can not be done on many persons.

4.4.5 Group discussion

A group discussion, also called focus group, is when several users sit in a group and discuss the test/product [29, 31]. The group should be well balanced with respect to the potential users. The discussion can be lead by the test supervisor.

In an evaluation like this can give a lot of valuable feedback on changes and desirable improvements. The group members can encourage each other to think in different ways. Group discussion can be used in a product's development phase.

Disadvantages with this kind of evaluation are that people can say that they want some functionality which they later on not necessarily would use. This is not a controlled environment and can be hard to evaluate.

4.4.6 Our Evaluation method

As mentioned above there are several ways in doing a user test. In our case it was impossible to do observations due to the technical difficulties. Furthermore, the time limit did not admit any time-demanding user-tests. We talked about having group discussions, but we also rejected that method due to that our evaluation is quite small and there should not be enough to talk about in the group. Some other, more practical hindrance was to gather the test persons at one occasion. After that the test persons have used the prototypes we chose to use a questionnaire with some questions having answers in a range and some open questions.

We wanted these questions to be answered when testing Smart Bailando compared to Bailando,

- Does Smart Bailando add usability and/or readability to Bailando?
- How does it feel to read a text using Smart Bailando compared to Bailando?
- What could make the technique better?
- In which situations could Smart Bailando be better/worse than normal reading?
- Some free words about the systems.

4.5 Description of the user test

The test, held at our office, should be done by at least 10 people. As a reward for their participation the test persons were offered coffee/tea and a baguette.

4.5.1 How will the tests be carried out?

The test included three different texts taken from the author Carl Fredrik Sandelin books, this because the different texts should be written in the same manner. In Appendix E the different texts used in this test will be found (called A, B, and C). Text A was read by all test subjects as practice before they started testing Bailando and Smart Bailando.

In order not to let any prototype or text come in favour of the other, the participants had to draw a lot for which order the prototypes and texts should be tested. After reading a text using one prototype the test person had to read the other text, using the other prototype. There are four ways to carry out the test.

- Start read text B with Bailando and then text C with Smart Bailando.
- Start read text C with Bailando and then text B with Smart Bailando.
- Start read text B with Smart Bailando and then text C with Bailando.
- Start read text C with Smart Bailando and then text B with Bailando.

First of all, the subjects were given general information about the test, see Appendix E. As to exercise reading text presented in a RSVP manner they all had to read a text on an emulator. During the exercise the test persons were encouraged to adjust the speed and to read the text as many times as it took to make them feel comfortable reading in a RSVP manner.

When the subjects had come this far it was time for the real test. After reading the first text, the subject had to fill in a questionnaire and then proceed with the next test.

During the tests unforeseen things happened that were staged by the test supervisor - this to resemble a mobile environment and to make the test person look away from the screen, and then continue reading.

4.5.1.1 Test persons

The test persons were selected by the same criteria as in the Bailando evaluation test in order to give the results more substance. The criteria were:

- Number of participants: About 10 persons.
- Age: At least 20 years
- Selection: Sending a mail to all people working at or studying at the institute of Computer Science at University of Gothenburg.
- Sex: Mixed.
- Mother tongue language: Swedish.
- Other requirements: Read at least one book a month.

4.5.2 Choice of questions

The main goal with the questionnaire was to get knowledge about if the subjects thought it was better to read using Smart Bailando than with Bailando. We also wanted to know how they experienced the reading, naming the pros and cons for each technique. In order not to expose these questions too much, some questions about the text content and a free comment section were added.

4.5.3 Pre-test

One of the subjects was made pre-test person, this to give feedback on if the test was well composed, could be improved, and to find difficulties that not were foreseen. On the overall the pre-test person thought that it was exciting and worked well.

5 Result

Here we present how the porting process, testing the precision of the Smart Eye system, development of Smart Bailando and evaluation of the same. In the next chapter, Discussion, causes behind the results and some suggestions of future work is discussed. Problems that arose are given in Appendix C 3.

5.1 Porting

The Smart Eye Company did not want to make the source code of the Smart Eye system public. Therefore, they had to try to port their system to a PDA themselves. They concluded that it would not work and brought forward several reasons:

- Compatibility reason
- CPU speed
- Limited resources

The compatibility reason depended on that their product was developed for desktop operating system. The operating system on a PDA, Windows CE 3.0, is much smaller and does not support all functionality that a desktop operating system does (e.g. Windows CE does not support exceptions).

The power of the CPU was also a problem. In order to run their system on a desktop and to have 30 frames per minute, they suggested a CPU-speed of 1 GHz. The most powerful PDA had a 206 MHz ARM processor. Furthermore, a Pentium processor does a lot of more work each cycle than an ARM processor does. Unfortunately, PDAs are not built for Pentium processors.

Finally, the Smart Eye Company is small and could not, for the moment, allocate resources to port their system and analyse what calls to change. They suggested a client/server implementation, in which the Smart Eye system is a desktop-server.

5.1.1 Client/Server

By running the Smart Eye system on a desktop, Smart Bailando could receive information on the socket that the Smart Eye system sends them to. A new thread was added to the Bailando code that established a connection to the socket and read information from that. In figure 5.3 you can see an outline of the system.

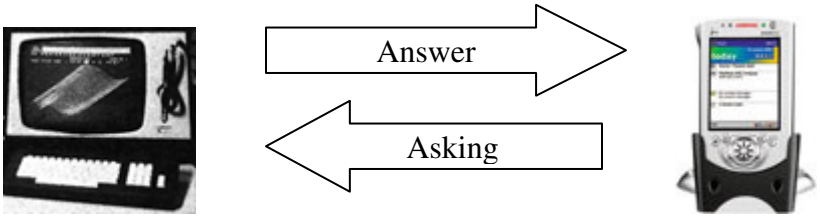

Figure 5.3: Smart Bailando running on the PDA ask the Smart Eye system, running on a desktop, for x- and y-values.

5.2 Precision of Smart Eye system

The Smart Eye system produces packages with some x-, y-, and q-values. The x- and y-values make together a virtual coordinate that indicates where the user is looking. The q-value is a quality-marker for the x- and y-values. (For example, if the Smart Eye system does not recognize all parts of the face the q-value becomes, like the certainty of the x and y, less.)

The coordinates are used to create a virtual area, a hot area, resembling the screen of the PDA. By defining a hot area the system could then decide if the user is looking outside or inside this hot area.

When testing the precision of the Smart Eye system, Smart Bailando wrote x-, y- and q-values to a log file, while the user looked, for five seconds, at each corner of the screen. During the different tests package rate of the Smart Eye system, and head-, body- and camera-position were changed.

At the beginning of these tests, most of the coordinates were in a small range for each corner, but some values differed a lot. These values were either caused by the saccadic eye movements (quick conjugate movements that bring a new target to fixation) or had a bad q-value.

These extreme values could create an improper hot area that was bigger or smaller than it should be. This could cause problems if the system thought that the user looked inside the hot area, when she actually looked outside. Therefore, the bad values were filtered out and an average was computed on the good ones. By computing such an average the effect of the saccadic eye movement could be mitigated.

After each test a hot area was painted in a coordinate system; this to get a clue of how the hot area looked like, a rectangle or something else. After finished testing, the different hot areas showed a similarity, but the size differed a lot, see figure 5.2.

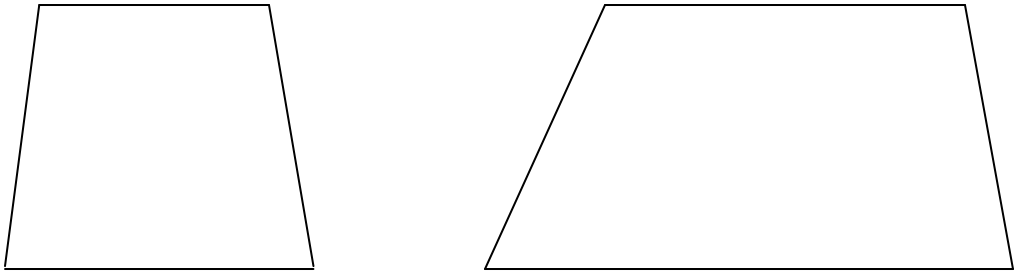

Figure 5.2: The rhombs shows how the virtual hot area could look like

Conclusions drawn from test of the Smart Eye system,

- When the Smart Eye system runs in 30 Hz it gave more accurate values than running in 10 Hz.
- The closer the head was to the camera the wider the virtual hot area got, and vice versa.
- If using different positions in front of the screen the Smart Eye system gives different x- and y-values for the same corner.
- The Smart Eye system gave different x- and y-values if moving the head but still looking at the same place.
- Calibration has to be done, each time, before a user should read a text.

5.3 Calibration

In order to accomplish automatic stop/start functionality the system had to know when the user looked at the screen and when she didn't. A calibration sequence was added where the user was asked to look at the four corners of the screen. During this calibration phase the system updates some variables that hold the extreme value for each corner. By only keeping the extreme values, the virtual screen got bigger than it actually should be (see figure 5.3). To map the real screen accurately the right and left boundaries had to be calculated, which was excluded as it was considered not to affect the overall performance. These extreme values define the "hot area".

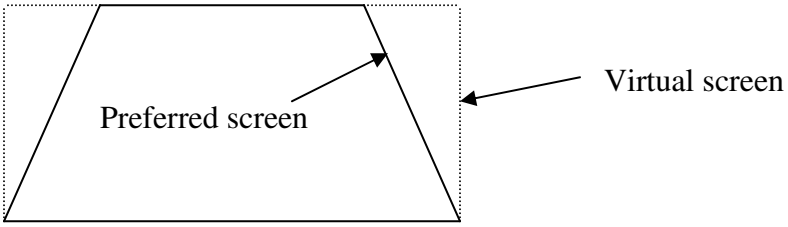

Figure 5.3: The virtual screen is larger than it preferably should be

5.3.1 Trash values on the socket

When developers from the Smart Eye Company tested our calibration they did not get a proper hot area. The coordinates given from the calibration process created a virtual triangle and not a rectangle/rhomb. The conclusion was, that when a person calibrates and does not proceed as fast as an experienced person do, a queue builds on the socket, causing Smart Bailando to read old values, referring to previous corners.

To solve this problem, two threads were added. First a "dumper" thread, that continuously read packages from the socket and updates some global variables every time it has read a package. Secondly, a "worker" thread that read the global values and takes care of the calibration (see figure 5.4).

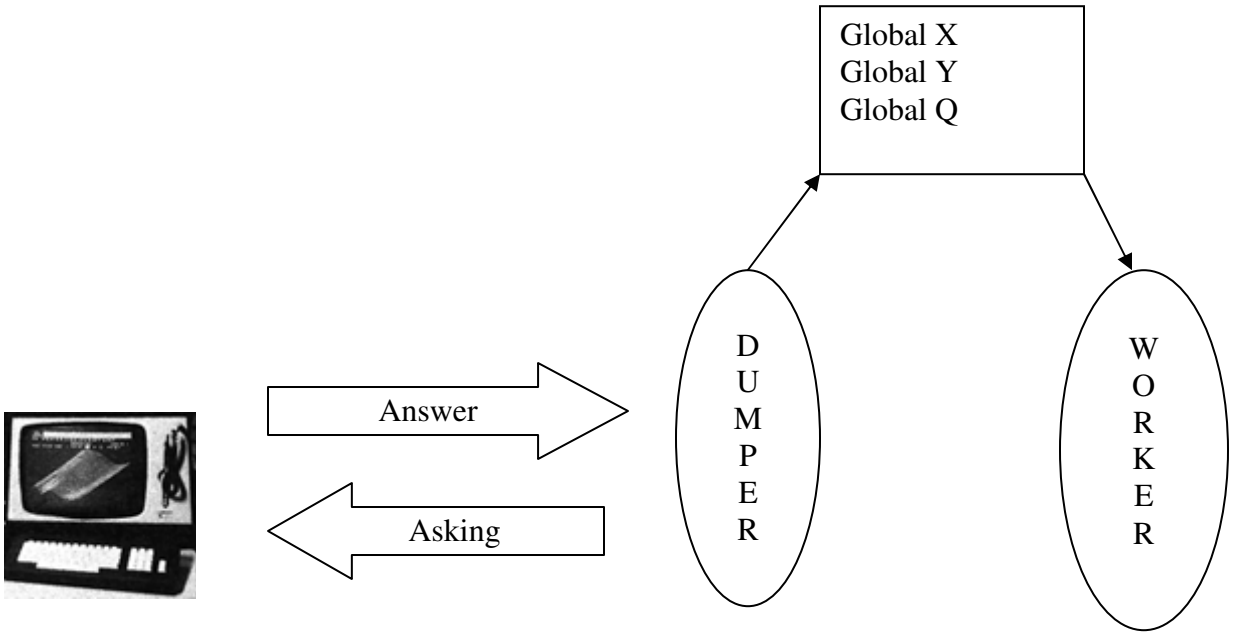

Figure 5.4: Shows how one thread, Dumper, is reading from the socket and then updating some global values. The other thread, Worker, is reading the global values during the calibration.

5.3.2 Concurrency problem

The solution, shown in figure 5.4, contained a concurrency problem. By setting the client side to work in non-blocking mode, the worker most often read old values, as the operating system controlled the CPU time. This disabled the Dumper to trash all the old packages, before the Worker had a go. Neither the Worker was forced to sleep as soon as it had read the global coordinates. When the Worker then should calculate an average value from a number of packages, they all came from the same package.

To solve this problem the Dumper was made to read from the socket until there was no package left to read, and then go to sleep, letting the Worker collect the latest one. After the Worker has read one package it gives back control of the CPU to the Dumper again.

Time	*Dumper*	*Worker*
1	Read package	
2	Update global variables	
3	Sleep	
4		Read global variables
5		Compute average
6		Sleep
7	Read package	
8	Update global variables	
9	Sleep	

Table 5.1: Shows how the calibration phase works. Each thread sleeps the same amount of time and only works one cycle.

The sleeping time has to be adjusted according to the speed at which the Smart Eye system delivers new packages. For example, if the Smart Eye system delivers 20 packages each second the threads sleeps for 50 milliseconds;

$$1 \text{ sec} = 1000 \text{ ms} = 50 \text{ ms} \times 20$$

When evaluating this, by making a log file, it showed that in the worst case the Dumper could read two packages, after the calibration was done, before the Worker got CPU time. The same goes for the Worker, who could use the same global variables at most two times, before the Dumper started to work again. The structure was kept as shown in figure 5.4 with these important changes, to overcome the concurrency problem.

5.4 Control Smart Bailando

To handle start and stop of Smart Bailando the Worker thread read the global x-, y- and q-values to se if the coordinate is inside or outside the hot area. Depending on the state, in which the text presentation is, the Worker sends either a start- or a stop-message to the event handler.

When the user looks at the screen, after she looked away, the text presentation starts displaying text in a slower pace, and automatically increases up to the selected speed. This is handled by another thread, SpeedIncreaser, which is started by the Worker.

A description of the whole system is given in Appendix B, figure B.1.

5.4.1 Help indicators

During the development of the Smart Bailando system, suggestions arose of creating some indicators that tells the user if she looks outside the hot area and in which direction. This in order to help the user as it is difficult to know where the system thinks the user is looking and because it is sensible for movements. Below, a description of the different approaches is described.

A dot-indicator was implemented to indicate the point of gaze. This function was removed because it took to much attention away from the reading as the dot was flipping around.

Instead, when the Worker thread recognized that a user looked outside the hot area, it activates the displaying of an arrow. The arrow shown indicates which boundary the eyes crossed. When an arrow is shown the text presentation stops.

A last helping indicator was implemented that showed if the Smart Eye system could not find the face. A text ‘lost contact” is then displayed and the text presentation is stopped.

In the user documentation in Appendix A there are more to read about how the user should act when an indicator is displayed.

5.6 Test result

In the evaluation of Bailando versus Smart Bailando, 11 test persons participated; 4 female and 7 male, all between 20 and 32 years of age. All of them were students at the Institute of Computer Science at Gothenburg University. Their mother tongue was Swedish and they read at least one book each month. Before the test started, all of them practiced reading in RSVP manner for a couple of minutes and they were encouraged to change the speed according to their preferences.

5.6.1 Bailando versus Smart Bailando

5.6.1.1 Reading comprehension

The participants read some text using Bailando and Smart Bailando. After each test they were asked three questions about the content. As shown in table 5.2, the test persons had difficulties in remembering what they had read. The columns show how many right answers each subject gave. The person with the highest score red really slow (100 wpm).

Participant	Bailando	Smart Bailando
1	1	0
2	0	0
3	0	0
4	2	0
5	0	1
6	2	0
7	2	2
8	1	0
9	1	2
10	0	0
11	0	0
Average	**0.82**	**0.46**

Table 5.2 Number of right answers on the text using the two prototypes.

5.6.1.2 Reading experience

The test persons were asked to mark an overall score, relating how it was to read using Bailando and Smart Bailando, on a one-to-five scale (1 = bad, 5 = great). As shown in figure 5.5 they did not experience reading with Bailando or Smart Bailando very good.

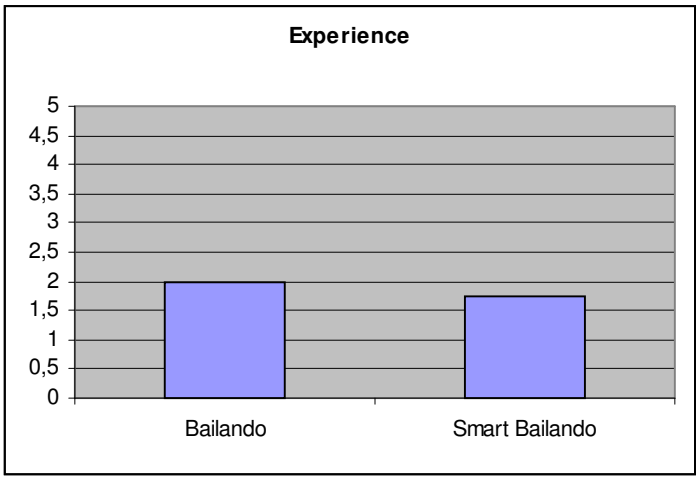

Figure 5.5 Reading experience for Bailando and Smart Bailando

When the eleven subjects were asked to mention something good about Bailando four of them could not find any, one thought it was fast, three mentioned that they were freed from page flipping, one pointed out that it only takes a small screen to show the text, one liked the fact that the prototype only shows a small amount of the text and thereby keeps track of where the user are in the text, one mentioned the speed setting feature, and one (who had tested Smart Bailando first) said that it was nice not to be interrupted (probably by the arrows) and that he could decide when to stop the text.

On the same question for Smart Bailando four of the subjects could not find any good about Smart Bailando, four liked the automatic start/stop functionality, one appreciated the reduction of speed after looking away, and one pointed out the liberation of page flipping, that she did not have to search for the next line to read, and the fact that only a small amount of text is displayed.

The test subjects found several bad things with Bailando. Most frequent were the fact that it was hard to get consistency in reading. Several reasons were stated like not being able to see a whole sentence; the user did not know when to take a break; too short text segments; hard to remember the text; straining; hard to read when difficult words shows up; and hard to understand the content. The speed setting also caused a problem as the user tried to adjust it while the text was rolling. The user then "missed a lot of text before the speed was set". Finding a comfortable speed was considered hard by one user. Several subjects wanted to go back in the text. The reasons mentioned were: forgot to stop Bailando; "Stressing, could not go back because the text rolled all the time"; and "short sentence disappear to quick".

Smart Bailando was mostly disliked for its disturbing arrows and the limited freedom of movement. The arrows caused the user to miss text as they took too much attention. The freedom of movement got many negative comments: "Could not move around despite the camera thought that I was not there"; "Difficult to find the right position after having looked away"; "Straining, sensitive for movements"; "The text stopped despite I was looking at the text. Limited freedom of movement"; "The concentration is spent to keep

the head in right position"; and "Stressing, bad eye detection system. Too sensitive, can not move." The inability to rewind the text some sentences was considered bad. As Smart Bailando is based on Bailando the same comments were made on the one-row-presentation in both these prototypes - "One row system gets a fragmental impression and bad conditions to remember the content of the text."; "Too short lines for getting consistency"; "Too little text is showing."; "Did not get any consistency as you not saw a whole sentence. I did not know when to take a break. It gets a poetry experience."

5.6.1.3 Comments on the technique

Compared to normal reading almost all subjects had negative comments on the Bailando prototype. Four said it was worse than normal reading and three thought it was stressful. Others said that it was hard-to-grasp, hard to control the speed while reading, and hard to remember what has been read for those who like to read some text twice. Two of the subjects disliked the short pieces of text. The only positive comment was that "it feels like it would become easier after some practice".

To improve the Bailando prototype one comment was distinct - longer/more rows preferably a whole paragraph. Two of those subjects wanted to manually flip pages, whilst one preferred it to be done automatically. Two subjects wanted a rewind function in order to read a section again. Leading text presentation was thought a better solution by one subject, and one would like to add line-break after each period.

Most comments on Smart Bailando were, even them, negative. Three just said it was worse than normal reading. Furthermore, the subjects noted that it was impossible to get something out of the text due to the difficulty in consistency; that it was hard to get a good flow in the reading because of the limited line width; that it "takes a lot more to keep the concentration on what you read"; and that it's "more a challenge than an effective way to give information".

Even the comments to improve Smart Bailando mostly dealt with the RSVP technique. Five out of the eleven subjects believed that displaying more rows should improve readability. One would like to "flip page" manually whilst two preferred automatic scrolling. Out of the latter ones one preferred page scrolling and the other believed that row-by-row scrolling should be better. Leading text presentation was thought as a better solution by one subject, and one subject would like to add a reverse function in order to read a section again. For those who had comments on the gaze detection system, all mentioned that stability needs to be improved in order not to end up with the text stopping and starting every now and then, disrupting the reading. Two subjects thought that the user should be allowed to move more freely, one of them thought that automatic calibration should be a feasible functionality. Just one test person would like to get rid of the arrows.

5.6.1.4 Situations

When the test persons were asked to mention situations when RSVP could be better than normal reading the answers were almost unanimous. They stated short texts, like instructions, news, and information, in cars or on the bus, or to skim through a text. One subject said that the screen area had to be limited (e.g. microwave ovens, watches, telephones); otherwise normal reading would be preferable. Regarding Smart Bailando, one subject mentioned the freeing of hands as positive. The test person thought of a surgeon reading instructions while operating. Another situation, when gaze detection added usability, was "in stressful situations" where the user is interrupted frequently.

No one would like to read a whole book this way and it can not by far compete with reading a book the normal way. Four subjects could not find any useful area for Bailando and five persons thought that Smart Bailando was worse than normal reading in all aspects.

5.6.1.5 Free comments

One subject thought it was tiring for the eyes but that it probably would be less tiring after getting the hang of it. One test person said that the arrows took too much attention away from the text. Two design proposals were made:

1. Let the user (if possible, depending on space) decide how many rows of text that shall be shown. Newest text always on the bottom row. As long as the user looks at the bottom row, let the text flow. When the user wants to look back on the previous rows the text stops. Only display a new row when the user has read the last word.
2. Fill the whole screen with text. Make it possible to flip page forward and backward by activating a suitable button at the bottom of the screen.

No subject complained about the text running at a lower pace at start-up. Those that said anything about it thought it was nice and could be helpful.

6 Discussion

Here we discuss around our results; what the future might bring on the PDA market, some thoughts on eye detection systems, comments about the test results, and suggestions for future work.

6.1 Porting

Looking back at the assignment, porting the Smart Eye system is a thing that's missing. It would have been interesting to see how many and what kinds of fault-messages there would have been. Today's hardware, mainly CPU capacity, makes it impossible to run the Smart Eye system on a PDA and unfortunately, as mentioned earlier, we had no access to the source code of the system and could therefore not try to port the system. Maybe this could be an issue for another master thesis, investigate what problems a porting will cause and how to solve them.

6.2 Smart Eye system

Despite that eye detection systems have been on market for the last 10 years, none of them works really well. The largest problem with these systems is that the user has to sit in the same position; otherwise the system does not work satisfactory. It is very important that an eye detection system allows movements to have a broader market - especially if the target is a PDA.

The Smart Eye Company would not distribute the source code of their system because the algorithms in the Smart Eye system are very important for the company. Therefore, we do not know how the system works; how it calculates the x- and y-values. Does the system compare the eyes or one eye in relation to the head? Maybe some implementation parts could have been done in a different way if knowing how the algorithms worked. We have a lot of question about the system, but we also understand why the Smart Eye Company would not let us have the source code.

Before starting with our thesis we knew that the Smart Eye system also worked by using two web cameras - Smart Bailando uses one. After some months, we got the knowledge that there were others, more exclusive, versions of the Smart Eye system which gives a depth value. With such a value the system automatically could compute a new virtual coordinate system from the old one, allowing the user to move more freely on the z-axis.

In an article in Ny Teknik April 4 2002, a web camera that follows the user's movements was described. This camera can turn an angel of 180 degrees in x-axis and an angel of 60 degrees in y-axis. It seems like this camera also could increase the freedom of movement but we are not so sure, though we do not know how the algorithms in the Smart Eye system works.

The Smart Eye system has a version that uses two web cameras. Martin Pettersson at Smart Eye AB said that by comparing the values from the two cameras, the freedom of movement is increased. But is it realistic to have two web cameras on a commercial hand held device?

The technical development of hardware is going very fast - also for hand held devices. With better hardware, such as memory- and CPU-capacity, the Smart Eye system can run on a PDA – probably in 1-2 years. It will not solve the freedom of movement problem, but the system would not need a client/server solution. The developers at Smart Eye AB have also said that, in the near future, the system will be more flexible and for example, no calibration of their system should be necessary. Such a system will by itself recognize a user' s eyes, mouth and so on.

During the tests, the Smart Eye System sometimes had problems finding the face of the user if the background were too bright. The mask settings were changed and even so the camera settings without improvement. The system repeatedly tried to find the face in the bright areas it could find. But when the indoor light was turned off the result was better.

6.4 RSVP

The evaluation of Smart Bailando gave so many negative aspects on the RSVP technique that we want to discuss this issue. Several questions popped up like; why were people so negative to RSVP in this evaluation? Did the test differ from the others ones that had tested RSVP?

In the evaluation done by Öqvist [14] the subjects had to read one short (2 minutes) and one long text (20 minutes) in four different ways, all adapted to small screens. Adaptive RSVP did not differ from the others in reading speed, comprehension and task load. Öqvist had also some experience questions where the subjects had to mark their opinion on a scale. Except that Öqvist evaluation is more rigorous, the main thing that differs is that we ask the subjects to compare reading RSVP to reading on paper. Of course this will give a more negative picture of RSVP.

Although we do not think that this thing alone is the whole truth. Öqvist also had some experience question and those answers were not as negative as ours. Many of our test persons wanted to see a whole paragraph displayed on the screen - like Microsoft Reader. If they had tested reading in this way and then read in RSVP manner, then maybe they would have experienced reading using RSVP-technique much more positive. Furthermore, we only had one question where we asked about the whole experience - Öqvist had eight questions, with different focus on experience. Having several questions with different focus the subject have to think more careful before answering and we think that this gives a more fair result than our single question. With one question the subjects may not think of everything, their first impression affect their judgment.

Two questions that we have about RSVP are; do people want to read long text on small screens, or will they be forced to do it in the future? As we worked with our thesis these two questions have grown. It feels like the RSVP technique is created by some engineer and researchers without asking some presumptive consumers. On the other hand, this is a way of prototyping - some techniques are rejected some are not.

6.4 Smart Bailando

To make Smart Bailando better, the freedom of movement has to be improved. With more than one camera this is already achieved according to Smart Eye Company. Smart Bailando has to wait for handhelds designed for two cameras.

The calculation of the point of gaze has not undergone any intense development. Adjustments were made until it produced reasonable results and the performance felt good - the number of packages produced per second and how many packages to calculate an average from.

With a more accurate point of gaze calculation buttons can probably be controlled even if they are relatively small.

6.4.1 Calibration

Instead of staring at the four corners of the screen, a one-point-calibration could be done. In order for this to work the system has to know the screen size in advance. By making the user to look at the center of the screen, the hot area could be calculated from that. The problem would then be that it depends on the distance between the user and the screen - the closer the user is the larger the hot area becomes. A gaze detection system with a depth value would then be necessary.

During the calibration phase the hot area got bigger than it had to be. Even so, the text presentation stopped most frequently. If the hot area had been calculated more accurately the text presentation probably would stop even more often.

6.4.2 Reading comprehension

Regarding the bad reading comprehension we found two causes; the arrows and the presentation-speed. As mentioned earlier, the arrows took a lot of attention away from the reading. Even so, the reading comprehension did not differ that much between the two prototypes. Maybe the subjects were too afraid to miss some text that they did not care to change the default speed, even if it was too fast. This might have caused them not to understand what they read.

6.4.3 Overall judgment

The fact that Smart Eye hanged and that there were some network problems could have had an influence on the overall judgment. Even the fact that the screen had space for more letters on one row and more rows than one might have affected the result.

6.5 Future work

As most of the comments referred to the RSVP technique, many suggestions on how to improve it arose. Below we justify those suggestions we felt appropriate together with some improvements on Smart Bailando.

6.5.1 Smart Bailando

Below example of functionality's that can improve Smart Bailando are given and described.

- *Increased freedom of movement*

With a better version of the Smart Eye system (perhaps with two cameras) which provides a depth value a translation function could be implemented that computes relative x- and y-values depending on how far from the screen the user is. This will increase the movement freedom.

- *Dynamic speed control*

It should be feasible to change the speed while the user is reading. With a better gaze detection system it should be possible to discover when the user has read all words and awaits new text. Furthermore, the system could decrease the speed if the user is unable to keep up.

- *Automatic roll-back function*

Most often words aim at earlier once in a text and some people like to read a text segment twice. It would therefore be nice if the user can go back and read some parts again.

6.5.2 RSVP

- Let the user (if possible, depending on space) decide how many rows of to show. Put newest text always on the bottom row. As long as the user looks at the bottom row, let the text flow. When the user wants to look back on the previous rows the text stops. Only display a new row when the user has read the last word

7 Conclusion

The handheld market is not yet ready to introduce gaze detection, partly because the lack of processor capacity and partly for the reason that all too few units have built-in cameras. Some handheld devices have a camera as an add-on, but it makes the unit all too heavy to make it feel comfortable in the every day use.

In order to increase the precision and the freedom of movement it takes two cameras, which no handheld device on the market has today. That a handheld device should go from zero to two cameras ought to take a while. The test persons were, in addition, very negative towards RSVP, mostly because it was hard to understand and to get a consistency in what they read – one row was considered far too little.

Below the questions asked in chapter three are answered.

How common is it that handheld devices have a built-in camera or as an add-on module?

> It's not common but more and more manufacturers build in cameras or sells them as accessories/add-ons.

Is the performance of today's handheld computers enough to cope with Smart Bailando or is a client/server implementation needed?

> No, mainly because of lack of CPU power.

How precise are the values from the Smart Eye System?

> This is still an open question. Our belief is that the values are good but as the system is used in a mobile environment they become unreliable.

If the values are not good enough is it possible to make them more precise?

> First of all, the implementation accomplished might not produce an optimal value. As mentioned, a two camera system will probably give accurate values even if the user or device is moving.

Is it achievable to control start/stop of the text, presented by Bailando, on a PDA with Smart Eye technology?

> Because the system is sensitive for movements the buttons have to be quite large in order to correctly respond to a hit and due to the limited screen such a button will occupy too much space of the screen.

If getting good values (one way or another) is it feasible to control/set the speed by looking at the controls for speed adjustment?

See answer above.

Can readability and/or usability increase by adding eye control to Bailando?

Today it's too early to answer this question. Obviously the subjects did neither experience increased readability nor usability as the system was unreliable. In a future with better hard- and software then it might be possible to increase these factors by adding eye control system.

Can the text start at a lower pace (wpm) and accelerate to the pace before being stopped?

Yes. This was quit easy to obtain.

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Appendix A User documentation

A 1 User guide

Before reading this guide, take part of the user documentation of the Bailando prototype [Gustav Öquist, Adaptive Rapid Serial Visual Presentation, Master thesis, December 2001.]. Below we add some new instruction on how to use Smart Bailando.

A 1.1 Starting Smart Bailando

First you have to start the Smart Eye application. Then you must edit a profile of your face, this because the Smart Eye system needs to recognize your face when reading. How you edit a profile in the Smart Eye system, read the user documentation.

Next you have to start Smart Bailando. To do so you first click on the start symbol and then click on Smart Bailando in the menu. Choose a text to read by clicking on the Menu and then Library. Change the Type to *.txt, you will now get a list of available texts to read. Select one by clicking on it. After that you will be asked to look at the upper left corner of the PDA, see figure A1.

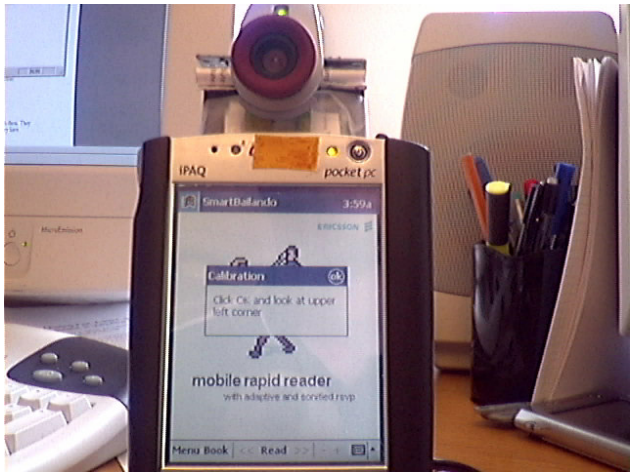

Figure A.1: This message will be shown after starting the program.

Click on the ok button and then start looking at the upper left corner. After a few seconds you the will be asked to look at the upper right corner, then lower right corner and finally the lower left corner. At the end of this calibration phase you will get a message that tells you that the calibration is done, see figure XX. After clicking on the ok button the text presentation will start as described in the user documentation of Bailando.

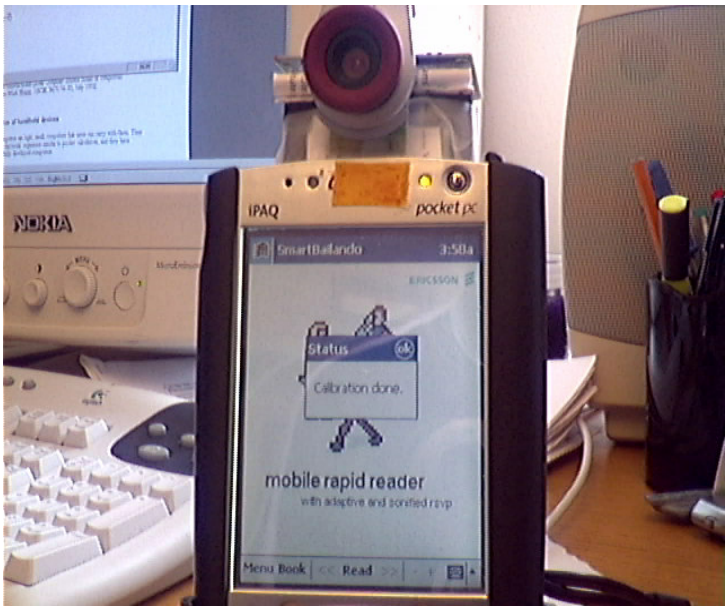

Figure A.2: After looking at each corner of the screen the system tell you that the calibration is done.

You have to do this calibration so that the system can define a "hot area". The system can then recognise if you look outside the screen or not.

A 1.2 Connection problems

If you have started Smart Bailando and the calibration sequence does not start then you just have to wait until it does. If the system failed contacting the desktop the system will let you know by a message. If contact fails you can still use the system reading text in RSVP manner but without any eye detection.

A 1.3 Automatic text control

When you read a text, for example an electronic book, the text presentation system will automatically stop the text if you look outside the screen. When you look back on the screen the text presentation will start again, first at a lower speed that automatically will increase up to your selected speed before looking away.

A 1.4 Head position guidance

When the system thinks you are looking outside the "hot area" the system will show you arrows pointing up, down, right or left. The arrows will guide you back to the "hot area". You then turn your head smoothly in the direction of the arrow.
When an arrow is shown the text presentation is stopped and is not starting to work again before the arrow is gone. In a commercial product the system will probably be more

stable and precise making the arrows superfluous. But for this prototype they can help you a lot.

When the eye detection system from Smart Eye doesn't find your face the text "lost contact" is shown on the screen. You now have to help the system to find your face again by slowly move your head in different direction until the text is gone.

You will not miss any text while an arrow is displayed or "lost contact" is shown. The text presentation is stopped and starts again when a guiding indicator is gone.

A 1.5 Ending Smart Bailando

You can't end the application by moving your eyes our head in any particular way. The only way to stop the program is by clicking on the menu and then click on exit. Forcing Smart Bailando to display a message (i.e. an arrow or "lost contact") might ease th e access to the menu.

Appendix B System documentation

B 1 Requirements

For using Smart Bailando you need a PDA, a desktop computer and a web camera. The Smart Eye system runs on the desktop. It requires at least a processor speed of 600 MHz. We recommend a CPU speed of 1 GHz because there is a risk that the Smart Eye system hangs if you use a lower CPU speed. You also need at least 128 Mb RAM. When the system was tested on a desktop with CPU speed 566 Hz the Smart Eye system took over 90 % of the CPU resources.
Today the system only works on Windows operating system so the PDA needs to have Windows CE 3.0 installed; you can not use Palm operating system.

B 2 System specification

We are not describing how Bailando is constructed. If you have interest in how Bailando works in detail we refer to the system specification of Bailando [6]. In figure B.1 you can see an overview of the Smart Bailando system.

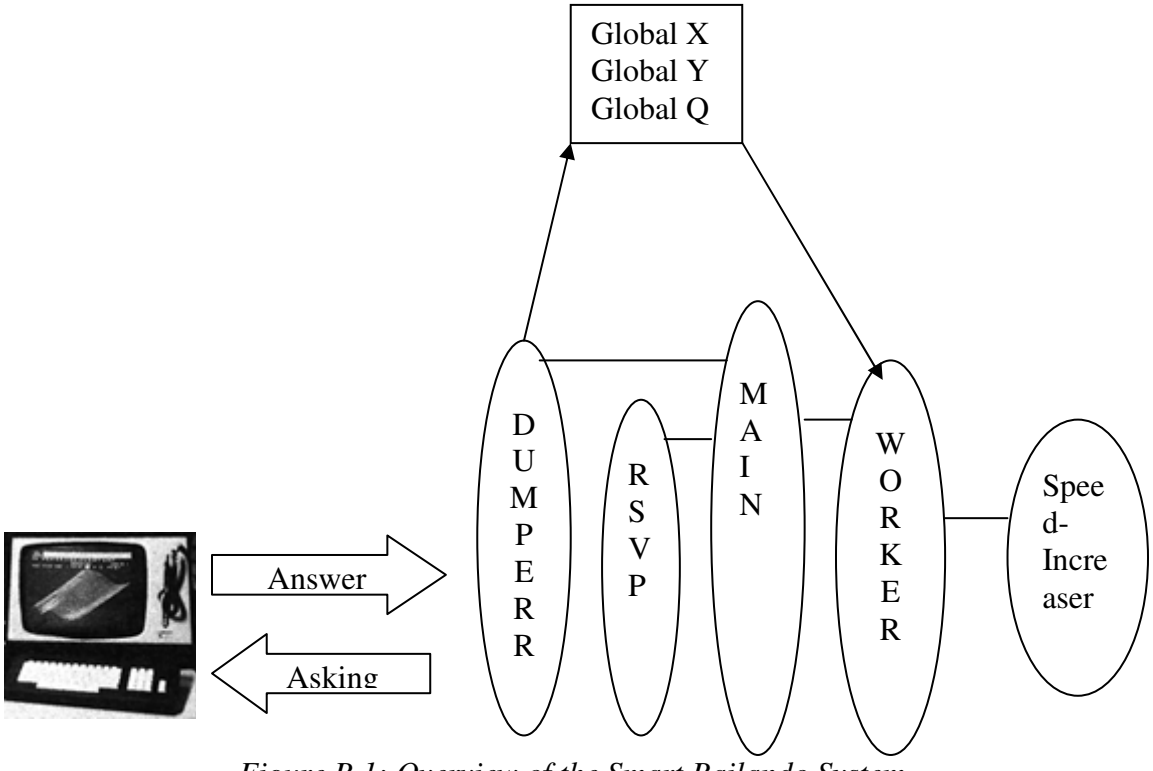

Figure B.1: Overview of the Smart Bailando System

B 2.1 Global values

X, Y and **Q** hold the values that the Smart Eye system produces. The x- and y-values forms a virtual co-ordinate point which indicates where the user is looking. Q indicates in what quality the x- and y-values is delivered, where 1 is good. If q is less than 1 and greater than 0 the system ignores the x- and y- values. If q is 0 it indicates that the Smart Eye system has lost contact with the users face.

B 2.2 Added functions

B 2.2.1 Dumper

This thread is reading package from the socket all the time. After reading a package it also updates some global values, x, y and q. This thread runs during the whole execution of the program. If not reading from the socket all the time there would be a queue on the socket and the global values will not have fresh ones.
The receive function in this thread is none blocking. This means that if there is no package to read on the socket the function is not blocking (not waiting for a new one) and starts to sleep for a little while before trying to read a new one.

B 2.2.2 Worker

The Worker thread has some important values. **Left, Right, Top** and **Bottom** holds the values that specify the "hot area" after calibration. Left is the lowest x value that was calculated in the calibration, Right the highest. Top is the highest y value given in the calibration and Bottom the lowest.

This thread first handles the calibration process. When the user is looking at a corner the system takes an average value of some x- and y-values. Then compare this xAverage- and yAverage-values to Left, Right, Top and Bottom. If the xAverage and yAverage is lower or higher the function updates Left, Right, Top or Bottom. This process is repeated some times for each corner.

Here we have a concurrent problem. The receiver thread can read the same value several times and compute an average on the same value. The receiver thread could also miss several values that the dumper thread reads because the dumper thread reads several new values from the socket and updates the global values that are overwritten. We have solved this concurrent problem by letting the threads sleep after reading one value. Then the operating system let the other thread work while the other one is sleeping. Here it is important to choose the right sleeping time according to the speed of the Smart Eye system. The Smart Eye system produces, in our case, 25 packages every second, so the thread is sleeping 40 ms after reading one value.

After that the calibration phase is done it is not so important for the Worker to sleep. It can read the same value several times without affecting the functionality. The thread is reading the global values and if the values indicate that the user is looking outside the hot area it sends a message to stop or start the text presentation.

B 2.2.3 SpeedIncreaser

This thread is activated when the text presentation has stopped and wants to start again. Then the text is displayed in a speed of 100 words per minute less then the speed that was selected by the user. It then increases the speed with 10 words per minute up to the selected speed.

B 2.2.4 Optimisation

We had to do some optimisation because when the system repainted the screen so often the user could experience that the text was blinking and it gets harder to read the text. To reduce the blinking we did two things.

- When SpeedIncreaser runs it does not repaint the screen after having increased the speed.
- When repainting the screen the system only repaints those areas that have been changed.

B 2.3 Package structure

The Smart Eye system is a separate process that runs on the desktop. Smart Bailando contacts that process and gets information from it. The Smart Eye process will send information in a package with this structure.

Package structure:

u32 syncID;	Should be ' SEPD'
u16 packetType;	Should be 1
u16 length;	Length of the following bytes
double eyeX;	X value
double eyeY;	Y value
double quality;	Quality of the X and Y values
u64 timestamp;	Timestamp

u16, u32 and u64 means that they are unsigned and the number of bits (i.e. u16 = 2 byte etc).

Appendix C Development documentation

C 1 Schedule

The preliminary schedule is;

Week	Date	Assignment
1-5	February	Reading and learning what Bailando and RSVP is Look at the Bailando code and try to understand how It works. Contact Smart Eye and get their software platform. Learn how the platform works. Investigate the PDA market and different development environment.
6-10	March	Programming
11-15	April	Testing and user test
16-20	May	Documentation and writing

C 2 Conclusion about the thesis work

In the beginning we said that we should work 8-16 every day. We wanted the work with our thesis to resemble as much as possible an ordinary work.

The fact that we never used an application development system before, that we where beginners at C++ programming and never seen Microsoft Foundation Classes nor the Active Template Library and still managed to come with a result proofs that we actually learnt something at school.

To work with an assignment like this is quite different from our laboratory work at school. Nothing is prepared to the same extent and you never know when to encounter problems, like we did when we tried to connect to a socket and when we found out that the connection settings on our iPAQ where wrong. It happened that the LAN where down disabling us from accessing our files. Another problem is that of getting in contact with other people when you need them the most. Most often they were out office and some times for a couple of days putting us in a kind of dead-lock situation.

We tested different approaches to attack a problem, just to come to the conclusion that some of the ways not lead to a solution to our problem. Thing like that doesn't show in the final result but that's the way it probably is in the computer science society. However, it has helped us to learn more about socket programming and developing client/sever applications.

In addition to the above we've also learnt about different RSVP techniques (i.e. adaptive, sonified and leading), handheld devices (mostly Pocket PC) and gaze detection techniques (mostly the Smart Eye System). Furthermore, the development of Smart Bailando has made us come in contact with human-computer interaction. Another thing that we had learned is to read reports more

C 2.1 Problems

During our work we had some difficulties that caused us more problems than usual,

- Values from the socket
- Local network and PDA
- PDA and socket

After that we have got the Smart Eye application installed and got information how the package looked like we started to do some socket programming. When we received some values we did not get the one's we expected. Developers from Smart Eye told us that the x and y values that was produced by their system should be in between –1 and 1. We got values in a much wider range. After almost a week of testing and discussions Smart Eye let us know that our values were the right ones because we used only one web camera. Despite we had worked for a week to solve this problem we were quit satisfied that we had not done anything wrong.

Next problem that caused us a lot of work, anger and time was when the PDA should get right adjustments for the local network. The expert of this was not so often at the office and we had no one else to ask. We tried to solve this without any big success. Finally our supervisor found the missing part.

After having tested our system on the emulator we transferred our code to the PDA but when we tried to run the program it did not work. The PDA could not create a connection to a socket. We were surprised though it worked on the emulator. We changed the code back and forward without success. We had some mail contact with people from German, England and USA but they could not help us. After some more days we got in contact with a person from Stockholm that could help us. After this we realised that the programming environment, eMbedded Visual Studio, not were reliable in all aspects.

Appendix D Detailed PDA information

D 1 Buyer's guide

In this appendix we have put together information from different tests on PDA and also a buyer's guide. Our intention with this appendix is to give you more detailed information about PDAs. Take the buyer's guide and the ranking of some PDA's with a pinch of salt. Read and make up your own opinion.

D 1.1 Summary

There is quite a difference between different PDA's concerning processor and memory and the possibilities of the operating system. Ever cense Palm "invented" the category it has evolved many new strong competitors based on other operating systems. The price for a handheld is between 1 600 SEK and up to over 10 000 SEK for the most powerful models. There is a couple, three competing operating systems where Palm OS and Microsoft Pocket PC is the biggest.
Hardware wise there is also different processors that has to harmonize with the different operating systems respectively. Some computers have a keyboard but most of them only have a touch screen as interface. This screen can be either black and white or in colour, the latter has become more and more common as the capacity of the memory increases.

D 1.2 With or without keyboard

The majority of today's handhelds has an interactive screen that controls the different functions via a special pen. These computers are suitable as calendar, telephone- and notebook but in some cases also for surfing the internet and e-mailing. Fax programs and software for e-mail use to go with most of today's PDA. Some models even has Mp3-software or similar.
If you on the other hand have a greater need for editing documents and if you are a diligent e-mailer you probably should take a closer look at a PDA that has built in keyboard. You ought to think about that the size of the keyboard is minimal in order to keep the weight and size as little as possible. Even if the computer has a keyboard touch screens use to be standard, even on these computers.

D 1.3 Colour or black and white

Traditionally handhelds are provided with a monochrome screen, but more and more manufacturers put a colour screen into their new devices. Colour is always a nice feature but the black and white has the advantage of being cheaper and consumes significantly

less energy. For those who like to surf the internet a colour screen can be worth the higher price and less battery performance.
How many colours the screen is able to show is even more important if you want to look at pictures on the screen. Common values are 12-bit colour depth (4 096 colours) or 16-bit (65 536 colours). Some monochrome screens have no background lighting. Most often the monochrome screens has 16 grey scales.

D 1.4 Different operating systems

The operating system is the software that meet the user and which handles the computer's functions. Different manufacturers use different operating systems, just as Macintosh and PC. Though Palm still is the leading the market its operating system Palm OS does too. Microsoft is on the march with its Windows adapted Pocket PC.

D 1.5 Pocket PC – demanding but complete

Microsoft's operating system for handhelds handles both video and music clips, and even the mini editions of Word and Excel. Pocket PC needs though a lot of the processor which makes the computer expensive. Pocket PC is an upgrade from the earlier version Windows CE, but even so is accused of being some what more complicated to use. Examples of popular Pocket PC's are Compaq iPAQ and the simpler Aero, and HP's Jornada series.

D 1.6 Palm OS – flexible and convenient

Palm's operating system is fast and simple, and it does not demand as much in memory- and processor-capacity. The ease of use is high, but the system has a limited support for sound and video clips. Palm OS is not only the operating system of Palm's own products but also for Handspring's Visor-computers. Palm OS does not support Microsoft Office documents but it can be obtained by software from other software developers. It is the vast range of software that is the big advantage.

D 1.7 Epoc – convenient but limited

Epoc is the third main category of OS and comes with Psion's computers. The system is, just as Palm OS, both easy to use and quite fast to work with. Epoc supports document handling better than Palm OS and is less demanding than Pocket PC. The disadvantage is that it doesn't have that much of the market, which limits the range of software.

D 1.8 Battery, memory and CPU

As long as the handheld is used as a calendar and address book the memory is hardly ever a problem. But for saving and playing music files or showing pictures with somewhat good resolution it takes quite more memory capacity. Due to that handhelds doesn't have an internal hard disk all information must be stored in RAM-memory. The memory capacity normally lays between 4 Mb and 64 Mb. If you buy a new handheld it should off course have rechargeable batteries. These use to hold for up to two weeks, but the way you use the computer affects the endurance. The CPU speed is for the most powerful models 206 Hz.

D 1.9 Synchronization and connection

Most handhelds supports synchronisation through a cradle that is connected to the desktop computer either by USB- or serial-port, where USB is to prefer. Some use a cable instead of a cradle. The advantage of a cradle is that the handheld is recharged at the same time it is connected to the desktop. Not every model has built-in modem, but some computers have an IR-port that together with a mobile phone gives wireless access.

D 1.10 Size and weight

The smallest handhelds are now a days not far from a credit card in size. The most common type of handheld has a thickness of one centimetre and upward, a width of about 8 centimetres and about 12 centimetres in height. The PDA's weight is in average 150 gram. There are also computers half the size of a regular laptop. The smallest ones handles calendar and addresses but not that much more. If you want a keyboard you often have to go up a little in size. Computers with colour screen are in rule bigger than the ones with monochrome screen.
Prize wise most handhelds lay between 2 000 – 6 000 SEK. The more advanced processor ditto functions, the more it costs. For about 4 000 SEK you'll get a fairly powerful, well designed handheld with a touch screen and/or keyboard.

D 2 Top 5 PDA's

Just to get more information about PDA we have taken part of a judgement done by the web site www.handdator.com. They rank the best buys in different categories. They have selected the PDA's that gives a little bit more for your money then their competitors.
Which one to choose of the five, depends on your needs; colour screen, keyboard etc. The five winners are Handspring Visor Deluxe, Compaq iPAQ, Sony Clié, Ericsson 218 and Xircom Rex.

This is a subjective test done by some test people. In spite of that we think that the test give good information about the PDA market and a description about different categories.

Top 5 PDA	Price (SEK)	Category	Test commentary

Handspring Visor Deluxe	2900	Budget	"Nice price Palm-choice"
Compaq iPAQ 3630	6500	Multimedia	"You can't be without it"
Sony Clié PEG-N710C	5500	Multimedia	"Pocket PC with Palm OS"
Ericsson MC218	5900	Keyboard	"Beat Psion"
Xircom Rex 6000	1650	Mini computer	"Double wallet nice"


Handspring


Compaq


Sony


Ericsson


Xircom

Mainly the PDA market has three subgroups: computers whit keyboards and Palm- and Pocket PC based computers. We have selected one cheep, one with keyboard and two multimedia computers and finally one with many functions in a small format. Generally is a keyboard based computer the best choice for the one who is emailing and writing a lot of text. Pocket PC is a windows based operating system where you among other things get access to small versions of Word and Excel. The most Pocket PC is also delivered with colour screen and a powerful processor. The most valuable Palm computers have not colour screen. The advantage of Palm operating system is the big number of software that can be downloaded.

"Best budget buy": Handspring Visor Deluxe
Handspring Visor Deluxe is a Palm-based computer with monochrome screen. Regarded to the testers it offers more computers for your money than comparable Palm products. It works fine with both PC and Mac and weigh only 100 gram. One disadvantage is that the operating system not can be upgraded. You can find a lot of good Palm based computers but the testers consider this one as the one you get most out of your money.

"Best multimedia-computer": Compaq iPAQ 3630 and Sony Clié PEG-N710C
When Compaq iPAQ 3630 reach the market it took the market with delights: 206 MHz processor, 32 Mb Ram and colour screen. But the good stuff also costs. The weight is 170 gram, and the system with expansion package is not appreciated by all testers. There has come some challenger from Casio and Hp but they do not reach all the way up to the iPAQ according to the testers.
Sony Clié PEG-N710C is the first really good multimedia computer with Palm operating system and it has colour screen. As Sony's other products it plays music files in the Atrac format with changeable memory stick. The navigation is smooth with the jog wheel like

the Sony mobile phone uses. The testers like the screen but the memory capacity could be larger.

"Best keyboard computer": Ericsson MC218
In this category there has not been anything new for a while. This computer as the testers still gives you most of your money is Ericsson MC218. It is based on the Psion's computers but the testers think that it is better than the original. It is of course adapted to Ericsson mobile phones. It also has a very good keyboard and 18 Mb ram.

"Best mini computer": Xircom REX 6000
Finally a really good small, and also cheep PDA that you can place in your wallet. It only has 2 Mb ram and a monochrome screen, but has surpassingly many useful functions. You have to give up mp3 possibilities and email program.

As we said above this is not a scientific test but it will give you a hint of how the PDA market and what different types of computer you can buy.

Appendix E User test

E 1 Information given before test

Information inför test

Välkommen på test,

Vi, Roger och Per, håller på med vårt examensarbete i Datavetenskap. Vår uppgift är att sammanföra två olika tekniker, Bailando och Smart Eye, till en. En tanke med examensarbetet är att titta på om denna teknik kan underlätta läsandet i en framtida mobil miljö.

Bailando
Ericsson och Play Interactive har i ett samarbete tagit fram en prototyp, Bailando, för textpresentation på små skärmar, (mobiltelefoner och handdatorer). Bailando använder sig av Rapid Serial Visual Presentation, RSVP, som innebär att en text presenteras på en rad och i en viss längd, på skärmen. Utifrån en viss hastighet, ord/minut, så byts hela raden ut och en ny rad med text presenteras.

Smart Eye
Smart Eye är ett Göteborgsbaserat företag som har utvecklat ett system som upptäcker var du tittar på skärmen. Deras system är dock utvecklat för ”vanliga” datorer. Systemet från Smart Eye är även tänkt att i en framtid fungera i en bil där systemet t ex kan varna en förare som håller på att somna.

Vårt arbete
I vårt examensarbete har vi försökt få de två olika teknikerna att samarbeta. Vi har nu kommit så långt att vi vill testa vår prototyp, Smart Bailando, på andra än oss själva.

Testet
Testet kommer att gå till så att du först får träna på att läsa en text presenterad med RSVP teknik. Därefter börjar själva testet. Du läser en text med hjälp av Bailando och en annan text med Smart Bailando.

Efter att ha läst en text kommer du att få svara på några frågor om bland annat,

- Hur du upplevde läsandet
- Några frågor på innehållet i texten
- Några öppna frågor och fritt tyckande

Frågor?

Tack för din medverkan.

E 2 Questionnaire B and C

Frågeformulär - Text B

C F Sandelin: Världens ände

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1. Med vilken teknik läste du?

Bailando Smart Bailando

2. Hur många böcker läser du per månad?

1 2 3 4 5 fler

3. Texten du nyss läste, kommer du ihåg att du läst den förut?

Ja Nej

4. Vad hette han som körde båten?

5. Vilka nyheter läste helst Erik?

6. Var läste de vuxna tidningen?

7. Hur upplevde du att det var att läsa?

Mycket bra *Dåligt*

5 4 3 2 1

7 a. Vad var bra?

7 b. Vad var dåligt?

8. Hur var tekniken jämfört med vanlig läsning?

9. Finns det något som skulle kunna förbättra tekniken?

10. I vilka situationer skulle detta vara bättre än vanlig läsning?

11. I vilka situationer skulle det vara sämre än vanlig läsning?

12. Övriga kommentarer.

Frågeformulär - Text C

C F Sandelin: Vintertid

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1. Med vilken teknik läste du?

Bailando Smart Bailando

2. Hur många böcker läser du per månad?

1 2 3 4 5 fler

3. Texten du nyss läste, kommer du ihåg att du läst den förut?

Ja Nej

4. Vad var det som lästes upp i radion?

5. I vilken månad satt Julle och Ville på verandan och pratade om krig?

6. Varför var det lättare att försvara Finland än Polen?

7. Hur upplevde du att det var att läsa?

Mycket bra *Dåligt*
5 4 3 2 1

7 a. Vad var bra?

7 b. Vad var dåligt?

8. Hur var tekniken jämfört med vanlig läsning?

9. Finns det något som skulle kunna förbättra tekniken?

10. I vilka situationer skulle detta vara bättre än vanlig läsning?

11. I vilka situationer skulle det vara sämre än vanlig läsning?

12. Övriga kommentarer.

E 3 Texts used in user tests.

E 3.1 Text A

Carl Fredrik Sandelin

En del av det hela

Markus trodde inte sina ögon. Det var faktiskt ett frihetskors som låg i fönstret bland militära utmärkelsetecken från olika länder. Samma kors av fjärde klass som han hade varit så stolt över, men som också hörde ihop med ett av hans bittraste minnen från ungdomsåren.
Det är snart fyrtio år sedan, tänkte han. Magnus hade varit död redan länge, men varje gång han såg korset, hans eget eller någon annans, greps han av en slags skuldkänsla, en skuld som han var oskyldig till, men en känsla som han inte kunde förklara med andra ord. Farmor var den skyldiga, i bästa välmening, som det hette, och det var klart att hon inte medvetet hade tänkt sig såra Magnus. Men man skall aldrig säga någonting oeftertänksamt, det hade han lärt sig då, och man skall inte säga sådant som kan skada någon.

Kriget var slut, det var hösten 1944, men han var ännu inte hemförlovad och han kom i uniform till farmors middag. På hennes begäran hade han fäst frihetskorset på uniformen. Han hade troligen gjort det också utan att hon hade bett om det, bara för att visa det för sina släktingar, kanske för att imponera litet på dem, men han hade inte särskilt tänkt på Magnus, åtminstone inte i avsikt att lysa på hans bekostnad. Men i diskussionerna efteråt om Magnus utbrott, och det var ett återkommande tema under de närmaste åren, hade det varit lätt att hänvisa till farmor och på det sättet frita sig själv från anklagelser.

E 3.2 Text B

Carl Fredrik Sandelin

Världens ände

Erik vaknade när Pickwick lade till vid bryggan. Ljudet från motorbåten steg och sjönk och i samma takt kom puffar av rök ut ur ett hål i sidan. Röken luktade bensin och ibland lät det som om också motorsurret kom ut ur hålet. När Pickwick åter satte fart dunkade motorn jämnt under den stora mahognyhuven. Kurki, som körde Pickwick, lyfte på huvens luckor och sprutade olja i motorn för att den skulle gå bättre. När luckorna inte dämpade ljudet blev dunkandet så starkt att passagerarna nästan måste skrika för att höra varandra.

Varje morgon på sommaren, med undantag för söndagarna, kom Kurki med Pickwick. Han körde från Herttuala till den ena bryggan efter den andra vid Suomenvedenphja. På bryggorna väntade farbröder som steg ombord för

att åka till sina kontor i Viborg. De steg av i hamnen, nedanför saluhallen, och sedan återvände Kurki och Pickwick till Herttuala. På eftermiddagen körde han igen till staden och farbröderna kom tillbaka till sommarvillorna. Då kom också tidningarna och den andra posten. Hufvudstadsbladet och Karjala och ibland också Wiborgs Nyheter.

Erik var alltid på bryggan när tidningarna kom. Han ville vara den första som tog emot bunten för att genast kunna lägga sig på bryggans bräder och snabbt bläddra fram till sportnyheterna i Hufvudstadsbladet. När han läst om fotbollsmatcherna och idrottstävlingarna gick han till villan med posten. Vid den tiden på dagen satt de vuxna ofta på stora verandan. Där läste de tidningarna och breven och talade om för varandra vad som stod i dem. Från verandan såg man när Pickwick fortsatte från Kiviranta, som Omas villa hette, till Linnenniemi och Käärmekallio. Där vände den och satte riktning över viken mot Herttuala. Den såg ut som en vit prick som blev mindre och mindre tills den blev svart och försvann bakom en holme.

Han och Ninni och kusinerna hade länge trott att motorbåten hette Pick-kvick för att den gick så fort när Kurki satte full fart. Men den hette Pickwick därför att hans morfarsfar hade tyckt om en bok som handlade om en farbror med det namnet. Morfarsfar hade dött för många år sedan. Han hade bott på Herttuala. Också morfar var död, men mormor levde. Hon kallades Oma av alla. När Erik var liten trodde han att Oma var hennes riktiga förnamn, men sedan hörde han att några av de vuxna som kom på besök kallade henne Karin eller tant Karin. Ibland också Tante Karin. Det var tyska.

Han tyckte om att ligga med ögonen slutna för att vakna riktigt långsamt. Pickwicks ljud trängde in i rummet genom myggnätet och de tunna, gröna gardinerna. Motorn brummade och surrade och blev sedan tyst när den gick på tomgång. Pickwick låg stilla vid bryggan. Han hörde Kurkis röst när han talade med Omas köksa Liisa, som hade gått till bryggan efter mjölken och grädden från Herttuala där det fanns kor. När morbror Calle, som bodde i lilla villan på Kiviranta, var försenad blev Kurki tvungen att tuta några korta signaler för att skynda på honom. Calle kom gående på sandgången i vanlig takt och ropade tillbaka jag kommer, jag kommer...

E 3.3 Text C

Carl Fredrik Sandelin

Vintertid

Erik låg på golvet i gröna rummet på Sjövik och såg på Finlands karta. I nedre högra hörnet Viborg, Karelska näset och på andra sidan gränsen Leningrad. Längs hela högra kanten, från Petsamo till Ladoga, den långa gränsen mellan Finland och Ryssland, eller Rådsunionen som landet hette i tidningarna. Några talade också om Sovjetunionen, men alla som Erik kände talade om Ryssland och ryssarna.

Han frös när han såg hur nära Viborg de ryska trupperna var. Det hjälpte inte att kakelugnen i rummet var varm. Han drog upp knäna under hakan och tryckte armarna hårt omkring benen för att inte skaka.

Ryssarna hade gått över gränsen på Karelska näset. Fågelvägen var det endast hundra kilometer från Systerbäck till Viborg och till Kiviranta, mormor Omas sommarvilla. Bara några timmar med bil... Han kom ihåg en bilfärd från Kiviranta till Terijoki, som låg nära gränsen. På samma dag körde de av och an och de hade god tid på sig att springa på den långa sandstranden och simma i Finska viken. Hur fort körde de ryska stridsvagnarna? Han bet ihop tänderna.

I en kommuniké från högkvarteret, som lästes i radion, hette det att de finska gränstrupperna drog sig tillbaka till försvarsställningarna på Näset. Vad betydde det? Kunde ryssarna hejdas där? Vad hände om det finska försvaret inte höll? Ryssland hade säkert en miljon soldater.

Vägarna! Och järnvägarna! Han lade sig på nytt på golvet och såg på kartan. Där, där och där... Han blev varm av iver. En kväll i augusti hade morbror Julle och en överste, som hette Ville, suttit på verandan på Kiviranta och pratat om krig. De var säkra på att Hitler snart skulle gå till anfall i Europa och att Stalin inte ville vara sämre. Vad hände med Finland? Ville sade att det var bra, ifall Finland blev angripet, att det gick endast några få vägar och järnvägar från Ryssland in i Finland. Mellan dem låg sjöar och skogar. Landet var lättare att försvara än till exempel Polen med de stora slätterna.

Vägarna över gränsen var faktiskt inte många. Om finnarna sprängde broar och sköt med artilleri på vägarna var det inte lätt för ryssarna att ta sig fram. I skogarna gick det långsamt både för deras soldater och stridsvagnar. Kanske det finska försvaret höll. Det måste hålla!

Julle och Ville hade haft rätt. Hitler hade gått till anfall och det stora kriget i Europa hade börjat. På några veckor hade tyskarna slagit Polen. Ryssarna hade också anfallit polackerna. I skolan tyckte några av pojkarna lika illa om tyskarna och ryssarna och sade att engelsmännen och de andra nog skulle vinna till slut, precis som i första världskriget. Men en av pojkarna visade tyska tidskrifter med bilder av Stuka-plan, som flög brant ner genom luften, fällde sina bomber och steg lika brant uppåt igen. På andra bilder sågs skrattande tyska soldater peka på polska krigsfångar, och tyska stridsvagnar körde i rasande fart genom brinnande polska städer. I en klunga på skolgården stod pojkar och tittade beundrande på bilderna. Några av dem marscherade till och med som de tyska soldaterna och sträckte ut händerna till hälsning.

På Näset grävde finska soldater och frivilliga skyttegravar och byggde tankshinder. Trupperna övade sig.