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EyeSee - An RFID equipped identification tool for people with visual impairments

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Table of Contents

1 Introduction

In the modern world of information there are several things that we need to keep track of. This might not seem like a problem for most people, but how do you deal with situations like finding your misplaced keys, or opening a can of tomatoes instead of corn, if you have a visual impairment?

1.1 The problem

When dealing with a visual impairment a simple task like doing the laundry can be quite frustrating and time consuming. The main problem is that in many situations there are a lot of thing to keep in mind and normally your vision makes it easier to remember them.

A device that easily could search for and identify a selected object might be a way to solve this particular problem. Applying the same identifying method to other difficulties that people in this target group experience, could create a tool for everyday use.

1.2 The aim

The purpose of this Master's thesis was to investigate and create a system for searching and detecting different objects using RFID technology (see *2.1 Introduction to RFID*). The reading device should be small and wireless so that it easily can be brought along. It should also have a basic user interface, containing only significant applications and be provided with sound feedback so people with visual impairments easily can use it.

It might be difficult to primarily satisfy all the needs and desires for the system from people in the selected target group. However, it is of greater importance to initially construct a system that meets the detection requirements, and subsequently enhance the system with applications that fulfil the special needs of the target group. There are also several other limitations in the project such as technical, financial and time requirements that need to be taken into consideration.

It was thoroughly to be considered which technology was required to form the system and what resources were available. The market was investigated for existing solutions, whereupon a concept could be designed. Another important aspect was to examine what kind of device people with visual impairments desired. The finished prototype was then tested in authentic environments.

1.3 The method

We programmed a user interface for the PDA (Personal Digital Assistant), which was tested at the Eye Clinic. Some improvements were made and the PDA was then attached to the RFID reader and the interface was enhanced with a method to control the communication between the PDA and the reader. The program was tested again at the Eye Clinic and with several other test persons. After the tests, the final improvements were made and future prospects for the reader were discussed.

2 Technical background

To build some personal knowledge and understanding in Radio Frequency Identification (RFID) technology and its limitations a survey was made. The components of an RFID system and the differences between active and passive systems and system were issues that needed to be investigated. Several tags and readers were reviewed and an initial technical concept was created.

2.1 Introduction to RFID

Automatic Identification of Data (AID) is a description of systems for identification of objects and one of the methods applied is RFID, which uses wireless radio communication [1]. It is related to bar coding that however uses optical communication.

The RFID system consists of three main components: tags, a reader and system software (see Figure 1).

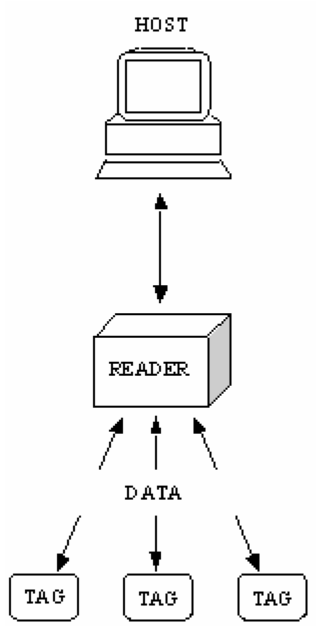

Figure 1 *The components of an RFID system*

A tag (also called a transponder) consists of an antenna and in most cases also a microchip. The microchip extends the tag with a memory and calculation capacity. Most tags are used to give objects a unique identification, however there are tags that just indicate their presence [2]. The construction of the tags is robust which makes them suitable for rough environments with e.g. high/low temperature, high pressure and dirt [1].

The shape and size of the antenna is a large determining factor regarding tag structure and the main influence on the size of the antenna is the operating frequency. In general, a higher frequency results in a smaller antenna. However, when operating in low frequencies (125 to 134kHz) the tags become smaller due to the short reading range, typically less than 0.2m.

The tag can be passive, semi-passive or active. A passive tag is powered by the electromagnetic field from the reader's transmitting signal, which results in a small range. A semi-passive tag has an attached battery, which in general makes the tag larger than a passive one. Because of the battery, the tag can boost the transmitting signal, which gives it a larger range, typically more than 0.5m. An active tag is also powered by an attached battery, and has an active transmitter that can signal independently. In general, active tags are more expensive but have a longer reading range, typically more than 1m.

The tag can be read-only or read-write. Read-only tags have an identification code recorded at the time of their manufacture, and can afterwards only be read and never modified. Read-write tags can be written to many times, but they still have an identification code recorded when they were manufactured. In other words, read-write tags offer additional functionality because of the variety of information that can be written. Unfortunately but understandably, this increases the tag cost. However, if read-only tags were used in combination with a well-designed database, it would basically provide the same functionality as a read-write tag [3].

To retrieve information from the tags an RFID reader (also called an interrogator) is used. The RFID reader is both a transmitter and a receiver that also provides the tag with power (if the tag is passive or semi-passive). While scanning an area, the reader will activate the tags within the range of the reader [1]. During the communication the reader can identify tags through some obstacles (the level of penetration mainly depends on the frequency and the transmitted power). Passive and semi-passive tags respond with a modulation of the reader's signal while active tags respond by using an active transmitter powered by a battery. The reader then converts the responded signal into readable data [3]. It is also possible to read several tags in an area at the same time, if the RFID system is equipped with an anti-collision algorithm.

The system software communicates with the reader, collects and stores data from the tags. It can be located on a computer or be integrated in the reader [4].

There are four different types of operating frequencies in use today: Low frequency (125 to 134kHz), High frequency (13.56MHz), Ultra High Frequency (868 to 956MHz) and Microwave (2.45GHz) [5]. Several parameters depend on the frequency in use, such as the reading range, cost and the reading rate. In general, the reading rate increases with a higher frequency. Both cost and especially reading range depend not only on the frequency but also on a number of other parameters, such as antenna size, polarisation and design of the integrated circuits.

2.2 Technical limitations

There are quite many differences between types of tags, readers, and operating frequencies. Their physical parameters were the main limitation when a technical concept was selected, however there was a probability that existing solutions would be modified.

2.2.1 Tags

The main differences between active and passive RFID tags are, as discussed in the previous chapter, reading range, size and price (see Table 1). The shorter operational life for active tags is due to the life span of the attached battery.

	Active RFID	Passive RFID
Reading range	0–100 m	0–3 m, (usually <1m)
Power source	Yes, has an attached battery	No, receives energy from reader
Size	Greater tag size (10 g – several kg)	Lighter tag size (can be very small)
Price	$10–100	$0.5–3
Data storage	Up to 128kb	Up to 128b
Operational life	6 months–5 years	3–10 years
Multi-tag reading	1000's of tags over a 3 hectare region	Hundreds of tags within 3m

Table 1 *Comparison of active and passive RFID tags* [6][7]

Several tags are available on the market (see Figure 2, Figure 3, Figure 4 and Figure 5) and the difference between them depends on their class and frequency (see Table 2 and Table 3).

Figure 2 *TI Laundry tag [9]*

Figure 3 *EMS rfid LPR-P125 [10]*

	LOGI TAG 160 Sedna	TI Laundry tag	EMS rfid LRP-P125	Rafsec Label tag
Frequency	13.56MHz	13.56MHz	13.56MHz	13.56MHz
Read range	0.1m	0.1m	0.15m	0.15m
Class	Passive	Passive	Passive	Passive
Dimensions (mm)	16 x 3	22 x 2	22 x 1	60 x 20
Price	$2.52	$2.50	$0.68	-

Table 2 *Comparison of RFID system parameters with different tags* [8][9][10][11]

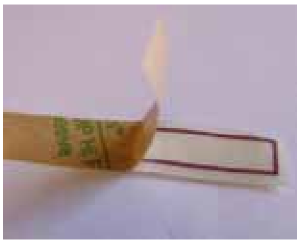

Figure 4 *iP-X Tag* [13]

Figure 5 *MiniTag* [15]

	Pinger	iP-X Tag	EcochipTag	MiniTag
Frequency	315, 434, 868MHz	869.4 – 869.65MHz	868 – 870 MHz (GSM)	916.5 and 868MHz
Read range	≤100m	1-2m	6 – 11m	1-85m
Class	Active	Passive	Passive	Active
Dimensions (mm)	35 x 35 x 10	170 x 10 x 0.1	80 x 35	34 x 30 x 12
Price	$25.75	-	$3.68	$24-30

Table 3 *Comparison of RFID system parameters with different tags* [12][13][14][15]

2.2.2 Frequency

The parameters of the RFID system depend to a great extent on the operating frequency (see Table 4).

	LF 125kHz	HF 13.56MHz	UHF 300-1200MHz	Microwave 2.45 & 5.8 GHz
Read range	≤0.5 m	1m	100m (active) ≤4m (passive)	10m (active)
Tag type	Passive	Passive	Active or passive	Active or passive
Reading rate	Low	Low-medium	Medium	High
Reader cost	Low	Medium	Medium-High	High
Environmental interference	Low	Low	Medium	High

Table 4 *Comparison of RFID system parameters in various frequencies* [1][2]

2.2.3 Readers

Several readers are available on the market, and the variation between them is extensive (see Table 5, Table 6, Table 7 and Table 8). The aim was to find a small wireless reader that could read many different tags, and that would be easy to program. Finally a small selected group of readers was thoroughly investigated including three possible candidates: the MC9000-G with RFID (see Table 8 and Figure 11), the TimbaTec Pocket (see Table 6 and Figure 8) and the TEK Protégé iPAQ scanner (see Table 8 and Figure 12). After evaluating these readers on the basis of their characteristics the TEK Protégé iPAQ scanner was considered to be the most qualified reader applicable to our system.

	MPR1510 UHF RFID Reader	Ubiquitous Communicator	Trolley Scan UHF Reader
Frequency	868MHz	13.56MHz and 2.45GHz	860 – 930MHz
Power supply	Li-Ion batteries	Portable	NiMH batteries
Range	1-2m	-	≤6m
Tag type	BiStar™, Dura-Label™, EPC and ISO 18000	-	EcoTag®
Anti-collision	Yes	-	Yes
Dimensions (mm)	203 x 93 x 40	120 x 75 x 17.2	200 x 120 x 80
Antenna (mm)	Integrated	Integrated	250 x 250 x 30
Polarisation	-	-	Linear
Programming environment	Connections; RS232	Connections; IR, Bluetooth, Wireless LAN	Connections; RS232 9600 baud
Price	Withdrawn	$2700	$2440

Table 5 *Comparison of RFID system parameters with different readers* [16][17][18]

Figure 6 *Ubiquitous Communicator* [17]

Figure 7 *Trolley Scan UHF Reader with tags and antenna* [18]

	TimbaTec Pocket	Di-400	IP3 Intellitag portable reader
Frequency	869MHz or 916MHz	125kHz, 34.2kHz, 13.56MHz	915MHz
Power supply	1800mAh rechargeable NiMh	Li-Ion batteries	Li-Ion batteries
Range	3-10m	≤0.12m	1.5m (With large tags)
Tag type	ILR i-Q tags and i-D tags	Many different	Passive (Intellitag RFID tags)
Anti-collision	Yes	Maybe	Yes
Dimensions (mm)	205 x 90 x 37	186 x 134	94 x 178 x 132
Antenna (mm)	External	Integrated	Integrated
Polarisation	-	-	Circular
Programming environment	Microsoft Windows CE 3.0 platform	Windows CE .NET 4.2 Connections; GPRS, Bluetooth	Connections; IR to 700 Colour
Price	$4900	$3480	$1475

Table 6 *Comparison of RFID system parameters with different readers* [19][20][21][22]

Figure 8 *TimbaTec Pocket* [23]

Figure 9 *IP3 Intellitag portable reader* [24]

Figure 10 *Mobile UHF RFID Reader* [27]

	i-scan	Mobile UHF RFID reader	Intellitag Developer's kit
Frequency	13.56MHz	900MHz	915MHz or 2.45GHz
Power supply	4 Mignon cells 1.2–1.5V AA	Cable	-
Range	≤0.2m	≤1.5m	0.9–3.5m
Tag type	I-CODE, Tag-it, ISO 15693	EPC Class 0, 0+ and 1 ISO 18000-6	Passive (Intellitag RFID tags)
Anti-collision	Yes	-	Yes
Dimensions (mm)	231 x 80 x 100	-	-
Antenna (mm)	Integrated	Integrated	External
Polarisation	-	-	Linear
Programming environment	Connections; RS232, USB	Standard protocol APIs, Windows sockets (WinCE)	Microsoft Visual C++ 6.0 using Intellitag API
Price	$449.69	-	-

Table 7 *Comparison of RFID system parameters with different readers* [25][26][27][28]

Figure 11 *MC9000-G with RFID* [29]

Figure 12 *TEK Protégé iPAQ scanner* [32]

	MC9000-G With RFID	TEK Protégé iPAQ scanner	IR 8000 Eval. Kit
Frequency	902-928MHz	13.56MHz	869MHz
Power supply	7.4V Li-Ion battery pack	1.2V Nickel Metal Hydride	24V, 900mA
Range	0.06–3m	≤0.15m	≤4m
Tag type	EPC Class 0 or 1	TI ISO, Tag-it Philips ISO Philips I-code	Atmel's passive TAGIDU chip
Anti-collision	-	-	Yes
Dimensions (mm)	273 x 119 x 195	185 x 86 x 32	280 x 151 x 60
Antenna (mm)	Integrated	Integrated	200 x 200 x 43
Polarisation	Linear	Circular	Linear
Programming environment	Windows CE .NET , Windows Mobile 2003 OS Wireless LAN	Connection: RS232	Connections; RS232, RS485
Price	$4845	$459	$3680

Table 8 *Comparison of RFID system parameters with different readers* [29][30][31]

The **MPR1510** (see Table 5) has been withdrawn from the market due to the recent changes in ETSI regulations (new 2 Watt power regulations). A re-designed product is expected sometime between May 25th and June 25th in 2005.

The **Ubiquitous Communicator** (see Table 5 and Figure 6) has many exiting additional features like for instance a 2-megapixel camera, a 300 000-pixel unit for videophone calls and a fingerprint sensor. However, these attributes are not essential for this project and only add an additional cost to the device. The device is not for sale for private use but a corporation membership can be applied for and then it is possible to buy an evaluation kit.

The **Trolley Scan portable UHF Reader** (see Table 5 and Figure 7) is part of a system that comes in two sizes: small (100 transponders) and medium (1000 transponders). The EcochipTag that comes with the system is quite small, 80 x 35 mm and can be detected in a range of 6m with the portable reader. The price mentioned in table 4 is for the small kit and the portable reader [33].

Identec Solutions active tag reader the **TimbaTec Pocket** (see Table 6 and Figure 8) can only read two types of tags (also produced by Identec Solutions): the i-D tag or the i-Q tag (not displayed in any table). They are both quite large but if one has to be chosen it has to be the i-D tag. It is the smaller of the two with the dimensions 87 x 50 x 5mm and has a reading range of up to 6m and a price between $27 and $86.

At present, the **Di-400** (see Table 6) offers two low frequencies, one high frequency and no UHF RFID options. It may be possible to integrate UHF RFID options into the Di-400 product but, of course, there would be engineering costs associated with this work in a range of $55000.

The **IP3** (see Table 6 and Figure 9) can read 105mm tags from a distance of 1.5 meters at a rate of up to 6 tags per second. The reader’s memory can retain up to 100 tag identifications.

The **i-scan** (see Table 7) is equipped with connections that allow up to four external antennas to be used at the same time. This makes it more suitable for a stationary solution than for our system.

The **Mobile UHF RFID Reader** (see Table 7 and Figure 10) is handheld but unfortunately not wireless. A solution could be to use a portable computer to make the system somewhat wireless.

The **Intellitag RFID Developer's kit** (see Table 7) is not yet available for the Swedish market. The company is however working on it and there might be some products for sale during 2005.

The field of the **MC9000-G with RFID** (see Table 8 and Figure 11) is a 70-degree cone, which makes the reader rather directed. Because of the frequency the reader is only suitable for sale in the US and Canada.

The **TEK Protégé iPAQ scanner** (see Table 8 and Figure 12) is an adapter for a HP iPAQ 5550 PDA. It quickly snaps on to the PDA and since it has its own rechargeable batteries, it does not derive power from the PDA. It comes with demo software.

The **IR 8000 Evaluation Kit** (see Table 8) requires large tags to be able to operate in a range of 4 m (the tag size for mounting on metal is 180 x 14 x 8 mm). At the moment there are no small passive tags that can work in the range of 4 m when using 0.5 W with this system. The tags are also still quite expensive, about $10 to $22.

2.3 Technical concept

After searching the market for available and suitable system parts, the technical concept could be determined. It was to consist of a number of tags and a reader.

2.3.1 The tag

To sum up, the most important qualifications for the prospective tag is that it has to be cheap, since there has to be a whole network of tags identifying a specific area. This applies especially on future uses of the proposed system. At the same time it must be small but hold enough memory to contain an identification number from a system designed to uniquely identify massive numbers of objects. At present this probably corresponds to a read-only passive tag with an integrated circuit chip.

2.3.2 The reader

The desired property for the reader is to have a reading range of a couple of meters (about 1-3m) in order to obtain information from objects located within that area. Readers with such reading ranges produce beam characteristic that become unpredictable because of the higher frequency, which is very sensitive to its surroundings. The type of material the tag is placed on will also make a big difference to whether the reader will get a response signal from the tag or not. Using special tags that are formed depending on where they are going to be used could solve this problem. Unfortunately, this concept is too expensive and there has not been enough research made on the tags. European Telecommunications Standards Institute (ETSI) regulations have recently been changed, so there will probably be more research done about this matter in the future (see *9.3 Future prospects* and *Appendix A Standards*). While waiting for the development on new RFID products using the new regulations, the proposed concept will be tested with a shorter reading range and a smaller frequency, 13.56MHz. Other qualifications for the reader are low weight, portability and operation on batteries.

3 The users and the task

During this Master’s thesis many target groups were of interest (such as people with visual impairments, people with cognitive disabilities, elderly or stressed people) and they were all systematically discussed. As the technical concept changed the initial target groups were reduced to one key group that we chose to focus on, namely people with visual impairments (see *3.2.1 People with visual impairments*). However, elderly people are also included in this group because as you get older your eyesight is reduced. Since it will be possible to put the original technical concept into practice in the near future, the initial target groups will still be described in this thesis (see *9.3 Future prospects*).

3.1 An enlightening study visit

In the beginning of the project, when no target groups had been decided yet and just a few thoughts about RFID technology where discussed, some scenario suggestions and information sources were presented. At the department of Certec a device called Panasonic ZER-868V was introduced [34]. The device is an RFID reader, which is used to identify objects in a very small range (approximately 1-3cm) using voice messages that the users record themselves. Certec has extensive cooperation with a Swedish day activity centre called Tryckolera [35] and since they just recently had introduced this particular RFID reader to the personnel at Tryckolera, a study visit was made. At Tryckolera “pictures are used to communicate with people that do not have any words”.

At Tryckolera there are pictures everywhere and behind each picture lies a story that can be retrieved through a bar code that is attached to it. The persons at Tryckolera have a bar code reader that when scanned over a bar code generates a voice recording that tells the story behind the specific picture. This way of communication was now to be enhanced with RFID technology, which was of interest to our project. It was an interesting meeting that provided understanding about how we all experience things differently, a thought which is important to keep in mind when working with aids within rehabilitation. However, we chose to work with visually impaired people since it was our initial thought and because it allowed us to create a wider and more general solution.

3.2 The target group

To a person with some kind of visual impairment the inconvenience of not being able to identify or find an object can be very frustrating and time consuming. If the situation becomes more stressed, it grows to be even harder to deal with.

3.2.1 People with visual impairments

People with reduced or no sight might find it hard to find and identify different objects. There are some ways to compensate for their loss in sight, maybe by having a good memory or the ability to keep all things in order. A tool that could help them in identifying things a little faster, or better, would not only save time but also make them feel less dependent on other people.

Therefore, the device has to be easy to use with reduced or no sight and it has to be able to give feedback that does not require the ability of seeing. A talking tool with a basic talking menu system and just a few buttons could solve this problem.

However, another target group could and should be considered within this one. As people get older they tend to forget things more frequently and many of them also have problems with their sight. A tool that would help them to easily identify specific items without having to put on reading glasses or ask for help could relieve them in their everyday life.

In contrast, many elderly people have lived their life without various technical devices and are therefore typically not used to having to rely on a technical piece of equipment. In general elderly people are somewhat uncomfortable around technical objects, something that probably will change in the future.

A helping tool for elderly people should therefore primarily be easy to use, with only a basic menu system. It has to be of a size where the keys will be easy to press, but still be small enough to carry around, similar to a basic remote control.

3.3 Possible scenarios

To build some understanding to problems where this tool can be useful some scenarios were visualized and are listed below.

3.3.1 Helen – a blind mother doing the laundry

Helen is a 30-year-old woman with a family of four. A family of this size generates a substantial amount of dirty laundry, which Helen deals with every Saturday morning. The fact that Helen is blind makes the situation slightly complicated and hard to perform without help from another person. The solution to her problem is RFID technology. Every piece of clothing is tagged and the reader gives her information about colour and washing temperature. Helen easily performs a rather difficult task for a blind person and feels strong and independent.

3.3.2 Peter – an elderly man identifying a can of tomates

Peter and Susan is an elderly couple that live on their own in a small terrace house. It is four p.m. and it is time to cook dinner. Susan asks Peter to go to the basement and bring a can of chopped tomatoes. When Peter arrives at the poorly illuminated basement and locates all the different cans, he can not seem to tell them all apart. Instead of going back up to get his glasses, or asking Susan for help, he uses his RFID reader to find out what is inside the different cans. This way he can find the desired can efficiently and from a distance even when the light is poor.

3.3.3 Henry – an elderly man with reduced sight shopping for groceries

Henry is a man in his late sixties and is currently living alone with his dog Lisa in a small house. It is soon spring and Easter is approaching. Henry is planning the annual Easter dinner for him and his four children that come and visit him from time to time. The shopping list is prepared and Henry is on his way to the grocery store, something he used to hate just a few years ago. Because of his reduced sight and his stubbornness he used to have a very hard time finding the right groceries. He believed that he did not need his glasses and therefore he often came home with diet soda instead of ordinary soda, with conditioner instead of shampoo and this made him furious. The children felt sorry for him and got him a portable RFID reader, something that boosted Henry’s self-confidence. This technical solution nowadays helps him not only to identify groceries but also to read the ingredients, something that has been impossible up till now.

3.4 Possible solution

To construct a device that easily can be used by the target group, a couple of compromises had to be made. To start with, the device should be easy and fast to use since that is the main requirement of the target group. The device should be equipped with as few buttons as possible to make it easier to remember and use the system.

The design of the device is imagined to be in the shape of a cellular phone or a PDA i.e. a small device with a display and some hardware buttons. To be able to collect data from the tags some sort of database should exist. The database should be structured in a way that makes it easy to search trough and to quickly get information about the tag that has been found. The user interface should consist of a small menu system (to make it simple) for scrolling through the databases and a search function, which gives a user the option of finding the desired objects in a faster way.

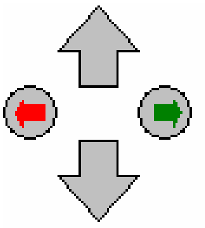

Figure 13 *Buttons*

The menu should be designed with a maximum depth of three levels. If there are too many submenus they will be hard to browse and too time consuming to use. There also has to be enough depth in order to separate tagged items into satisfying groups e.g. clothing, cans or more specifically a wallet. To reach the menus and orientate through them in an easy way the device panel should be equipped with four buttons (see Figure 13). Two arrow shaped buttons to scroll up or down the selected menu and two buttons for entering and leaving the menu.

To start with, a database is selected on the reading device. A database could for instance include the tags at home, at work or maybe the tags in the local library. The databases containing information about the library should be accessed through the Internet while the more personal database that contains information about your home can be accessed from a PC (Personal Computer). Databases used for more personal environments like the home should be easy to modify and rebuild. When the device has downloaded a couple of databases it is ready to be used without the computer.

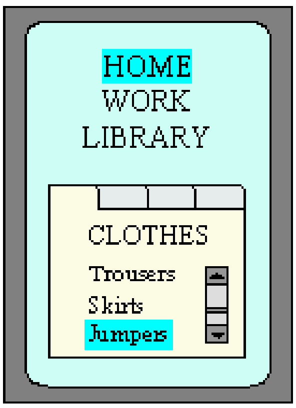

Figure 14 *Display with menu system*

For instance if the database for the home is selected, a few predefined submenus will appear (see Figure 14). Examples of submenus in the home could be clothes, groceries and hygiene products. If none of them are chosen, the reader will be able to read every tag in the home. When a submenu is chosen, the reader will only be able to read tags that are located on for example clothes if that is the chosen submenu. To make the device even more selective there could be categories like trousers, skirts or jumpers that can be selected in the clothes menu.

The communication from the device to a blind person should be realized with a speaker, to give the person adequate feedback. This application is also suitable for elderly people. People with poor sight, that are not completely blind, might find the speaker function a bit unnecessary, so there should be a possibility to disable this function.

4 Creating a solution

In order to create a complete solution, a couple of phases and obstacles had to be overcome a way to merge technology, design and user friendliness had to be found. The different steps and also the problems with collecting information, software and hardware parts for the final solution are described below.

4.1 Hardware

The hardware for the project consists of a reader, a PDA and a few tags. All of these things had to be selected and then acquired. Most of the implementation of the user interface was made prior to the delivery of the reader so when the reader finally was obtained a large piece of effort could put on the interface between the PDA and the reader.

4.1.1 The reader

As stated in the beginning of chapter *2.2.3 Readers*, the TEK Protégé iPAQ scanner (see Figure 15) was considered to be the most qualified reader applicable to our system with regard to the frequency compromise. The choice was based on the following arguments:

- Low price (compared to other, non-adapter, solutions)
- Compatibility with many different tags
- Short delivery time

Figure 15 *TEK Protégé iPAQ scanner*

The scanner, produced by TEK Industries in Vernon, USA, is one of their three available PDA adapters. Each adapter has different physical dimensions so it can be snapped on to different PDA’s. The TEK Protégé iPAQ scanner came with a RS-232 cable and a CD with demo programs. Unfortunately, the power pack (for charging the scanner) used in the US in not equal to the one used in Sweden. As a result a power pack needed to be acquired.

4.1.2 The PDA

The scanner is an adapter to a PDA (Personal Digital Assistant). The fundamental requirements for functions in the PDA are the following:

- Speaker
- Microphone
- Touch screen
- Few hardware buttons

Figure 16 *HP iPAQ 5550*

The only PDA of those that can be used with the reader, which meets all demands, is the HP iPAQ 5550 (see Figure 16). Fortunately this particular PDA was available at the Department of Certec.

4.1.3 The Tags

Many different tags are compatible with the TEK Protégé iPAQ scanner and this opens up several possibilities when choosing a tag for purchase. Especially when it comes to testing which tag would be the most appropriate one for a particular scenario or which tag would generate the longest reading range, it is favourable to be able to test different tags instead of being locked to a specific one that might not be optimal.

Figure 17 *Set of different tags*

When purchasing tags the minimum order seldom falls short of 250, a number rather large for our needs. Since today’s tags still are quite expensive, an effort to acquire free samples was made. Only companies in Sweden were contacted to prevent additional shipping fees. Surprisingly, many of them were very interested in the project and were glad to be of any help, which resulted in several different tags being gathered (see Figure 17).

4.2 Software

When choosing a suitable programming environment, several aspects had to be taken into consideration: What are the advantages and disadvantages of a particular language and how familiar is it?

Most of the actual experience consisted of Java programming and therefore Java would be the best choice. A number of programming environments for PDA’s in Java were found on the Internet but none of them were satisfactory. However, Certec could provide an environment called Microsoft Visual Studio .NET for programming in C which is very suitable when working with Windows CE (the operating system in the PDA). Although there was lack of experience in the C language it was given a try. During the initial phase of the implementation an important discovery was made. It appeared that this particular environment also offered programming in C#, a language very similar to Java. C was swiftly abandoned and the C# programming started.

4.3 Financial plan

A small budget should not be considered as a problem but simply something to take into consideration when writing a Master's thesis. Like many other Master's thesis projects, this one did not have a large budget, but by acquiring a number of things for free, this was not a problem.

4.3.1 PDA

Since Certec had a PDA that met all the requirements and that was available for use, the problem with purchasing a new one was eliminated.

4.3.2 RFID reader

The price of the reader was a bit too high, but since it was the cheapest one on the market and since the project could not be completed without a reader, it was bought anyhow. The reader was purchased for $545,50 with a shipping fee of $86,50 included. Since there was no power pack for usage in Sweden, included in the RFID package, a new power pack was bought at Kjell & Company for $13,30.

4.3.3 Tags

Since the RFID reader somewhat exceeded the budget it would be preferable if the tags would not be purchased but instead brought together as samples. Different companies in Sweden contributed with all the tags and on the whole; a number of 85 tags were accumulated, including 10 different types of tags.

4.3.4 Software

Certec provided the software, which eliminated the need of purchasing commercial software.

5 Prototyping

The prototyping started with the construction of a mock-up of the PDA and created a foundation for the programming that was initiated shortly after. A couple of weeks later, a meeting was held at the Eye Clinic in Malmö. Subsequently, keeping all the suggestions and points of view from the meeting in mind, the programming proceeded.

5.1 Mock-up

As soon as the final solution was determined, a mock-up was constructed from cardboard (see Figure 18), in order to thoroughly perform a walkthrough of the menu systems of the future program. The mock-up has the dimensions 208 x 143mm (the PDA has the dimensions 84 x 138 x 16mm). The buttons are represented with cardboard as well so they easily can be detected and the display consists of six paper flaps representing the operation made when the equivalent button is pressed.

Figure 18 *Mock-up*

5.2 Meeting at the Eye Clinic

To a person without any visual impairment it is impossible to understand how a visually impaired person thinks or experiences and what he or she needs. When developing a prototype for a specific group of people an interview with a person from that group is very important.

Through Krister Inde, who works as a low vision therapist at Certec, we got in touch with Johanna Olin who agreed on being our main test person.

When the meeting was held, a part of the programming was already done in order to be able to receive all the necessary feedback (see 5.3 Software development).

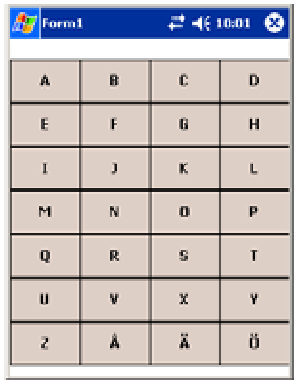

Figure 19 *Alphabet program*

5.2.1 Preparations

Before the meeting, a number of things had to be organized. Initially a questionnaire was composed (see *B.1 Questionnaire 1*) and subsequently a special alphabet program for the PDA was constructed to simulate how a person with a visual impairment would be able to type on the touch screen (see Figure 19). A plastic film with the Braille Alphabet printed on it (see Figure 20) was placed on the PDA's touch screen just on top of the program's alphabet buttons. The main program was adjusted with the

Figure 20 *Plastic film with the Braille alphabet*

intention that the most significant applications, regarding testing with persons with visual impairments, would work.

5.2.2 The meeting

Figure 21 *Johanna Olin*

The meeting was held at the Eye Clinic in Malmö with Johanna Olin (see Figure 21). Johanna is 37 years old and works as a sight counsellor. Her assignments are group activities, education about helping tools and Braille, but also to function as a social contact, a role model and to show other blind people that life is possible and there is much to do and learn, even if you are blind. Johanna has a husband with visual impairments, who is not entirely blind, and an 11-year-old daughter. Johanna has been blind for 13 years.

During the meeting a demonstration was held to show Johanna the mock-up and the prototype and explain the thoughts around them. The questions from questionnaire 1 were read (see *B.1 Questionnaire 1*) and Johanna presented her points of view. Different solutions to discovered errors and future enhancements were also discussed.

There is a big difference in getting about between people with no sight and people with a very reduced sight. As an example people with no sight almost never do their own shopping. It is too difficult with all the groceries always being shifted around and that many articles are hard to tell apart. However, people with reduced sight can find their way through the store but consider it difficult to read from an item. For instance, if the person maybe has an allergy or wants to know the sugar content, reading the ingredients if a very important issue. These people find it very hard and uncomfortable to always be in the need of asking someone for help.

Another difference in getting about is when people go for a walk in the city. A person with no sight needs to be trained on specific paths to reach the desired destination and there is no possibility to go for a stroll. However, when the person is in the beginning of the training it could be a comfort to be able to 'listen' to the surrounding buildings, street corners etc. to get a rough navigation. Similarly, when the person enters a store, it would be a comfort to get information about which store is being entered and the location of the counter to get further help.

To travel by bus is often a must if one lives in a city. When a person with no sight has been trained to find the bus station there is only one problem, how to know which bus to enter. To be able to get the information about the bus number without shouting to every bus driver that drives along could create that feeling of safety and independency that many people with visual impairments experience. To know how many different buses that make a stop at a particular bus stop would also be a comfort.

When living in a family, it can be hard to get everyone to respect ‘what is mine and what is yours’ and that each thing has its place. And it becomes even more important if a member of the family is blind. To find misplaced objects can be hard and becomes even harder when someone else has misplaced them. That the world we live in is a ‘seeing world’ is a fact that is hard to change and just needs to be accepted.

Another problem for a person without sight is that it can be hard to separate things that feel the same like cans, spices etc. To be able to mark these objects in a smart and easy way, maybe by marking them in the store already, could save time.

For a person with a visual impairment, or with other impairment for that matter, there is a risk of collecting several aiding devices, all needed for a special purpose. That is unfortunately because it is very rare to find a multifunction device today, and if Johanna had her wish come true every function she needs would be realised in her cellular phone.

5.3 Software development

The programming started as soon as the *.NET* environment was installed. To get acquainted with the programming language a couple of test programs like ‘Hello world’ were implemented. Several other minor test applications were made to get an idea about the functions of the hardware buttons, the voice recorder and the communication between the PDA and the RFID reader.

5.3.1 The hardware buttons

The first interface solution was discussed when the technical concept did not include a PDA, therefore a button panel was needed (see *3.4 Possible solution*). Since the current technical concept is going to use the existing hardware buttons on the iPAQ (see Figure 22), the old button panel design is not very applicable on the PDA. However the train of thought remains relevant and is merely somewhat adjusted. The operations made when a button is pressed are described below:

Figure 22 *HP iPAQ 5550*

On/Off – turns the PDA on or off
W1 – Writes a second description on the selected tag
W2 – Writes a first description on the selected tag
S – Scrolls through the databases
R1 – Reads the first description on the selected tag
R2 – Reads the second description on the selected tag

5.3.2 The program code

The **MainForm** encloses the main program and some of its methods are `TheButtonIsPressed()`, `OnKeyDown()`, `PortDataReceived()` and `SendData()`. The methods in the **MainForm** and all the classes are described further in *Appendix C* and the complete code can be found on www.certec.lth.se. On the whole, the **MainForm** contains the code for the actions of all buttons and databases. A schematic figure of how the program is built up is shown below (see **Figure 23**). Every time a hardware button is pressed on the PDA a message is sent in the PDA. The class **MyMessageWindow** listens to these messages [1] and calls the method `ButtonPressed()` in the **MainForm** [2] whenever one of the four hardware buttons is pressed. The class **RegisterHKeys** has the function of preventing the actions usually carried out in the PDA when a hardware button is pressed. When an action require that the RFID reader is activated i.e. should search for a tag [3], the `SendData()` method in the **MainForm** is called. A message is then sent to the class **PortManager** [4] containing the instructions that should be carried out by the RFID reader. When the RFID reader either has found a tag or not, it sends the information back to the **PortManager** [5]. The **PortManager** will then notify the **MainForm** by calling `PortDataReceived()` [6]. When a sound file is played or recorded, methods in the classes **Player** [7] and **Recorder** [8] are called from the **MainForm**. The class **Tag** is an object class that has the function of storing the information about each tag collected and stored in the system. It contains information about the ID, sound one, sound two and to what category the tag belongs to (the attribute) like clothes or cans. The class **TagList** underlies the databases, which contains the objects Tag and is used to easier handle the tags in an improved way like finding out if the tag is in the database with the information about its ID.

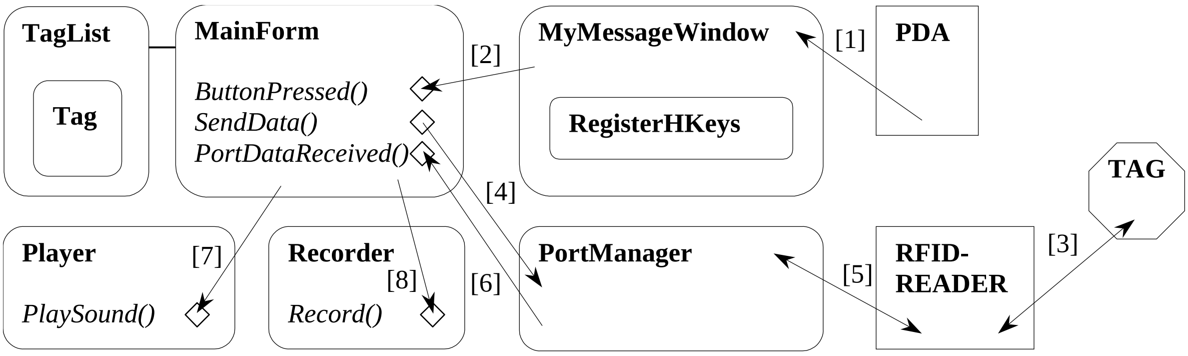

Figure 23 *Schematic figure of the program*

5.4 Program walkthrough

When the program is initiated the main form is in display. At this point the main form holds two appearances depending on whether the databases are empty or not (see Figure 24 and Figure 25). Initially the user can press all of the hardware buttons and all of the buttons on the screen. A description of a walk through of the program is described below.

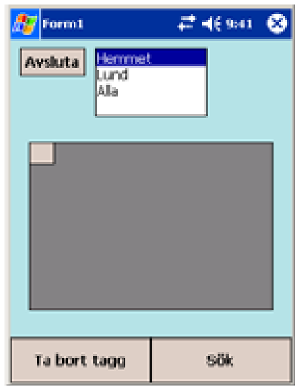

Figure 24 *Empty database*

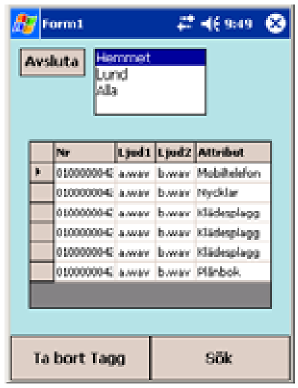

Figure 25 *Database with tags*

Figure 26 → *Lund*

5.4.1 Scroll button

When scrolling up or down, the user can browse through the different databases, for example ‘Lund’, ‘Hemmet’ or ‘Alla’ (see Figure 26). If ‘Alla’ is chosen, the reader is able to read all tags, assumed that they are added to the system. When scrolling to the right the user enters the chosen database and a new database appears (see Figure 27 and Figure 28). When scrolling to the left the user leaves the database and returns to the last chosen one. The scroll button is described as B3 in *5.3.1 The hardware buttons*.

5.4.2 Write-1 button

To write a sound (.wav-file) to the tag the *write-1 button* (described as W1 in *5.3.1 The hardware buttons*) has to be pressed. Over again a beeping sound tells the user that the reader is searching for a tag to write to. When a tag is found a message is played asking the user if he or she wants to record information about the tag. If the tag already has a ‘sound-1’ recorded, a message is played asking if the sound should be replaced. A tag that is already being used in another database cannot be replaced and if this is the case a message is played to indicate which database it belongs to. To return to the starting position, without recording a sound, one of the other three hardware buttons has to be pressed.

Figure 27 *'Hemmet' → 'Pryl'*

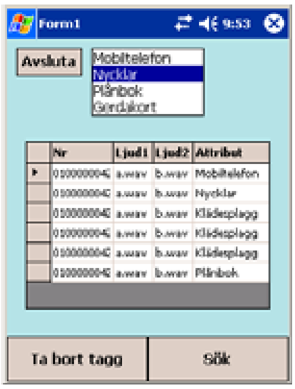

Figure 28 *'Pryl' → 'Nycklar'*

5.4.3 Write-2 button

To be able to add a second piece of information to the tag the *write-2 button* (described as W2 in *5.3.1 The hardware buttons*) has to be pressed. This information however, can only be added to tags that hold a 'sound-1'. When the *write-2 button* is pressed a beeping sound indicates that the reader is searching for a tag. When a tag is found, a message is played to ask the user if he or she wants to record a new 'sound-2' or replace it, if the tag already has a 'sound-2'. If the tag does not hold a 'sound-1', the message being played tells the user that the specific tag has not yet been added to the system. This action can only be accomplished with the *write-1 button*. To return to the starting position, without recording a sound, one of the other three hardware buttons has to be pressed.

5.4.4 Read-1 button

When pressing the *read-1 button* (described as R1 in *5.3.1 The hardware buttons*) the user receives a beeping sound informing that the RFID reader is searching for a tag. A reading cycle lasts for seven seconds at most, but if there is no tag to be found a new cycle is started. To make the RFID reader stop searching the *read-1 button*, or any other hardware button, has to be pressed again. The reader will then have to complete it's present reading cycle. When the reader finds a tag that it is looking for it automatically stops. Due to the construction of the RFID reader, there is no way to instantaneously interrupt the reading cycle. When a tag is found, the user receives feedback informing whether the tag is in use and has a sound or not. If the user previously recorded a sound it will be played.

5.4.5 Read-2 button

When pressing the *read-2 button* (described as R2 in *5.3.1 The hardware buttons*) the user receives the second recorded information about the tag, if there is any. Just as the *read-1 button* a beeping sound tells the user that the reader is searching for the tag. However, when pressing the *read-2 button* (unlike the *read-1 button*) the reader will only initiate one reading cycle. To start a new reading cycle, the button has to be pressed again.

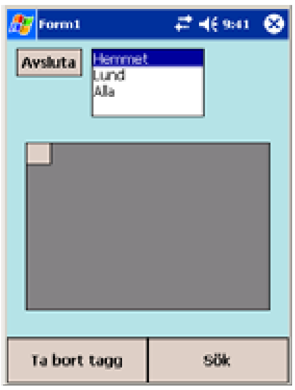

Figure 29 *Screen buttons*

5.4.6 Remove button (Ta bort tagg)

This button (see Figure 29) is used to erase information about a specific tag. When a tag has been erased it is no longer in the system and both 'sound-1' and 'sound-2' is lost. To be able to erase a tag the database that contains the tag has to be active and the RFID reader has to be able to read it. Therefore when this button is pressed a beeping sound starts, indicating that the reader is searching for a tag that then can be erased.

5.4.7 Search button (Sök)

When this button (see Figure 29) is pressed, a search mode is displayed (see Figure 30). A number of nine buttons, with an alphabet arranged on them and one button with special characters, is put on view and the *Remove button* is transformed to an *Erase button* (Sudda button). The user is now able to type the attribute of a specific tag he or she wants to search for. For instance, if the user writes 'Plånbok' the reader will only be able to find tags with the attribute 'Plånbok' assigned to them, in the searching area. When typing, the user receives feedback in the form of the typed letter being narrated and the typed letters appear on the display. A timer keeps track of the button presses and is triggered if the user for instance wants to write *b* then *a*. The timer then prevents a *c* from being typed. To start the search cycle the *Sök button* is pressed once more. To end the search mode without searching for a specific tag and to return to the starting position, the user must press one of the four hardware buttons.

Figure 30 *Search mode*

5.4.8 Terminate button (Avsluta)

When pressing the *Terminate button* (see Figure 29) the program will be terminated and a message is played to inform the user about it. The pieces of information about the tags are saved to files and the communication between the PDA and the reader closes.

6 Prototype testing

When the prototype finally was ready it needed to be tested with different people and in different situations. Initially the prototype was tested together with people without any visual impairment and later the final test was conducted at the Eye Clinic in Malmö.

6.1 Tests at the department

The tests at the department consisted of setting up a test environment, trouble-shooting and testing on people without visual impairments. These test were mainly performed in order to eliminate possible incidences of error before the final test at the Eye Clinic in Malmö.

6.1.1 Test environment

The test environment was created to simulate how a number of scenarios could take place. Many different scenarios were thought of, but it was important to take into account that the scenarios found essential, might never take place in the everyday life of a person with visual impairments. Finally three possible scenarios were chosen to put to the reader to the test.

Figure 31 *Shopping scenario*

The shopping scenario - The task was to select a box of cookies that did not contain nuts, from a shelf (see Figure 31). The test objects consisted of three cookie boxes, each with a tag attached to it. The information on the tags described whether the cookies contained nuts or not. More accurately, when searching for cookies without nuts, the reader only responds to tags with the attribute 'no nuts'.

Figure 32 *Laundry room scenario*

The laundry room scenario - The task was to separate the dirty laundry pile into smaller piles with regard to features such as colour or washing instructions (see Figure 32). The test objects consisted of four pieces of clothing, each with a tag attached to it. The information on the tag described of which colour the piece of clothing was.

Figure 33 *'Leaving home' scenario*

The 'leaving home' scenario - The task was to inspect if the handbag contained everything that was supposed to be brought along (see Figure 33). The test objects consisted of a fabric bag that represented a handbag. Initially a real handbag was tried out but the reader had some trouble reading through the thick leather.

The fabric bag contained three tags attached to it from the inside and they represented a cellular phone, a wallet and a bunch of keys. No real objects were used in this scenario because of the short reading range and the inconvenience of using a simple fabric bag. The information on the tag described what kind of object it was attached to for example a cellular phone, wallet or a bunch of keys.

6.1.2 Tests with people without visual impairments

The prototype was primarily tested by ourselves, but some tests were also conducted together with a number of randomly chosen people without any sight impairments to provide us with some feedback. The tests were carried out using the three testing environments, in order to see if it was easy, hard or even possible to use the product without any visual impairment. The test persons, including ourselves, were able to try out the prototype with and without a blindfold.

6.1.3 Trouble-shooting

When testing a product to eliminate errors it is crucial to put every single implementation to the test. The code needs to be looked through thoroughly, especially inspecting the risk of having the program starting an endless loop.

The trouble-shooting was also performed by ourselves and every function, action or button press was investigated. This procedure was conducted throughout the entire programming part of the project and attempts were made to adjust all discovered errors.

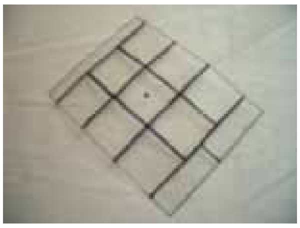

Figure 34 *Plastic film with display buttons*

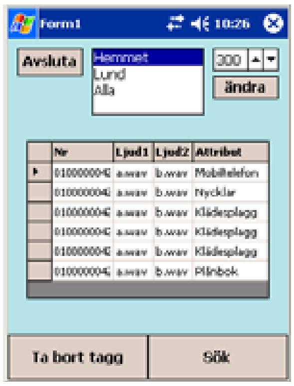

Figure 35 *Timer speed control (upper right corner)*

6.2 Tests at the Eye Clinic

Clearly, all errors discovered during the tests at the department had to be corrected before the final test and several preparations had to be taken care of. The final prototype test was once again carried out with Johanna Olin at the Eye Clinic in Malmö.

6.2.1 Preparations

A new questionnaire was composed as well, to document new points of view (see *B.2 Questionnaire 2*). The test environments were prepared and slightly adjusted to satisfy the needs of a blind person. A piece of plastic film was cut out to be used on the display in order to inform a user with visual impairments where the display buttons are located (see Figure 34). This is especially important when operating in the search mode and a set of nine alphabet buttons appear on the touch screen. A speed control for the timer in the search mode (see *5.4.7 Search button (Sök)*) was added to examine which speed would be suitable to use when typing with the alphabet buttons (see Figure 35).

6.2.2 The test

Two of the three scenarios were going to be tested together with Johanna and all the items had to be arranged. The “leaving home” scenario was not tested together with Johanna because there was some trouble finding the tags in the short reading range. Moreover, the other two scenarios were considered enough to provide a satisfying amount of feedback. Instead, this scenario was tested at the department, on people without any sight impairments.

Figure 36 *Johanna tries out the reader*

Johanna received key instructions about how to use the reader for approximately 20 minutes and was guided through the program to create an understanding for button-clicks and navigation. The testing of the two scenarios, the shopping scenario and the laundry room scenario, subsequently followed (see Figure 36). Johanna also got to write information to a tag, read the information and then erase this specific tag from the database.

The questions from questionnaire 2 were recited (see *B.2 Questionnaire 2*) and Johanna answered the questions explaining her thoughts and advantages and disadvantages with the prototype.

7 Test results and final adjustments

Thanks to performing the tests with numerous people, with different needs and for that reason with different ways of understanding and perceiving, the results from the tests all gave valuable insights from different kind of views. Altogether, the results and evaluations helped to create a better prototype.

7.1 Tests at the department

7.1.1 Tests with people without visual impairments

As stated in *6.1.1 Test environment*, a real handbag was initially tried out in the 'Leaving home' scenario but when we tried out the reader with different tags, it was hard to detect any tags through the leather. Therefore, a more suitable bag was selected in order to avoid complications during the test.

We also discovered a few new bugs when browsing through the menus and performing different tasks like reading and writing to a tag. Sometimes a bug only appears when a certain cycle of events has been performed and therefore it is important to test different kinds of event cycles even if they end up performing the same task. All of the discovered bugs were adjusted.

When testing your own prototype it is likely to forget to try something out that you have not thought of, and therefore the other test persons were of great importance and help. They discovered that it was a bit hard to press the alphabet buttons in the search mode. Some thought that it was hard to know how many times the button had been pressed until you got the sound feedback of the letter and then it was a little too late. They also found the design of the prototype to be consistent and easy to use.

7.1.2 Troubleshooting

As always, when creating a prototype, plenty of errors become evident and the trouble-shooting provided a great opportunity to correct all errors. While browsing through the code, some parts seemed to be excessive, and should be removed. The names of all the buttons, variables and methods were found to be inconsistent and should be changed so the code would be easier to comprehend. Some of these parts of the code (buttons, variables and methods) had been written in Swedish, as well as all the comments, which was not very consistent either.

7.2 Tests at the Eye Clinic

In general, Johanna thought that the prototype was a great idea. In fact, using her own words, she said that if it could be implemented in a phone the concept would be *“bloody brilliant”*. Although most blind people would not want an additional device, Johanna believes elderly people might not mind having to bring along a helping tool just for shopping. Since many elderly people do not use cellular phones the helping tool would simply be a device instead of being an additional device.

One thing Johanna considered to be difficult was using the scroll button. It was far too sensitive and reacted to easily while pressing and scrolling. Often when scrolling in one desired direction the PDA would not perform the desired action and the scrolling would proceed otherwise. Johanna, who really wanted to understand how the reader works and wanted to operate it without any help, found the scroll button quite irritating even though she believed she scrolled very gently.

Another thing that she found deficient was the display buttons. She was very understanding to the fact that the hardware buttons were not enough to realize the concept and that some of the buttons had to be positioned on the display. The problem, however, was that when fingering the display to orientate oneself through the buttons it was very easy to accidentally press one of them. In other words, the display is much too sensitive to be used as a button pad. A better solution would be possible if the reader would be implemented with a cellular phone and the cellular phones hardware buttons could be used. This would be especially beneficial when operating in the search mode with the alphabet display buttons. Hardware buttons are better because they are not as sensitive as a touch screen. They also give better feedback since they are mechanical and you actually have to press down the button.

The current solution to the display problem, using the plastic film placed on top of the display with markings informing the user where one button ends and another begins, was for the time being not a bad way to solve the problem. Furthermore, the way the middle button was distinguished, with a raised dot, Johanna believed was a very good way to provide the user with an adequate amount of information. This can be compared to the first solution, with the Braille alphabet on the plastic film, where the user was provided with too much unnecessary information. Johanna stated that it is important to remember to provide the user with explicit in preference to over-explicit information. For instance, when the reader is turned on, a voice tells the user in Swedish ‘The reader is now on’ instead of just ‘on’ which would be a more suitable piece of explicit information.

The problems we discovered during the programming, of the sounds to be too long and slow, Johanna also had the same opinion about. Especially the instructions, informing the user what to click, what to do and when to do it, were too long.

Finding the way through the menus, scrolling up and down to select a database, scrolling to the right to enter and scrolling to the left to leave, was very easy to understand. Most cellular phone menus are built up in the same way and the more things that are built up the same way, the easier it is to learn how to use a new device. Johanna felt that it was more important to build programs similarly, than trying to come up with a different, but maybe easier, solution.

A function that Johanna lacked when testing the prototype was that when operating in the search mode, she would like to be able to be reminded of what she has typed so far. Maybe by pressing a button, all the letters could be narrated to the user. She would also like to know which letters remain after erasing a part of the typed word, instead of just a beeping sound informing the user that a letter has been erased.

An interesting question Johanna had about the future was how people are supposed to learn how to use the reader. Maybe there will be someone who will educate people about the reader since many blind people find it hard to grasp new devices. When living with a visual impairment some things becomes harder to achieve and it is inevitable to get away from the fact that the world we live in is a ‘seeing world’ that we all have to adjust to.

7.3 Final adjustments

The solutions of the issues and errors discovered during the tests, that were found important, are described below. The initial action was to try to correct the program errors discovered during the visit at the Eye Clinic since they were considered to be of greatest importance at the moment. Johanna’s improvement suggestions were also taken into consideration and many of them were put into practice (see below).

7.3.1 After the tests at the department

The excessive parts found in the code were successfully removed and as a result of the inconsistent name giving of buttons, variables and methods; they were all changed to be easier to understand. Another thing that was changed to make the code more consistent was the code and comments, which were all translated to English. The problem with the alphabet buttons concerning the fact of not knowing how many times they had been pressed was never further modified. In the end, after the adjustments and some debugging, the program continued working as it was supposed to.

7.3.2 After the tests at the Eye Clinic

It turned out that the scroll buttons sensitivity could be adjusted in the PDA's settings and so the repeat rate was set to very low. This way, when using the scroll button, it would only respond to one click at a time.

Recording new, faster and more concise sounds solved, for the time being, the problem with the sounds being too long, over-explicit and slow. Sounds like "Now you are in the search mode" or "The reader is off" were replaced with just "Search mode" and "Off".

The idea of having a function that reminds the user of what has been typed so far in the search mode was put into practice. The reader was enhanced with a method that reads the typed letters successively whenever the user presses the scroll button.

An additional method was implemented within the search mode on account of extra time. When the user has typed the first two letters of a desired attribute, a sound is played giving the user alternatives of the word being typed. If the user agrees on the word suggestion, the attribute will be typed and the reader will search for a tag with the specific attribute. If there is no attribute that begins with the typed letters, no alternative is given.

8 Problem log

During the prototyping there was obviously going to be some problems to deal with. All the encountered problems and their solutions will be described in this chapter.

8.1 The PDA

The PDA did not work properly. It was hard to keep its battery on a satisfying charge level and when it had been shut down and off use for a week, it ceased to work. After a complete restart of the software, it was possible to use it again.

While building a program that had to listen to the hardware buttons it appeared that the middle button did not respond in the same way the other hardware buttons did.

8.2 The RFID reader

Since the RFID reader was bought from the US there were some problems with the power supply. The power cable that comes with the reader cannot be used in Sweden, hence it was excluded from the package.

Due to the design of the RFID reader some functions are hard to completely control. For instance one reading cycle lasts for seven seconds or until a tag has been found. It was not possible to change the duration of the cycle and therefore the only solution was to begin a new cycle if no tag was found. If the user tried to end the search, it would take at most seven seconds before the scanner would end the current cycle.

When the prototype was tested by ourselves, according to the scenarios, some of the tags ceased to respond to the reader the way they used to, which led to the disturbing problem that they could not be read or written to. At one occasion the reader completely stopped working and the reason why was never discovered. We were never able to trigger this incident again.

8.3 The software

It was hard to make the middle hardware button to respond to the program in the same way as the other four could. By putting the main form in focus all the time, a listener could be created that solved this problem. It would have been better to solve the problem similar to the other hardware buttons but this has to be a future modification.

Unfortunately when working with C# in a Windows CE application the predefined classes are limited. This was a disappointment when working with the serial communication between the reader and the PDA, which became complicated. Getting help with solutions from Internet forums solved this and some merges and changes were made to fit them into our program [36]. The result was a class called **PortManager**.

To find out how the voice recorder worked and what flags to use was harder than first imagined. After some searching on the Internet and a lot of flag testing a solution was established. Another problem with playing the sound was that it was too slow. This was particularly a problem when operating in the search mode, where a voice has to read the letters the user presses. Due to the slow reading time the voice reads the letter after it has been chosen and not while choosing.

8.4 The tags

Some tags are harder to read, because they do not respond to the reader like most other tags. Measures will be taken if there will be some time to spare, and if it is believed that this is an important issue to resolve.

9 Conclusions

After the tests were conducted, a concluding discussion was carried out. All the results were reviewed and an evaluation was made to see if the result actually agreed with the aim. As a final point, future prospects were considered and a few solutions with improvements and safety aspects were discussed.

9.1 Review of test results

When creating a prototype it is always important to try it with test persons and it is preferable that prototype tests are continuous during the development phase. The test persons will see the prototype from another perspective and try to do things to it that might never be thought of.

In this project, tests were made both with a person from the target group and with persons outside the target group. During the tests it was realized that it is not always easy to imagine oneself in another persons situation and it is very easy to become home blind.

9.1.1 Tests at the department

Each time trouble-shooting was performed new discoveries of errors were made. Our conclusion is that when creating a prototype, it is hard and time consuming to eliminate every small error. New issues will always come to mind and changes will always have to be made in order to improve the prototype. It is important to remember that the purpose of this thesis was not to create a problem free product for the market but to test a concept.

When testing with people it was realized that different people, of course will have different opinions, and therefore also will grasp things differently. There will always be people whose needs will not be satisfied and that is something that needs to be taken into consideration. It is vital to find the middle ground in order to create a solution that meets the needs of many people.

9.1.2 Tests at the Eye Clinic

When the prototype was tested by ourselves at the department, it was of course found to be easy to understand, and it is somewhat easy to become a little home blind. When to click or what to do was never a problem. However, when the prototype was tested with Johanna Olin it was realized that the way a blind person perceives is quite different from persons without any visual impairments. The way a blind person takes in information is more prioritized in ways of touching, feeling and hearing, while a person with normal eyesight takes in a lot of information using his/her eyes. For a person with normal eyesight, to disable his or her vision while taking in information and relying only on touching, feeling and hearing, appeared to be quite hard. For a blind person, of course, these senses are widened. It was realized that a person obtains more information by vision than one may think. To conclude, creating a device for people that do not share the same way of perceiving, as one do, there will be complications that will be hard to understand.

Johanna had a lot of suggestions on improvements that were very reasonable and we tried to come up with good solutions (see *7.3 Prototype adjustments*). There are still improvements that have to be made to form this concept into a useful helping tool but they are not impossible (see *7.4 Future prospects*).

Concerning the question about how people will be able to learn how to use the reader, several solutions were discussed. A manual, in computer format, that can be narrated could be one solution. Another solution might be that somebody could teach people how to use the reader. Or maybe sound instructions could be included with the reader to tell the user how to use it.

9.2 Aim versus result

When approaching the end of the project the initial aim and the final result were compared in order to see if they corresponded with each other. In our opinion most of the specifications were met, such as making the device wireless, easy to use and with sound feedback, even though the ambition to make the device small fell short, since it was completely out of our reach. Nevertheless, most important of all, the foremost aims of investigating and creating the concept of a helping tool for people with visual impairments was accomplished.

9.3 Future prospects

This project was just the beginning of something that can be very useful in the future. The concept has been introduced and has some potential but many improvements have to be made. The first thing to improve is the reading range, which has to be at least 2-3m in order to search from a satisfying distance instead of just to be able to identify an object from a short distance. This means that more research has to be made on RFID systems with higher frequency (UHF).

9.3.1 Problems when using UHF and long range

When working with passive tags in a long range, i.e. higher frequency, they have to be coupled with electromagnetic energy. This type of signal can have different types of polarisation. To make the communication work between tag and reader their polarizations have to be the same. This means that if the reader tries to identify a transponder with a different polarisation, the transponder will not get enough power to answer. Simply by turning the reader while scanning the room can solve this problem but in a way the user probably would not accept. A better way to solve the problem is by using circular polarization on for instance the reader. This will make it able to communicate with both vertical and horizontal polarized tags, i.e. which side of the tag is facing up, will make no difference on the communication. Unfortunately in using circular polarization there will be losses (around 3dB), which shows in reduction of reading range.

Another thing to take into consideration when working with higher frequencies is that the beam characteristic will change. The reader will have an improved directional effect but there will also be reduced penetration ability. In the US there are RFID readers working in the region of 900MHz with a protocol that allows them to work in a span of frequencies, e.g. 902-928MHz, at the same time, which makes it much easier to detect tags. This is because it increases the chance of one of the beams having its peak where the reader is held. At the moment it is prohibited to work with RFID in the region of 900MHz in Sweden and instead 868MHz is used which was recently decided. But not enough research has been done yet to know if they really are useful to our project.

9.3.2 Future improvements

Enhancing the reader with a speed control for the sounds would be a solution to the problem with the sounds being too long, over-explicit and slow. When using the device for the first time and learning how it works, the speed could be set on slow. Subsequently the speed can be increased as the user becomes more familiar to the device.

Another future improvement is portability, and by implementing the concept into a cellular phone this problem could be solved. This will also reduce the amount of devices that need to be carried around with you.

9.3.3 Applications for other target groups

There could also be several uses for this concept in other target groups. Stressed people or just forgetful people would probably also appreciate a device that could save them time and energy when they most need it. For instance, when leaving home with a bag full of things, the fact that something might have been forgotten is probably and often considered. The situation becomes irritating and stressful when turning the bag inside out just to find out that everything is there.

9.3.4 Other scenarios

In a future world with RFID tags everywhere, the tag could find new working areas. The technology could be used for changing business cards; instead of carrying around a bunch of business cards all that would be needed is an RFID tag. Would it not be preferable to just get all the information into your address book in a button press, i.e. just by reading the tag with a cellular phone or a PDA.

Another area is the record business where the technology could be used to let the customers listens to records without having to wait for a listening booth to be ready. When the customer is inside the store he or she is able to listen to samples attached to the record in the shape of an RFID tag with their cellular phones provided with RFID readers.

A third area is virtual post-it. Imagine that a person is going to the grocery shop; at the door someone has left an RFID tag with for example a good recipe. The RFID tag can easily be changed from home and the information is stored in a database.

9.3.5 Security aspects

If there will be further work done with this system, there are some things to take into consideration regarding safety. Security becomes an important issue when a person has tags on all his or her belongings. If other people are carrying an RFID reader, they will be able to read the tags. They won't be able to hear the specific recorded sound but they can still listen to the tag's identification. This problem is something that could be solved in the future, maybe by making personal tags completely invisible to unauthorized readers.

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Glossary

AID	Automatic Identification of Data
API	Application Programming Interfac
The Braille alphabet	A system of reading and writing with raised dots developed by Louis Braille.
Certec	The Division of Rehabilitation Engineering Research in the Department of Design Sciences in Lund.
C#	C sharp, a Java-like C language
EAN	European Article Number
EPC	Electronic Product Code
ETSI	European Telecommunications Standards Institute
ISO	International Organization for Standardization
OS	Operating System
PDA	Personal Digital Assistent
RFID	Radio Frequency Identification
RS-232	A cable standard
SKU	Stock Keeping Unit
UHF	Ultra High Frequency
UPC	Universal Product Code
USB	Universal Serial Bus. A peripheral communication port used on most modern computers.

Appendix A: Standards

There are several standards and regulations that have to be taken into consideration. The ETSI, for example, tells the maximum transmitted power allowed at a specific frequency. There are also some standards for the tags, which makes it easier to determine whether it can communicate with a specific reader or not. Moreover, there are different standards in different parts of the world.

A.1. The EPC standard

EPC stands for Electronic Product Code and is a coding standard, consisting of a set of digits, designed by the EPC Global Inc. for the identification of items using RFID technology.

Tags and readers can be categorized into different EPC classes depending on their specifications (see Table 9).

EPC Class	Definition	Programming
Class 0	Read-only passive tags	Programmed during manufacturing
Class 0+	Write-once, read-many version of EPC Class 0	Programmed once by the customer, then locked
Class 1	Write-once, read-many passive tags	
Class 1 – Gen2	Currently being drafted and reviewed	
Class 2	Rewritable passive tags	Can be reprogrammed many times
Class 3	Semi-passive tags	
Class 4	Active tags	
Class 5	Readers	-

Table 9 *The definition of different EPC Classes* [37]

The EPC can be regarded as an extended form of the existing UPC (Universal Product Code) or EAN (European Article Number) that at present is used by manufacturers to identify objects.

The UPC and EAN codes both consist of two segments:

- A manufacturer identifier
- A product identifier

The EPC however, consist of three segments:

- A manufacturer identifier
- A product identifier
- An item serial number

The complete format of the EPC is a 96-bit number including a header and three data segments:

A.BBB.CCC.DDDD

A : Header: 8 bits
B : Manufacturer: 24 bits
C : Product (SKU or Stock Keeping Unit): 24 bits
D : Serial Number: 40 bits

Information is not stored directly within the code, instead the code serves as a reference. In other words, the code is an address [38].

A.2. The ISO network

ISO (International Organization for Standardization) is a network of the national standards institutes of 148 countries. International Standards provide a reference structure, or a common technological language, between suppliers and their customers. This is achieved by a consistent application of specifications and criteria in the classification of materials, in the manufacture and supply of products, in testing and analysis, in terminology and in the provision of services [39].

ISO/IEC 18000 is a series of standards for Air Interface Communications and consists of seven parts:

- 18000-1 – Generic parameters for the Air Interface for Globally Accepted Frequencies
- 18000-2 – For communication below 135kHz
- 18000-3 – For communication at 13.56MHz
- 18000-4 – For communication at 2.45GHz
- 18000-5 – For communication at 5.8GHz (withdrawn)
- 18000-6 – For communication at 860 to 930MHz
- 18000-7 – For communication at 433MHz

As can be seen, each of these parts deals with a different aspect of RFID. The first part is the defining document that explains how the standard works and the rest are divided by frequency [40].

ISO 15693 standard applies to 13.56 MHz and consists of three parts, 15693-1, -2 and –3. There are only two commands, which must be supported in the ISO and they apply to both reader and tag. For standard –1 the products must be able to list all the tags in the field and for standard –2 the reader must be able to tell a tag to be quiet to further notice. In standard –3 the products must include both standard –1 and –2 [41].

ISO 14443 is an international standard for contact-less smart cards operating at 13.56MHz in a close distance with the reader antenna. It consists of the following four parts [42]:

- Part 1: Physical characteristics
- Part 2: Radio frequency power and signal interface
- Part 3: Initialization and anti-collision
- Part 4: Transmission protocols

A.3. The ETSI

ETSI (European Telecommunications Standards Institute) was created in 1988 and produces telecommunications standards with 55 member countries. Standards that are relevant to RFID operation in the UHF bands are defined in EN 300 220 [43].

EN 300 220 allows a maximum reader transmitted power of 0.5W in the band 869.5MHz. However, a new standard has recently been approved of by ETSI, which will allow RFID readers to use more power and operate in a wider bandwidth. The new regulations are named EN 302 208 and would increase bandwidth to 866 – 868MHz and allow a transmit power of up to 2W [44].

Appendix B: Interviews

B.1. Questionnaire 1

Personliga frågor (personal questions)

1. Vad jobbar du med, vilka är dina arbetsuppgifter? /*What do you work with, what are your assignments?*

2. Hur gammal är du? /*How old are you?*

3. Hur länge har du varit blind? /*How long have you been blind?*

4. Har du familj? */ Do you have a family?*

Allmänt (in general)

5. Vad är viktigt att tänka på när man ska skapa ett hjälpmedel för synskadade? /*What is important to have in mind when creating a tool for people with sight impairments?*

6. Är det stor skillnad i behovet av hjälpmedel beroende på hur länge man varit synskadad? /*Is there a big difference in the need of a helping tool depending on how long you have had a sight impairment?*

7. Är det stor skillnad i behovet av hjälpmedel beroende på personens ålder? /*Is there a big difference in the need of a helping tool depending on age?*

8. Vilka kunskaper har synskadade om datorer i allmänhet? /*What knowledge about computers do people with sight impairments have in general?*

9. Hur vanligt är det med datoriserade hjälpmedel, och är det något som synskadade i allmänhet är intresserade av att använda? */How common is it with computerized helping tools, and is that something that people with sight impairments in general are interested in using?*

Efter test (after test)

10. Vad tyckte du om apparaten? */What did you think about the device?*

11. Är det här ett hjälpmedel du tror att synskadade kan ha användning av? */Is this a tool you think people with sight impairments would use?*

12. Varför eller varför inte? */Why or why not?*

13. Tror du att den här tekniken skulle skrämma bort många? */Do you think that this technology would scare off a lot of people?*

14. Vad tycker du om idén om att senare utrusta apparaten med en sökfunktion? */What do you think about the idea of equipping the device with a search function?*

15. Finns det andra funktioner som du skulle vilja ha med, eller ta bort? */Are there any other functions that you would like to add or remove from the device?*

16. Skulle du själv vilja använda den här apparaten? */Would you personally want to use this device?*

17. Andra kommentarer? */Other comments?*

B.2. Questionnaire 2

1. Vad tyckte du om apparaten? */What did you think about the device?*

2. Var det någonting du tyckte var för svårt? */Was there anything you felt was too difficult?*

3. Om ja, kan du komma på ett annat sätt att lösa det på? */If yes, can tou think of another way to solve it?*

4. Var det någonting du tyckte var dåligt eller onödigt? */Was there anything you think was deficient or unneccesary?*

5. Var det någonting du tyckte var bra? */Was there anything you think was well done?*

6. Var det lätt att förstå vad man kunde och skulle göra? /*Was it easy to understand what you could and should do?*

7. Finns det andra funktioner som du skulle vilja ha med, eller ta bort? */Are there any other functions that you would like to add or remove from the device?*

8. Andra kommentarer? /*Other comments?*

Appendix C: Summary of the program code

The MainForm

The main form encloses the main program and its methods are described below. On the whole, it contains the code for the actions of all buttons and databases. The complete code can be found on www.certec.lth.se.

`TheButtonIsPressed()`

Every time a button is pressed, except for the close and the scroll button, the methods `ButtonPressed()` or `dataReceived()` call this method. This method will decide what actions should be taken when a specific button is pressed and keeps track of how many times a button has been pressed.

`ButtonPressed()`

This method is called when one of the four hardware buttons (two on each side of the scroll button) is pressed. It decides whether a search cycle on the RFID reader should be started or if it instead should call the method `TheButtonIsPressed()`.

`ChangeDatabase()`

Changes the current database to the previous or next one when using the scroll button in the directions up or down. This is only performed when standing in the main listBox where the databases are stored. However, when scrolling in any of the listBoxes and the last item in the listBox is selected, scrolling down will cause the first item in the listBox to be selected. If the first item in the listBox is selected, scrolling up will cause the last item in the listBox to be selected.

`FastClick()`

`FastClick()` initiates the timer, and assigns *timeInterval* with a large value. It is used when typing on the alphabet keypad in order to search for a specific tag. This method allows the user to type quickly.

`IsInList()`

When searching for a specific tag the search method use the tags attribute to decide if the found tag actually is what the user is looking for. If the user is searching for tags, for instance with the attribute '*clothing*', the search method has to decide if the detected tag has the attribute '*clothing*' or an attribute that is a subgroup to this attribute. To decide whether the tag has the attribute '*clothing'* or not, this method is called.

`OnKeyDown()`

This method contains the code of the actions that takes place when the scroll button is being used. It is an event only the main program can respond to and unfortunately, as a result of this, the method can only be performed if the main program is in focus.

`OpenList()`

Converts the selected file into a **tagList** and displays it in a data grid. If there is no file to convert an indication is made to the `SaveList()` that a new file has to be created.

`PortDataReceived()`

When a message is sent from the RFID reader to the PDA this method is called from the class **portManager**. It handles the message and then sends it on to TheButtonIsPressed, which will take further actions. When the PDA receives a message from the RFID reader, initially a button has been pressed and a message has been sent to the RFID reader. This is followed by the method `TheButtonIsPressed()` being called.

`SaveList()`

Converts, at present, the only two available databases into binary streams that are saved as .dat files; '*hemmet.dat'* and '*lund.dat'*. If the files already exist, an indication is received from `OpenList()` and the old files are replaced.

`SearchOtherDatabases()`

This method is used to check if the detected tag belongs to another database. If that is the case the user is not be able to store the tag in a second database before erasing it in the first.

`SendData()`

This is a method used to send instructions to the RFID reader in the form of predetermined integers. For example the integer 130 tells the reader to start a reading cycle, and is the only instruction used in the program.

`SetCurrentListBox()`

A method that changes the current listBox when scrolling left or right through all the listBoxes. It is used to keep track of the path taken to reach a certain listBox (when scrolling to the right) so when scrolling to the left, in order to leave the current listBox, the user can return to the correct listBox.

`ShowButtons()/HideButtons()`

When the search button is pressed a nine-button display is shown on the touch screen. The buttons represent an alphabet that is used to write search words. To make them visible or invisible these methods are used.

`SlowClick()`

`SlowClick()` initiates the timer, and assigns *timeInterval* with a small value. It is used when typing on the alphabet keypad in order to search for a specific tag.

Other classes

Some other classes were also written and they were put outside the main form to make the code easier to comprehend. Among these, the class *Tag* was written to describe the tags and to give them functional attributes. Furthermore, a special list called **tagList** was created to handle the tags in an improved way.

MyMessageWindow

This class listens to the internal (WndProc) messages that are sent between Windows CE and, for instance, the hardware buttons. If the message is sent from one of the four hardware buttons (not the scroll button) **myMessageWindow** alerts the `ButtonPressed()` method in the main program.

RegisterHKeys

RegisterHKeys overrides the fundamental operations of the hardware buttons' to replace them with new ones. This is done by registering the new message window **myMessageWindow** and by using an unregister function in the coredll.dll file.

Player

This is a class created for playing the sound files. It can play sounds both synchronously and asynchronously depending on which flag is being used. When the player is set with the asynchronous flag (SND_ASYNC) it plays the sound as other functions proceed simultaneously. If several sound files are being played directly after one and other the synchronous flag is used (SND_SYNC) to prevent the sounds to override each other.

TagList

The task of the **tagList** class is to store and control the tags. It holds the two methods `find()` and `CopyTo()`. The `CopyTo()` method merges two **tagLists** together and the `find()` method searches for a tag with a specific ID, given as a string, in the list.

PortManager

The class responsible for the port communication between the RFID reader and the PDA is called **portManager**. The **portManager** holds threads that listen to the RFID reader and notifies the `PortDataReceived()` method in the main program when a message is received. It also opens and closes the port and converts the sent data from the main program to bytes and sends it to the RFID reader. The **portManager** holds the settings for the communication like baud rate, number of data bits and stop bits, the parity and the hardware and software handshake.

Recorder

Recorder is the class used for recording sound. It holds the methods `Record()` and `Close()`. It records sounds with the method `Record()` using a synchronous flag (SND_SYNC), which prevents other sounds from being played while the recorder is running. The recorded sound is saved to a file and the recorder is disabled using the method `Close()`.

Tag

This is an object class with the attributes *tagNumber*, *tagSound*, *tagSound2* and *attribute*. *TagNumber* holds the unique identification number, *tagSound* and *tagSound2* hold the recorded pieces of information and *attribute* holds information about in which database the tag was stored.

Appendix D: Technical Datasheets

D.1. The Protégé Scanner

Case Dimensions

Length = 7.25 inches = 185mm
Width = 3.4 inches = 86mm
Height = 1.25 inches = 32mm

Weight

275g

Case Material

Black Polycarbonate

Operational Temperature

0 to 50 °C

Batteries

(6) 1.2V Nickel Metal Hydride @ 550MaH

Charge Rate

C/15 or 35Ma

RF Frequency

13.56Mhz

RF Power output

250mW @ 50Ohm circular polarization

Tags supported

TI ISO
TI Tag-it
Philips ISO
Philips I-CODE 1
Infineon ISO

Other protocols available upon request

Read Distance

3 to 6 inches depending on tag mfg and size

Impact Survivability

3 ft. drop to concrete (all planes)

Water Resistance

Minimal (recommend indoor operation)

Connection to PDA

Serial NRZ @ 57600 Baud

Data Download

Serial Download through charging/download cable under application control. Wireless download under application thru the PDA radios. (Bluetooth or WiFi)

D.2. HP iPAQ 5555 Pocket PC

Product Description

HP iPAQ Pocket PC h5550

Dimensions (W x D x H)

84 x 16 x 138 (mm)

Weight

207g

Handheld

Yes

Processor

Intel Xscale PXA250 400MHz

Memory

48MB Flash ROM Memory; 128MB SDRAM

Display

3.8” Diagonal (96mm), 16-bit TFT (64 colours), resolution: 240 x 320

Audio output

Speaker(s)

Audio input

Microphone

Supported Digital Audio Formats

MP3

Wireless connectivity

Bluetooth, IEEE 802.11b

Input device

Touch-screen, 5-way navigation button, stylus

Power

110/230Vac (50/60Hz)

Battery

1250mAh Lithium-ion Polymer removable/rechargeable battery (in docking cradle or with AC Adapter)

Recharge Time

2.5 hours

Average Run Time

10 hours

Operating System

Microsoft Windows Mobile 2003 for Pocket PC

Software

Clock, Calculator, Notes, Voice Record, Asset Viewer, Calendar, File Explorer, Inbox, Pocket Excel, Pocket Internet Explorer, Pocket Word, Solitaire, Tasks, Memory, MSN Messenger, VPN Client, Terminal Services Client, Infrared beaming, Microsoft Outlook 2002, Microsoft ActiveSync, Windows Media Player for Pocket PC, Microsoft Reader, Align Screen, Jawbreaker

Humidity Range Operating

10 – 90 %

Max Operating Temperature

40°C

Min Operating Temperature

0°C

Expansions Slots Total

1 x SD Memory Card

Output interfaces

1 x headphones, 1 x USB – 4 PIN USB Type A, 1 x serial – RS-232

Security

Integrated Biometric Fingerprint Reader

Manufacturer Warranty

1 year warranty

D.3. TI 13.56MHz Encapsulated Transponder

Supported Standard

ISO 15693-2, 3

Resonance Frequency (at +25°C)

13.56MHz ± 300kHz

Typ. Required activation field strenght to read (at +25°C)

112dBμA/m

Typ. Required activation field strenght to read (at +25°C)

115dBμA/m

Factory programmed Read Only Number

64 bits

Memory (user programmable)

2k bits organized in 64 x 32-bit blocks

Typical programming cycles (at +25°C)

100,000

Data retention time (at +25°C)

>10 years

Simultaneous Identification of Tags

Up to 50 tags per second (reader/antenna dependent)

Dimensions

∅ 22 ± 0.2mm x 3 ± 0.2mm

Weight

1.6 ± 0.3g

Case material

PPS, black

Protection Class

IP 68

Operating temperature

-25°C to +90°C

Storage temperature

-25°C to 120°C
+160°C for total 50 hours
+220°C for total 30 seconds

Vibration

ISO/IEC 68.2.6 (10g, 10..2000Hz, 3 axis, 2.5h)

Mechanical Shock

ISO/IEC 68.2.27 (100g, 6ms, 6 axis, 20 times per axis)

Mechanical Stability

Axial compression strength: 1000N (10s, static)
Radial compression strength: 500N (10s, static)
Isostatic water pressure: 45bar (10h)

Chemical Resistance

Typical chemicals used in laundry and dry-cleaning processes

Delivery

1000 units in bulk

Certecs rapporter

Ett urval av rapporter från CERTEC

Enquist Henrik
Mina medicinska bilder
Certecrapport, 2004
http://www.certec.lth.se/dok/minamedicinskabilder/

Gustafsson Jörgen
Optik för synsvaga människor
Doktorsavhandling, 2004
http://www.certec.lth.se/dok/optikforsynsvaga/

Mandre Eve
Vårdmiljö eller lärandemiljö?
Doktorsavhandling, 2002
http://www.certec.lth.se/dok/franvardmiljotill/

Svensk Arne
Design av kognitiv assistans
Licentiatuppsats, 2001
http://www.certec.lth.se/dok/designavkognitiv/

The purpose of this Master's thesis was to investigate and create a concept for searching and detecting different objects using Radio Frequency Identification (RFID) technology in order to ease the everyday life for people with visual impairments. The finished prototype was tested with Johanna Olin, who works as a sight counsellor at the Eye Clinic in Malmö. The final test was carried out using the prototype in different arranged scenarios.

Den här rapporten hittar du också på Internet:
www.certec.lth.se/doc/eyesee

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Certec är en avdelning inom institutionen för designvetenskaper vid Lunds tekniska högskola.

Vår forskning och utbildning har en uttalad avsikt: att människor med funktions- nedsättningar skall få bättre förutsättningar genom en mer användvärd teknik, nya designkoncept och nya individnära former för lärande och sökande.

Drygt 20 människor arbetar på Certec. Den årliga omsättningen är cirka 12 miljoner kronor.

EXAMENSARBETE CERTEC, LTH NUMMER 7:2005
JUNI 2005

Joanna Doweyko, Bibi Sandberg

EYESEE - An RFID equipped identification tool for people with visual impairments