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A STUDY OF A NON-TOUCHABLE AND USER FRIENDLY INTERFACE FOR RAAHE MUSEUM

A STUDY OF A NON-TOUCHABLE AND USER FRIENDLY INTERFACE FOR RAAHE MUSEUM

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Degree Program in InformationTechnology
Oulu University of Applied Sciences

PREFACE

This work is performed as a part of KAMARA-project in Rikastamo for the Raahe museum in Raahe, Finland. The work itself is a practical implementation of the system that provides the end-users with the interface that deals with the interaction of the treasures or the history of Raahe just by pointing to the GUI. This project actually is about utilizing capacitive proximity sensors in a contact-free and unimpeded user interface. I believe that the Raahe museum will benefit from this new technology.

Raahe, May 2013
Srijana KC

ACKNOWLEDGEMENTS

I would like to thank Raahe museum for having interest and for providing me with the demanding topic as my Bachelor's Thesis. I'm grateful also to VTT in Oulu for providing me with the tools and equipment necessary for my project and for an opportunity to obtain the experience throughout the work for all the available conditions organized.

At first, I would like to give my sincere thanks to Mr. Juha Räty for supervising me all the way through this task . And Mrs. Lea Hannila for giving me right instructions and information on how to manage the time while studying and showing me the correct path for good studies mostly during my Bachelor's study time. Also, my thanks go to all of my teachers here who provided me with the knowledge that is required for the accomplishment of this given task like Mr. Lauri Pirttiaho for guiding me for the programming languages and Mr. Veikko Tapaninen, and most of the staff at Raahe Campus, like Mr. Risto Korva, Maija-Leena Mylly and so on for making my studies one of the best, memorable and successful one after my studies at Kathmandu University, Nepal.

Many thanks to student Juho Nisula at Oulu UAS, OAMK technical unit Raahe Campus for guiding me with the correct way to get the UI ready. He recommended me to use Visual C# and the WPF to get the UI as desired which was really the best method and fulfilled the requirements of the museum for this particular project.

Along with that, I would like to thank my mom (teacher), dad (politician and a writer), my brother, Prashant KC who is a top doctor student in Nepal receiving Mahatma Gandhi Scholarship and Golden Jubilee for his great studies, and my younger brother, Prabesh KC who is studying in Helsinki. I would like to thank them for all their support, encouragement, enthusiasm and strength that they have provided to me in every aspect of my study and all my life including my Bachelor's thesis writing process, too.

TIIVISTELMÄ

Oulun seudun ammattikorkeakoulu
Tietotekniikan koulutusohjelma

Tekijä: KC Srijana
Opinnäytetyön nimi: Tutkimus kosketusvapaasta käyttöliittymästä Raahen Museolle
Työn ohjaaja: Juha Räty
Työn valmistumislukukausi ja -vuosi: Kevät 2013 Sivumäärä: 49

Tämän insinöörityön tarkoituksena oli tehdä tutkimus sellaisista käyttöliittymistä, joita voidaan osoittaa sormella ilman suoranaista pintakosketusta. Käyttäjän osoitettua haluttua kohdetta näytöllä käyttöliittymä kertoo lisätietoa kyseisestä asiasta. Tämä käyttöliittymä voi antaa lisätietoja esimerkiksi muinaisesta hautapaikasta tai vanhasta aarrekätköstä. Loppukäyttäjä voi valita vaihtoehdoista yksinkertaisesti sormella osoittamalla.

Valinnan tehtyään loppukäyttäjä voi saada lisätietoa aiheesta kaivamalla käsiliikkein yhä syvemmälle ja syvemmälle. Kaivuuliikkeet vaihtavat uuden kuvan näyttöön yksi toisensa jälkeen. Jokainen uusi kuva tuo joko lisätietoa aiheesta tai vie käyttäjän syvemmälle maan alle ikään kuin käyttäjä oikeasti kaivaisi maata oikeilla arkeologisilla kaivauksilla käytetyillä työkaluilla, kuten lapiolla tai harjalla. Eri kuvien täytyy vaihtua uusiksi hyvin sujuvasti ja hitaasti luoden vaikutelman siitä, että näyttelyssä vieraileva näkisi pölyn ja maakerrosten poistuvan millimetri millimetriltä oikean kaivauksen tavoin.

Kuvailevaisuus, älykkyys, yksinkertaisuus ja esteettömyys ovat hyviä sanoja kuvailemaan Raahen museon uusia periaatteita tulevien esitysten suhteen. Tämä tutkimuksen alla ollut käyttöliittymä on osana joukossa muiden sellaisten uusien tekniikoiden kanssa, joita museo haluaa lähitulevaisuudessa yleisölleen tarjota. Niinpä tämä tutkimus on erityisesti omistettu Raahen museolle, jotta voitaisiin luoda pohja ja ominaisuudet sellaiselle käyttöliittymätekniikalle, jonka avulla uusissa tiloissa asioivat asiakkaat, vierailijat ja turistit voivat uudella mielenkiinnolla ja esteettömästi tutustua museon tarjontaan .

Avainsanat: UI, käyttöliittymä, kosketusvapaa, USB-muunnin, sensorilevy, virtuaalisarjaportti, kapasitiivinen tunnistus.

ABSTRACT

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Degree Programme in Information Technology

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Title of Bachelor's thesis: A Study of a Non-touchable and User Friendly Interface for Raahe Museum
Supervisor: Juha Räty
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The main aim of this Bachelor's thesis was to make a research of a system which works by pointing with fingers without the need of touching the display. After pointing the particular image, it will tell more information about that specific point. This point can have more information about either the certain graves or the certain treasure, user can choose between those just by pointing with his/her fingers.

When the user has chosen the option, he/she can get a more detailed vision which goes deeper and deeper with a digging action. This action gives new slides after each other. Every new slide gives new information or goes deeper to the ground as if a person is actually digging with real tools like a spade or a brush. Different slides must change very smoothly to create the feeling that you can really see dust and ground is removed millimetre by millimetre as in a case of a real archaeologist.

Self-descriptiveness, intelligibility, simplicity and accessibility were key properties for an interface, which should be delivered to the user. And, along with all of these features, this also is one of those newest technologies that Raahe museum is going to implement in the near future. This research was particularly dedicated to the Raahe museum to create a UI to their customers, visitors and tourists who come into the museum to see the history of Raahe.

Keywords: UI, touch free, USB-converter, Sensor board, Virtual serial port, capacitive sensing.

Table of contents

SYMBOLS AND ABBREVIATIONS

Listed below are the abbreviations used in the whole document and their respective full-forms.

UI	User Interface
IT	Information Technology
USB	Universal Serial Bus
WPF	Windows Presentation Foundation
ASCII	American Standard Code for Information Interchange
IC	Integrated Circuit
XAML	Extensible Application Markup Language
XML	Extensible Markup Language
CS	Computer Science
CLR	Common Language Runtime
COM	Component Object Model
PCB	Printed Circuit Board
API	Application Program Interface
IDE	Integrated Development Environment
XSLT	Extensible Style sheet Language Transformations
HTML/XHTML	HyperText Markup Language/Extensible HyperText Markup Language
CSS	Cascading Style Sheets
JPEG	Joint Photographic Experts Group
PNG	Portable Network Graphics
GIF	Graphics Interchange Format
PC	Personal Computers

1 INTRODUCTION

In today's 21st century we are surrounded by science and technological innovations which are emerging day by day. Our life has become much simpler and easier with the help of these kinds of technological inventions which are there in every aspects of our life. For example Smart Television, Smart Mobile phones, Computers such as Apple Computers, iPads, iPhones, tablet PC's, calculators and so on. It is becoming almost impossible for us to imagine our life without these technologies surrounding us because they are so handy and at the same time save our time. In one hand, technology is good for us because it saves our time, but at the same time it makes us little lazier than in the past when people needed to do most of the calculations by using their own hands and their own mind.

This work was done for the museum of Raahe. The main requirements for the system were a sensor board made by VTT, a USB hardware to make a connection between the computer and the sensor board and the UI. The User-Interface (UI) system was required for users' interaction.

Describing my research idea, it dealt with the technology of a UI (User-Interface) and how it should look and act. This UI was between the end user and a PC and of course there was also an interface between the sensor board and the PC. Using the UI the end user just points to the certain image on the display and then it would lead the user to the information and the history of that particular place. It uses the sensor board to get the co-ordinate information in order to know in which particular area the user has pointed his/hers finger and depending upon that, the UI will display the image in a very special electronic screen. This sensor board has the characteristics of a changing capacitance which has been provided to us by VTT, Technical Research Centre of Finland.

Self-descriptiveness, intelligibility, simplicity and accessibility are key values of an interface, which the system should deliver to a user.

1.1 Self-descriptiveness

When the user sees this new technology for the first time, he/she should find out easily how this technology can be used just by looking at the display. So, this means self-descriptiveness. It that

means no extra definition should be demanded from the users or the client about how to use it. It should be quite clear from its development process and the presentation of it. Talking about the benefits of this project, since it should deal with the capacitive sensor board and hence the user should not necessarily need to use the keyboard or the mouse at all. It should be quite beneficial and easy to use for the elderly people and the little children, too. It should just work with the pointing of the fingers and the swiping of one or two hands.

1.2 Intelligibility

The target of this research was to find an intelligent and easy way to show information to people. Programs like C# and the WPF should be used to create an example of this kind of UI and those programs are now the competitive in the IT field. This can be found in the statistics shown in the website www.tiobe.com.

1.3 Simplicity

The UI studied in this research should be simple to use, without the necessity to learn to use complex pointing techniques or hand movements. The use of the capacitive sensor should make it quite simple to create a simple and non-touchable UI. One should just change the images and the display with the swiping of his/hers hands and the pointing of fingers. He/she should not need to touch the keyboard or the mouse to perform this task. Hence, it should be simple to use.

1.4 Accessibility

This technology should be accessible to all groups of people, from small children to the elderly people because of the characteristics that it possesses. They were simplicity, intelligibility and self-descriptiveness. People of all age groups should be able to learn this technology easily and they should use it to see the history of Raahe (i.e. Tervakangas zone and also the treasure and coins zone). In other words, this just should be easily accessible from the electronic medium to which the sensor board must be connected so as mentioned before.

We have two target groups: a group of end-users as a final target and a group of devices as a means for a good display presentation. The figure 1 below represents a conceptual model of the whole system.

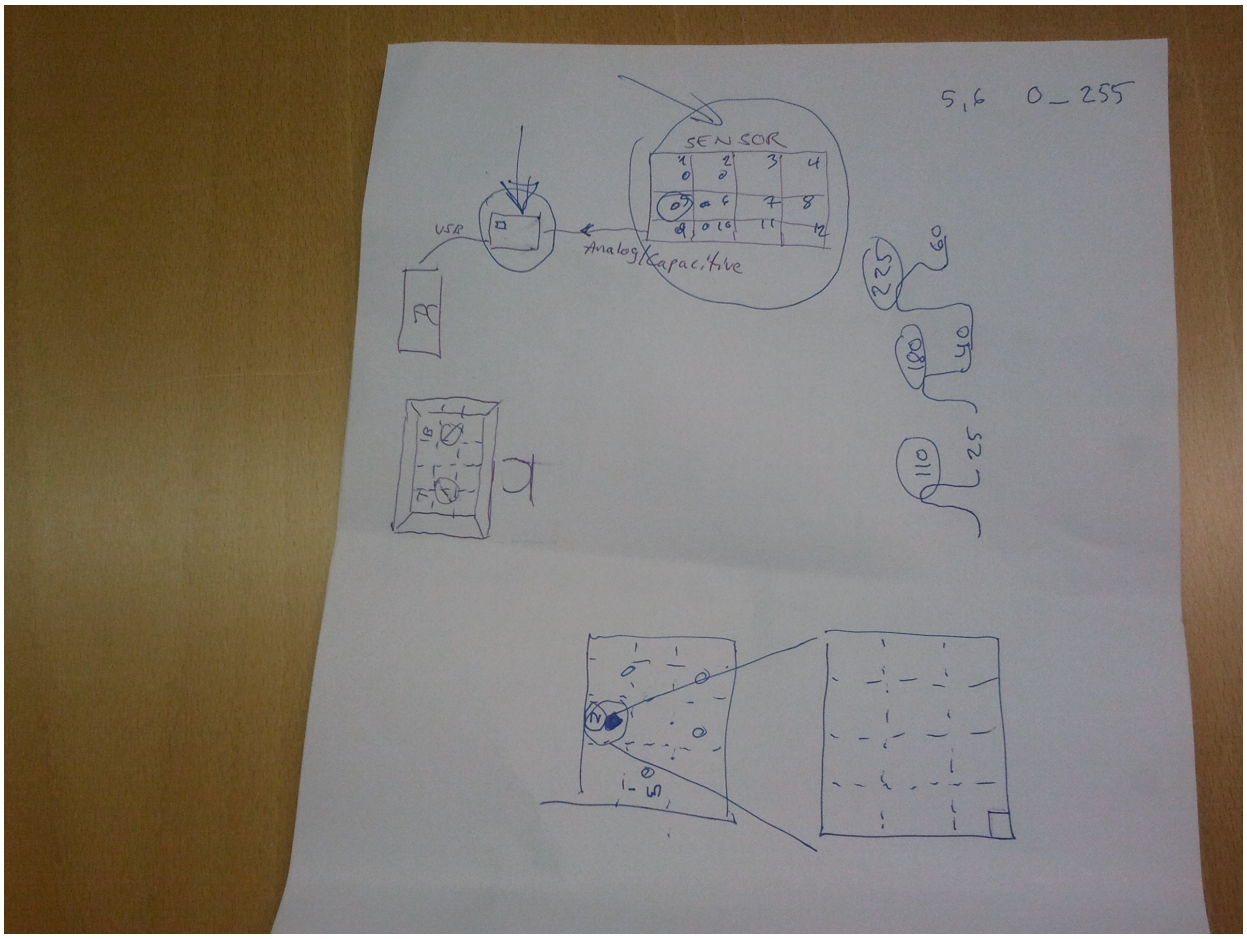


*FIGURE 1: Conceptual model of the whole system (*OAMK 28.11.2012, Meeting)

The above conceptual model of the whole system describes the analogue capacitive sensor board, USB and the computer connected to each other and how the system would work exactly in a diagrammatical representation as shown. The USB will connect the hardware parts of the system i.e. the sensor board to the computer display having a User-Interface (UI). Figure 2 shows the model of the capacitive sensor board that was used in this system.

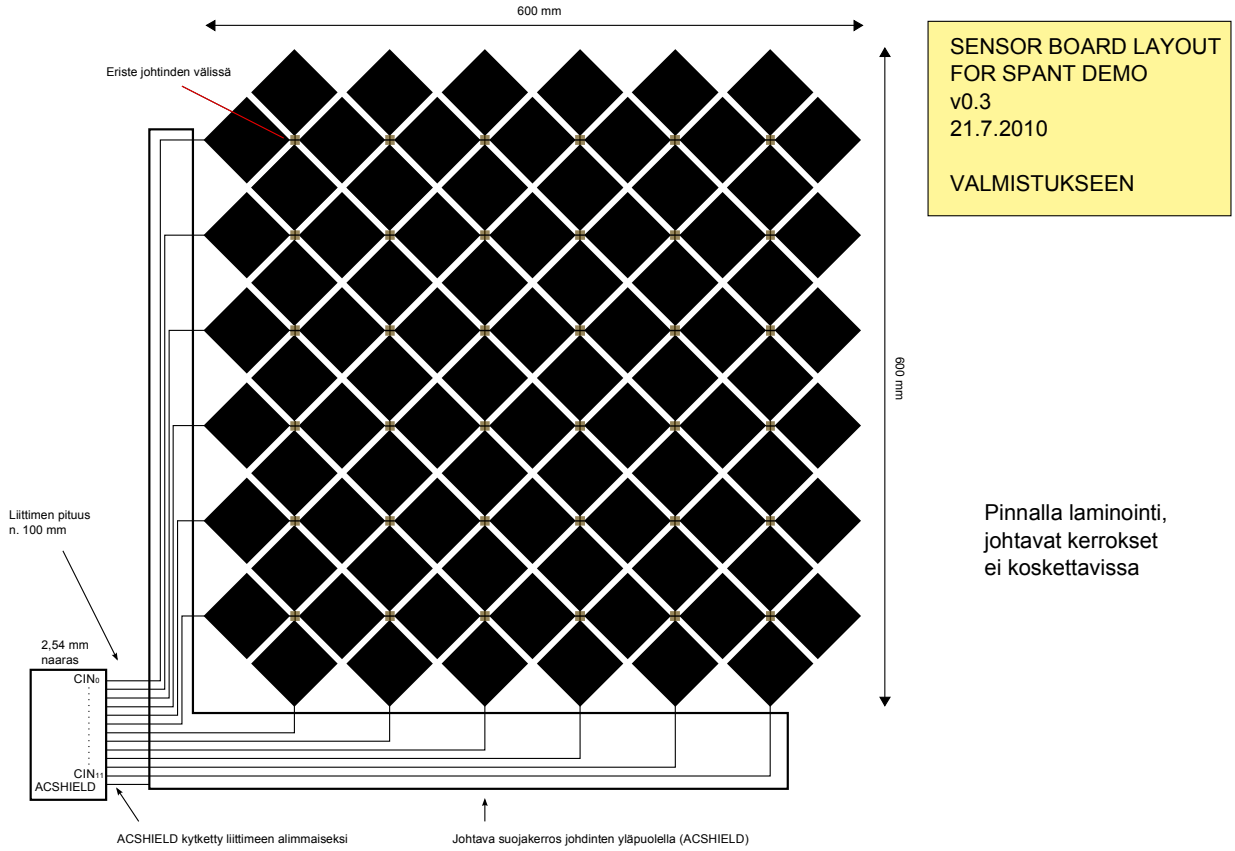


FIGURE 2: Sensor board Demo. (VTT 28.3.2012, meeting)

And, the programs used to make the User-Interface (UI) are WPF and Visual C# which are good and competitive programming languages definitely easy to understand because of their good descriptive skills .

1.5 Research and developmental tasks, empirical results (observations) and process

For this particular research project work, VTT, the technical Research center of Finland had given the required tools like the sensor board and the USB device, which connects the sensor board to the computer. The real image of the sensor board is given below:

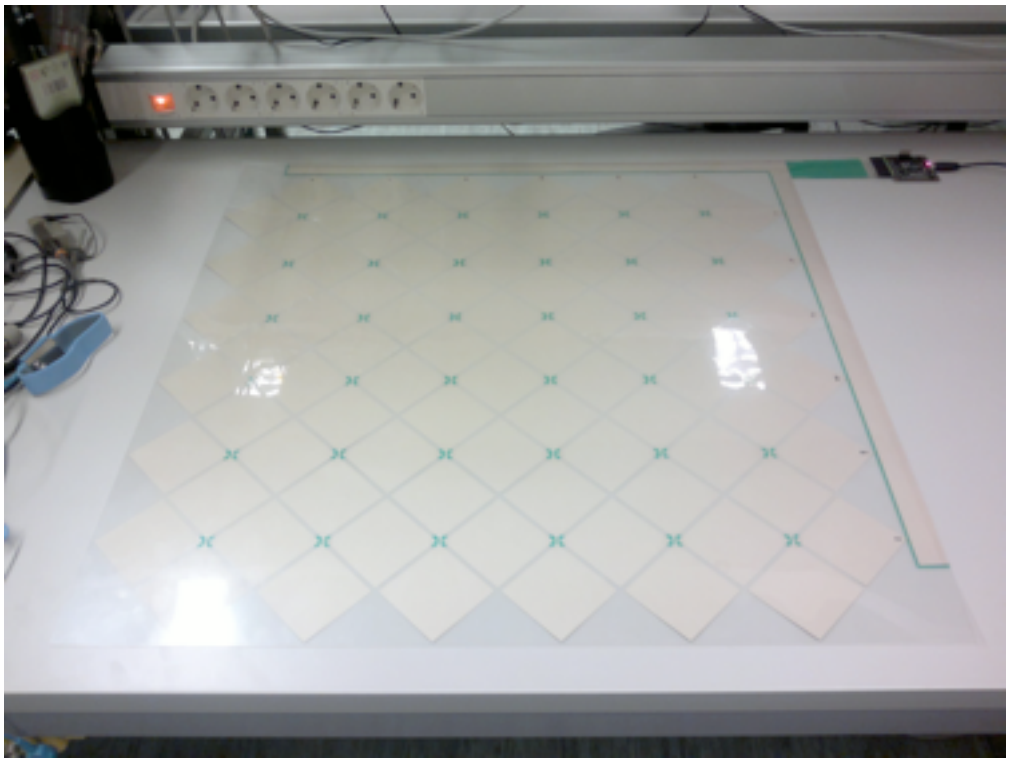


FIGURE 3. Capacitive sensor board and its controller hardware (up right).(VTT 28.3.2012, meeting)

After this, the research process involves finding the best way to get the project's task to be accomplished. Hence, the research process involved finding the technology and programming environment i.e. which program can be made to work in a good way and fast. The programming process of this project started with the Java programming language. After many discussions and research, the programming language was changed to Visual C# and WPF. The reason was that the UI could be more easily connected as a module to that program which reads the sensor board through the USB connection card.

We know that the world is getting modernized day by day. People want everything faster and faster and in an easier way. So, this technology, which was used in the museum, can give people more information about the history of Raahe and certain places of Raahe. This can be done just by pointing the User Interface seen on a special display. This makes the UI more attractive and easier to use.

First, the research was involved in how to make this certain idea of the project to realize. We already know that in today's competitive world, there are so many programming languages, which

can make the best software (computer programs) in the world, with all the best qualities embedded in them, like a good presentation style, a good interaction with the user, a good usage, security, robustness, dynamic, high performance, like Java, JavaScript, C, C++, C#. Definitely, to choose the best programming language among all of the competitive programming languages, was a challenging task. The figure below shows the top 20 programming languages in the world until now. This has been described in the www.tiobe.com website and the figure below has been taken from that particular website.

Position Apr 2013	Position Apr 2012	Delta in Position	Programming Language	Ratings Apr 2013	Delta Apr 2012	Status
1	1	=	C	17.862%	+0.31%	A
2	2	=	Java	17.681%	+0.65%	A
3	3	=	C++	9.714%	+0.82%	A
4	4	=	Objective-C	9.598%	+1.36%	A
5	5	=	C#	6.150%	-1.20%	A
6	6	=	PHP	5.428%	+0.14%	A
7	7	=	(Visual) Basic	4.699%	-0.26%	A
8	8	=	Python	4.442%	+0.78%	A
9	10	↑	Perl	2.335%	-0.05%	A
10	11	↑	Ruby	1.972%	+0.46%	A
11	9	↓↓	JavaScript	1.509%	-1.37%	A
12	14	↑↑	Visual Basic .NET	1.095%	+0.12%	A
13	15	↑↑	Lisp	0.905%	-0.05%	A
14	16	↑↑	Pascal	0.887%	+0.07%	A
15	13	↓↓	Delphi/Object Pascal	0.840%	-0.53%	A
16	32	↑↑↑↑↑↑↑↑↑↑	Bash	0.840%	+0.47%	A
17	18	↑	Transact-SQL	0.723%	-0.04%	A
18	12	↓↓↓↓↓↓	PL/SQL	0.715%	-0.66%	A
19	24	↑↑↑↑↑	Assembly	0.710%	+0.24%	A–
20	21	↑	Lua	0.650%	+0.08%	B

TABLE 1: TIOBE Programming Community index.Date of retrieval 24.4.2013. (http://www.tiobe.com/index.php/content/paperinfo/tpci/index.html)

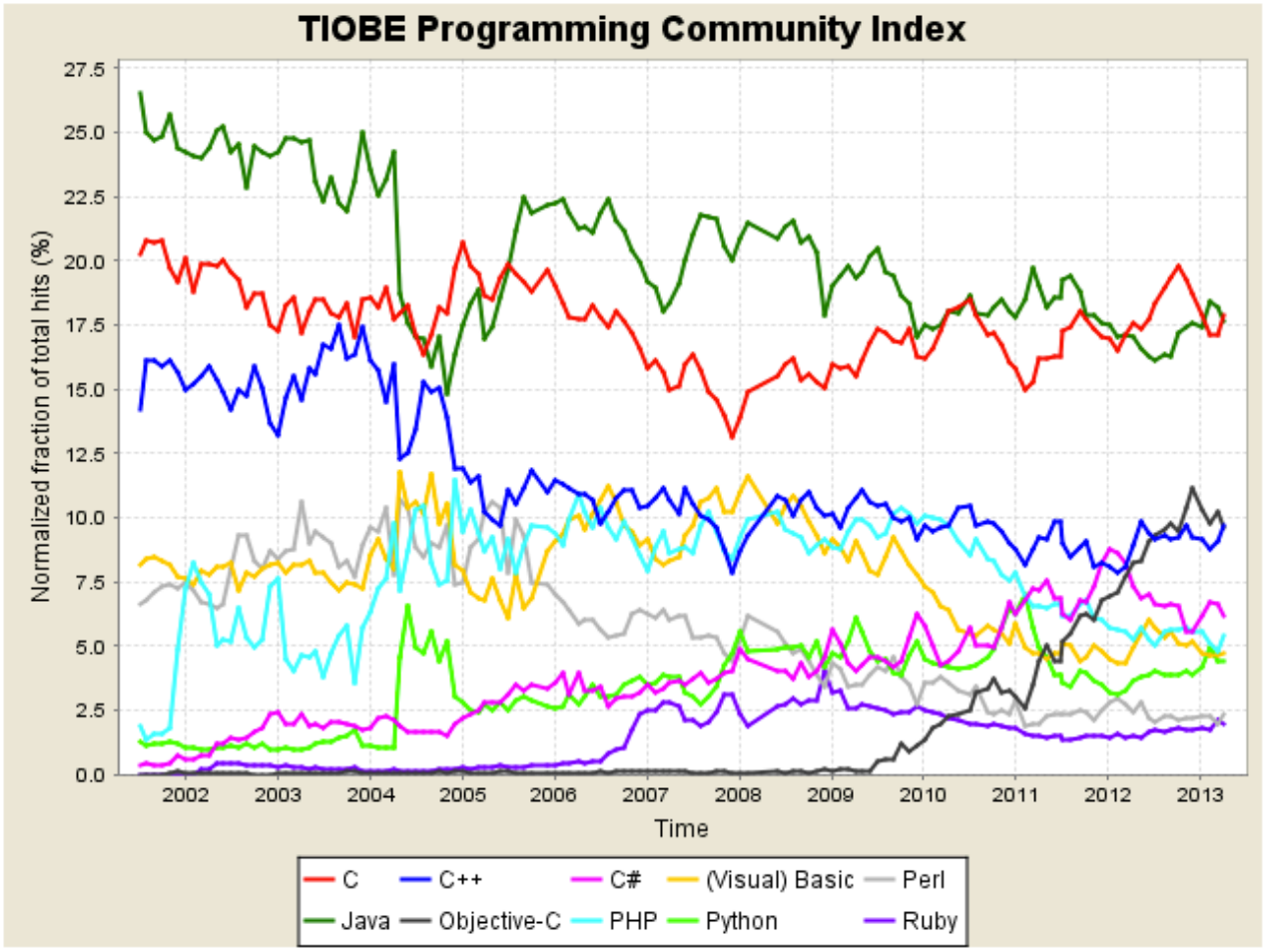


TABLE 2: Line diagram, the long-term trends for the top 10 programming languages. Date of retrieval 24.4.2013.
(http://www.tiobe.com/index.php/content/paperinfo/tpci/index.html)

As mentioned earlier, to choose the best programming language to create this UI possible was definitely a challenging task. I had some skills in PASCAL programming language, C, and Java. However, taking into the consideration the needs of my research project, the WPF (Windows Presentation Foundation) for the Interfaces and Visual C# was used. WPF creates a unified foundation for creating interfaces. The technologies WPF contains can be examined in discrete, understandable parts. These parts include documents, images, graphics, animation, and more. All of them depend on WPF's basic application model.

So, this research process involved the process how to get this work done like the developmental task, research and so forth. It means that how the empirical results (observations) could be realized.

2 DEFINITION

2.1 Sensor Board

The sensor board is a system consisting of a flexible sensor board sized 60 cm x 60 cm and of separate sensor hardware on a circuit board sized 5 cm x 5 cm.

The system uses a capacitive sensing to detect the presence and position of a user's hand user's over and on the flexible board. The maximum detection distance depends on environment's properties and system's ground connection but it is normally 5 to 10 cm. The more precise point we want to point, the more closer we have to be. Over the sensor board, metal or conductive layers are not accepted, wood, plastic and other things like that are allowed. This means that the sensor board can be hidden under the table surface or some other suitable things. A visible sensor board can be scary for children or elderly people, but the hidden one can be under a picture or a painted surface and therefore people do not have to be afraid to use this UI.

The system is connected to a computer using a USB cable which also provides power to the hardware. The circuit board includes a serial-to-USB -converter IC and the communication between the hardware and the computer is established via a virtual serial port connection in an ASCII format. Capacitance values and/or coordinates of the hand above the board are read to the computer to function as an input for the application software.

2.2 User-Interface (UI)

UI exactly stands for User Interface. User interface design and user interface engineering is the design of computers, appliances, machines, mobile communication devices, software application, and websites with the focus on the user's experience and interaction. The goal of user interface design is to make the user's interaction as simple and efficient as possible, in terms of accomplishing user goals - what is often called user-centred design. Good user interface design facilitates finishing the task at hand without drawing unnecessary attention to it-self. Graphic design may be utilized to support its usability and in this special case this design is very important because we want to create an old fashioned, exciting and easy to use looks. The design process

must balance technical functionality and visual elements (e.g., mental model) to create a system that is not only operational but also usable and adaptable to changing user needs.

Interface design is involved in a wide range of projects from computer systems, to cars, to commercial planes; all of these projects involve much of the same basic human interactions yet also require some unique skills and knowledge. As a result, designers tend to specialize in certain types of projects and have skills centred around their expertise, whether that be software design, user research, web design or industrial design. (https://en.wikipedia.org/wiki/User_interface)

In the context of this project, UI will be displayed in an electronic device and the users can quite easily interact with that UI. The main page of UI, which I did, consists of two most active parts which are shown in the figure below:

FIGURE 4: The first page of a User Interface (UI) in an English language.

The first part is an area called “The Tervakangas Iron Age burial ground” and the second one is

called “A coin hoard from the Middle Ages in Pattijoki”. Hence the main page was created in two different languages and the user can select between those languages according to their preferences like it is shown in the given figure.

FIGURE 5: The first page of a User Interface (UI) in a Finnish language.

As mentioned earlier, under the same topic, the first page of UI contains two parts:

a. The Tervakangas, Iron Age Burial Ground

b. A coin hoard from the Middle Ages in Pattijoki.

2.2a The Tervakangas, Iron Age Burial Ground and its 11 different layers are shown below in the table with images of those different layers.

HIDDEN IN THE GROUND

The Tervakangas Iron Age burial ground - English version

	**1. sivu in english.jpg** This is the Mainpage, where museum customer chooses either the grave or the coin hoard. There are four (4) link or activated areas in this page: 1. The Tervakangas Iron Age burial ground (text & big circle-shaped image), 2. A coin hoard from the Middle Ages in Pattijoki (text & big circle-shaped image) 3. Link "Suomeksi" (in finnish) 4. Copyright –picture at the top right
	**2. karttasivu in english 2.jpg** This is the first page of the Tervakangas Iron Age burial ground. There are 12 activated areas in this page: 1. Ten (10) circle-shaped images (numbers from one to eight and two symbols). Number five is the grave to dig. Other numbers and symbols are of such nature about which you get information for example in the small information box or on the information page. 2. Link "Suomeksi" (in finnish) 3. Link "Mainpage" (text & compass image)

FIGURE 6a: The first two layers of a User Interface (UI) in an English language with notes under the Tervakangas Iron Age Burial Ground.

3. hautapiirros in english 3.jpg

This is the tomb of the number five. This is the level where the museum customer initiates the grave digging. With the help of hand businesses the plants and stones disappear and the color of the country (the earth layers) gradually changes until eventyally the grave finds come out.

There are 3 activated areas: 1) link "Mainpage" with compass image, 2) link "Suomeksi" and 3) the grave.

4. hautapiirros in english 4.jpg

The broken glass bottle begins to be seen in the grave.

There are 3 activated areas: 1) link "Mainpage" with compass image, 2) link "Suomeksi" and 3) the grave.

Main structure: Hidden in the ground/The Tervakangas Iron Age Burial Ground

FIGURE 6b: Layers 3 and 4 of a User Interface (UI) in an English language with notes.

2

5. hautapiirros in english5.jpg

This earth layer is grey. On this level, museum customer is using a spatula to dig grave. You can place the picture of the spatula also in some other section in this picture. From us the picture in question is found also separately.

There are 3 activated areas: 1) link "Mainpage" with compass image, 2) link "Suomeksi" and 3) the grave.

6. hautapiirros in english6.jpg

On this level, museum customer is still using a spatula to dig grave, but the color changes to different.

There are 3 activated areas: 1) link "Mainpage" with compass image, 2) link "Suomeksi" and 3) the grave.

FIGURE 6c: Layers 5 and 6 of a User Interface (UI) in an English language with notes.

	**7. hautapiirros in english7.jpg** On this level, museum customer is using paintbrush to dig grave. You can place the picture of the paintbrush also in some other section in this picture. From us the picture in question is found also separately. The color of the grave is still changing to darker. Objects of the grave start to show. There are 3 activated areas: 1) link "Mainpage" with compass image, 2) link "Suomeksi" and 3) the grave.
	**8. hautapiirros in english8.jpg** On this level, museum customer is still using paintbrush to dig grave and the color of the grave is still changing to darker. Objects of the grave show more. There are 3 activated areas: 1) link "Mainpage" with compass image, 2) link "Suomeksi" and 3) the grave.
	**9. hautapiirros in english9.jpg** Museum customer is still using paintbrush to dig grave and the color of the grave is still changing to darker. You can see the objects of the grave and little bit of figure. There are 3 activated areas: 1) link "Mainpage" with compass image, 2) link "Suomeksi" and 3) the grave.

FIGURE 6d: Layers 7 and 8 of a User Interface (UI) in an English language with notes.

3

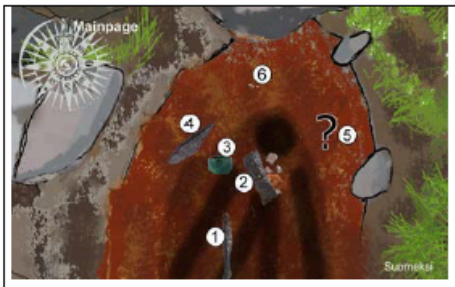
	**10. hautapiirros in english 10.jpg** This is a close-up from the grave. When a museum customer shows numbers, he will get additional information about the objects for example on the separate information page or in the information box. There are 8 activated areas: 1) link "Mainpage" with compass image, 2) link "Suomeksi" and 3) six (6) circle-shaped images (numbers from one to six).
	**11. hautapiirros in english 11.jpg** This is the final layer of the grave, where is one circle-shaped image. By pointing that icon museum customer will receive additional information about the deceased. There are 3 activated areas: 1) link "Mainpage" with compass image, 2) link "Suomeksi" and 3) the symbol/icon.

FIGURE 6e: The diagrams above show the last two layers that are under the Tervakangas Iron Age Burial Ground. (Raahe Museum, November 2012)

Those same images with different functionalities than the above mentioned will be on Finnish pages, too. That is especially designed for the users or the customers who would like to see the images and their required details in different languages.

2.3 WPF (Windows Presentation Foundation)

"Windows Presentation Foundation (WPF) is a computer-software graphical subsystem for rendering user interfaces in Windows-based applications. WPF, previously known as "Avalon" was initially released as part of .NET Framework 3.0.WPF employs XAML, an XML-based language, to define and link various UI elements. WPF applications can also be deployed as standalone desktop programs. WPF aims to unify a number of common user interface elements, such as 2D/3D rendering, fixed and adaptive documents, typography, vector graphics, runtime animation, and pre-rendered media. These elements can be then linked and manipulated based on various events, user interactions and data bindings."
(https://en.wikipedia.org/wiki/Windows_Presentation_Foundation)

This defines one of the methods or platform that have been used in this project work to get the UI as desired .

The figure 3 shows the subsystem which is a part of .NET Framework 3.0.

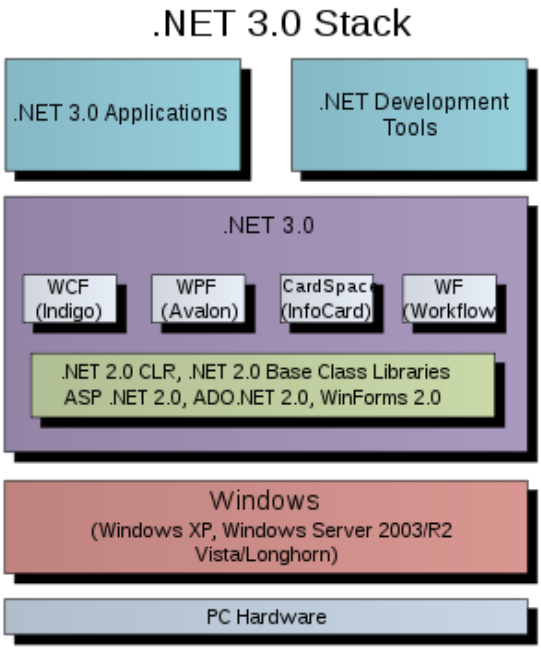


FIGURE 7: This subsystem is a part of .NET Framework 3.0.

2.4 XAML

XAML stands for Extensible Application Markup Language (XAML). This is a declarative language. Basically, XAML can initialize objects and set properties of objects, using a language structure that shows hierarchical relationships between multiple objects, and using a backing type convention that supports extension of types. Actually, XAML files are xml files that have the .xaml file extension .

The XAML language supports interchange of sources between different tools and roles in the development process without information loss, such as exchanging XAML sources between Microsoft Visual Studio and Microsoft Expression Blend. By using XAML as the interchange format, designer roles and developer roles can be separate and designers and developers can iterate during the production of the application. The definition of XAML is taken from here. XAML is one of the feature that is used in the Visual C#.

Basically, the XAML file just defines the user interface and what elements it has and CS contains the actual function of the program it is talking about the WPF .
(https://en.wikipedia.org/wiki/XAML)

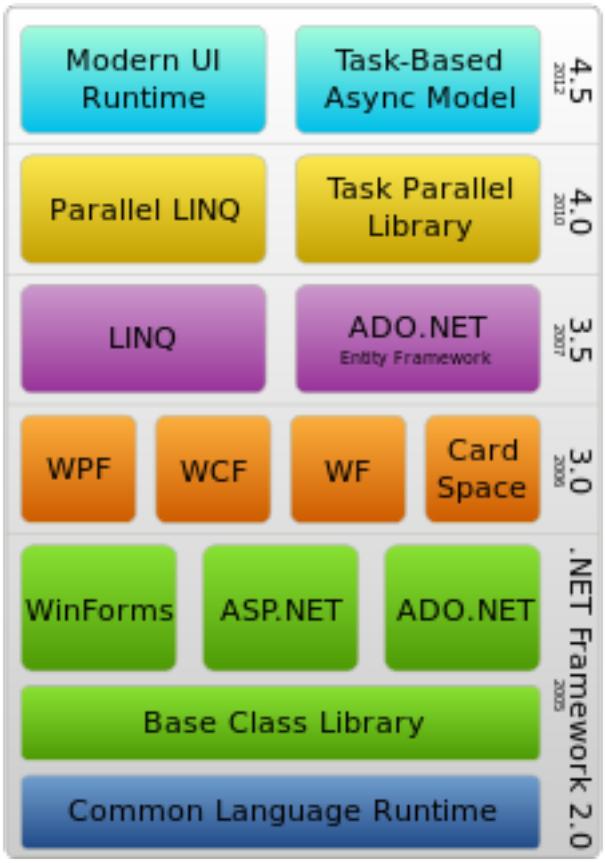
2.5 Visual C#

C#, (pronounced as C Sharp), is a programming language that is designed for building a variety of applications that run on the .NET Framework. C# is simple, powerful, type safe and object-oriented. Many innovations in C# enable a rapid application development while retaining the expressiveness and elegance of C-style languages. Visual C# is an implementation of the C# language by Microsoft.

Visual Studio supports Visual C# with a full featured code editor, compiler, project templates, designers, code wizards, a powerful and easy to use debugger and other tools. The .NET Framework class library provides access to many operating system services , and other useful, well defined classes that speed up the development cycle significantly.
MICROSOFT 2013, Visual C#, Date of retrieval 6.5.2013
(http://msdn.microsoft.com/en-us/library/vstudio/kx37x362.aspx)

2.6 .NET Framework

.NET Framework is a software framework developed by Microsoft that primarily runs on windows . It includes large library and provides language interoperability (each language can use code written in other languages), across several programming languages. Programs written for the .NET Framework execute in a software environment, known as the Common Language Runtime(CLR), an application virtual machine that provides services such as security, memory management, and exception handling.
(WIKIPEDIA 2013, .NET Framework, Date of retrieval 22.4.2013
http://en.wikipedia.org/wiki/.NET_Framework



The .NET Framework Stack

FIGURE 8: The .NET Framework Stack

3 TECHNICAL INFRASTRUCTURE

In information technology, and on the Internet, infrastructure is the physical hardware used to interconnect computers and users. Infrastructure includes the transmission media, including telephone lines, cable television lines, and satellites and antennas, and also the routers that transfer data between disparate transmission technologies.

And, in this museum project, the technical infrastructure consists of the electronic display device such as a monitor or the screen. This display is connected with the USB to the sensor board. The sensor board gets the charge from this USB.

3.1 FT232R Driver installation

The serial-to-USB converter IC used on the sensor hardware circuit board is FTDI's FT232R. Virtual serial port driver needs to be installed before connection the system to a computer. The driver can be downloaded for various operating systems from IC manufacturer's home page from address: http://www.ftdichip.com/Drivers/VCP.htm. Driver installation should be straightforward.

After the driver is installed successfully the circuit board can be connected to the computer. A red led next to the USB connector indicates that the power is on. Check from Windows' Device manager that a new COM port is visible, titled "USB Serial Port". Check the COM port's number (e.g. COM3). The circuit board draws approximately 21 mA current from the USB port. (http://www.ftdichip.com/Drivers/VCP.htm, Date of retrieval 11.11.2012)

3.2 Hardware Overview

Analog Devices' AD7147 capacitance-to-digital converter IC is used to measure the capacitance of the electrodes on the flexible sensor board. The circuit board has 12 input channels numbered from CIN0 to CIN11. These are routed on the flexible sensor board to form a 6 by 6 matrix. The Capacitance value for each channel is separately measured by AD7147. A separate channel

called ACSHIELD is used to bring a shielding signal to the sensor to prevent an unwanted capacitance pickup from wiring.
Atmel's ATmega1284P 8-bit microcontroller is used as data processor on the PCB. It listens to serial port for commands (FT232R is used to convert serial port data to USB format), does data reading from AD7147 and does the calibration and data processing required.

AD7147 has an internal algorithm to compensate for environmental changes in capacitance values. However these are only usable when the decision whether there is a touch detected or not is left for AD7147. In this application where raw capacitance data is read from AD7147 and used for calculations in the microcontroller, this algorithm is not usable. Instead a user definable threshold value is used in the microcontroller to make the decision.

The flexible sensor board consists of six horizontal lines and six vertical lines with square shaped electrodes. Each line is an independent measurement channel. Capacitance is measured for each channel by AD7147 and is represented by numerical value between 0 and 65536. Values are calibrated by software to middle point 32768 in power up sequence and also by reset command. Measured values from individual channels can be used to calculate point of maximum capacitance on board (position of the hand). The board does not support multi touch, meaning that only one maximum capacitance point can be calculated.

There are also additional I/O ports on the circuit board titled PORTA and PORTB. They are not used in this application. If needed, they can be programmed to function as input or outputs by modifying the microcontroller software.
(http://www.ftdichip.com/Drivers/VCP.htm, Date of retrieval 11.11.2012)

3.3 Software interface and operation

The system is interfaced via a virtual serial port with following parameters:

- Baud rate: 38400
- Data bits: 8
- Stop bits: 1

- Parity: none

All communication is done using ASCII characters, so it's possible to interface to the board using a terminal software, for example Putty or HTerm. Of course in more advanced applications dedicated software can interface the serial port directly.

In idle mode, the board is waiting for commands from the computer. A command is essentially a single ASCII character. When a command is received, it is executed and results are sent back to computer. Available commands are:

h	Help, list all commands
a	Read raw (but calibrated) capacitance values for all channels. Capacitance value for one channel is an integer between 0 and 65536. Each channel is calibrated during power on and reset to 32768. When hand is brought close to the board, capacitance value increases.
c	Calculates and outputs coordinates of the hand above the sensor. X and Y coordinates (value between 0 and 10) represent the location of the hand and Z coordinate represents the capacitance value (approximately inversely proportional to the distance) in that location. Threshold value (see below) is used to decide whether there is a hand above the board. When threshold is not exceeded, X and Y coordinate values of 65536 are used to indicate "no touch" situation.
t	Increases coordinate detection threshold one step. Use this to adjust the sensitivity so that noise does not cause false detection. Threshold value is stored in non-volatile memory and is restored during power up. Start with thresholds between 100 and 150.
g	Decreases threshold value one step.
r	Resets and recalibrates the sensor. Each channels capacitance value is adjusted to 32768. Use this when the environment of the board has changed and capacitance values have drifted away from 32768. This is also done on power up.
o	Same as *c*, but in shorter format.

3.4 Sensor boards' notable characteristics

The sensor board is very sensitive to all capacitance changes around it. It means that when the environment changes, for example the sensor board is moved or a large object is brought near it,

the hardware needs to be recalibrated. This can be done in software using command *r* as mentioned previously.

Another source of possible problems is grounding. Capacitance sensing IC AD7147 measures capacitance between electrodes on sensing board and ground net of the board. Because sensing electrodes are relatively far away from the sensing IC there needs to be a strong ground reference present. Poor ground reference will decrease sensitivity greatly. In experiments it has been found out that the system works best in a system where the computer is connected to mains power using grounded power outlet. This is the optimal situation. In laptop system running on battery power the sensitivity can be increased by using long wire between the hardware and pc or by soldering an additional wire to the ground net of the hardware board and fixing it in the vicinity of the sensing board.

4 IMPLEMENTATION

In any project, there needs to be the research and the correct method of implementing the research ideas so that the required goals can be achieved.

In the first page of a User Interface (UI), there are 4 main active areas.
a. The Tervakangas or the Iron Age Burial Ground.
b. A coin hoard from the Middle Ages in Pattijoki.
c. Link Suomeksi (In Finnish).
d. Copy right mark at the top right.

4.1 The Tervakangas or the Iron Age Burial Ground

The Tervakangas or the Iron Age Burial Ground: When the user points in this area which is called as “The Tervakangas or the Iron Age Burial Ground”, then the page will change its slide and goes to the next layer which is called the “karttasivu in English 2.jpg” layer. This is the second layer. In this particular layer there are multiple choices, on the left most top, there is an ancient compass and when the user points to that part, the page will go to the previous level. There is no background sound in this layer.

In the same map layer called as Karttasivu, there are graves shown with numbers such as 1,2,3,4,5,6,7,8. When the user points those numbers from 1 to 8, excluding the number 5, the user can get more information about that certain grave. More detailed information about these graves has been given by the museum of Raahe. The number 5 grave is the most important grave. In this specific grave, the user needs to dig deeper to get what he/she wants to see. There are multiple sounds in this layer. At first someone is walking on rough ground then we can hear wind blowing and birds singing on the background.

There are 3 active areas in this Karttasivu along with those 9 graves. Those 3 active areas include the Language button by which the user can switch between the Finnish and the English language. The second one is the link to the first page of UI with an ancient compass. When the user points to that ancient compass, it will go to the first main page.

There is a tomb of the number 5. This is the level where the museum customer initiates the grave digging. Just using hands, plants and stones disappear and colour of the ground (earth layers) gradually changes until eventually the grave comes out. There are some sounds in this layer, we can hear wind blowing and birds singing on the background.

In this layer of the grave, a broken glass begins to be seen. There are 3 activated areas in this grave. One is the link to the first main page of UI with an ancient compass. And, the second is for different languages and the third active area is the grave itself. There are some sounds in this layer, we can hear wind blowing and birds singing on the background.

In this 3rd layer of the grave 5 digging, the earth layer is now grey. In this layer, the museum customer is using a spatula to dig deeper. There can be the picture of spatula in the same picture to show the customer what kind of tool is used. In this layer, there are 3 active areas. The first one is the link to the first page of UI with an ancient compass image, the second is for different languages and finally, the third one includes the grave itself. There are some sounds in this layer, we can hear wind blowing and birds singing on the background.

In this layer, the customer is using the spatula to dig the grave and not the hand. However, the colour of the grave changes to a different colour. There are 3 main activated areas in this grave layer, one is the link to the first page of UI with an ancient compass, the second one is for different languages and the third one is the grave itself. There are some sounds in this layer, we can hear wind blowing and birds singing on the background.

In this level, the museum customer is using the paint brush to dig the grave. The picture of the paint brush can be embedded to this layer by the help of the Photoshop Elements. The archaeological approach is used in this technique while digging the grave. This is because we need to dig the grave slowly so the next layer becomes visible slowly, bit by bit. There are some sounds in this layer, we can hear wind blowing and birds singing on the background.

In this level, the customer is still using the paint brush to dig deeper and the colour of the grave is still changing into darker shades. The objects of the grave are shown more. There are 3 activated areas: The first one is the link “Mainpage” with a compass image. The second one is the link “Suomeksi” and the third one the grave itself. There are some sounds in this layer, we can hear wind and birds singing on the background.

This is a close up picture from the grave, where is one circle shaped image. When a museum customer points to numbers, he will get additional information about the wanted objects. This information can be given by an information box or a separate information window. There are 8 activated areas in this layer. The first one is the link “Main page” with the compass image. The second one is the language “Suomeksi” and the third one is six circle shaped images (from number 1 to 6). There are some sounds in this layer, we can hear wind blowing and birds singing on the background.

This is the final layer of the grave, where is one circle shaped image. By pointing that image, the customer will get additional information about that dead man’s corpse.
There are 3 activated areas: One is the link “Main page” with the compass image, the second one is the “Suomeksi” and the third one is that icon image to tell more information about that dead man’s body. There are some sounds in this layer, we can hear normal forest sounds like wind blowing and birds singing on the background.

If a person who uses this UI gets tired and just goes away and leaves application open, a timer starts to run and after a certain amount of time, the application jumps back to the main page. This makes it easier for the next user to start from the beginning of this application without needing a guide to the front page. Time is now set to be around 1 minute.

4.2 A coin hoard from the Middle Ages in Pattijoki.

Here we can use exactly the same techniques to implement this choice as we did in the section 4.1 which is called “The Tervakangas or the Iron Age Burial Ground”.

The implementation part consists of various methods that can be used to get this whole project done. With the process of research throughout this whole project, I found out that there are many ways to design ,test and implement. Like Java program can be used for the UI, or the WPF and C# depending upon the easiness that the users can get while using this technology.

4.3 Use of a keyboard or a mouse

The user can get the various images display or change between different slides using a mouse or a keyboard, for example by clicking the button in the display. Hence this method can switch between the pages which are shown in the program given below:

FIGURE 9 : The first page of User Interface.

When a person chooses the left hand side choice from the first page, he/she gets the next image to the display, which is shown in the figure below:

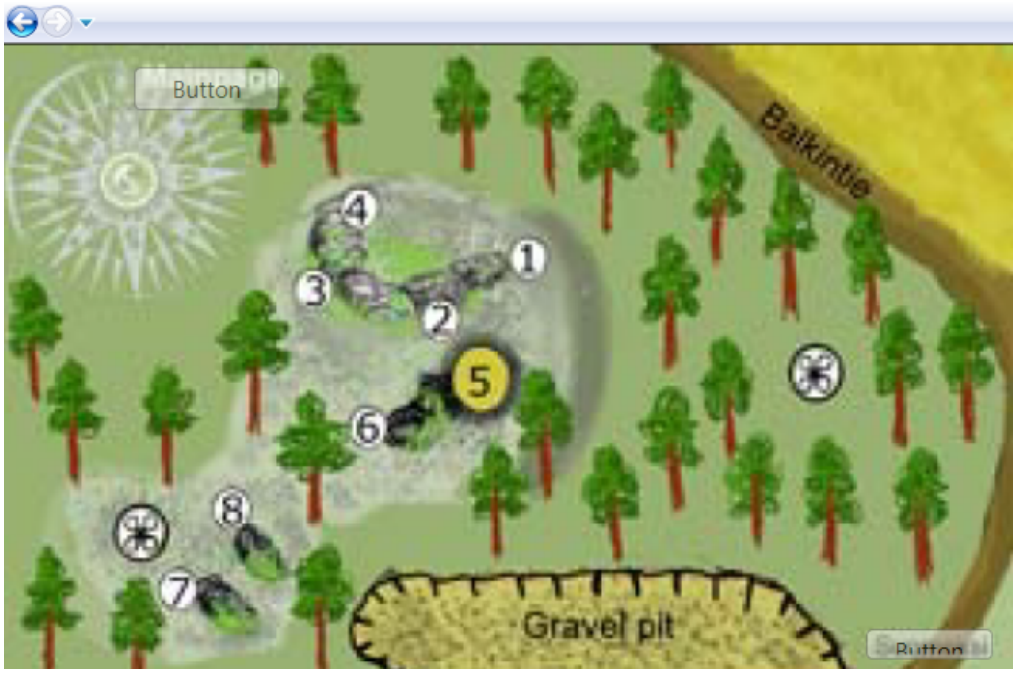


FIGURE 10: The first layer of the burial site.

4.4 Sensor board implementation

Another method is to sense the user's hand movement from the sensor board and send that information to the software so that the user can get the required image to the display. The information of the sensor board can be obtained by Java. For that reason, there should be a way to send that information to the WPF program or to create some kind of interface for it. For example, it would be nice to have a Java program that constantly saves the sensor board information to a file and the WPF program would periodically read the information from that file. Then, we could use the (x,y) coordinate information we just read to switch pages instead of button clicks.

Hence, going through the research, it was found out that the use of the sensor board was the best way to make the easy-to-use UI. Because in the museum, not only the technologically advanced people go to see demonstrations, but there are also many small children, elderly

people and handicapped, as visitors. Hence, looking upon the circumstances, it can be easy for all groups of people to use the sensor board. Because, the user just needs to point to the sensor board and it can lead the UI to change the slides and give the required information the user wants to know.

Nonetheless, looking for the benefit for all groups of people and their methods to use technology, it was found out that the sensor board, which was developed by the VTT, is definitely the easiest one to use as a hardware part of this project and then this demanding new technology can be achieved. This is because the flexible sensor board can be hidden out of the sight of people and be put for example under the table surface or behind a painting or a screen. Thus, we can display wanted pictures to that surface and people need to point only well known articles from the picture. By this way, no one has to be afraid of new technology because it is totally hidden. It is easy to point these things without fear. A very scientific looking sensor board might look scary if were visible.

4.5 Developmental Tools

In this work, the main development tool for running the required program is NetBeans, version 7.3 for Windows 7 and NetBeans 7.0.1 for Apple iOS. This refers to the Integrated Development Environment (IDE) developed to use the NetBeans Platform, a set of APIs for implementing a core IDE and its extensions. The NetBeans IDE supports the development of all Java application types (Java desktop, web, network, and mobile applications) out-of-the-box. The Java development requires a special plug-in for the NetBeans IDE. It includes a drag-and-drop palette for adding objects with transformations, effects and animations, plus a set of samples with best practices.

”The NetBeans IDE is the recommended tool to create, test, debug, and deploy Java applications for the desktop, browser and mobile platforms. You have the option of deploying Java projects as Java web start (JNLP), Java Applet, stand-alone applications, or in a mobile emulator.”

Along with that, Microsoft Visual Studio 2010 is being used as a developmental tool for the C# and WPF applications.

Microsoft Visual Studio is an integrated development environment (IDE) from Microsoft. It is used to develop console and graphical user interface applications along with Windows Forms or WPF applications, websites, web applications, and web services in both native code together with managed code for all platforms supported by Microsoft Windows, Windows Mobile, Windows CE, .NET Framework, .Framework and Microsoft Silverlight.

Visual Studio includes a code editor supporting IntelliSense as well as code refactoring. The integrated debugger works both as a source-level debugger and a machine-level debugger. Other built-in tools include a forms designer for building GUI applications, web designer, class designer, and database schema designer. It accepts plug-ins that enhance the functionality at almost every level—including adding support for source-control systems (like Subversion and Visual

SourceSafe) and adding new toolsets like editors and visual designers for domain-specific languages or toolsets for other aspects of the software development lifecycle (like the Team Foundation Server client: Team Explorer).

Visual Studio supports different programming languages by means of language services, which allow the code editor and debugger to support (to varying degrees) nearly any programming language, provided a language-specific service exists. Built-in languages include C/C++ (via Visual C++), VB .NET (via Visual Basic .NET), C# (via Visual C#), and F# (as of Visual Studio 2010). Support for other languages such as M, Python, and Ruby among others is available via language services installed separately. It also supports XML/XSLT, HTML/XHTML, JavaScript and CSS. Individual language-specific versions of Visual Studio also exist which provide more limited language services to the user: Microsoft Visual Basic, Visual J#, Visual C# and Visual C++.

Microsoft provides "Express" editions of its Visual Studio 2010 components Visual Basic, Visual C#, Visual C++, and Visual Web Developer at no cost. Visual Studio 2012, 2010, 2008 and 2005 Professional Editions, along with language-specific versions (Visual Basic, C++, C#, J#) of Visual Studio Express 2010 are available for free to students as downloads via Microsoft's DreamSpark program.

(WIKIPEDIA 2013, Netbeans, Date of retrieval 22.4.2013

http://en.wikipedia.org/wiki/Netbeans)

The WPF and the Visual C# code written to perform the images display in the UI for museum's project is shown in the figures below:

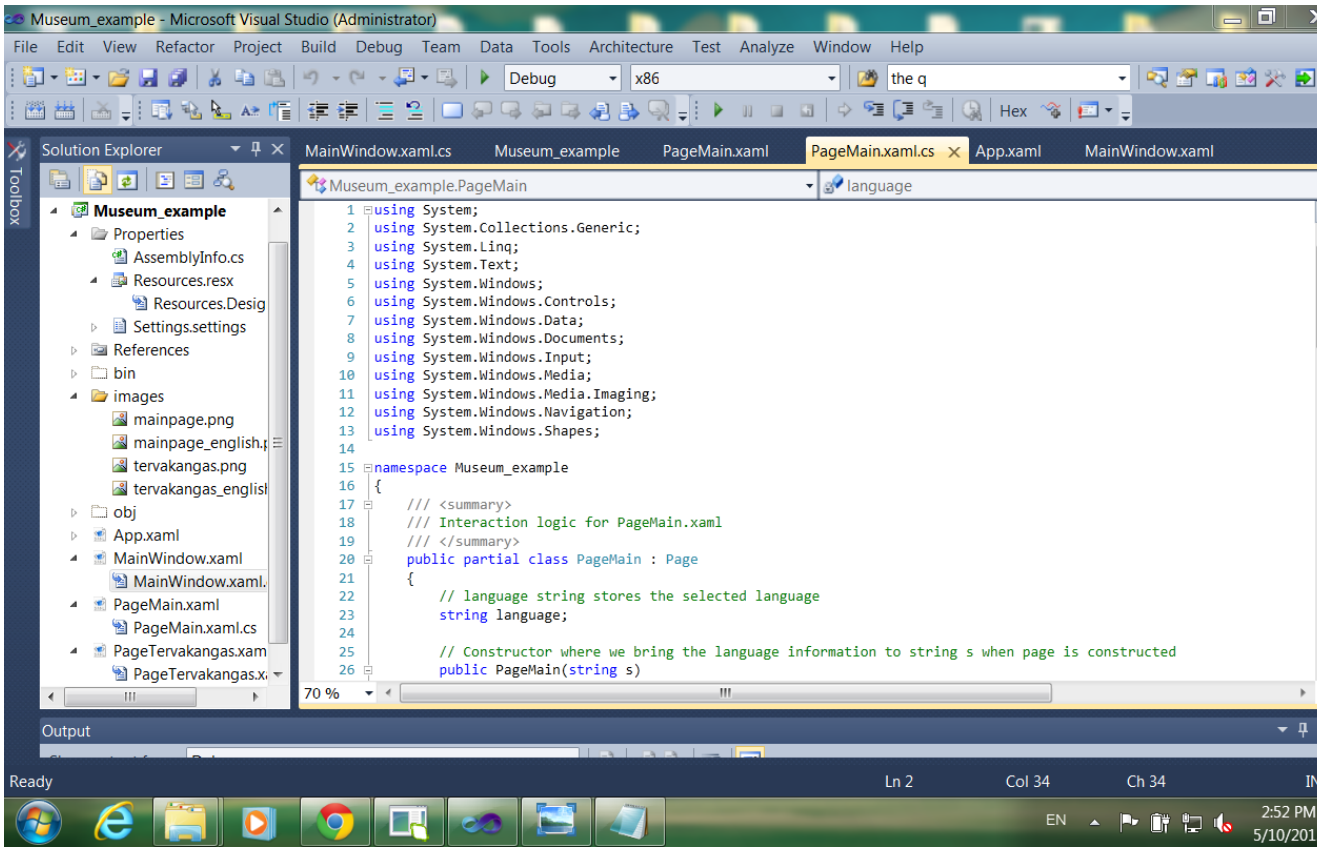


FIGURE 11a: The WPF code example to display the required images

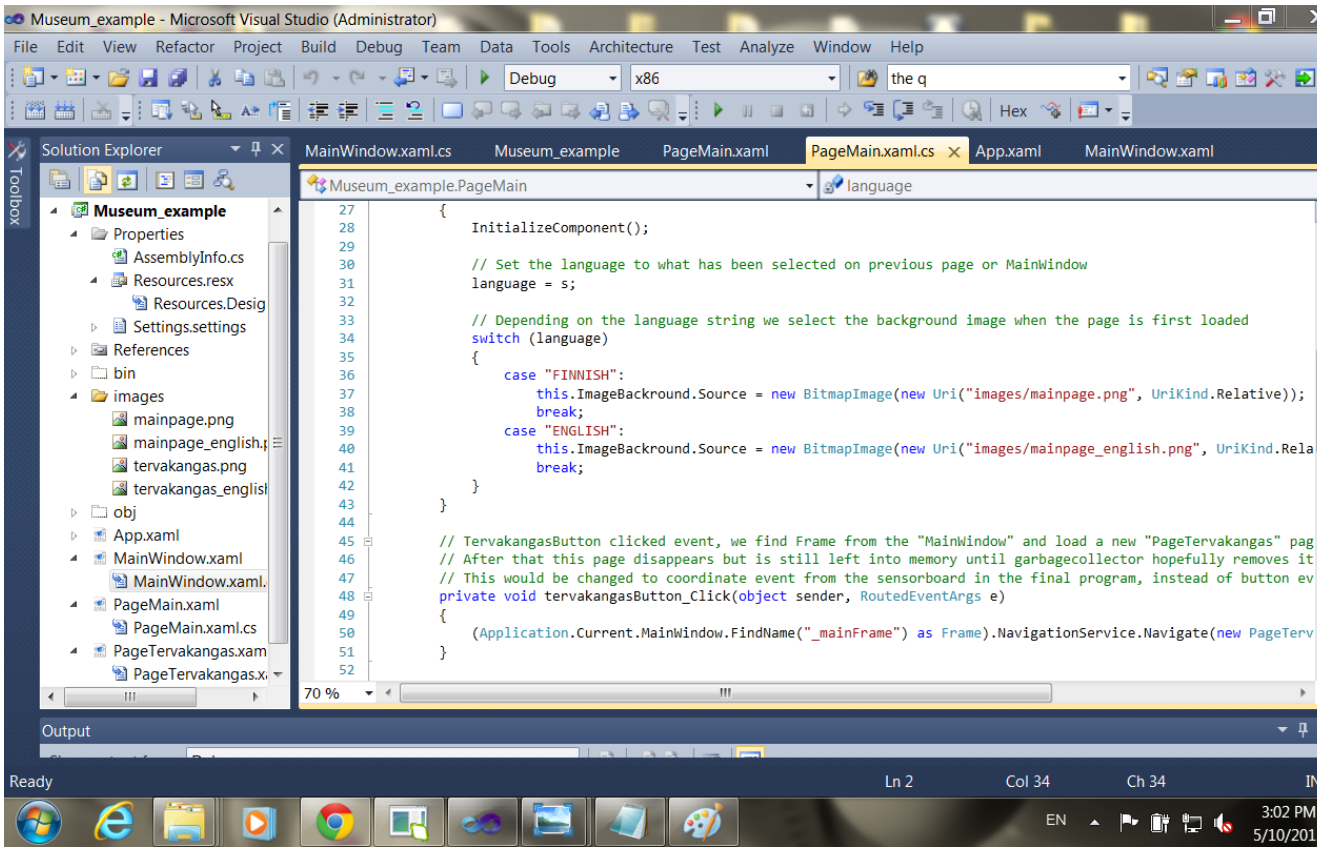


FIGURE 11b: The continuation of FIGURE 11a.

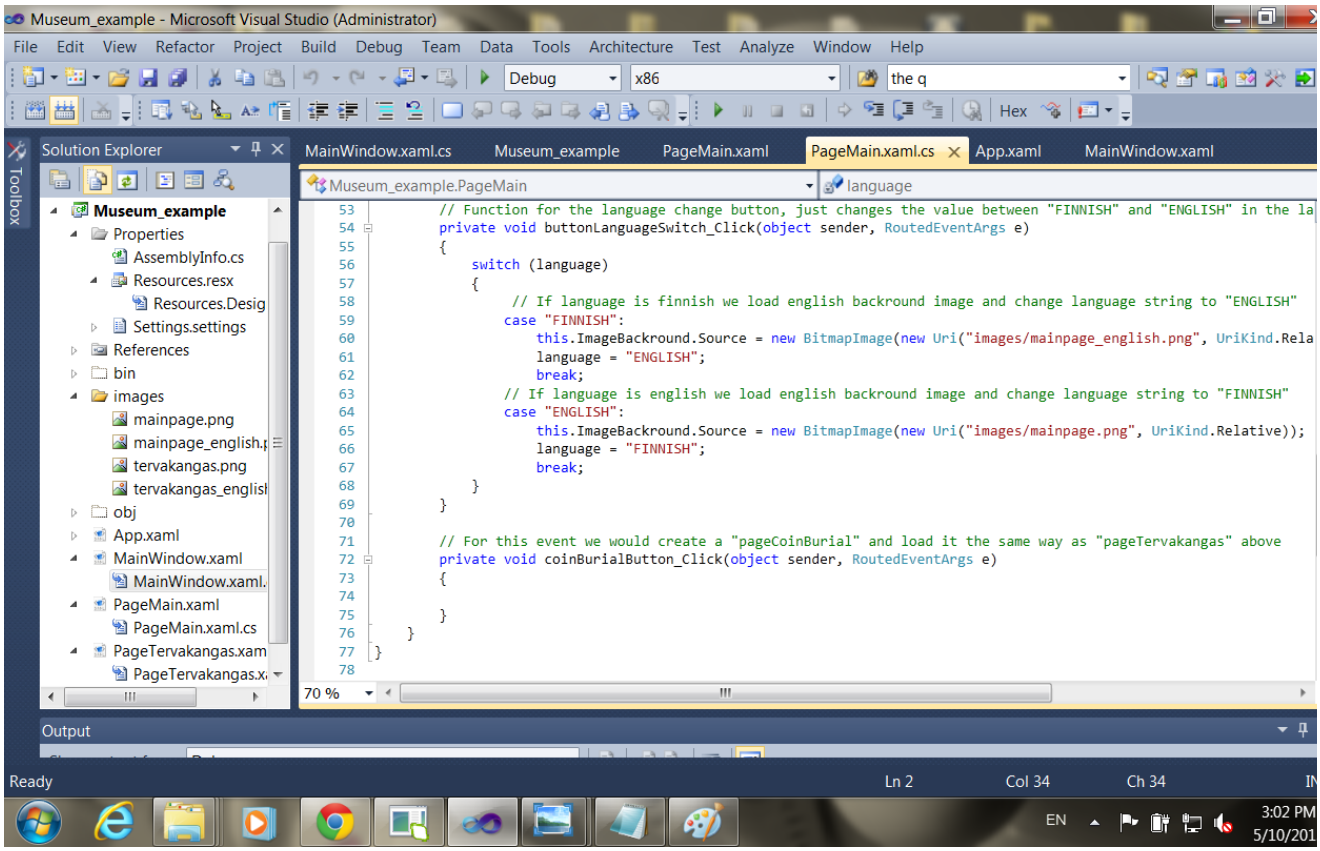


FIGURE 11c: The continuation of the same figure 11b and 11c.

Paint.Ink is a free image and photo editing software. It features an intuitive and innovative user interface with a support for layers, unlimited undo, special effects, and a wide variety of useful and powerful tools. An active and growing online community provides friendly help, tutorials, and plug-ins. Also, Paint.NET supports common image formats: .JPEG, PNG and GIF were actively used during the development of the user interface. The version used within this project is Paint.Ink.

5 TESTING

Testing is a relevant part of any application development. With testing we can confirm that the requirements of the application are met and passed. Testing provides us with information about the quality of the application, the requirements that are currently met and the bugs found.

(Knowledge from the Software Engineering course taught in OAMK in 2009, Autumn).

There are different software testing methodologies. We will apply 'Regression Testing' while developing the application. Regression testing deals mainly with testing all the components that makes up a system. In regression testing, the system is continually tested while development goes on. Regression testing flags old bugs that have been resolved previously. If these old bugs reappear while new components are added to the system, then we try to fix and resolve them before moving on with new features. Regression testing also flags new bugs creeping in.

(http://en.wikipedia.org/wiki/Regression_testing, Date of retrieval 10.5.2013)

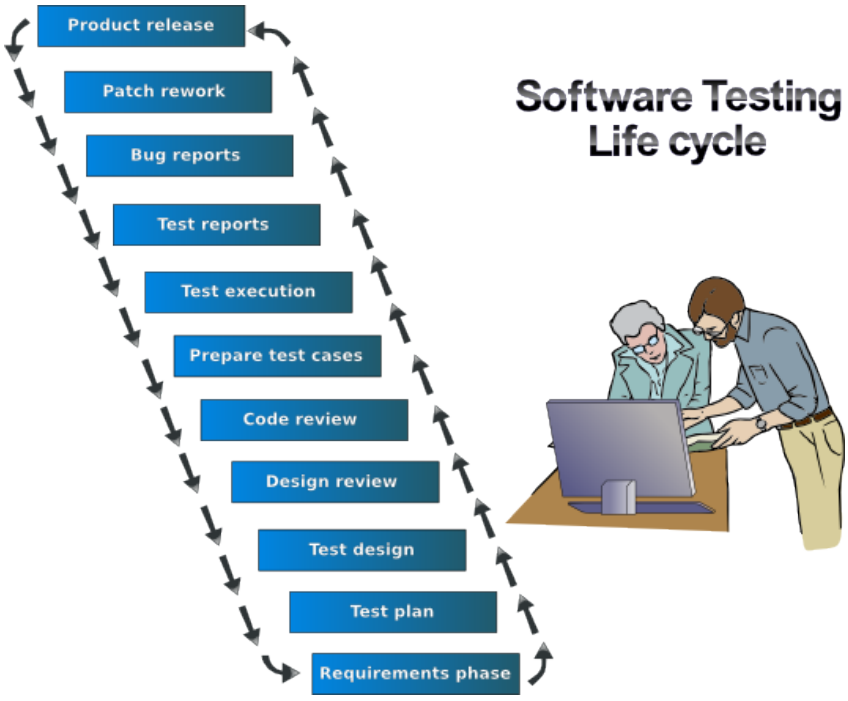


FIGURE 12: Shows the different stages of software development and testing lifecycle.

Test made so far have shown that this UI works nicely if this sensor board is placed over and under the right kind of surface. At first there were some problems with the sensing distance but it was found that the ESD table used in our labs caused this problem. Also, in the burial site application, either some graves or many graves were so near each-other, that the resolution of the sensor board was not enough. The distances between pointing points should be at least more than 10 cm.

6 FUTURE DEVELOPMENT

One delightful fact about software is that there is always room for improvement. No matter how good a piece of software is, there is always something that can be tweaked to improve the usability, user experience and performance of the software.

The future development of the software made for this project using the capacitive sensor board has many possibilities. They can be used for upgrading day by day with the time available. Many features like the pictures on the display, can be changed into different slides.

Objects in some slides should have more distance. And, new slides between the ones we use now should be added, to make the digging action to look more smooth and realistic. The user Interface module made along this research should be combined with the program module developed by a different person. This was not possible now because those codes made by another person were not available when this study was made.

7 CONCLUSIONS

This KAMARA project from Rikastamo for the Raahe museum can be performed by the sensor board and with the WPF and Visual C# developing environment because of their robust, user friendly and good libraries. This research was useful for all groups of people visiting the museum. This is because they do not need to know how to use the keyboard or the mouse as the sensor board placed under the table or any easily reachable place can make it really easy to get UI information.

During various research and developmental processes of this whole project, I have come to know about many things related to this new technology in the information technology field. I have learnt about how to utilise the time in a correct way so that it is possible to achieve desired goals. I have learnt about the project plan, design, implementation and testing. I also found out how important is the co-operation with fellow team mates, teachers and instructors. I have also understood the importance of correct guidance from the required authorities and good equipments and facilities to reach the goals in good and reasonable time.

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