Julien Della Valle

Designing UI/UX for the colorblind users

Optimization of a touchscreen application

Helsinki Metropolia University of Applied Sciences

Bachelor of Engineering

Media Engineering

Thesis

18 April 2017

Helsinki Metropolia University of Applied Sciences

Author(s) Title Number of Pages Date	Julien Della Valle Title of the Thesis 38 pages 18 April 2017
Degree	Bachelor of Engineering, BEng
Degree Programme	Media Engineering
Instructor(s)	Ulla Sederlöf, Lecturer

The purpose of this thesis was to analyse the accessibility for the colorblind people in UI/UX and to optimize the application on the touchscreen display on the frescoes in the National Museum of Finland. That was the demonstration which was already created by Metropolia University of Applied Sciences.

This thesis project was carried out at Metropolia University of Applied Sciences. The content of my thesis was based on the theoretical background about color blindness and the UI/UX Design as well as the analysis on the visual graphics and the optimization of the application.

The application needed a touchscreen display and contained a data of pictures processed by Krpano to make the 360° panorama display into a touchscreen display. The method was to analyze the facts of color blindness and the accessibility then to propose the solutions for colorblind users in UI/UX.

Finally, the ergonomics of the application looked good and the design was more sophisticated while it was modified and developped by using Html, Css and Javascript under Sublim Text. The application will be published with the touchscreen display in the museum in the near future. The accessibility was the most important thing in my opinion.

Keywords	UI/UX Design, panorama, frontend, touchscreen, color blindness

Contents

1 Introduction 1

2 Theoretical background 2

2.1 The National Museum of Finland 2
2.2 UI/UX 4
2.2.1 Designing the user interface (UI) 4
2.2.2 Measuring the user experience (UX) 5
2.2.3 Interaction Design 7
2.3 Touchscreens Technology 9
2.4 Color blindness 13
2.4.1 Types of Color Blindness 14
2.4.2 Solutions in the user interface 17

3 Application Design 19

3.1 Display Touchscreen in the National Museum of Finland 19
3.2 Design 20
3.2.1 Pre-design 21
3.2.2 Redesign 24
3.3 Coding - Frontend 26
3.4 Final product 32

4 Conclusion 34

References 35

1 Introduction

The purpose of this thesis project was to study and to analyse the accessibility of an interaction design created for people with visual disabilities, mostly the colour blind. Another aim was to analyse the user experience of this design. This study was carried out as part of a project to build an interaction enabling several user experiences in optimizing technologies for museum visitors.

The National Museum proposed a new product about viewing the frescoes, which were painted on the ceiling in the main building, using a touchscreen display for the visitors. The application was already done before but it was just a demonstration version that was available to be redesigned and be improved to make it more sophisticated by using the language of frontend (Html, Css and Javascript). Shortly, the project was mainly about designing and optimizing the application for the touchscreen.

I chose this project because the National Museum needed to achieve the demonstration of the application and it needed a UI/UX designer to improve the application for the touchscreen display.

The word “accessibility” is an important part of my life. People who have different disabilities, for example deafness or reduced mobility, need daily, facilitated access to different locations. Often they also need facilitation to be able to experience different things, such as a museum visit. In this project, I focus on the accessibility for the color-blind users also bearing in mind people with other disabilities.

2 Theoretical background

The National Museum of Finland illustrates the history from the 10th century to the 19th century. The museum's unique expositions narrates of the life from a period of over 1000 years across Finland. [1]

The theoretical part was the fruit of my studies in Metropolia University of Applied Science. It is divided in four parts and it will represent the National Museum of Finland, the UI/UX Design, the touchscreens technology then the color blindness.

2.1 The National Museum of Finland

The buildings of the National Museum of Finland (Figure 1) have been designed by three great Finnish architects, called Herman Gesellius, Armas Lindgren and Eliel Saarinen, with the characteristics of new architecture of the 20th century. The building is one of Finland's most significant national-romantic works of architecture. It has been built along Mannerheimintie between 1905 and 1910, and then opened to the public in 1916. Akseli Gallen-Kallela painted the frescoes on the ceiling in the central hall in 1928 and their themes were Kalevala, which is the national folklore and mythology epic of Karelic and Finland. The frescoes content four pictures, one by each corner pillar: Sammon taonta (The Forging of the Sampo), Sammon puolustus (The Defence of the Sampo), Ilmarinen kyntää kyisen pellon (Ilmarinen Ploughs a Field of Vipers) and Iso hauki (The Great Pike). [1]

Figure 1. The National Museum of Finland. [2]

Nowadays some buildings of the National Museum have been renovated for some months. The museum got an application developed by Metropolia UAS for a touchscreen display on the fresco so as the visitors can enjoy navigating virtually through the frescoes thanks to the touchscreen display. But the application had only the version demonstration and the museum needed to optimize it. The project was continued with me as an UI/UX designer to analyse, improve and achieve it.

Thereafter, the frescoes had already been digitized to become the 360° panorama with the high-resolution on the touchscreen display, which allows the visitors to view and zoom the frescoes version 360°. The process is described in my thesis advisor‘s Ulla Sederlöf’s Master thesis [3], which title is Art Meets Technology – Creating Gigapixel Panoramas for Historical Sites. This thesis explained about the method of the digitization method of the painting with the high-resolution images. Then the pictures of the frescoes are processed and transformed into 360° panorama with the application called krpano [4]. Finally, the final product of 360° panorama on the frescoes contained the data of pictures and the file javascript, which was connected with the data. The work was ready to display on the touchscreen TV but the source code needed to be optimized for the application.

Finally, to optimize the application using Html, Css and Javascript will be discussed in the next section 3.2. The style of the application must be respected and follow the style of the National Museum of Finland. These visual guidelines were used in this project.

2.2 UI/UX

This section will focus on the terms of the user interface (UI) and the user experience (UX) in the technical domain and also explain what the interaction design means with the following outline:

- Designing the user interface (UI)
- Measuring the user experience (UX)
- Interaction

The thesis requires the knowledge of an UI/UX design, and to understand how to use this knowledge to optimize the application.

2.2.1 Designing the user interface (UI)

User interface design is the design of user interfaces for machines and software, such as computers, mobile devices, and others electronic devices, with the focus on maximizing usability and the user experience. 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. [5; 6, 11]

> "A good user interface design facilitates finishing the task at hand without drawing unnecessary attention to it. Graphic design and typography are utilized to support its usability, to influence how the user performs some interactions and to improve the aesthetic appeal of the design. The design aesthetics may enhance or detract from the ability of users to use the functions of the interface. The design process must balance technical functionality and visual elements to create a system that is not only operational but also usable and adaptable to changing user's needs. Consequently, designers tend to specialize in certain types of projects and have skills centered on their expertise, whether that be software design, user research, web design, or industrial design." [7]

Fadeyev Dmitry wrote the article in his blog and there is a lot of information available about various interface design techniques and patterns, i.e. a written document that

can be used when crafting the user interfaces and websites, the solutions to global problems and the general usability recommendations. [8; 9, 12] There are eight characteristics for a good user interface design: [10]

- Clarity
- Concision
- Familiarity
- Responsiveness
- Consistency
- Aesthetics
- Efficiency
- Forgiveness

Additionally, designing the user interface is the Art and the Science at the same time. Artistic designer makes accessible when imagining an attractive style and aesthetic, but at the core of UI design make the relation between the logic and method. The light, the color and the contrast are the very basic things that are frequently neglected and can negatively affect the user interface by disturbing the attention and focusing on the others things. There is a very good example applying these principles from a well-known usability expert, Apple. Its user interface is very clear, visual and understandable without making efforts. This is the interface for the OS X operating system's control panel for the Mac. [11]

2.2.2 Measuring the user experience (UX)

At the beginning, the word « usability » had its complex sense in several term. For Jackob Nielsen [12], this word is a quality attribute that assesses the level of facility for the user interfaces are to use. The word "usability" also refers to methods for improving ease-of-use during the design process. This term is defined by 5 quality components: [12]

- Learnability
- Efficiency
- Memorability
- Errors

- Satisfaction

Meanwhile, according to the book « Measuring the user experience », the word « usability » refers to three aspects of this word, defining it as the extent to which a product can be used by specified users to achieve goals with the effectiveness, the efficiency, and satisfaction in a specified context of use. Also, there are several common themes: [13, 5]

- An user is involved.
- An user is doing something.
- An user is doing something with a product, system, or other thing.

Then the term « user experience » corresponds to a concept that places the end-user at the focal point of design and development efforts, as opposed to the system, its applications or its aesthetic value alone. It is based on the general concept of user-centered design, that is to say it outlines the phases throughout a design and development life-cycle all while focusing on gaining a deep understanding of who will be using the product [14]. The user experience basically consists of four factors: [15]

- Branding
- Usability
- Functionality
- Content

The difference between these terms can be distinguished. The first term « usability » is usually considered as the ability of the user to do the thing to effectuate a task with the success, whereas the second term « UX » takes a broader prospect, dealing with the individual’s entire interaction with the thing, as well as the thoughts, feelings, and perceptions that result from that interaction. While the usability is just one block of a large UX iceberg, as seen below Figure 2, and a part of the overall user experience of products, either physical or online. [13, 5; 16]

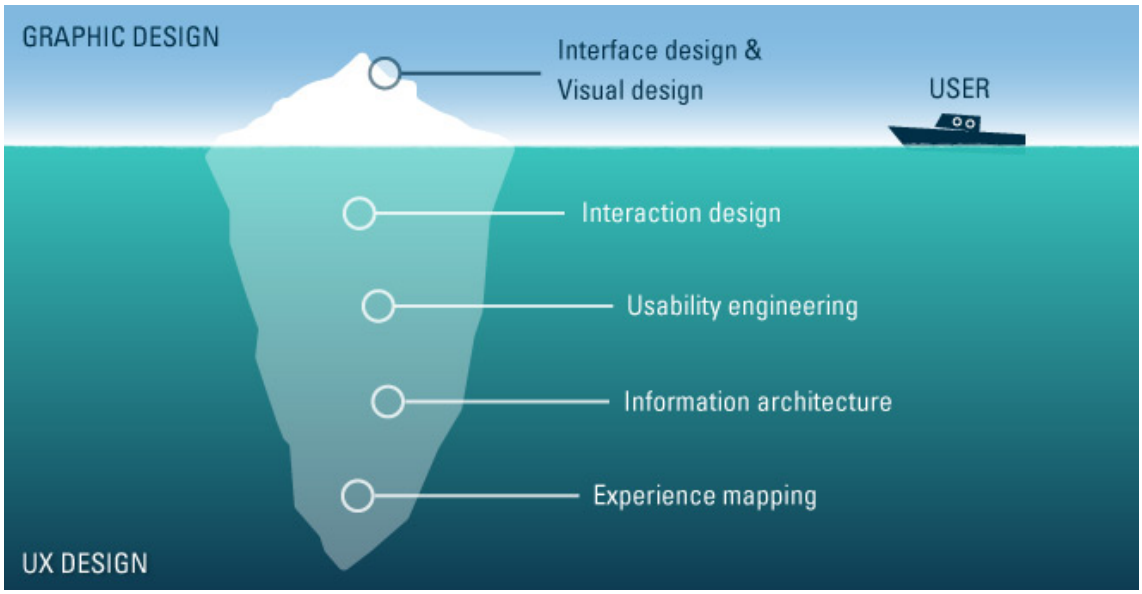

Figure 2. Most of the UX designers work below the surface and are invisible to the user. [17]

2.2.3 Interaction Design

In information and communication technology (ICT), the interaction is by definition a kind of action that occurs as two or more objects have an effect upon one another. The idea of a two-way effect is essential in the concept of interaction, as opposed to a one-way modal effect. [18, 5]

Although Bill Moggridge, who is cited in the book of Saffer Dan, would mention the term in 1990, the practice has been existed a long time, following the tribal peoples in North America used smoke signals to communicate over remote distances. Some centuries later, Samuel Morse created a system of communication called Morse Code to use the electromagnetic pulses into a language to communicate over long distances in a short time. Workers like telegraphers used the Morse language through the more or less sophisticated machines. A bit of time later, appeared the receiving devices, telephones, radios, and television sets for example, and also the devices used to create and to send messages, telephone switch, microphone, television camera, control booths for example. In these cases, for the most part, the machines are necessary to respond to human input but it is not in a very sophisticated way. Since about 20 years, computers have revolutionized the field of the communication media, and by the way people's dairy life. [19, 2-8]

Nowadays, millions of people write the emails, talk on mobile phones, visit the websites and use the social medias, and this last is becoming the lifestyle. To understand the meaning of the interaction design, there are both good and bad interactions. The benefit from the good side is to update a status on Facebook and the reverse, which could cause the sufferance from the bad side, is often true and is to struggle to synchronize a mobile phone to any computer. It is a kind of discipline in ICT to design something about doing to connect people through the products that are used. Moggridge called this new discipline interaction design. [19, 20]

In the book of designing for Interaction written by Dan Saffer, Interaction design as a formal discipline has been around less than twenty years. Its place is among sister disciplines such as visual graphic, user experience (UX) design, and human factors. To clarify the relation between the disciplines of a design landscape, see Figure 3. [19]

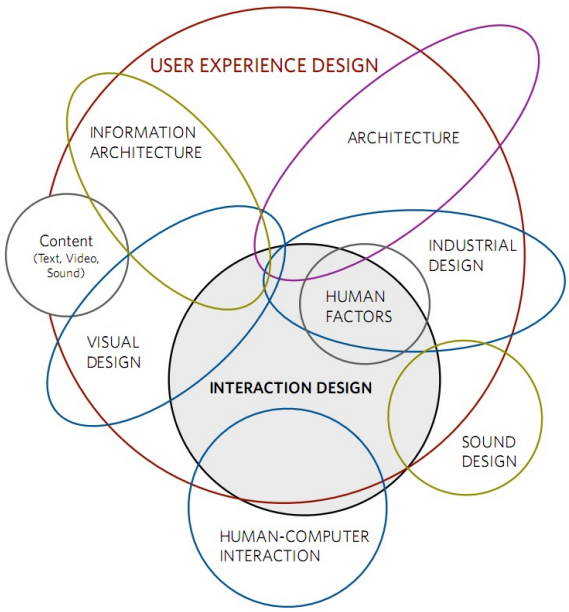

Figure 3. The disciplines surrounding interaction design. [19]

According to Bob Baxley, the interaction design is one of parts “art and science”, it is considerate to all forms of design, and the definition corresponds better to this speciality of design issues and challenges. The interaction design breaks the field into five pieces that are still useful and relevant today: [20]

- Human/machine communication is the translation of conversations between the device and user.

- Action/reaction looks at how interactions happen and unfold.
- State ensures that users know what is happening and why in terms of the application.
- Workflow ensures that users know how to use a tool or application and what happens next.
- Malfunction takes into account mistakes that are bound to happen.

The products are well-designed interactive balance each of these interests with the respective limitation and capability of both people and the technology. The products allow people and technology to deal with a complex and awesome move relying on multiple, synchronal forms of communication. Therefore the role of the interaction design is to the choreograph and the facilitate the dance. [20]

2.3 Touchscreens Technology

A touchscreen is technically a computer display screen that is also an input device. The screens are sensitive to pressure and the touchscreen is an electronic visual display capable of “detecting” and effectively “locating” a touch over its display area. It is sensitive to the touch of a human finger, hand and passive objects like a pen. Then users can simply move things on the screen, scroll them, and zoom on them and many more. [21, 413]

Touchscreen technologies can be mainly divided into four types: Capacitive, Resistive, Surface wave and Infrared [22]. From this part, the explication of different types is based on the report written by TRU-Vu Customizable Industrial LCD Monitors, and it summarizes the type of touchscreen technologies following:

- Capacitive: The protective cover is coated with a transparent electrode layer on the glass substrate. When the cover is touched, a small amount of charge is drawn to the point of contact. Circuits located at each corner of the panel measure the charge and send the information to the controller for processing. There are two sub-types of capacitive: Surface capacitive in Figure 4 and Projected capacitive in Figure 5. [23]

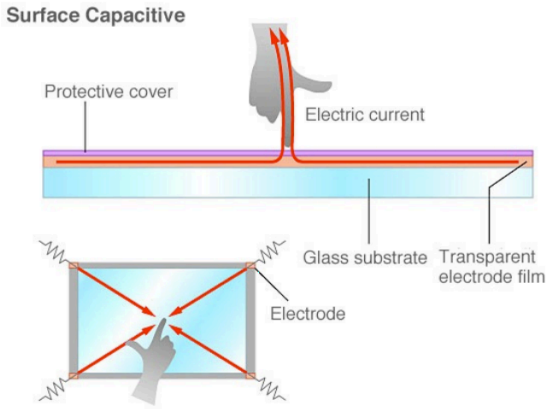

Figure 4. One of two subtypes of capacitive: Surface capacitive. [23]

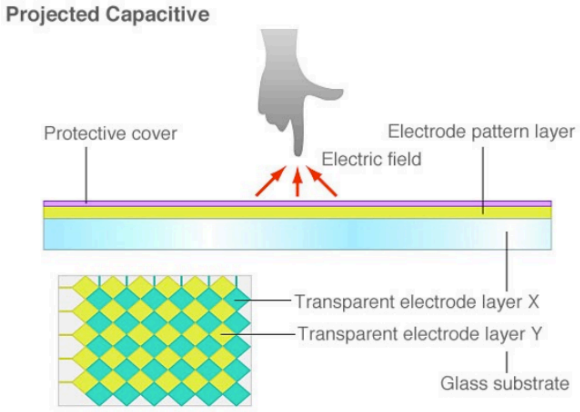

Figure 5. Other of two subtypes of capacitive: Projected Capacitive. [23]

- Resistive: The most widely used touchscreen. A resistive touch screen monitor contents a glass panel and a film screen, each covered with a thin metallic layer, separated by a narrow gap. See Figure 6. When an user touches the screen, the two metallic layers are both bumped, due to the electrical flow. The point where the user points out is detected by this change in voltage. [23]

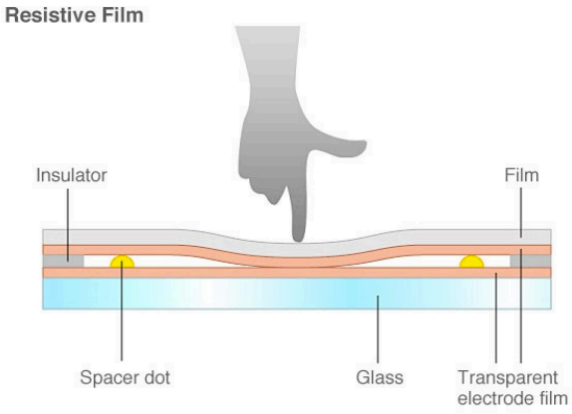

Figure 6. The Resistive Touch. [23]

- Surface wave: That is the most advanced ones it uses ultrasonic waves that pass over the touch screen panel. When an user touches the panel, a portion of the wave is absorbed. See Figure 7. This change in the ultrasonic waves registers the position of the touch event and sends this information to the controller for processing. [23]

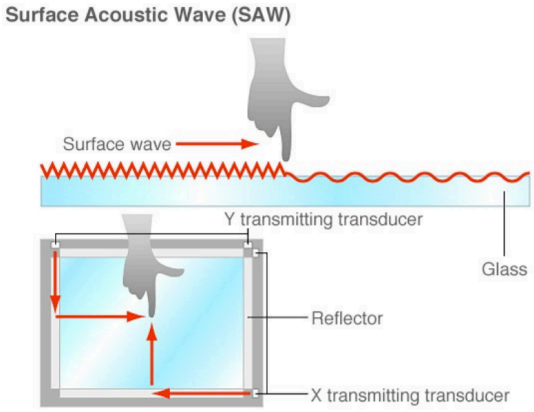

Figure 7. The Surface Asouctic Wave Touch. [23]

- Infrared: The touch screen monitor does not overlay the display with an additional screen or screen sandwich. In the first place, the IR emitters and receivers are used which allows to create an invisible grid of light beams across the screen. See Figure 8. That ensures the best possible image quality. When an object interrupts the invisible infrared light beam, the touch point can be locate by the sensors. [23]

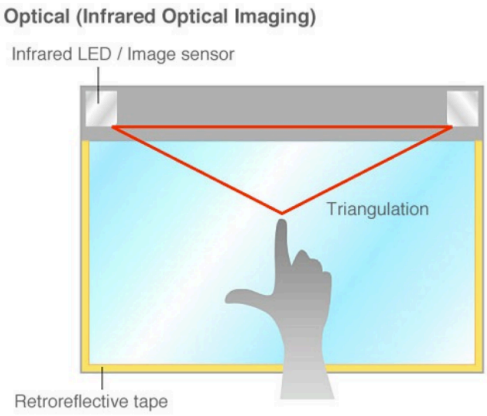

Figure 8. The Infrared Touch. [23]

After, below is a basic table of comparison to indicate the advantages and the disadvantages of each device. See Table 1.

Type	**Advantages**	**Drawbacks**
Resistive	• Active with some objects • Tactile Feel • Lowest costs • Low consumption • Resistant	• Lower clarity • Vulnerable
Capacitive	• Better clarity • Durable • Excellent resistance • High scratch resistant • Multi-touch (projected)	• Only bare finger or stylus (surface) • Exposed finger, thin surgical and cotton gloves (projected) • Sensitivity to EMI/RFI
Surface wave	• Excellent clarity • Better scratch resistance • High touch life	• Not activated with hard items • Not resistant against water • Able to create non-touch areas
Infrared	• Highest clarity • Unlimited ”touch-life” • Impervious to surface scratches	• Not resistant against contaminants/liquids • Sensitive to water (snow and rain) • Sensible to ambiant light interference • Higher costs

Table 1. Table of the comparison between the types of touchscreen technology. [23]

According the table 1, the infrared touch would be the good choice for the application because this type touchscreen has a high clarity and a suitable display. The touchscreen display will be placed inside the building then the rain will not touch it. The National Museum of Finland already had the touchscreen TV and the TV model will be introduced in the chapter 3.

2.4 Color blindness

The colorblind people have confronted the barrier of the UI and UX because of a lot of colors that has made them confused between several different colors in front of display.

According to the site “Colour Blindness Awareness” and to the National Eye Institute, the color blindness, also known as color vision deficiency, is the decreased ability to see color or differences in color. It can make some educational activities difficult. The daily challenge for the people having this disability, for example, be buying fruit, picking clothing, and reading traffic lights. Problems, however, are generally minor and most people adapt. People with the total color blindness, however, may also have decreased visual acuity and feel uncomfortable in bright environments. [24; 25]

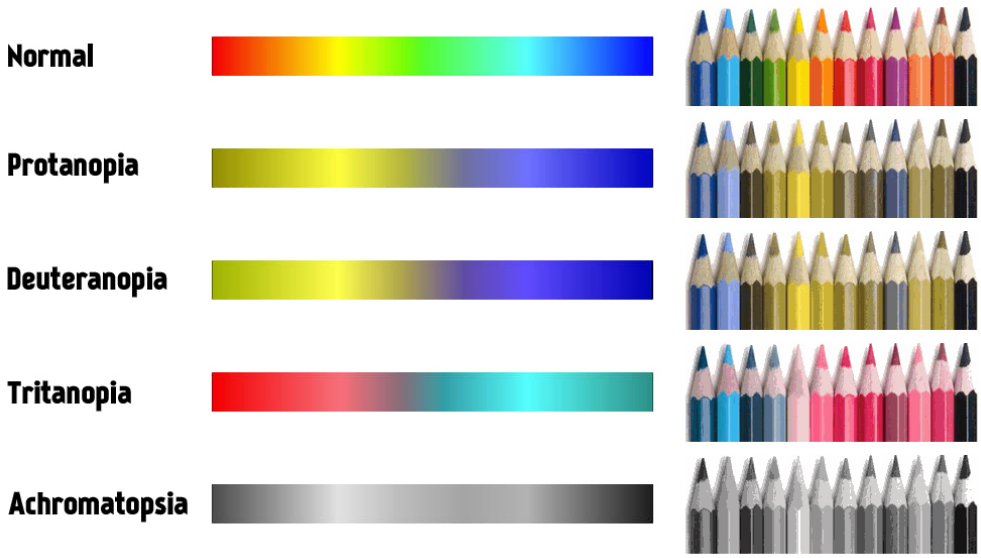

Figure 9. Spectras and colored pencils for each different type of color blindness. [26; 27]

Most color blind people are able to see things as clearly as other people but they are unable to fully « view » red, green or blue lights. There are different types of color blindness and there are extremely rare cases where people are unable to see any color at all. See Figure 9.

In the world, 8% of men and 0,5% of women are affected by the color blindness. Men are more susceptible to become colorblind than women because the gene of the X-chromosome is responsible of this disability and men possess only one X-chromosome while women have two. Then a “healthy” X-chromosome is enough to compensate the recessive other. That is why men are more affected by the color blindness than women. [24; 28; 29]

2.4.1 Types of Color Blindness

The “healthy” people are called trichromats while the three types (red-green-blue) of cones (6 millions in each human eye) photopigments can be perceived. The cones are more responsive to bright light, such as in the daytime when light is plentiful. This makes cones sensitive to red, green, or blue wavelengths of light. The presence of three types of photopigments, each sensitive to a different part of the visual spectrum, is what gives us our rich color vision. [25] Then the three types of color blindness are Red-Green, Blue-Yellow, and Complete. See Table 2. [30]

Trichromacy (healthy people)		
Dichromacy	Red-Green	*Protanopia*
		Deuteranopia
	Blue-Yellow	*Tritanopia*
Monochromacy	Complete	*Achromatopsia*

Table 2. The classification of color blindness.

The types of color blindness will be enlightened in the next paragraph, each type is demonstrated by two pictures to compare between the trichromat and the type of color blindness. In the case, the “Nyan Cat”, shown below, was chosen because it is the perfect illustration of the color of rainbow (Figure 10-13). The picture’s filter is modified

according to each type of the color blindness through the Color Blindness Simulator Coblis [31].

Firstly, the Red-Green color blindness is the most common of three types. This color blindness is due to the loss or the malfunction of red cone (protan) or green cone (deutran) photopigments:

- Protanopia: there are no working red cone cells. Red appears as black. Some shades of orange, yellow, and green all appear as yellow.

Figure 10. Two pictures of Nyan Cat: trichromatopsia (left) and protanopia (right).

- Deuteranopia: there are no working green cone cells. They tend to see reds as brownish-yellow and greens as beige.

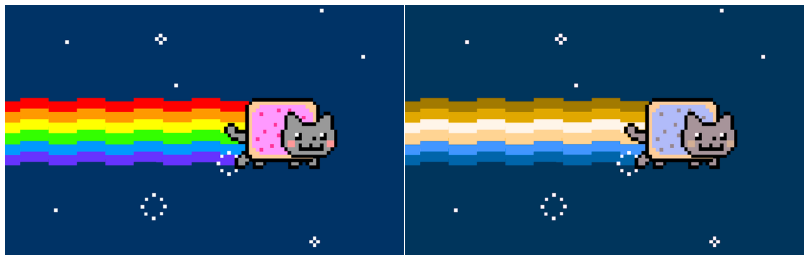

Figure 11. Two pictures of Nyan Cat: trichromatopsia (left) and deuteranopia (right).

Secondly, the Blue-Yellow color blindness is more rare than the precedent and its effect is the lack of blue cone (tritan) photopigments:

- Tritanopia: the blue cone is partially or totally missed. Blue appears green and yellow appears violet or light grey.

Figure 12. Two pictures of Nyan Cat: trichromatopsia (left) and tritanopia (right).

Finally, the third type of the color blindness is the Complete color blindness. The people with this defect are unable to see all the colors and its effect is the loss of three cones photopigments:

- Achromatopsia: Lacking all cone vision, people with the monochromacy see the world in black, white, and gray.

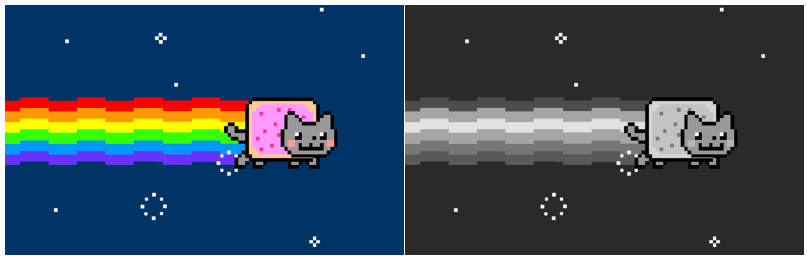

Figure 13. Two pictures of Nyan Cat: trichromatopsia (left) and achromatopsia (right).

Meanwhile, the different types of color blindness are mentioned and are gathered to make the global comparison between all types. Here the picture, Figure 14, taken in Havana during my holiday in Cuba is chosen because it displays a lot of colors. Through Coblis[1], the simulator allows to change the picture's filter in the function of the view of the colorblind people.

[1] www.color-blindness.com/coblis-color-blindness-simulator

Figure 14. Picture taken in Cuba and a lot of colors may be observed. Different pictures display the different colors from the colorblind people. The biggest picture (1) is watched from trichromats. Four pictures, under the biggest one, in order: Protanopia (2), Deuteranopia (3), Tritanopia (4) and Achromatopsia (5).

In summary, the protanops and the deuteranops have difficulties to distinguish two color red-green, they watch only “yellow” and “blue”. The tritanops have trouble to make the difference between the warm colors (yellow-orange-red) and between the cold ones (purple-blue-green). They respectively look at the two colors like pink-red and turquoise. Those suffering from the third type of color blindness, the achromatops, do not see any colors besides black-white. The solutions in the user interface for the accessibility for the colorblind people are proposed in the next chapter below.

2.4.2 Solutions in the user interface

According to some articles about the accessibility, the potential solutions for the colorblind users may be found in the way of designing the user interface. It allows getting more accessible to the people being colorblind about user interface, maps, graphs, visualizations and the other informational graphics. The contrast, the color, the size of text and the forms are the important elements for the accessibility [32; 33; 34] The site

“wearecolorblind.com” [28] gives the good tips for designing with the colorblind in mind, including the color combinations to avoid below, see Table 3. It states that the combinations should definitely be avoided. [29; 35]

Low tolerant	Medium	Enough tolerant
Green and Red Green and Brown Blue and Purple Green and Blue	Light green and Yellow Blue and Grey Green and Grey Green and Black	Blue and Yellow Yellow and Violet Dark blue and Black

Table 3. The combinations of colors to avoid for the colorblind people. [36]

In addition to watching color combinations, here are some additional tips:

- In graphs, place the legend directly in the chart.
- Use varied icons or varied shapes in addition to colors for status icons.
- When users are required to select a color, name the color in text as well as showing the color.
- Never use color alone to indicate any information.

Consequently the high number of colors, the low contrast and the color green-red must be avoided in the same image. The “black and white” looked as the best option for the project. [36]. Considering the guideline of the museum, its own visual graphic (color, logo, its own fonts) looks well adapted to these solutions as it chose the black/white color combination.

3 Application Design

"Accessibility is not a barrier to innovation" [32]

The National Museum has been built in the beginning of the 20th century. It has been designing by three famous Finnish architects. Akseli Gallen-Kallela painted the frescoes on the ceiling in the main building in 1928 and they were based on the frescoes for the Finnish pavilion of the Paris World Exposition in 1900. [1] Next, the museum needed to optimize the demonstration application using UI/UX and to complete the skeleton of this application with Html, Css and Javascript.

3.1 Display Touchscreen in the National Museum of Finland

The National Museum of Finland bough the display touchscreen that has its model called LG: 43SE3KB-B 2016 and the display is the 43" Full HD Edge-Lit LED Monitor from LG. See Figure 15. It is a commercial-grade display that is suitable for digital signage applications.

Figure 15. The model of TV touchscreen: LG 43SE3KB-B year 2016

Then the model of the computer is HP EliteDesk 800G1 in Figure 16, and this computer was added to connect with the TV touchscreen. It allows launching the touch application and its operating system is Windows 7 Professional, which appeared on the display touchscreen.

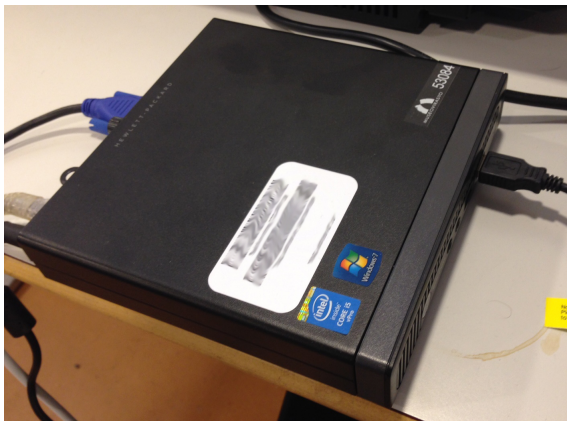

Figure 16. The model: HP EliteDesk 800 G1

Before launching the application, the TV touchscreen and the computer were connected by two cables. According to the own manual book, the first cable is D sub 15-pin Signal Cable and the outputs were VGA, it was designated for the display. The second one is USB that was plugged into the output of the computer for touchscreen input. Then these machines were tied with the outlet. Last, to access to the application, it needs the Internet. The computer was connected by the cable RJ 45 to access to the Internet. The application having the old version worked very well. Next, to design/redesign the application will be explained in the next chapter 3.2.

3.2 Design

The National Museum of Finland had developed the new application. This application allows the visitors to view the frescoes nearer utilizing 360° panorama processed by Krpano [4]. The application needs to load images and run into (CORS) a local server.

According to the wishes discussed in the meeting in the National Museum of Finland, the following elements need to be changed: [37]

- To move the logo to the right top corner.
- To delete the white border around the links.
- To delete the white borders with the images.
- To adjust the text and the images to fit nicely to the museum touchscreen.
- To change the text to the museums typography.
- To delete the grey degrade top border up the bottom menu.

- To delete the flags for languages and to replace the text like FIN / SWE / ENG / RUS.
- To change the type fonts using the visual guidelines.
- To improve the accessibility for the colorblind people.

Finally, there will be two main processes to improve the design of touchscreen display using Adobe Photoshop to redesign then coding the language of the frontend (html, css and javascript) as explained in chapter 3.

3.2.1 Pre-design

Initially, the touchscreen display (Figure 17) was observed and it contained two layouts: the panorama and the menu “navigation”. The last layout was contained three groups: the logo, the links and the languages.

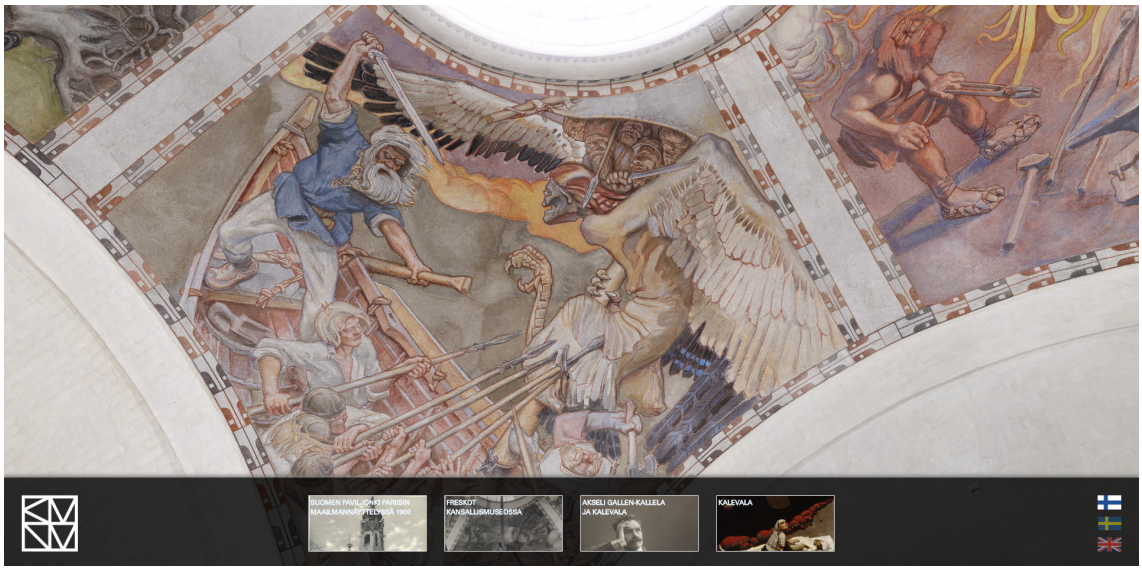

Figure 17. One of screenshots on the application.

Meanwhile, the elements were worth noticing, for example the background of the menu “navigation” was a bit transparent (80% opacity / 20% transparence according to the file *style.css*) therefore the panorama was a little visible behind the menu “navigation”. However, it was not very useful because the colorblind users would not do care the background under the menu. Besides, there was a grey horizontal line over the menu “navigation”, the style was the linear gradient in the vertical direction, it will be deleted as the customer asked, look at the chapter 3.2 [37].

At the right side, there were three flags that represent three different languages (Finnish, Swedish and English), and the user can choose one among these languages. The flags should be replaced by texts because the colorblind people could make a mistake with national flags, for example French and Italian could appear as the same flag, if they were represented in the future. Therefore texts are more understandable and sober than flags.

The four links were placed on the center of the menu “navigation”. Each link had a picture related to its title. They were in the order from left to right:

- Suomen Paviljonki Pariisin Maailmannäyttelyssä 1900
- Freskot Kansallismuseossa
- Akseli Gallen-Kallela ja Kalevala
- Kalevala

This order was not very coherent in the menu “navigation” because the panorama, which was considered as the background of the page and linked with the article “Freskot Kansallismuseossa” which was the second link after the article “Suomen Paviljonki Pariisin Maailmannäyttelyssä”. It would be better if the first link would swap places with the second link to look more coherent.

The article “Freskot Kansallismuseossa” contained the text and the 4 pictures. The pictures all contained one piece of the original fresco paintings. The functionality was just to click one picture to localize a piece of frescoes corresponding to this picture.

Next, the logo of the National Museum of Finland was placed to the left. As wished by the customers, it should be moved to the right or left top corner. It was moved it to the right top corner be done because the third layout appeared on the left of the screen (Figure 18) when the link was clicked. Indeed these two things should not be superposed, that is why the logo is moved to the right top corner.

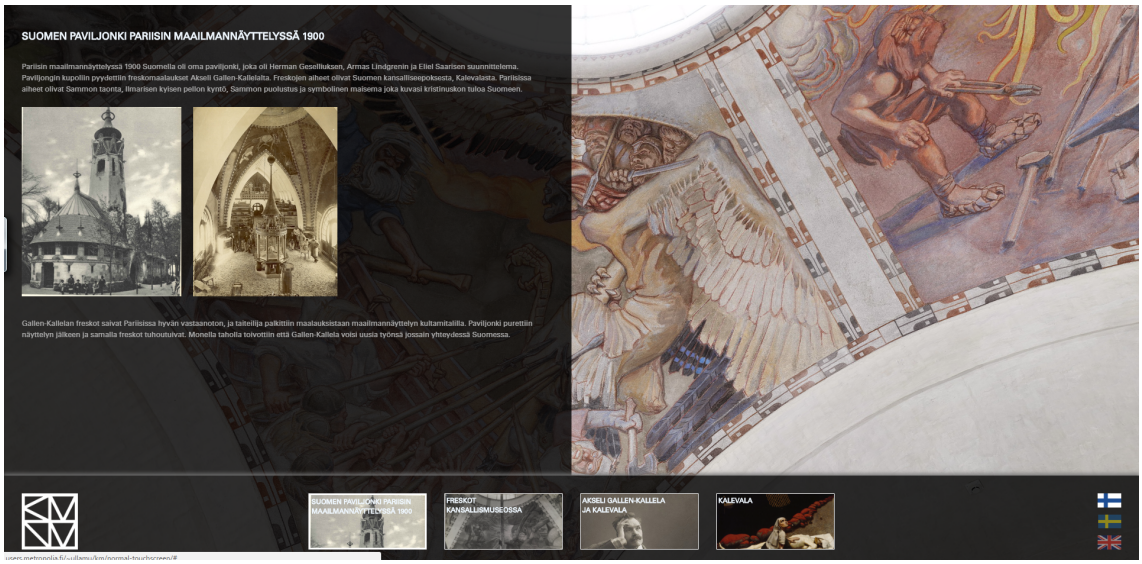

Figure 18. Another of screenshots with the text at the wrapper on the application.

Lastly, the third layout appeared on the left of the screen, as seen in Figure 18, and it was called wrapper as the functionality of code will be explained in the chapter 3.3. The wrapper contained the texts and the images and it appeared when one of four links was clicked in the menu “navigation”. The width of the wrapper takes 50% of the total width on the display, shown in Figure 18. Hence, the picture of the fresco was not so good to view and looking smaller while its width was a half of the display.

After the observations, the visual graphic did not look friendly because the order of links was a bit messy and the logo was placed on the bottom of display while the visitors will touch mostly the bottom of the TV display. That was why the graphic user interface needed to be changed as the wishes of the museum and it will make it more modern and more visual graphic is on the display.

After all the comments related to the old version, the UI/UX design required the clear organization, a good contrast, a space to navigate, readability for the colorblind users and intuitive use. All these ingredients gathered together to make the graphic user interface nice. [38] The new version was drawn in Adobe Illustrator CC and Adobe Photoshop CC. It is going to be shown in the next chapter 3.2.2.

3.2.2 Redesign

Before to redesign the old version, to make a mockup was a necessary step to follow the principles of Suzanne Martin about the effective way for the graphical User Interface [38]. The mockup (Figure 19) was using Adobe Illustrator CC 2017.

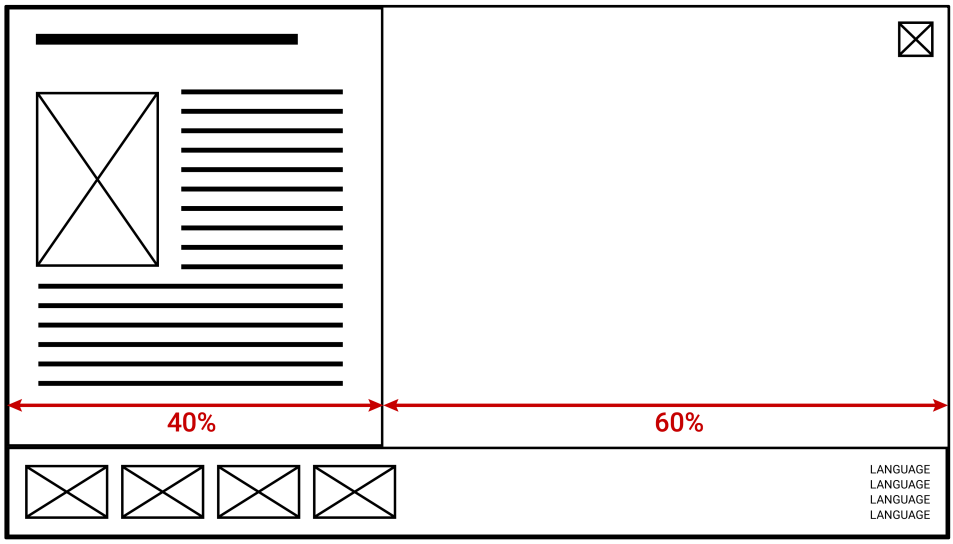

Figure 19. The mockup in progress.

As the elements that are needed to change were mentioned in the chapter 3.2: [37]

- The logo is moved to the right top corner but its size shrank.
- The width of the wrapper is reduced from 50% to 40% and it keeps the same transparence as the old version.
- The text has grown a little in the wrapper.
- The flags are replaced by the texts and added one.
- The background of the menu “navigation” becomes opaque.
- The grey degrade is removed.

After the modification, the new version was drawn in Adobe Photoshop CC 2017 and the procedure following the solutions of UI/UX design for the colorblind people were applied for this new one. As mentioned in the section 2.4.2, the solution for the colorblind people was the color black/white following the guideline of the museum, which was good for the accessibility for the colorblind people.

Adobe Photoshop CC 2017 was used to draw the mock-up from the screenshot on the application. The elements were changed and made by a group according to the layouts like the menu “navigation” and the wrapper.

Finally, the “final” framework in Figure 20 looked cleaner and clearer than the old one (Figure 17) and the menu “navigation” was mostly opaque.

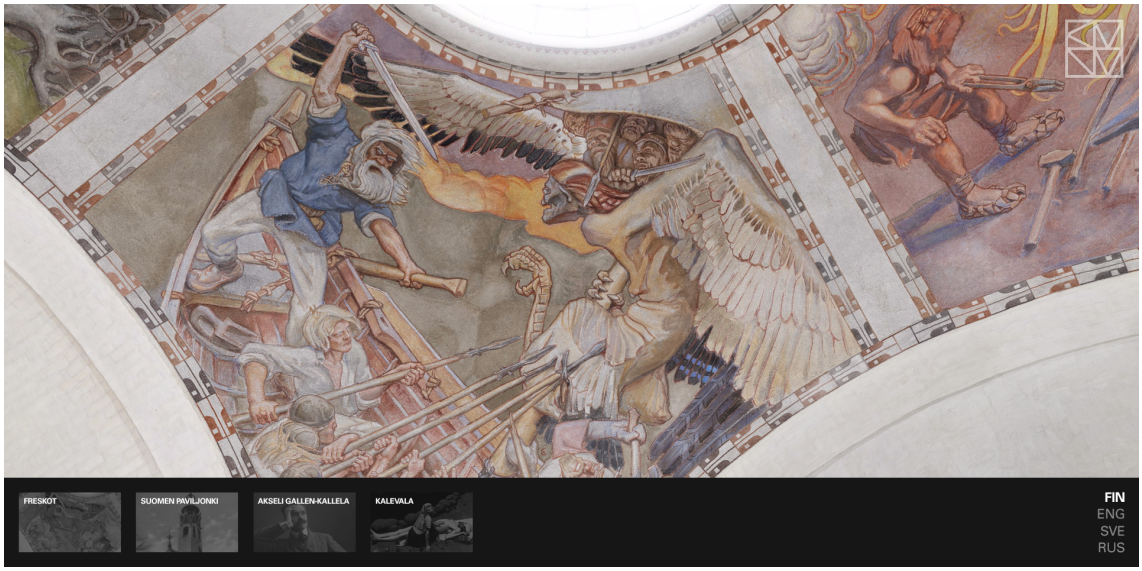

Figure 20. The framework of the application, work in progress.

After the main page, the other new one in Figure 21 possessed the wrapper with text and some pictures, and it looked a bit better than the old one. The width of the wrapper was 40% and also the frescoes looked bigger than the old version, because it allowed the users to enjoy viewing the frescoes. The background of the wrapper holds the same transparence because the difference is very visibly different when the wrapper and the menu “navigation” are compared.

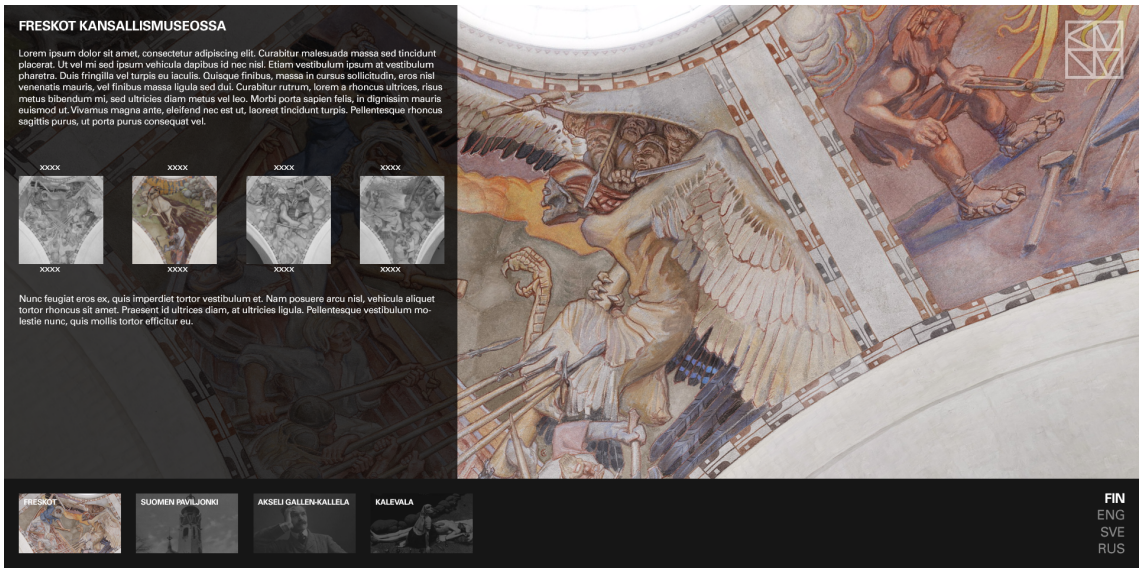

Figure 21. The framework, work in progress with the wrapper.

Then the customer, the National Museum of Finland, wished to add a little text for each part of frescoes shown in Figure 21. In other words, when one picture was clicked in the wrapper and the text would appear under this picture. After making the mock-up, the coding started and will be explained in the next section 3.3.

3.3 Coding - Frontend

Before beginning to code, it is important to keep in mind that the krpano Viewer is a small and very flexible high-performance viewer for all kind of panoramic images and interactive virtual tours. [4] The 360° panorama was already processed by Krpano. In the demonstration the 360° panorama could be viewed on the touchscreen display by the visitors. The image files were already included in the folder « *panorama.tiles* », as shown in Figure 22.

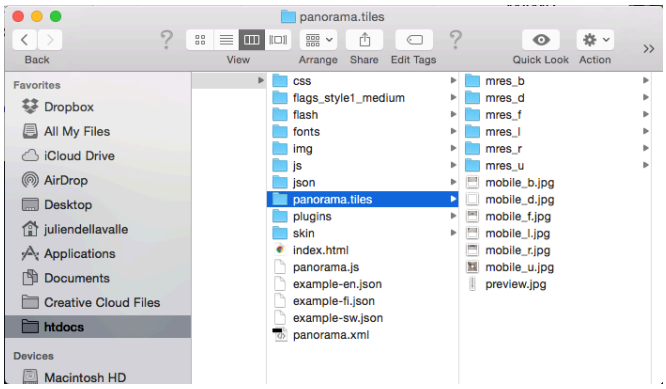

Figure 22. Screenshot on the main folder.

The application is a page with a panorama that is linked with the UI/UX. The html page (*index.html*) where 360° panorama is running into the background is linked with Javascript. Therefore the panorama can be controlled with scripting (javascript and xml) since it has an interface for the panorama. [3,62] Javascript and API controlled the relation between the UI/UX and the panorama/krpano as seen in Figure 23.

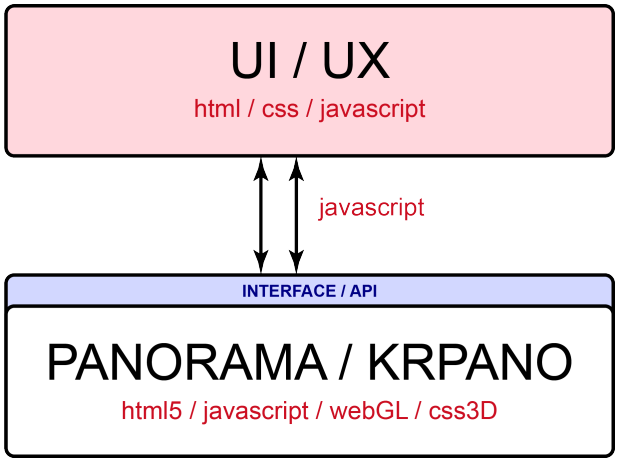

Figure 23. The relation between UI/UX and Panorama/Xml controlled by API.

Here, the application had to be optimized and it was necessary to also complete its skeleton because it needed to modify three files:

- **index.html** – a html page displayed into the touchscreen display. It is linked with the file *style.css* and several files in javascript including one linked with the file *panorama.tiles* processed by Krpano, which displayed like the background. Mostly it is organized in several parts like the menu “navigation”, with the wrapper and the text.

- **style.css** – a style described the html page. This file needed to be modified. For example, it made the background of the menu “navigation” completely opaque. Also, it controlled the responsive design web and the graphic user interface.

- **script.js** – a script controlled the html page and the application, it allowed to localize a part of frescoes, to change the language chosen by the users and to appear the text in the wrapper. The last will be implemented into this file.

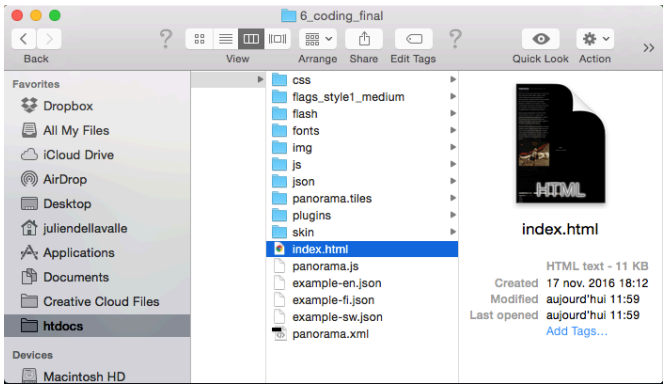

Figure 24. The content of folder, showing the file “*index.html*”.

The files *index.html* (Figure 24) and *style.css* were opened into the source code under the application Sublim Text 2 [39]. Also, the elements that were mentioned in the section 3.2 were going to be changed into this application and the source code is shown below.

In the file *style.css*, the attributes of the menu “navigation”, under `<div class="menu-wrap">`, were modified:

- The grey degrade was finally removed.
  ```
  /* box-shadow: 0px -2px 10px 1px #777777; */
  ```
- The background had become opaque.
  ```
  background: rgb(0,0,0);
  ```

Moreover the museum had its own fonts, called “*Linotype – UniversLTCYR*” for the text and “*Benton-Cyrillic*”, and they were already added into the file *style.css*.

In the case of the wrapper, the style was modified under `<div class="wrapper xxx">` using `.wrapper`.

- The width was reduced to 40% under
  `width: 40%;`
- The transparence keeps the same as the old version.
  `background-color: rgba(0,0,0,0.8);`

The links “Freskot” and “Suomen Paviljonki” were exchanged because the link “Freskot” was related with the background displaying the panorama of frescoes. Then this link was put first in order from left to right.

Then the flags were replaced by the texts with three first letters by each language while one language was added. The logo was moved from the left bottom corner to its opposite and its size shrank but the black band appeared on the top. And also the logo became a little transparent. The text was grown a little in the wrapper.

The National Museum of Finland wished to make the page more dynamic on the wrapper about the frescoes with 4 pictures (a piece of frescoes). The idea was to have an apparition of a small text for each picture of frescoes when one of them is clicked. This method is used in Javascript that controlled the Html page.

Firstly, the section `<div>` with the attribut “`class=…`” was added into the section “`wrapped freskot`”, see Code example 1:

```
<div class="text_freskot">
          <p id="p_sammon-puolustus"><span>Sammon
puolustus</span><br>...</p>
          <p id="p_kyinen-pelto"><span>Kyinen pelto</span><br>...</p>
          <p id="p_iso-hauki"><span>Iso Hauki</span><br>...</p>
          <p id="p_sammon-taonta"><span>Sammon taon-
ta</span><br>...</p>
</div>
```

Code example 1.

Secondly, the file *script.js* was opened under the software Submit Text 2. The ID selector `$("#xxx")` and the method `.hide()` were used. `xxx` was the identity of the ele-

ments and the function of the method `.hide()` was to hide the elements in the wrapper, see Code example 2.

```
$("#p_kyinen-pelto").hide;
$("#p_iso-hauki").hide;
$("#p_sammon-taonta").hide;
$("#p_sammon-puolustus").hide;
```

Code example 2.

Then these four selectors were added in each selector `$("#targetx")` and x was the number of the elements. The methods `.hide()` and `.show()` were also added in the same selector in the function of the identities of pictures and paragraphs. The function of the method `.show()` was to show the elements. The relation between the identities is in the Table 4.

Identity of picture `<a id="targetx">`	Identity of paragraphs `<p id="xxx">`
target1	p_sammon-puolustus
target2	p_kyinen-pelto
target3	p_iso-hauki
target4	p_sammon-taonta

Table 4. The relation between the identities of pictures and the paragraphs.

Finally, the methods were written respecting the identities of two elements in the source code into script.js in jquery, see Code example 3.

```
$("#target1").click(function() {
        krpano = document.getElementById("krpanoSWFObject");
        // Sammon puolustus
        $("#p_kyinen-pelto").hide();
        $("#p_iso-hauki").hide();
        $("#p_sammon-taonta").hide();
        $("#p_sammon-puolustus").show();
        krpano.call("lookto(-81.48,-54.27,47.43,smooth(100,50,20))");
});
$("#target2").click(function() {
        krpano = document.getElementById("krpanoSWFObject");
        // Kyinen pelto
```

```
        $("#p_sammon-puolustus").hide();
        $("#p_iso-hauki").hide();
        $("#p_sammon-taonta").hide();
        $("#p_kyinen-pelto").show();
        krpano.call("lookto(-172.89,-52.51,47.43,smooth(100,50,20))");
});
$("#target3").click(function() {
        krpano = document.getElementById("krpanoSWFObject");
        // Iso Hauki
        $("#p_sammon-puolustus").hide();
        $("#p_kyinen-pelto").hide();
        $("#p_sammon-taonta").hide();
        $("#p_iso-hauki").show();
        krpano.call("lookto(-262.59,-54.27,47.43,smooth(100,50,20))");
});
$("#target4").click(function() {
        krpano = document.getElementById("krpanoSWFObject");
        // SAmmon taonta
        $("#p_sammon-puolustus").hide();
        $("#p_kyinen-pelto").hide();
        $("#p_iso-hauki").hide();
        $("#p_sammon-taonta").show();
        krpano.call("lookto(9.98,-54.13,47.43,smooth(100,50,20))");
});
```

Code example 3.

After this addition, each picture was clickable to make one little text appear under the pictures and to call the panorama which the users can control and move.

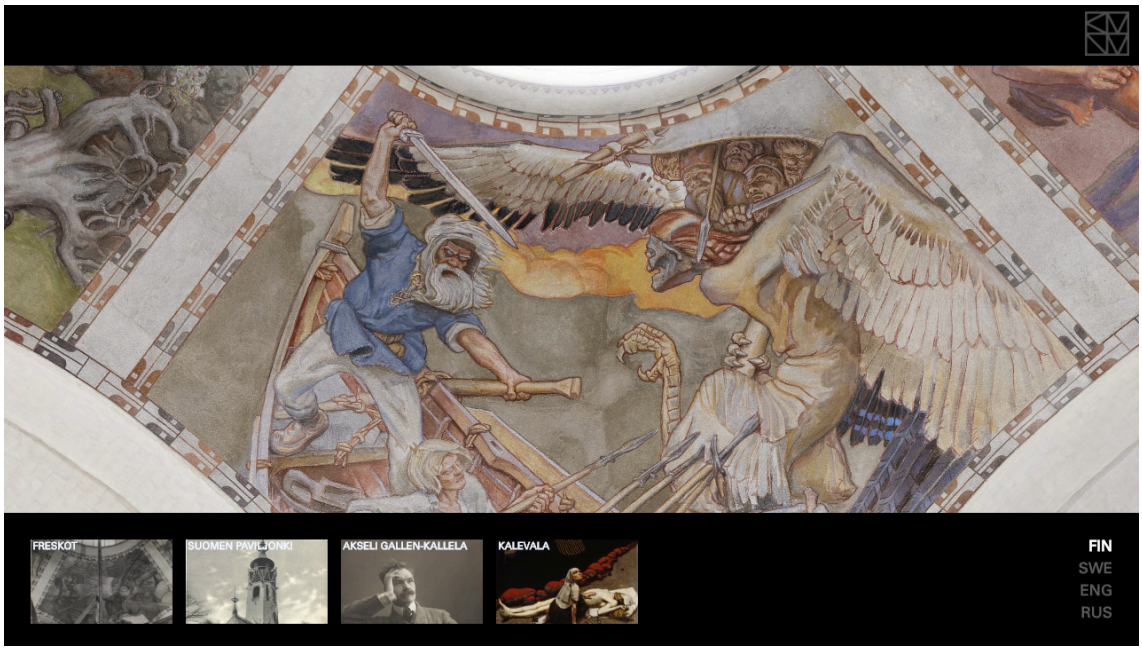

Figure 25. The application with the new version, local server.

After the modifications of all elements that were in the list, the applications got the new display illustrated in Figure 25. Although the code has worked well, unexpected bugs appeared on the display in the menu “navigation”. But it was not urgent because the code has worked very well sometimes depending on the devices as for example from my computer and the touchscreen for example. The bugs can be fixed easilly.

The improvements which were the wishes of the museum, as cited in the chapter 3, were done in several parts. [37]

3.4 Final product

When I started working on my thesis project, the idea was to make the National Museum accessible for everybody. However, this proved to be quite a big challenge and I decided to limit my study to a specific visual “handicap”, namely color blindness. Still, the global accessibility for everyone will always be my goal.

Before the began this project, I read three books in related to UI/UX design and the interaction design to understand better the principles of this domain. I configured a small TV touchscreen, brand LG, and an elite desk described in chapter 2.3. These materials were bought by the Finnish National Museum.

After the modification, the new version looked more modern and clearer than the old one. The application will appear into the touchscreen display through the EliteDesk, mentioned in the chapter 2.3, and it has Microsoft Windows 7 operating system. On the display as seen in Figure 25, the menu “navigation” is placed on the bottom to be nearer the visitors who can touch it. The logo on the top is only shown.

The application with the new version will be used in the main building where the frescoes were painted on the ceiling in the National Museum of Finland. The visitors can enjoy viewing the frescoes closer though to the application with the touchscreen display.

The improvement wishes of the National Museum were implemented into the demonstration application according to the principles of accessibility for the colorblind people, as explained in chapter 2.4.2. The best practices of UI/UX design were also followed. In the future, the application with the touchscreen display could be optimized for everybody, supporting the idea of global accessibility. Such groups could, for example, be the Finnish Sign Language for the local deaf and International Sign for the deaf foreigners.

4 Conclusion

The objective of my thesis was to study the relation between the color blindness, the design of user interface and the user experience, as well as the touchscreen technology.

According to the wishes of the National Museum of Finland as a customer, the modifications about the UI/UX design were done. In spite of the little bugs, the application worked very well and its looked more sophisticated. Although the application will be published in the museum, the application is not yet completed in term of the global accessibility.

It was interesting to study color blindness because this visual disability is well known. However, UI/UX design and technology have not been used in creating accessible opportunities for this specific group. I am deaf myself so I know in my heart how very important accessibility is. I often find myself in a difficult situation due to the lack of the global accessibility. That is why I decided to choose accessibility for color blind people as my thesis topic. The accessibility for everybody such as the deaf, those with reduced-mobility and the blind people always remain important for me.

As my research proceeded, this topic became clearer and more inventive to me, starting from Interaction Design in chapter 2.2.3 and especially when studying the relationship between the language of frontend (Html, Css and Javascript), the language XML and the 360° panorama.

During the project, I also learnt how to manage timetables and how to balance between my career and personal life. When writing my thesis, I was often able to stay at home. However, I often went to school because the materials were there. This project work taught me that being responsible is one of the main qualities to work as a professional in future.

References

1 Kansallismuseo. History of the National Museum and the museum building [online]
URL: http://www.kansallismuseo.fi/en/nationalmuseum/history-of-museum-and-building.
Accessed 30 March 2017.

2 Blog For Photos. HDR in Helsinki: Kansallismuseo [online]. March 2012.
URL: http://www.blogforphotos.com/hdr-in-helsinki-kansallismuseo/.
Accessed 30 March 2017.

3 Sederlöf Ulla. Master's Thesis: Art Meets Technology – Creating Gigapixel Panoramas for Historical Sites. Helsinki, Finland: Metropolia UAS; 2016.
URL: http://urn.fi/URN:NBN:fi:amk-201605117147
Accessed 18 April 2017

4 Krpano.com. [online]. Deutschkreutz, Austria: Krpano; 2017.
URL: https://krpano.com/.
Accessed 30 March 2017.

5 TechTarget WhatIs.com. User Interface UI [online]. November 2016.
URL: http://searchmicroservices.techtarget.com/definition/user-interface-UI.
Accessed 2 April 2017.

6 Little David. User interface design: definitions, processes and principles [online] London, UK: King's College London; November 2012.
URL: https://www.slideshare.net/littleddotnet/user-interface-design-definitions-processes-and-principles-15366100.
Accessed 1 April 2017.

7 Norman D.A. Emotion & Design: Attractive things work better [online]. jnd.org; 2002.
URL: http://www.jnd.org/dn.mss/emotion_design.html.
Accessed 2 April 2017

8 Fadeyev Dmitry. 8 characteristics of successful User Interfaces [online]. Usability Post; April 2009.
URL: http://usabilitypost.com/2009/04/15/8-characteristics-of-successful-user-interfaces/.
Accessed 2 April 2017.

9 Shneiderman Ben & Plaisant Catherine. Designing the user interface. 4th edition. Strategies for effective human-computer interaction. University of Maryland, USA: Pearson Education; 2005.

10 Treehouse. 10 User Interface Design Fundamentals [online]. August 2012.
URL: http://blog.teamtreehouse.com/10-user-interface-design-fundamentals.
Accessed 4 April 2017.

11 Fadeyev Dmitry. Using Light, Color and Contrast Effectively in UI Design [online]. Usability Post; August 2008.
URL: http://www.usabilitypost.com/2008/08/14/using-light-color-and-contrast-effectively-in-ui-design/.
Accessed 2 April 2017.

12 Nielsen Jackob. Usability 101: Introduction to usability [online] Nielsen Norman Group; January 2012.
URL: https://www.nngroup.com/articles/usability-101-introduction-to-usability/.
Accessed 12 April 2017.

13 Tullis Tom & Albert Bill. Measuring the user experience. Collecting, Analyzing, and Presenting Usability Metrics. Burlington, MA, USA: Morgan Kaufmann; 2008.

14 Usability.gov. User-Centered Design Basics [online]. Washington DC, USA: Department of Heath&Human Services; April 2017.
URL: https://www.usability.gov/what-and-why/user-centered-design.html.
Accessed 11 April 2017.

15 Rubinoff Robert. How to quantify the user experience [online]. Site Point; April 2004. URL: https://www.sitepoint.com/quantify-user-experience/.
Accessed 12 April 2017.

16 Nemberg Marko. 8 Effective Ways of Measuring UX [online]. CXL; 2014.
URL: https://conversionxl.com/8-effective-ways-of-measuring-ux/.
Accessed 2 April 2017.

17 Davidsson Linn & Keserovic Mirza. Vad gor egentligen en ux-designer? [online] Sweden: Maverick By Sigma; July 2016. (in Swedish)
URL: https://maverickbysigma.se/2016/07/vad-gor-egentligen-en-ux-designer/.
Accessed 31 March 2017.

18 Heller David. History of Interaction Design [online]. Washington DC, USA: IDSA National Conference; August 2005.
URL: https://www.slideshare.net/dmalouf/history-of-interaction-design.
Accessed 1 April 2017.

19 Saffer Dan. Designing for interaction. 2nd Edition, Creating Innovation, Applications and Devices. Berkeley, CA, USA: New Riders; 2010.

20 Baxley Bob. Introducting Interaction Design [online]. Silicon Valley, CA, USA: Boxes and Arrows; November 2002.
URL: http://boxesandarrows.com/introducing-interaction-design/.
Accessed 1 April 2017.

21 Walker Geoff. A review of technologies for sensing contact location on the surface of a display. Journal of the Society for Information Display; August 2012. 20 (8): 413-440.
URL: http://onlinelibrary.wiley.com/wol1/doi/10.1002/jsid.100/full
Accessed 18 April 2017.

22 EngineersGarage. Touchscreens or Human Machine Interface (HMI) [online]. 2001.
URL: https://www.engineersgarage.com/articles/touchscreen-technology-working.
Accessed 10 April 2017.

23 TRU-Vu Customizable Industrial LCD Monitors. The 5 Types Of Touch Screen Technology. Which One Is Best For You? [online]. n.d.
URL:
http://www.truvumonitors.com/images/Touch_Screen_Basics.Comparisons.pdf
Accessed 28 March 2017.

24 Colour Blindness Awareness. Colour Blindess [online]. n.d.
URL: http://www.colourblindawareness.org/colour-blindness/.
Accessed 30 March 2017.

25 National Eye Institute. Facts About Color Blindness [online]. USA; February 2015.
URL: https://nei.nih.gov/health/color_blindness/facts_about.
Accessed 16 April 2017.

26 Hallman Katelyn. Man Sees Purple For The First Time... And Could Help Answer A Philosophical Question? [online]. Florida, USA: Odyssey Media Group; August 2015.
URL: https://www.theodysseyonline.com/enchroma-colorblindness-philosophy.
Accessed 31 March 2017.

27 McDonnell Ken. I'm Color Blind & This Is What It's Like To Play Video Games [online]. Now Loading; May 2016.
URL: https://nowloading.co/posts/3910546.
Accessed 16 April 2017.

28 van Beveren Tom. We are colorblind [online]. The Hague, The Netherlands; 2012.
URL: http://wearecolorblind.com/.
Accessed 31 March 2017.

29 Johnson Joshua. Tips for Designing for Colorblind Users [online]. Design Shack; July 2010.
URL: https://designshack.net/articles/accessibility/tips-for-designing-for-colorblind-users/.
Accessed 31 March 2017.

30 Colour Blindness Awareness. Types of colour blindess [online]. n.d.
URL: http://www.colourblindawareness.org/colour-blindness/types-of-colour-blindness/.
Accessed 31 March 2017.

31 Wickline Matthew. Coblis – Color Blindness Simulator [online]. Colblindor; 2001.
URL: http://www.color-blindness.com/coblis-color-blindness-simulator/.
Accessed 31 March 2017.

32 Hausler Jesse. 7 Things every designer needs to know about accessibility [online]. Salesforce UX; April 2015.
URL: https://medium.com/salesforce-ux/7-things-every-designer-needs-to-know-about-accessibility-64f105f0881b#.jju671np4.
Accessed 4 April 2017.

33 Rapp Adrian. Accessible Interface Design [online]. Salesforce UX; February 2015.
URL: https://medium.com/salesforce-ux/accessible-interface-design-d80e95cbb2c1#.eqapj9ht8.
Accessed 31 March 2017.

34 Shaver Kelli. 5 Ways to Ensure Your Site Is Accessible to the Visually Impaired [online]. Mashable; April 2011.
URL: http://mashable.com/2011/04/20/design-for-visually-impaired/#MjPNVit6lPqw.
Accessed 17 April 2017.

35 Fulton Graeme. Accessibility Basics: Designing for Visual Impairment [online]. Envato; November 2016.
URL: https://webdesign.tutsplus.com/articles/accessibility-basics-designing-for-visual-impairment--cms-27634.
Accessed 31 March 2017.

36 Malamed Connie. Designing For Color Blindness [online]. 2009.
URL: http://understandinggraphics.com/design/designing-for-color-blindness/.
Accessed 31 March 2017.

37 A discussion with Heikki Aittala and Joose Niemi in the National Museum of Finland. February 2017

38 Martin Suzanne. Effective Visual Communication for Graphical User Interfaces [online]. 1993.
URL: https://web.cs.wpi.edu/~matt/courses/cs563/talks/smartin/int_design.html.
Accessed 30 March 2017.

39 Sublim Text [online]. 2017.
URL: https://www.sublimetext.com/.
Accessed 4 April 2017.