MyOcean - Improving an exhibition visit with wearable technology

Pedro Diogo Candeias Santiago Oliveira
Instituto Superior Técnico - Taguspark
Av. Prof. Dr. Cavaco silva,
2744-016 Porto Salvo, Portugal
pedro.santiago.oliveira@ist.utl.pt

Abstract

This is the technology era. Every single day the world leaps forward and discovers new ways to improve and make our life better. This evolution influences almost every corner of society such as our work, our transports, our culture and even us. Everything today has an app. Museum and art galleries are not an exception. In fact, there has been a large growth of museum applications, supported by different types of hardware. We took that step and experimented the usage of wearable technology using Lisbon's Oceanarium as the main case study. The main target for this project, were users with ages between 10 and 15, considering this group is a big part of the visitors of our case study. Through games and a very fluid application, we tested their reaction. Although this experiment was not tested in the field, it has shown some positive results on using an application to visit this museum, considering it currently does not have one. We also obtained some negative results related to the chosen hardware, such as excessive weight or an unfocused screen. The main conclusion was that this hardware, considering the current developments of the technology, it is not the ideal solution for this type of projects.

Introduction

This document presents an evaluation on the benefits and drawbacks of using technology to improve the experience of museum visitors. This project was developed under the guidance of Card4B Systems, S.A., a Portuguese company related to several IT services for smart cities. Within these sectors, Card4B Systems, S.A. has been exploring the benefits of the most recent technology, such as smartphones or tablets, for some time. More recently, they've invested in a specific cultural area: museums and art galleries. Due to this connection with art and culture and, in order to have clearer results on this study, Lisbon's Oceanarium was chosen as the main case study for this experience, due to its relevance within its sector, its dimension, its complexity and also because it does not own any type of mobile application to offer its visitors. In order to perform this social experiment, it was necessary to develop an application for visitors to try out and evaluate their experience. Thus, this document also reports the design, development and implementation phases of an Android application called MyOcean.

Context

Technology leaps every day and now everyone carries a computer in their pockets. There are many types of wearable technology these days, from t-shirts to watches and glasses. This project aims to improve a museum visitors' experience by using wearable eyewear technology. For the past few years, the search for culture has been improving. Along with the attendance and technology evolution, art galleries and museums have been cooperating with IT companies and releasing mobile applications specifically designed for their line of work, in order to accompany technological evolution and engage their visitors with a modern type a visit[5].

Objective

The objective of this project is to develop a non-intrusive mobile solution for the Lisbon's Oceanarium, on a wearable hardware, and then evaluate the public response by gathering opinions on whether it improves the experience or not. The main target of this application will be visitors with ages between 10 and 15 years.

Solution Proposal

The proposal consists on a social experiment that will measure the improvement of the visiting experience using an Android application, specifically designed for the target museum and users, respectively, the Lisbon's Oceanarium and visitors between the age of 10 and 15. The implementation part of this solution consists on a Client-Server architecture: The Server is a web forms project, developed in asp .NET C\# and it communicates with its clients using JSON queries, developed by C4B, called MyMuseum. The Client is a wearable eyewear called Jet, developed by Recon, with an installed Android application called MyOcean. This hardware has Wi-Fi and Bluetooth available. These features allow the communication to exist between the Server and the iBeacons, Bluetooth devices that are used, in this case, for indoor location. After the implementation, the experiment part will be dealt by two inquiries

that will help to evaluate the success of the proposed solution.

State of the Art

Museum Apps

Museu da Marioneta's App [1]
Available on Android or iOS, for tablet or smartphone, the mobile application of "Museu da Marioneta" offers different ways to explore the space and different paths, thus guaranteeing an unique visit every time. In order to reach younger users, this application also offers a game section which presents a riddle to the visitor and requests him to find different items, hidden in the museum.

Fundação de Serralves's App [2]
Available for Android and iOS, the "Fundação Serralves" application allows visitors to explore the world of Serralves in a very easy and intuitive way. With this application, the visitors can quickly access the activities agenda, which is regularly updated and contains the information of all the programs that occur from expositions to dance and cinema events.

Museu Benfica Cosme Damião's App [3]
Available on Android and iOS, the "Museu Benfica - Cosme Damião"'s application gives access to the achievements, scores, pictures and videos of every sport that the club participates on. Besides general awards, it is possible to explore the personal history and statistics of every athlete, coach or even president that has passed by "Sport Lisboa e Benfica".

Museu Nacional dos Coches's App [4]
Only available for iOS, the "Guia \& Jogo do Museu Nacional dos Coches" offers a fun way to explore this museum by using several points of interest, throughout the rooms, and providing the visitors with fun facts, fun animations, tricky questions and storytelling. Although it may look like an application much more focused on younger users, many critics point out that this gamified idea[6] is very compelling and interesting to older users also.

MAB Experience
The MAB, Bilotti Open Air Museum (Museo all'Aperto Bilotti) is located along Corso Mazzini's pedestrian area between Piazza Bilotti and Piazza dei Bruzi, in the city of Consenza, Italy. The Mab Experience application offers an extra level of information to the MAB visitors that own Google Glass. Being near the sculpture and looking at it, Google Glass uses an image recognition algorithm and, after recognizing the item, it shows the user extra information regarding the art piece and its author.

Platforms

GuidiGo
This project aims to reinvent the visitor experience by allowing others to create stories to follow. GuidiGo Studio is the name of the platform on which the users can create tours and develop games just by adding pictures, basic information and route options. After publishing your tour, it becomes available for everyone using the GuidiGo application, which is available on Android, iOS and Google Glass platforms.

MyMuseum
a solution, developed by \ac{C4B}, that aims to build a tool for art galleries and museums which will allow them to self-manage their physical space, collections, exhibitions and automatically generate a multimedia guided tour, for mobile platforms, that will grant access and orientation to the visitor, without being too intrusive.

Overview

Museu da Marioneta's app offers games, information and has all types of multimedia available. On the other end, Museu Benfica - Cosme Damião is basically an app that replicates their website. Fundação de Serralves's app has important information on their agenda and has several routes that help the user along their visit but it demands a live Internet connection. After comparing the most direct and higher level specifications, they were installed in their preferable platform and explored. From top to bottom, the Museu da Marioneta's app offered a simple design and a quick menus. Fundação de Serralves' app, compared to the Museu da Marioneta's app, was much slower in the beginning, when it downloaded some content, but also along its usage. The menus were well organized and there was an interesting feature called "MySerralves" where the user can see his pictures that were taken, by him, during his visit and has the option to share them online. Museu Benfica - Cosme Damião's app was easy to navigate, had an interesting image and due to color choice and design, it seemed very connected to the museum itself. The only problem is that it contained almost the same information as the website, bringing nothing new to its user. Guia & Jogo do Museu Nacional de Coches has the obvious limitation of only being available for iOS. Compared to other apps, it had a quick start. The high point of this app is the game section. Unfortunately, the MAB Experience app was not tested since it was designed to Google's Glass and there was none available.

The Case Study - Oceanarium

Visitor's Experience
This research began with a visit to the Lisbon's Oceanarium, in order to understand the visitor's perspective and the needs he might have along the way. To enhance the quality

of his visit, the visitor has two additional options: audio guides, with a previous recorded guided visit, available in six different languages, that presents the information in a dynamical and appealing way; the guided tours, which give accompanied access to the entire facility. These special "passes" allow the visitors to know how the Lisbon's Oceanarium really works, by visiting the backstage rooms and getting to know the many professionals that keep the engine running. The visit consists in a single route, divided into two floors. Both floors have access to the five main areas, which are the Temperate Pacific, the Antarctic, the North Atlantic, the Tropical Indian and the Central Aquarium, which is the concept of the permanent exhibition and it represents "the one ocean". After the main section, there are two other small areas: the Amphibians, a section that contains many different species of amphibians and a large amount of information on this type of animals; and the House of Vasco, an environmental friendly house that teaches young visitors what to do and not do regarding the planet's health, through games and interactive objects. Considering the simple visit, no audio guides or personal guide, the first thing the visitor notices is the contrast of light intensity between sections. The halls around the Central Aquarium are very dark and so every information is on an illuminated billboard but, when a new section is reached, the light is the opposite because, not only abut also, natural light is used. When going from section to section, the visitor does not have a clear message on this transition because the section names are almost hidden due to the pipes and the air conditioning system. Only when he looks for information, which is when he realizes that the posters have a different section names.

Requirements

Based on the tour and the necessities encountered, as visitor, along the way, a list of general requirements was designed:

- Good quality screen - Due to the variations of lighting along the building
- Indoor location - Although every section began with a sign and its name, sometimes these signs were covered by air conditioning vents or columns
- Favorites - Being an exhibition composed by so many aquariums and different species, it would be interesting to allow the visitors to maintain a list of their favorite species
- Games - Adding games and riddles along the entire visit can improve the attention and amusement of the younger visitors

Hardware

Choosing the right hardware for this solution started as a very simple research on what was available on the market. After finding out that there are many types of wearable eyewear and several different manufacturers, the first step was to reduce the scope and only search for non-intrusive eyewear and hardware with covered sight. These were the minimum requirements defined for the hardware of this project:

- Battery with minimum lasting capacity of 2 hours
- Bluetooth 4.0 – compatible with iBeacons
- WiFi - Needed to communicate with the back office
- Camera - Needed to read QR Codes

Specifications

Google's Glass

- Price: 1500$
- Weight: 50g
- Display: 640x360 pixels
- Battery: 1 day
- Operative System: Android 4.4.2

Recon's Jet

- Price: 700$
- Weight: 60
- Display: 428x240 pixels
- Battery: 4 to 6 hours
- Operative System: Recon OS based on Android 4.1

Optinvent's Ora

- Price: 950$
- Weight: 80g
- Display: 640x480 pixels
- Battery: 3 hours
- Operative System: Android 4.4.2

Vuzix's M100

- Price: 999$
- Weight: 80g
- Display: 428x240 pixels
- Battery: 1 to 2 hours
- Operative System: Android 4.0.4

Overview

Based on the requirements, the first equipment excluded was the M100 by Vuzix. Although M100 is the only equipment that is usable on the left and right eye, which would allow a visitor with a lesion on his right eye to enjoy the experience anyway, its battery capacity is extremely low, compared with the other devices. Having reduced the list to three equipments, ORA by Optinvent still presents a low battery capacity, even though it is higher than the limit established by the requirements. Besides, considering the visitor must wear the equipment during the entire visit, which lasts from 1 to 2 hours, the weight is an important issue. Adding that to the lowest battery capacity, ORA was the next equipment removed from the list. Finally, we are left with Jet by Recon and Glass by Google. Both guarantee the minimum requirements, so the choice had to be done considering other factors, starting by the price. Google's Glass costs more than twice the Recon's Jet. Besides the price, there was a critical factor that lead to the final choice. Google stopped selling Glass because of a massive criticism from users that were having problems due to pri-

vacy and safety concerns. Even though Google did not stop sending Glass to companies, to test and develop new applications, the choice had been done and the Jet by Recon was selected.

Solution

Architecture

This project aims to add a bridge through technology, between the visitor and the museum, that not only will not interfere with the "normal" visit but which will also add a new entertaining level. This Android application improves the visitor's experience by giving him space notion, games and a memory slot, to save his favorite information. In order for the application to gain space notion, it will have to communicate by Bluetooth with Bluetooth beacons, spread out along the area. And finally, to obtain and save all the information necessary to provide a great experience to the visitor, the application will communicate through Wi-Fi with the back office.

Back Office

Developed by Card4B Systems, S.A., MyMuseum is a web form project, developed on asp .NET C\#, using a SQL server for the database and jquery for communication, this back-office has a simple and intuitive design which makes the organizing task quite simple.

Jet

Recon's Jet, similar to other Recon's projects, was developed with a specific user target: a sports practitioner, since that was the main market of the company. On the other hand, being part of Intel, one the largest IT companies in the world, the equipment is prepared and available for other purposes, such as, in this case, a tool to improve the visitor's experience inside a museum. Adding the four directional swipes and the two buttons, the Recon's Jet has six available controllers.

Application

Requirements Analysis

- Non-intrusive - The visitor should not spend more than a few interactions with the application
- Bluetooth - The application must be able to be triggered by Bluetooth beacons
- QR Code - The application must have a QR Code reader in order to the visitor to read the codes that contain the information about each animal or section
- Favorites - The application must have a favorites' section where the visitor can save his its favorites along the visit
- Games - The application must provide games along the visit in order to entertain the visitors

Use-Cases

- "I want to start my visit" - Description: The user opens the application for the first time and gets the start screen
- "I want to learn the controls" - Description: The visitor uses this tutorial to learn the controls for the app
- "I want to choose a language" - Description: The visitor uses this screen to define the language of the application during the visit
- "I want to read a QR Code" - Description: The visitor finds a QR Code and decides to read it
- "I want to add this to my Favorites" - Description: The visitor wants to save a specie's page to his favorites
- "I want to play a game" - Description: The visitor wants to play a game

Design and Development

Method

Based on the visitor experience, mentioned before, both phases were done based on a progressive method. This helped the design and development process to become more precise regarding the needs of each screen.

Process

Since the app was to be used continuously by several visitors for a complete day, there is not really a starting point but a common point between the end and the beginning of a new visit. Thus, this was the point to consider to start the design/development phase.

- Start Screen - After his tour, the visitor hands the hardware to the museum to be used on the next tour but the app has the preferences of the previous visitor and so it needs a reset. Since this process can take a few moments, the first screen to be designed was the start screen. This screen had two purposes: first, to keep the visitor entertained while the app was resetting and second, present the entities that participated on this project.
- Tutorial Screen - Being an unknown hardware for most visitors, after the information is returned from the server and the controls are unlocked, the visitor is likely to interact with it. Thus, any interaction will make the application advance to this next screen. The tutorial screen allows to get to know the controls and when and how to use them. First, there is a picture with the location and respective icons of each controller and then, a simple task to complete by the visitor that allows him to test his newly obtained knowledge on the controllers and their icons.
- Language Screen - A museum needs to be accessible to every visitor and so the necessity to be a multilingual application appeared right from the start. Thus, after the visitor gets to know the available controls, the application requests him to choose his preferred language. The tutorial screen had to be in English, not only to be understandable by almost every audience but also because the terms used on it belong to the smartphone language, already established around the world.
- Welcome Screen - Having explained the controllers and selected language, the last step is to explain the concept of the visit to the visitor. Although it aims to be non-intrusive, the application has some specifications that need to be ex-

plained in order for the visitor to enjoy and explore all there is to it. To accomplish that objective, the application presents the welcome screen. With just a couple of words and images, the visitor gains the necessary knowledge to complete the visit using the given tools. The first difference between this screen and the previous ones is that it will not go into another screen unless the visitor steps into another area. In a way, this screen represents the beginning of the tour.

• Area Screen - When entering a new area, the application, triggered by a Bluetooth beacon, presents the area screen. A custom screen that adapts itself according to current area where the trigger was fired. First, the visitor will be presented with information about the oceans the area includes, from temperature to location. After that, has it was informed in the previous screen, the visitor is invited to find and use the application to read the QR Codes around the area. There are two types of QR Code along the visit: the regular and the game QR Code. Although they look the same, the result of their reading leads to different screens.

• Regular QR Code Screen - This screen will be presented to the visitor once he reads a Regular QR Code. Here the visitor can learn about a specific animal or specie. The application presents information on the origin, the species' family, where and how it lives, what it eats and any other relevant data the user inserts on the back office in order to share with the visitors. This screen also allows the visitor to save the information in a favorites section. This data may be sent to his email, by the end of the tour, along with other information that the application does not show right away due to the reduced space available on screen.

• Game QR Code - the visitor reads a Game QR Code, these are the three different possibilities that can be presented by the application, chosen by the user. The first game is the "Belongs", where a picture is shown to the visitor and he has to decide whether that animal belongs to that area or if it does not. Then there is the "Finder" game, where the visitor is invited to search and find the golden QR Code within the given time. The last game available is called "Counter" and, as the name suggests, it asks the visitor how many animals does he see, similar to the one shown on the screen. All of these games intend to grab the visitor's attention and improve their experience by challenging them and also provoke their competitive side.

• End Screen - Triggered by the last Bluetooth beacon, the application presents the visitor with end screen. Like many other service providers, the application shows the visitor a thank you message for their choice and hoping its service improved their experience.

Evaluation

Testers

This project aimed to develop an application and experiment it with a group of users with ages between 10 and 15 years. Due to the possible conditions, the group was also adapted. The group of 10 testers was divided in these subgroups:

• 2 young adults, both 23 years old, with knowledge on technology and information systems

• 2 adults, 54 and 56 years old, with small knowledge on technology and information systems

• 6 teenagers, all around 13 and 14 years old, with some knowledge on technology and information systems

Application

As said before, it was not possible to test the application where it was first thought. So, to simulate the environment, the test phase occurred in two different places: at Card4BSystems, S.A.'s office and at the house of the student who participated in this project. In order for the application's success to be evaluated, the testers were invited to complete the use cases mentioned in the previous number. After the first phase, testers advanced to the second phase. This test phase was developed within the simulated environment but also on the street, in order to understand how others would react and how the user would feel knowing he was being observed. Since the tester had already completed the previous phase, there was already a notion on how to control the device but since the previous phase consisted in a set of separate tests, the tester did not had the time to understand how it felt to wear the device for a longer period of time. Thus, this phase consisted in a 20 minute usage of the device, where the tester was invited to explore the app, the space and to pay attention to details like the weight of the device, the eye dryness and other factors that usually an individual does not pay attention to.

Results

The results of the first phase are very positive. In the first use case, only one tester obtained a bad result and on the second use case, none did. On the third use case, where the tester is asked to choose a language, two testers got a bad classification. On the forth use case, once again, all testers managed to complete the task within the expected result. Then, on the fifth use case, two testers also had some difficulties and failed the test, getting the worst classification. Finally, on the sixth use case, regarding that each tester had already gained some contact with the application, each improved their result and obtained the expected or best classification.

Conclusions

Overall

The first and main conclusion of this project is that there is still space for development and improvements in this area. Although the results show a positive reaction to the application, the opinion on the chosen hardware for this solution is not very positive and considering the different options available, the results may have not been so different. One of the problems found on the Jet was the nonexistence of the single touch event that smartphones users are used to. It was challenging to choose another method to simulate the touch interaction, by the user, that was identically intuitive. Also, the two buttons were quite challenging for the users

because they had to use the entire hand to hold the device and press the buttons using the thumb. Another problem was its weight. Considering the other hardware to which it was compared, the Jet was one of the lightest and was, even so, considered heavy and that it brought some discomfort the tester. Knowing a visit lasts around an hour and the testers only wore them for about 25 minutes, with some interval between, this can be a problem that leads to failure. Considering that the tests were not developed inside the expected environment, they could have been different for better or for worst. In addition, a larger number of testers could have improved the weight of the result. Nonetheless, this reduced but varied group of testers shown that the solution was accessible to any age or knowledge on technology and information systems. The main focus was to offer the same information but in a more attractive way. Not only was this achieved, but it was also considered, in a general way, easy to use. It was also an objective to improve the visitor's experience but without intruding too much. This was achieved by requesting the least interactions possible and by adding games along the way, so the visitor would not get too attached to the controls, using them only when requested, or to complete the games. The use of the Bluetooth beacons had a very positive result and that addition to the visit was noticed by the testers for their location was known, every step of the way, and even if the simulated signs appeared covered, the beacons helped the visitor to know his location. Also, the fluidity of the application was noticed and successfully achieved, confirmed by the good results and opinions of the testers.

Future Work

The first idea appeared during the research phase and that is there were not found any wearable eyewear hardware compatible with iOS. Although many iOS products related to smartphones and wearables such as smartwatches, iOS as yet revealed any work on eyewear. Thus, it would be interesting to explore this possibility. Regarding the application, it would be very interesting to identify a specie just by looking at an animal, in this case. Even if the hardware is not capable of supporting an image recognition algorithm, perhaps it is possible to take a picture, send it to a server and do the recon service up there. This process could transform, even more, the idea of tourism we have today. Instead of reading a billboard, instead of reading a QR Code, the visitor would just have to get close enough to an item, an animal, a painting or even a building, look at it and then system would try to recognize it and inform the visitor what he was looking at. In this project, audio was left aside but it would be interesting to incorporate audio into the application as well. Adding an audio level to the application could also bring another types of games, experiments and experiences. In order to do that, the hardware must be capable of directing the sound to a single user instead of spreading its sound through a small speaker.\\Another interesting point that could be explored is an emergency button for this type of hardware. When applied to a small scale museum or art gallery it does not sound very important, but if we imagine a large and dark museum, like this project's case study, it is not that hard for a child to get lost. Having an emergency button installed, in certain situations, it could help the child inform the museum she is lost. In addition, a service that, with help from iBeacons or another type of indoor location, could inform the parent where the child is, or more precisely, where the hardware is. Thus, the parent would only need to take a look at his smartphone and, in a second, see where his child was at that moment.

References

[1] “Museu da Marioneta new application,” http://www.museudamarioneta.pt/gca/?id=78&pais=0&prod=4551, consulted on March 12th of 2016.

[2] “Fundação de Serralves launches an Android app,” 2011, consulted on March 12th of 2016.

[3] “Museu Benfica – Cosme Damião app,” http://museubenfica.slbenfica.pt/pt-pt/home/museuhome/museuinterativo/aplicacaomobile.aspx, 2015, consulted on March 12th of 2016.

[4] A. M. Henriques, “Lisbon’s ’start-up’ company develops an app for Museu dos Coches,” 2012, consulted on March 12th of 2016.

[5] R. Tsaih and T. Han, Managing Innovation and Cultural Management in the Digital Era: The Case of the National Palace Museum, ser. Routledge Frontiers of Business Management. Taylor & Francis, 2016. [Online]. Available: https://books.google.pt/books?id=zD9-CwAAQBAJ

[6] F. Borrero, P. C. S. Muñoz, and G. R. González, “Gamification techniques in tourism, application test, casa mosquera museum,”Sistemas y Telemática, vol. 13, no. 33, 2015. [Online]. Available:http://www.icesi.edu.co/revistas/index.php/sistemastelematica/article/view/2081