Department of Computing
Goldsmiths, University of London

Augmented Reality Navigation System for Commercial Spaces

Proposal

by

Arif Kharoti, Nicholas Orford-Williams, Hardik Ramesh, Gabriel Sampaio Da Silva Diogo, Hamza Sheikh, Jonathan Tang
Software Projects – Group 14

Autumn 2018

Submitted in partial fulfillment for the degree of
Bachelor of Science in *Computer Science*

Abstract

Frustration and confusion are common emotions that are apparent at large shopping centres. After analysing recent studies, it is evident that shopping centres have a huge role to play in the overall retail experience. In order to provide greater value to both consumers and retailers, retail settings are being challenged to become smarter. One approach that is becoming increasingly recognised is mobile augmented reality (MAR) apps. Many consumers have difficulties in locating the store which satisfies their needs. In this research, we endeavour to outline the market requirement of developing an application that allows for smart retail and describing how additional value is created to customers as well as benefiting retailers. It is proposed that the application will implement a 3D model of various shopping centres, featuring navigation functionality to assist users in finding their desired store.

Word Count

xyz

computed by `TeXcount`

Contents

Chapter 1

Concept Introduction & User Needs

The main concept for this project revolves around the user of augmented reality on smartphones. Augmented reality (AR) is the superimposing of a computer-generated image onto a user's view of the real world [1]. This technology first came about in the 1960s [2] but has recently gained consumer and wide-spread media attention after the use of it in Snapchat filters and the 2016 game *Pokémon Go* for example. There have been many times where people get lost in unfamiliar spaces such as a museum, immersed by the culture around them, and their sense of direction. This project aims to tackle this issue by allowing users to restore their orientation by having a mobile platform to route users to their destination, using AR. The platform will use the device's camera to work out its surrounding, and will produce a highlighted line on the screen to their destination in real time.

This concept has various applications to other similar scenarios such as finding products in a supermarket, books in a library, or even valuable items that people own that can emit an electronic signal for it to be tracked down. Further, the concept could also use machine learning in identifying user's traits in places visited in a museum in order to give personalised recommendations at other similar exhibitions.

Chapter 2

Stakeholder Requirements

The main stakeholders are museum visitors and staff. After consulting with them, and potential users of the proposed application, we were able to gain a better understanding of what the apparent need was in the relative market regarding museums. Out of the 21 responses we received, 15 potential users admitted to visiting museums at least once a month. This shows that there is some level of frequency in their visits, and that there is something that can be offered to this group of people.

Since our concept principally considers the user of navigation in museums, when users were asked, "do you find yourself using the maps in the museum more than once?"- a very reassuring 100% of visitors had agreed that they did in fact refer to the maps around the museum more than once, some respondents going on to say that they referred to it over 10 times. However, these maps are not free; in most museums, including the Natural History Museum and the Science Museum in London, require a fee of £1 in order to have access to the paper maps.

This shows that there is an evident need for an accessible tool other than the maps around the museum in order to assist visitors' navigation around the museum. 18 of the respondents had agreed they would much rather prefer using their phone to navigate rather than the paper maps that are currently available to assist in their navigation around the museum. These responses that we received first-hand were very reassuring for us as developers, as it brings to light an evident need for these visitors to have access to an improved navigation solution.

Based on the stakeholder research, the project requirements are,

- navigate the user to an through the use of augmented reality
- to display navigational routes in real time
- calculate the shortest route to the user specified location
- work transferrably in other museums/commercial spaces

- contain accessibility features such as magnified text and inverted colours for example

Chapter 3

Prior Knowledge

Chapter 4

Design

4.1 The Importance of Design

Design is a great initial investment owing to a number of different reasons. Having a design process allows for more efficiency and transparency when actually coming to design the application. It overcomes the risk of having to refer back to the drawing board when actually developing the application, setting in stone the main features and functionality of the application.

4.2 The Unified Modeling Language

A way in which effective design strategies were carried out was through the implementation of the Unified Modeling Language (UML), a powerful standard for creating specifications of various parts of a software system.

One example of the UML was our implementation of a use case diagram which outlined the different scenarios in which a user would function the application. See figure 4.1.

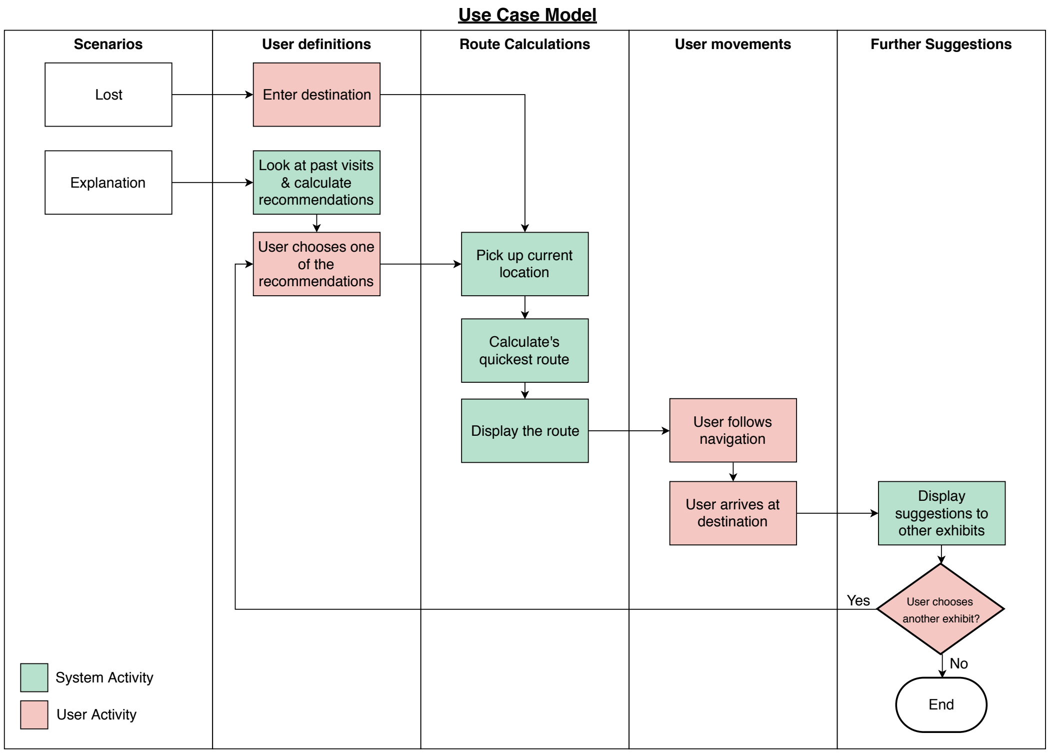

Figure 4.1: Use Case Diagram

Another way in which UML was implemented to further support and refine the designing phase of the software development was through an activity diagram. (See figure 4.2).

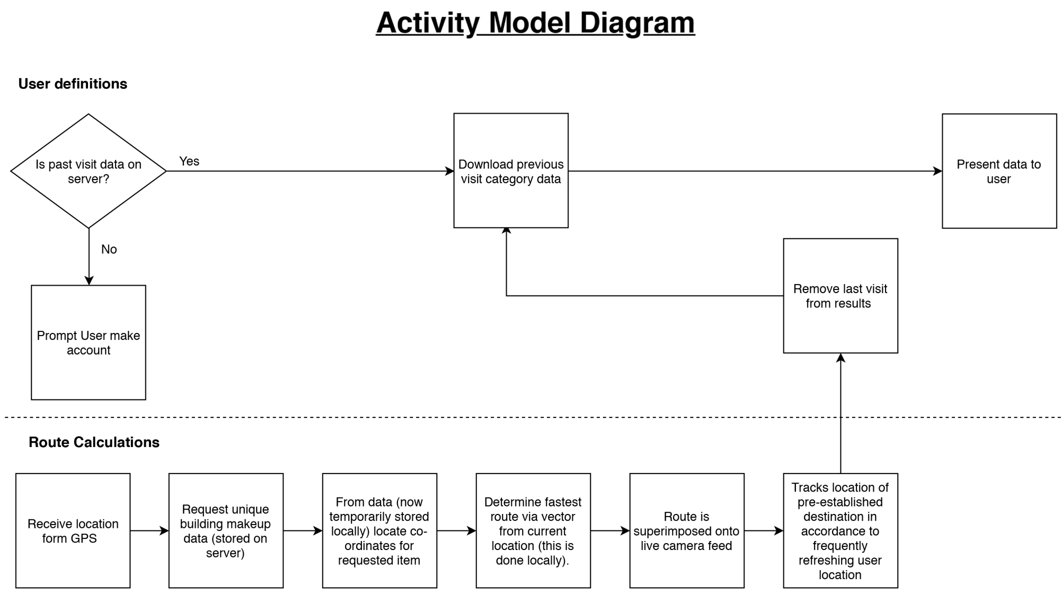

Figure 4.2: Activity Diagram

The use case diagram (Figure 4.1) represents the functional behaviour of the system in terms of goals that can be fulfilled by the system. These goals have been defined in the stakeholder requirements. The activity diagram (Figure 4.2) was designed to model the work flow of the system. One main reason that the activity diagram was essential in the designing phase was that UML included that these diagrams are normally easily comprehensible for both analysts and stakeholders. By producing and creating these models, we were able to have a clear understanding of what the application *has* to do, and enabled us, the developers, to visualise the application for the future.

4.3 Service Model

We have to first exclaim that the following cases are born out of one important principle; convenience. The **'lost'** use case, for example, comes from the fact that the user could be lost for whatever reason. What we would provide through this service would be the quickest and most **convenient** solution to finding their destination. Whether that be the exit, a cafe or a particular exhibition. Another use case; **'exploration'**, would become more convenient with the museum, and all its exhibitions (along with brief descriptions) at your fingertips (instead of the existing navigation options present at museums today e.g. wall-maps or paper maps).

Model around two cases (The lost and the exploring)

The lost-case and exploration-case has a virtually linear-stream of logic, and is as follows:

1. The user enters within the radius of an environment modelled by the service. In this case, a museum.
2. The user's location is picked up once they give use permission to (in this case, it would typically be when the user opens the app).
3. The user then picks their destination.
4. That location is then taken and parsed through a function containing an algorithm that calculates the most convenient route between the user's real-time location and their desired destination.
5. The user is then displayed the route, and directed towards their destination via their camera.
6. Once done, the user is given curated suggestions on possible places they can go.

Chapter 5

Prototyping

5.1 UI/UX Designs

5.2 Augmented Reality

In terms of Back-end prototyping, we had a research on Android and iOS platforms. This will help us to identify which platforms are best/worse for our **Augmented Reality (AR)** applications. We divided this prototyping into three parts where Hardik was working on Unity, Jonathan works on iOS and Gabriel works on Android. We had also built a small AR application to give any information about the various libraries and how they help with our project.

5.2.1 Unity

Unity is mostly used to create the games for iOS and Android, therefore, I have used unity to create a simple AR camera application where when your camera hover to an object/image it will display an information about that picture on your phone. In order to create this application, I have used **Vuforia** which is a software development kit (SDK) for mobile devices that enables to recognise and track the image targets. It is good for developing games, but this won't help us with our project. The disadvantages of unity are that there is a limited amount of library for locating user current location compare to Android.

5.2.2 iOS (XCode)

It is an integrated development environment (IDE) that includes everything you need to create an application for Apple platforms. In order to create an application, we have to learn **Swift programming** which is not that hard to learn. It is good for recognising images using an AR camera but when it comes to GPS it is difficult to locate the user location.

5.2.3 Android (Android Studio)

It is an IDE that helps us to build the apps for every Android device. Gabriel has used **ARCore** to create a simple 3D model which will show on your mobile device when your camera target on the flat surface. It is easy to code a GPS location function in Android studio compare to Unity and iOS.

Chapter 6

Functional Specification

What is a functional specification?

Functional specification describes the important technical requirements for a system. It also includes the procedures in which the requirements have been met.

In this section, we are breaking down the functional specifications of our idea and how it should respond to a given task:

1. The system should allow the user to enter their current location and their destination, this is key as it allows the app to calculate the route. 2. The system should be able to calculate and work out the shortest and closest route to a given exhibition in short amount of time. 3. The system should be able to display the route on the user's smart phone in good quality and allow them to follow the route to their destination. The route would be displayed using a thick blue arrow which goes all the way to their destination, so all the users have to do is follow the arrow. For users with disability the app would have a voice guide. 4. The system should ask the user for their rating of the museum and if they would suggest the exhibition to anyone else. 5. Lastly, the system should be able to display different users reviews and past visits on the system, the reason for this is that it would use this information in the future to suggest to new users where they should visit and what museum would be suitable to them. The way the data for this would be collect is that once the user has reached their destination. The app would display a rating screening including a feedback option where users can give their honest opinion on their experience.

Chapter 7

Ethical Audit

The field of AR is currently not heavily regulated in the UK owing to the emergence of this new technology in recent times. There are certain areas such as data protection, intellectual property (IP), and security that need to be strongly factored in and considered during the development lifecycle. It should be noted that AR will involve collecting an extensive amount of data per user such as names, age and email address, but also appearance, real time location, and their interaction with other users. Within the scope of this project, we will not be working with minors and vulnerable adults. Since the concept of the project relies on the user's camera, accelerometer, and location data on the user's device, ensuring that this data cannot be obtained unlawfully and fits the scope of the Data Protection Act (1998) along with the EU General Data Protection Regulation (GDPR) is of most importance.[3]

Based on large virtual reality companies such as Oculus, these obligations are addressed by the form of a privacy policy in order to detail how data is collected, used and if it is shared with third parties. Since GDPR presents many pitfalls for developers, it is critical these regulatory issues are addressed before the completion of the product and not after. Penalties for non-compliance can be up to £17 million or 4% of annual turnover. [4]

Another regulatory standard is the intellectual property (IP) of the software. The source code and object code that serves as the underlying foundation of the platform will be be original and qualify for copyright protection. Since computer software is usually excluded from patentability in the UK, any ideas that uses AR producing a technical effect, and its associated hardware can be protected by patents. Based on our competitors, it is important that we do not infringe on their patents owned by third parties. Equally, if the concept makes new technical developments in the field relating to AR, then it should be considered whether it would be eligible for patent protection.

Given that the AR experience is built using a database of information about the real world, the database can be protected by copyright. The concept could take on a machine learning viewpoint by recognising third party logos captured on the user's camera. This could cause an infringement claim since AR could be replicating, replacing trademark or copyright works, or distorting the logo.

Chapter 8

Technical Architecture

Chapter 9

Evaluation Plan

Chapter 10

Project Management

Chapter 11

Conclusion

Bibliography

[1] Oxford Dictionary Online. Augmented reality. https://en.oxforddictionaries.com/definition/augmented_reality.

[2] Interaction Design Foundation. Augmented reality – the past, the present and the future. https://www.interaction-design.org/literature/article/augmented-reality-the-past-the-present-and-the-future, 2018.

[3] Kate Brimsted. Virtual and augmented reality: time to update the legal handbook. https://www.itproportal.com/features/virtual-and-augmented-reality-time-to-update-the-legal-handbook/, 2016.

[4] Eversheds Sutherland. Virtual and augmented reality: what are the legal issues? https://www.eversheds-sutherland.com/global/en/what/articles/index.page?ArticleID=en/tmt/Virtual_and_augmented_reality_what_are_the_legal_issues, 2017.