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Augmented Reality Navigation System for Commercial Spaces

Proposal

by

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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 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

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Supervisor

Dr. Basil Elmasri

Contents

Nomenclature

AR	Augmented Reality
GDPR	General Data Protection Regulation
GPS	Global Positioning System
IDE	Integrated Development Environment
IP	Intellectual Property
MVC	Model-View Controller
SDK	Software Development Kit
UI	User Interface
UML	Unified Modeling Language
UX	User Experience
VR	Virtual Reality

Chapter 1

Concept Introduction & User Needs

The main concept for this project revolves around the use of augmented reality (AR) navigation on smartphones. AR is the superimposing of a computer-generated image onto a user's view of the real world [?]. This technology first came about in the 1960s [?] but has recently gained wide-spread consumer attention after the use of it on 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 an AR platform to route users to their destination. 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, or books in a library. 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 Importance of Design

Having a design process allows for more efficiency, and transparency when coming to design the application. It overcomes the risk of referring back to the drawing board when developing the application, setting in stone the main features, and functionality of the application.

4.2 Unified Modeling Language

An effective design strategies was carried out through the implementation of the UML, a powerful standard for creating various specifications the software system.

Our implementation of a use case diagram outlined the different scenarios in which a user would function the application. (Figure A.1). UML was implemented was to further support, and refine the designing phase of the software development through an activity diagram. (Figure A.2).

The use case diagram represents the functional behaviour of the system in terms of goals (as defined in the stakeholder requirements) that can be fulfilled by the system. The activity diagram was designed to model the work flow of the system. One main reason that the activity diagram was essential was that these diagrams are normally easily comprehensible for both analysts, and stakeholders. By producing these models, we were able to have a clear understanding of what the application does, and enabled us to visualise the application for the future.

4.3 Service Model

The following cases are born out of one important principle, convenience. The **lost** use case, for example, comes from the user that could be lost for whatever reason. The service we would provide would be the quickest and most convenient solution to finding their destination, whether that be the exit or a particular exhibition. The **exploration** case, would be more convenient with the museum, and all its exhibitions will be at the user's fingertips (instead of existing museum navigation options e.g. wall-maps or paper maps).

Model around two cases

Both cases have a linear-stream of logic:

1. The user enters within the radius of an environment (museum) modelled by the service.
2. The user's location is picked up once they give use permission to.
3. The user picks their destination.
4. That location is then taken, and passed through an algorithm calculating the quickest route between the user's real-time location, and their destination.
5. The user is then displayed the route, and directed towards their destination via their camera.
6. The user is given curated suggestions on possible places they can go.

Chapter 5

Prototyping

5.1 AR Libraries

In order to identify libraries that are good for implementing AR on mobile devices, we divided this prototyping into three platforms to explore them, and built test applications to find out how they help with the project.

Vulforia (Unity/Android)

Unity is a cross-platform game engine, used to test a simple AR camera prototype where the device's camera hovers an object/image, and displaying information about that object/image on the device. We used Vuforia, an SDK that enables recognition, and tracking of image targets, to build it. This library can be used for the exploration case in the use case model. Although, there is a limited amount of tools for locating user current location compared to Android.

ARKit (iOS)

We built a similar prototype to Unity on Apple's ARKit using Swift, which was easy to learn. It was intuitive to implement AR features as there was detailed documentation but logging GPS data was harder compared to Android.

ARCore (Android)

ARCore was used to create a simple 3D model showing on a mobile device when its camera targets a flat surface. Compared to iOS, it is easier to log GPS location, although connecting the user interface to the scripts was more challenging.

5.2 UI/UX Designs

Chapter 6

Functional Specification

The main functional elements of our concept are:

1. Receiving the **current coordinates** of the user, and the coordinates of the destination will be needed to create the starting and end points for calculating the route. The current location will come from sensors on the user's device, and the destination location will be queried against a mapping system.

2. The platform can **calculate the quickest route between two points** specified by the user. Data from the above, and the museum model will be required for this calculation.

3. A **3D line will be superimposed** that navigates the user to their destination. Sensor data from the user's device along with the user's relative position in the model will be required to show the line. Access to the user's camera is essential in this element.

4. When the user arrives at their destination, the system will give recommendations based on their current route, and allow the user to rate their journey.

5. The**user's camera can recognise artwork/objects**, and will display further information about the piece. There will be a storage area of current pieces in the museum so that the camera can query the information.

Chapter 7

Technical Architecture

Means of Software Development

IDE : Android Studio
The Android Studio is the only development IDE we'll be utilising because it involves a number of relevant exclusive packages and libraries - that if we were to use other IDEs, would have to be defined and therefore take valuable time from our development of the application itself.

Languages : Java & SQL

- Java is distinctly imperative to the project due to the fact that android app development is almost only possible in this language.

Architectural Pattern : MVC (Model-View-Controller)

Our application fits under the MVC pattern perfectly be it that the following are true.

- Model = The data provided by the user (example : geolocational data)
- View = The front-end interface (example : 3D line to location)
- Controller = The algorithms between M&V (example : route calculation)

Along with the fact above, the pattern's simplicity makes the most sensible one we can use.

SDKs & Packages : ARCore

- The ARCore kit by Google gives us the ability to apply the AR element of our application without having to spend time pre-defining AR methods ourselves.

Technicalities of satisfying user-related questions and stories

Chapter 8

System Requirements Specification

Chapter 9

Ethical Audit

AR is currently not heavily regulated in the UK owing to the emergence of this new technology. It should be noted that AR will involve collecting extensive amounts of data per user such as names and address, but also real time location, interactions 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 GPS on the user's device, ensuring this data cannot be obtained unlawfully, fitting the scope of the Data Protection Act (1998), and GDPR is of most importance.[**?**]

Based on large VR companies such as Oculus, these obligations are addressed by the form of a privacy policy, to detail how data is collected, used and if it is shared with third parties. It is critical these regulatory issues are addressed before the completion of the product and not after.

Another regulatory standard is the IP of the software. The source 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 AR field, there should be consideration whether it would be eligible for patent protection. The project could take on a machine learning viewpoint by recognising artworks 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 artwork.

Chapter 10

Evaluation Plan

Chapter 11

Project Management

Chapter 12

Conclusion

Appendix A

Figures

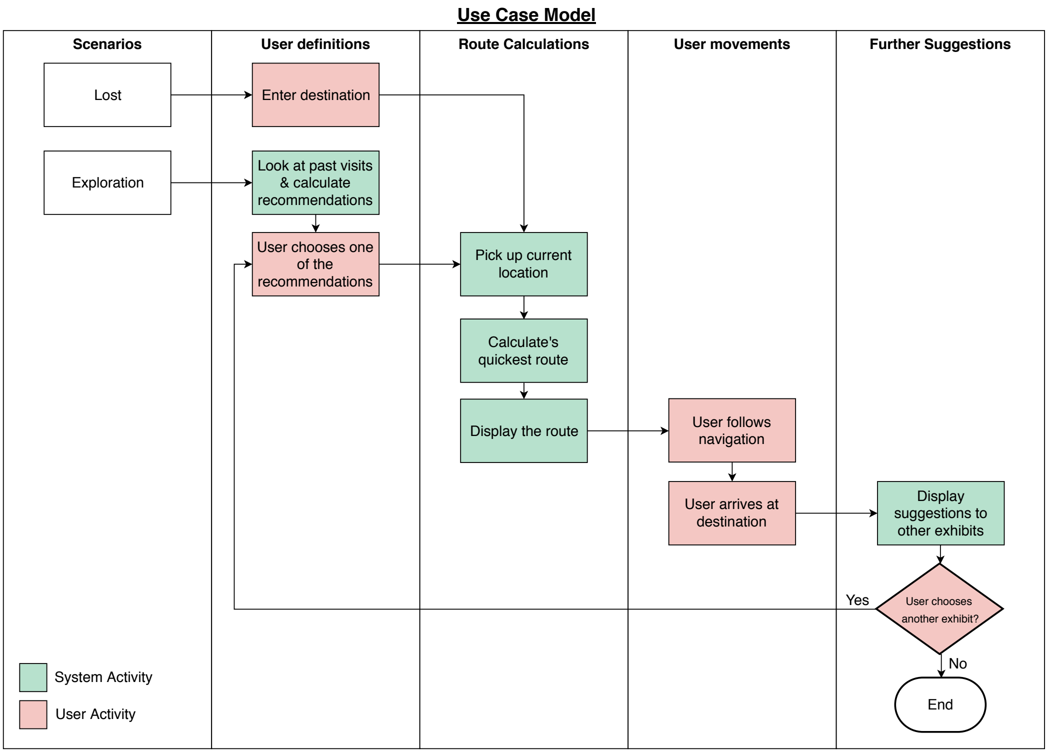

Figure A.1: Use Case Diagram

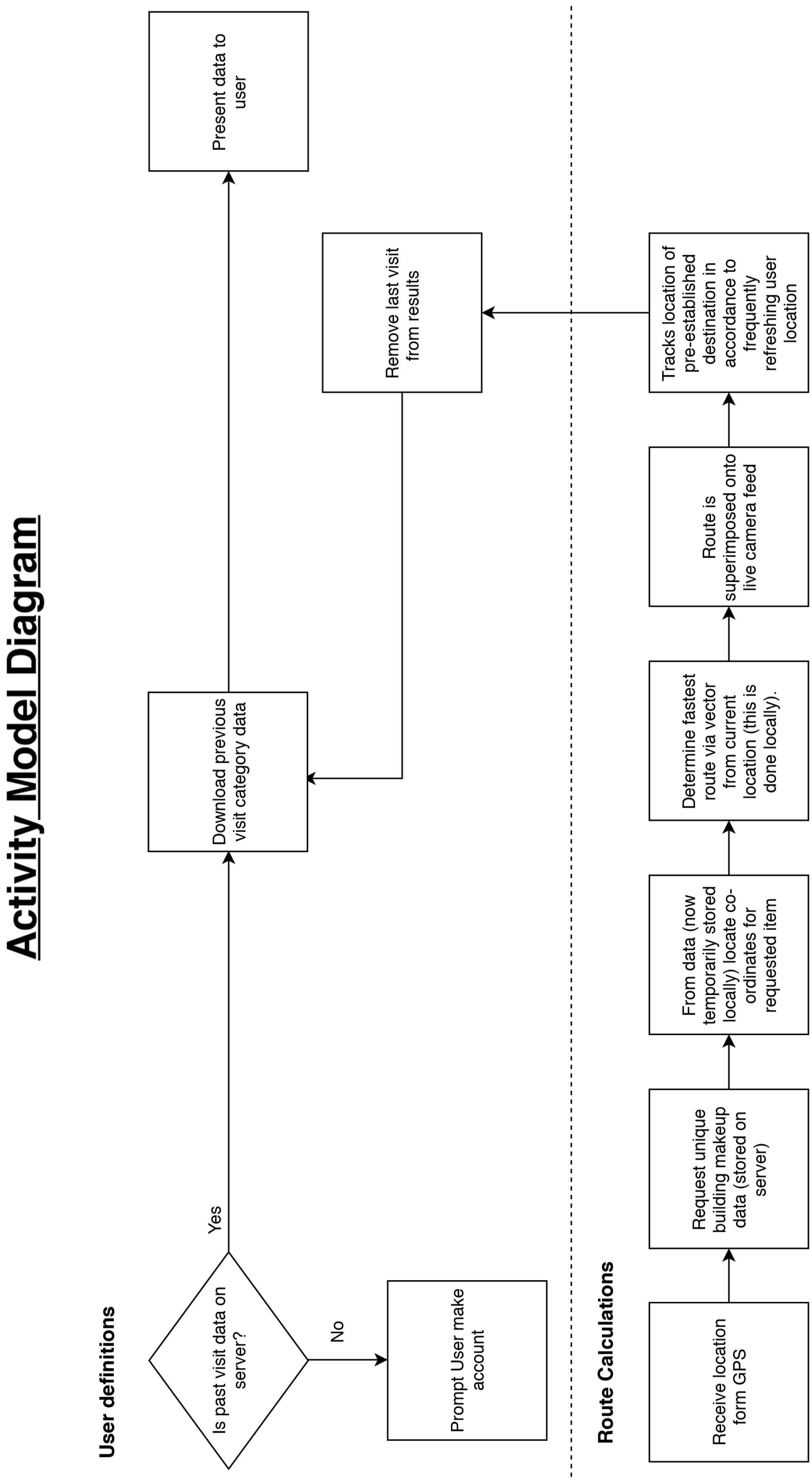

Figure A.2: Activity Model Diagram

Appendix B

Systems Requirements Specification

B.1 Purpose

B.2 Scope

B.3 System Overview

B.4 References

B.5 Definitions

B.6 Use Cases

B.7 Functional requirements

B.8 Non-functional requirements

Appendix C

Meeting Minutes

Structure

Academic weeks are indicated in brackets.

All weekly meetings are structured as:

- Monday (in person) - Lab sprint planning
- Thursday (virtual) - Team sprint review
- Friday (in person) - Project supervisor meeting

Week 1 (1)

Thursday 4 October 2018

- Meeting all team members
- Discussing potential concepts

Week 2 (2)

Monday 8 October 2018

- Reviewing potential concepts discussed
- Considering stakeholders

Thursday 11 October 2018

- Reviewing project concept

Friday 12 October 2018

- Updating project tracking form
- Meeting project supervisor
- Submission of project concept

Week 3 (3)

Monday 15 October 2018

- Updating project tracking form
- Tweaking project concept to be museum focused
- Creating scrum board to track tasks
- Allocating market research
- Creating stakeholder requirements activities
- Allocating questionnaire

Thursday 18 October 2018

- Updating project tracking form
- Reviewing market research
- Reviewing questionnaire

Friday 19 October 2018

- Updating project tracking form
- Submission of market research
- Submission of questionnaire
- Further research on different stakeholders of different demographics suggested by project supervisor

Week 4 (4)

Monday 22 October 2018

- Building use sequence model
- Allocating activity model
- Allocating service model

Thursday 25 October 2018

- Reviewing use sequence model
- Reviewing activity model
- Reviewing service model

Friday 26 October 2018

- Updating project tracking form
- Submission of all models
- Updating supervisor on team collaboration

Week 5 (5)

Monday 29 October 2018

- Creating open questions
- Allocating storyboard
- Creating outline for proposal
- Creating Gantt chart
- Allocating UI/UX prototyping
- Allocating AR libraries investigation

Thursday 1 November 2018

- Reviewing storyboard

Friday 2 November 2018

- Showed our storyboard
- Updating project tracking form
- Updating supervisor on storyboards and current prototyping
- Collate all half term work in one document and send to supervisor

Week 7 (Reading week)

Thursday 8 November 2018

- Gathering raw stakeholder research information
- Analysis and review on raw stakeholder research

Week 7 (6)

Monday 12 November 2018

- Reviewing Gantt chart
- Reviewing open questions
- Reviewing stakeholder research
- Creating plans for stakeholders using prototypes
- Peer-reviewing of UI/UX prototypes

Monday 13 November 2018

- Do research on Stakeholder

Thursday 15 November 2018

- Review of the peer-reviews
- Start with UI/UX prototypes
- Research on Android/iOS platforms

Friday 16 November 2018

- Updating project tracking form
- Demonstrating individual UI/UX prototypes to supervisor
- Demonstrating each AR library research to supervisor

Week 8 (7)

Monday 19 November 2018

- Reviewing Gantt chart
- Reviewing research on Android/iOS platform
- Building final UI/UX prototypes

Thursday 22 November 2018

- Review final android prototype
- Review final UX/UI prototype

Friday 23 November 2018

- Updating project tracking form
- Presentation on everything completed so far to project supervisor
- Submission of all prototypes

Week 9 (8)

Monday 26 November 2018

- Reviewing Gantt chart
- Allocating backlog
- Allocating open questions
- Allocating MVC
- Reviewing functional specification chapter

Thursday 29 November 2018

- Reviewing backlog
- Reviewing open questions so far
- Reviewing design chapter

Friday 30 November 2018

- Updating project tracking form
- Shows our Open Questions
- Shows back-log to
- Spoken about fuse comapany
- Progress of framework of technical architecture
- Finish User stories by next week
- Complete technical specification (Milestone) by next week

Week 10 (9)

Monday 3 December 2018

- Reviewing Gantt chart
- Reviewing backlog, open questions, and MVC
- Reallocating chapters 5, 6, 7, 8 of proposal due to change in guidelines
- Reallocating user stories
- Preparation for concept presentation

Thursday 6 December 2018

Friday 7 December 2018

- Updating project tracking form

Week 11 (10)

Monday 10 December 2018

- Reviewing Gantt chart

Wednesday 12 December 2018

- Proof reading all chapters
- Writing abstract and conclusion of proposal
- Completion of meeting minutes
- Submission of proposal

Bibliography

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