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Augmented Reality Navigation System for Commercial Spaces

Proposal

by

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Abstract

This proposal presents the use of augmented reality in museum navigation on mobile devices. After conducting stakeholder research, there were clear issues presented by current solutions on the market through the form of paper maps. Augmented reality library research was conducted on various platforms to find the appropriate one for the proposed system, and UI/UX prototyping prioritised key design aspects on the potential systems. Following this, technical architectures and user stories are defined through the model-view controller architectural pattern, along with technologies to be used during implementation. Methods and approaches to implementation are outlined, namely through the agile methodology along with consulting various testing methods to ensure stakeholder requirements are met.

Word Count

xyz

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Supervisor

Dr. Basil Elmasri

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Nomenclature

AR	Augmented Reality
FR	Functional Requirement
GDPR	General Data Protection Regulation 2016/679
GPS	Global Positioning System
IDE	Integrated Development Environment
IP	Intellectual Property
MVC	Model-View Controller
NFR	Non-Functional Requirement
SDK	Software Development Kit
SRS	System Requirement Specification
TDD	Test Driven Development
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 [1]. This technology first came about in the 1960s [2] but recently gained wide-spread consumer attention after the use of it on Snapchat filters [3], and the 2016 game *Pokémon Go*. 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, routing users to their destination. The platform will use the device's camera to work out its surrounding, and produce a highlighted line on the screen to their destination in real time.

This concept has various applications to other scenarios such as finding products in a supermarket, or books in a library. Further, the concept could also use machine learning in identifying user traits in places visited in a museum in order to give personalised recommendations at other similar exhibitions.

Chapter 2

Stakeholder Requirements

After consultation with the main stakeholders (museum visitors and staff), and exhibit owners, a better understanding was gained concerning the need shown in the market. Out of the 21 responses received, 15 potential users admitted to visiting museums at least once a month; showing some level of frequency in their visits, and that something can be offered to this group of people.

Since the concept principally considers the use of navigation in museums, when users were asked, "do you find yourself using the maps in the museum more than once?"- 100% of visitors agreed they referred to the maps around the museum multiple times, and some respondents over 10 times. However, these maps are not free; most museums, including the Natural History Museum, and Science Museum in London, charge a fee of £1.

18 of the respondents agreed they preferred using their phone to navigate rather than the paper maps, outlining a clear need for an accessible tool other than the maps around the museum.

Based on the stakeholder research, the project requirements are,

- Display navigational routes in real-time.
- Calculate the shortest route to the user specified location.
- Use AR to enhance user navigation routing.
- Contain accessibility features such as inverted colours.

Another key stakeholder are museum staff as they are instrumental to on-the-ground navigational assistance. The platform should endeavour to make it easier for museum staff to assist visitors.

The museum staff stakeholder requirements are,

- Exhibit an effective and easy-to-use design.
- Be economic and effective in its use of data, as most data would be sourced from the museum Wi-Fi.
- Written content and other media to be controlled by the museum.

During the field research, museum-floor staff and receptionists were consulted. The staff approached all received navigational inquiries, either from themselves or visitors. Although positive responses were received several concerns were cited,

- Battery performance
- Data usage
- Ease of use

Chapter 3

Prior Knowledge

3.1 Current Solutions & Competitors

The market of indoor museum navigation has grown recently with more solutions being submitted due to the growth in indoor navigational research. Most solutions cater well for a basic navigation of large public spaces, but fail to display an even proportion of navigational, and interactive content with well-presented data.

Since most museums use portable audio guides, user experiences can be vastly improved by mobile devices. Currently only a few solutions can be found; the Orpheo group [4] provide a unique app for each place; their solution is cumbersome to regular museumgoers who wish to have a hassle-free setup. As the aim is to appeal to museums, having an application whereby the user can walk into a museum, and greeted with relevant information is vital in comparison [5].

If museums wanted a solution for navigation, due to the low number of museum-specific competitors, would choose to use a standard indoor mapping software [6]. However, while there are many options out there from Google and Mapspeople [7] who try to provide this, they lack exigencies that are imperative for museums like heavily-integrated AR, and intelligent tour guiding from your location.

From a technological viewpoint, a problem in the solutions that museums implement today, would be their paper maps not processing real-time locations. AR allows for real-time data processing, picking up the user's current location, and displaying the best route for the user to take through their device's camera. A benefit of implementing AR is the unique approach to today's navigation solutions, whilst allowing users to create their own content, enabling more opportunities to interact with the application.

Chapter 4

Design

4.1 Unified Modeling Language (UML)

The implementation of the use case diagram outlines different scenarios in which users would function the application. (Figure A.1). It represents the functional behaviour of the system in terms of the goals (as defined in the stakeholder requirements) that can be fulfilled by the system.

UML was implemented to further support, and refine the designing phase of the software development through an activity diagram. (Figure A.2). It was designed to model the work flow of the system; this was essential as these diagrams are easily comprehensible for both analysts, and stakeholders. By producing these models, there is a clear understanding of what the application does, and enables the visualisation of the application for the future.

4.2 Service Model

The following cases are based on convenience for the user. The **lost** use case comes from the user that could be lost for whatever reason. The service provided would be the quickest 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).

Model around two cases

Both cases have a linear-stream of logic:

1. User enters within the radius of an environment (museum) modelled by the platform.

2. User's location is picked up once they give permission to.

3. User selects 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. User is displayed the route, and directed towards their destination via their camera.

6. User is given curated suggestions on possible places they can go.

Chapter 5

Prototyping

5.1 Augmented Reality Libraries

In order to identify libraries that are good for implementing AR on smartphones, prototyping was divided into three platforms to explore them, building test applications to discover how they assist with implementation.

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 image, and displaying information about that image on the device (Figure B.1). The application was built using Vuforia, an SDK that enables recognition, and tracking of image targets. This library can be used for the exploration case in the use case model. Although, there is a lack of tools for locating user current location compared to Android.

ARKit (iOS)

A similar prototype to Unity (Figure B.2) was built on Apple's ARKit using Swift [8], 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 targeted flat surface (Figure B.3). Compared to iOS, it is easier to log GPS location (Figure B.4), although connecting the user interface to the scripts was more challenging.

5.2 User Interface/User Experience Designs

The project lends substantial importance to its user interface and experience. As it will be used by people with a wide range of technical ability, the aim will be to make the app as simple as possible without having an impinging effect on any service the end product will feature. This prerequisite was clearly outlined in the surveying of museum guests and staff alike. The first mission was determining what interfaces, and experiences currently exists within the museum sector. Many museums employed simple interfaces but due to their mass-manufacturing, their design felt unoptimised with simple bare-bones media not beyond text and images. Furthermore, this design would fail to deliver anything more complex than texts and images.

The approach to the UI/UX prototyping was to create different interface mock ups and exhibit them alongside existing solutions. A storyboard and three potential interfaces (Figure B.7 B.8 B.9) were drawn up and put to stakeholders, implementing all the positive attributes (C) were combined into one (Figure B.10), and considering the negative attributes.

Chapter 6

Functional Specification

The main functional elements of the concept are:

Route Calculations

1. Receiving the **current coordinates** of the user, and the coordinates of the destination, to create the start, 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 model.

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

Superimposition

3. A **superimposed 3D line** 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 here.

Suggestions/Reviewal

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

5. The **user's camera can recognise artwork**, displaying further information about the piece. A storage area of current pieces in the museum will exist so that the platform can query the information.

Chapter 7

Technical Architecture

7.1 Technologies Supporting Functional Architecture

SDKs

Google's **ARCore** kit gives the ability to apply AR to the application without having to spend time pre-defining AR methods. It has distinct advantages over Apple's ARKit as ARCore can detect horizontal surfaces that is similar to motion tracking, and can accurately anchor virtual objects. [9]

Platform & Languages

The app will be developed on Android and in Java since it is only usable with ARCore.

IDE

Android Studio will be utilised because it involves a number of relevant exclusive packages. Other IDEs requires them to be pre-defined, and therefore takes out valuable time from application development.

Architectural Pattern

The application fits under the MVC (Figure B.13) pattern perfectly be it that the following are true.

- Model: Data provided by the user (e.g. geolocational data)
- View: Front-end interface (e.g. 3D line to location)
- Controller: Algorithms between the model & view (e.g. route calculation)

7.2 Satisfying Questions From the User Stories

Questions

1. How will the navigation system get me from point A to point B? (Figure A.3 In order for users to get from one point to another, the quickest route will be calculated. Route Calculations:
    - Algorithms to request, and process GPS signal.
    - Algorithms to calculation quickest route when user enter their destination.
    - Once calculated, show the result for user to start their journey.
2. How easy will it be to grasp the app? The basic map layout will be simple, and once the route has been calculated, a 3D line will be superimposed on the users screen to direct the user.
3. Can the app be used without Internet? No, otherwise the app will not have access to exhibit information, and other platform features such as querying mapping services.

Chapter 8

System Requirements Specification

The SRS was designed to show the structured collection of the requirements of the system along with its operational environments, and external interfaces [10].

The functional requirements (FR) comprise of the system behaviour, the functions and features (*what* the system should do). Whereas the non-functional requirements (NFR) place constraints on *how* the system should do it.

The FR considers the functionality of the application, looking at the key features such as the user navigation and its relative implications. The NFR considers the usability of the application, describing aspects such as performance, user actions and data usage.

1. **Constraints, Assumptions and Dependencies**:
   (a) **Internet Connection**: The application would not be able to query mapping services or have access to exhibit information otherwise.
   (b) **Android**: Users of this application are Android device users that requires assistance in museum navigation. An android device that can support basic dependencies of the application is expected for proper user experience.

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 emails, but also real-time location, and interactions with other users. Within the scope of this project, we will not be working with minors and vulnerable adults. Since the project concept 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 [11].

Based on large VR companies such as Oculus, these obligations are addressed by 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, 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 use machine learning 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

Test Driven Development (TDD)

TDD is the main developmental process of choice, both during and after creation because of the following qualities.

1. Tangible results that can reviewed with efficacy

As a test based method, it gives the creators the ability to prove what does and does not work asynchronously - if the project were to be developed with stand-up as the central process, this core quality, that gives way for quick and effective development would be lost, and because of its allowance for effective review, it makes it easy to adapt the application to the results. For example, the application requires a guiding graphic. TDD makes it easy to review whether a 3D line in reality, is the best case solution. Or whether an alternative, such as an arrow, is better.

2. Simplicity of implementation

As a relatively technically complex application, TDD helps break down each process effectively. For example, when choosing the best route. Does the algorithm place more weight on scalar distance? Or on obstacles? TDD makes the process of making this decision distinct and therefore, simple.

3. Re-usability

The project also only has a few purposes. Making it optimal for iterative testing and prototyping. Meaning that TDD also makes sure that the facets of the application can be created with a high degree of quality.

Chapter 11

Project Management

In order to manage the development process, the agile methodology using the scrum framework will be employed. In the scrum team, the project supervisor will serve as product owner, acting as the primary liaison for the project, and ensuring the stakeholders' vision are at the forefront of decisions made by the team.

The project manager will serve as scrum master, coordinating the scrum team, and managing scrum processes such as sprint planning, execution, and review. They will lead daily stand-up meetings, and decision-making processes so that any impediments that affect the team are removed efficiently. The scrum team, and the scrum master are responsible for all actions in the sprints; prioritising items in the backlog (Figure B.12) for sprint planning [12].

A Gantt chart will be used to visually represent sprints and progress made. Trello will host the scrum board to track sprints, and deadlines such as module milestones. Any specific development issues will be tracked on Gitlab so that they can be easily attributed to the affected code. For each repository commit, a code review will take place by other team members before integration to the system. This is to ensure a high level of consistency, maintainability, and secure code across the implementation and testing of the project.

Chapter 12

Conclusion

The concept is to build a solution to indoor museum navigation within its sector. Issues became transparent through market research, which defined the user requirements. Upon discovering the inadequacies of current solutions (chiefly failing in succinct user navigation with museum exhibitions) through the implementation of augmented reality the project will be able to offer real-time 3-D mapping.

UML models were drawn up using stakeholder requirements to define user and activity behaviours. Research was conducted around AR libraries to find the appropriate packages for the project. ARCore stood out as it can accurately anchor virtual objects better than Vulforia and ARKit. A storyboard, and three UI/UX prototypes were constructed to show stakeholders samples of the platform, then combining all effective features into one. This provided an understanding of user behaviour concomitant with usability.

From prototyping, the main functional elements were outlined. It was decided the platform will adopt the MVC architecture to aid modelling, and questions from the user stories were addressed. System requirements specification was composed to summarise, outlining features and behaviour of the system. During the system life-cycle, TDD will be used to test system components.

Ethical auditing helped to adhere to regulations, and standards in software development. Due to the wide scope of the project, Agile methodology will be used, allowing for ease of innovation in relation to features.

Appendix A

Systems Requirements Specification

A.1 Purpose

The main goal of this concept is to provide an exciting, and enjoyable experience for museum-goers through the use of AR. It includes users being lost, or searching for a specific location within the museum. The target audience is aware of this concept during the field research, it was discovered that the concept would make life easier for users and the museums since it would allow easy access to the information based on exhibitions.

A.2 Scope

This project will include creating an AR application for people to get an enjoyable journey in the museum. The project will be completed by 29 April 2019. The AR application will include simple navigation system to direct various part of the museum. Getting information on the user screen using the user's camera, and explore various museum using the app.

A.3 System Overview

The application will perform all the basic tasks to help users with their journey in the museum. Such as navigating from point A to B, getting the user back on track in case they are lost, allowing the user to view information based on camera recognition of an exhibit.

A.4 References

This specification should be read in conjunction with the following publications:
IEEE 24765-2017 - ISO/IEC/IEEE International Standard - Systems and software engineering–Vocabulary [10]

IEEE Std 29148-2011, ISO/IEC/IEEE International Standard - Systems and software engineering – Life cycle processes –Requirements engineering [13]
IEEE Std 730-2014, IEEE Standard for Software Quality Assurance Processes [14]
IEEE Std 24748-4-2016 - ISO/IEC/IEEE International Standard for Systems and Software Engineering – Life Cycle Management – Part 4: Systems Engineering Planning [15]

A.5 Definitions

Activity: A set of cohesive tasks of a process, which transforms inputs into outputs. [ISO/IEC/IEEE 12207:2008]

Augmented reality: A technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view.

Functional requirement: A requirement that specifies a function that a system or system component must perform [ISO/IEC/IEEE 24765:2010]

Non-functional requirement: The measurable criterion that identifies a quality attribute of a function or how well a functional requirement must be accomplished. A non-functional requirement is always an attribute of a functional requirement. [ISO/IEC/IEEE 730:2014]

Performance: Degree to which a system or component accomplishes its designated functions within given constraints, such as speed, accuracy, or memory usage. [ISO/IEC/IEEE 24765:2017]

Stakeholder: Individual or organization having a right, share, claim or interest in a system or in its possession of characteristics that meet their need and expectations [ISO/IEC/IEEE 15288:2015]

Usability: Extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use. [ISO/IEC/IEEE 25064:2013]

User: Individual or group that interacts with a system or benefits from a system during its ultilisation [ISO/IEC 25010:2011]

A.6 Use Cases

The use cases have been defined as follows:

1. Use Case Model
2. Activity Model

3. User & Acceptance Stories
   (a) In Exhibit going from A to B
   (b) Getting information from an exhibition
   (c) Exploring the museum
   (d) User get lost in the museum

A.6.1 Use Case Model

Two scenarios have been taken into account, where the user gets lost in the museum, and the user wants to explore the museum.

When a user is lost, they need to enter their destination where the app will receive their current location, and find the quickest route from the user's current position. The user follows that navigation until they arrive at their destination. For the exploration, the app will show the details where user know what they going to see in the museum.

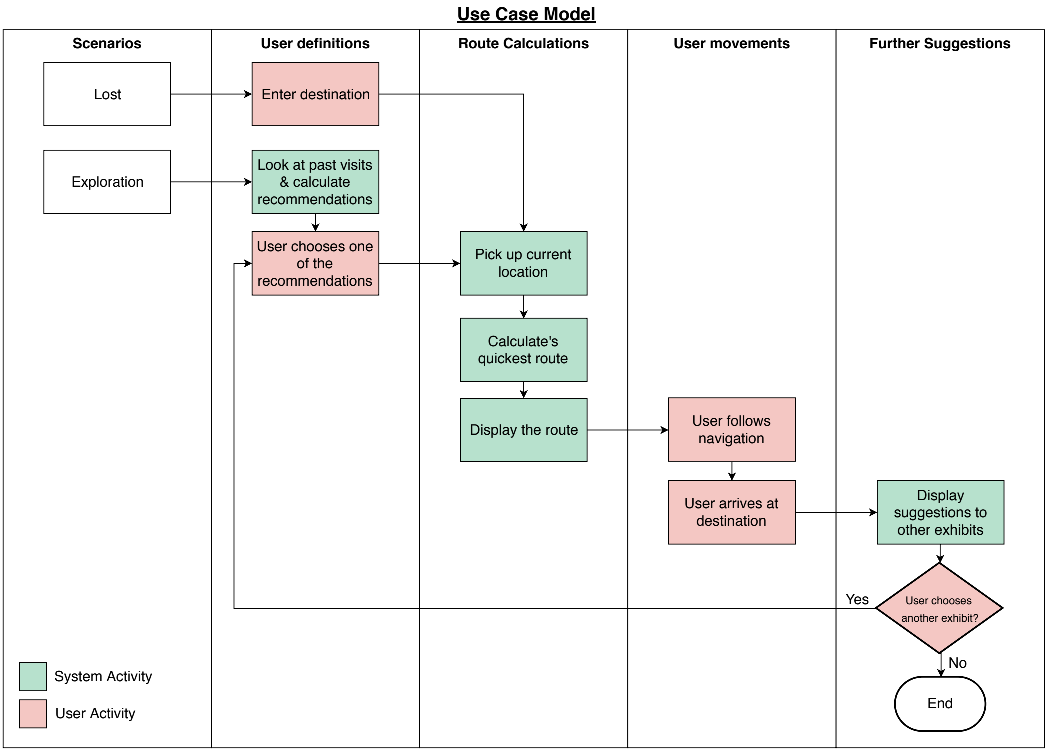


Figure A.1: Use Case Diagram

A.6.2 Activity Model

This is based on the back-end of the application for example when the user searches about the museum, this history saved in the server where if the user wants to go to the same place then they can use our function called past visit.

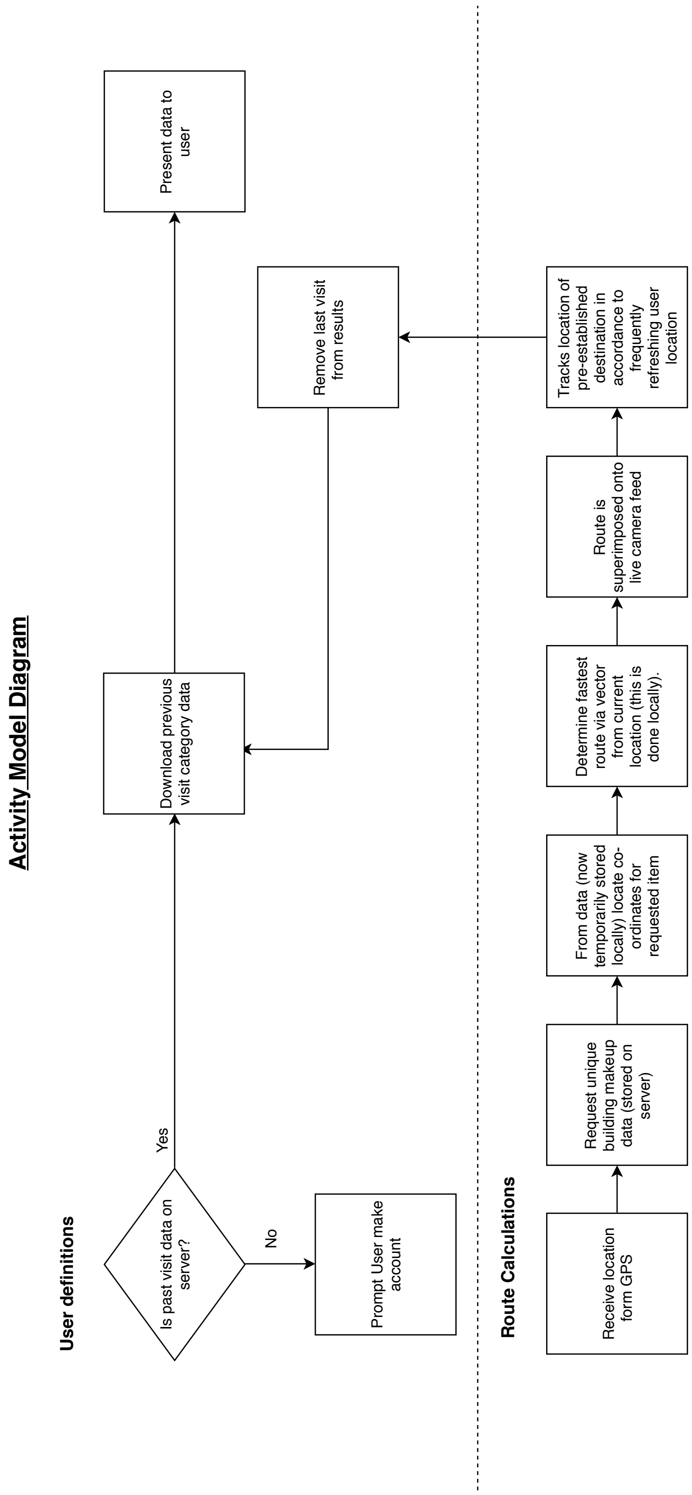


Figure A.2: Activity Model Diagram

A.6.3 User & Acceptance Stories

This will describe what will be achieved once the application is ready to be used by the user. A diagram has been created based on different scenarios where it can be found if the application has achieved the user needs.

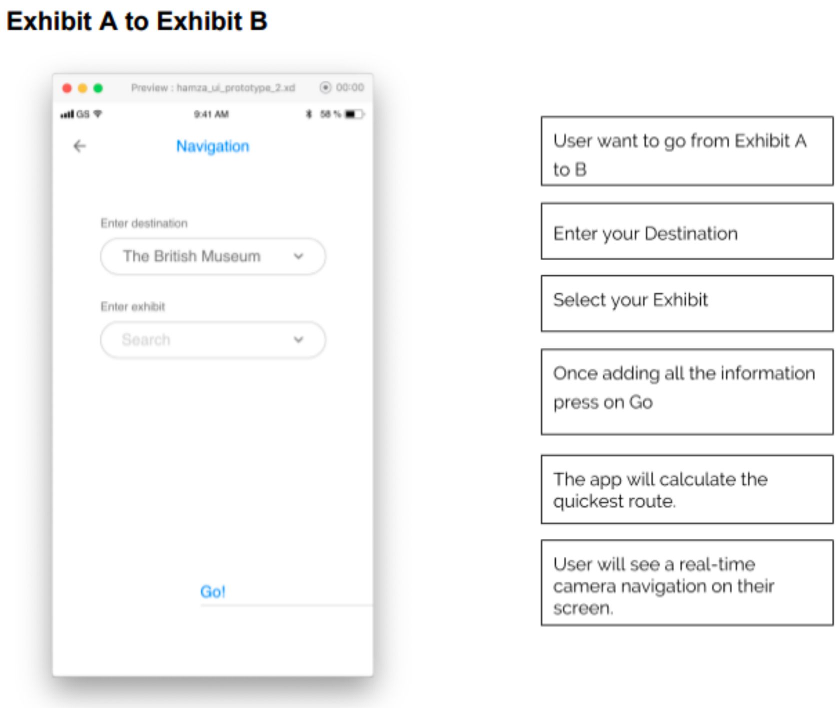


Figure A.3: Going from point A to point B

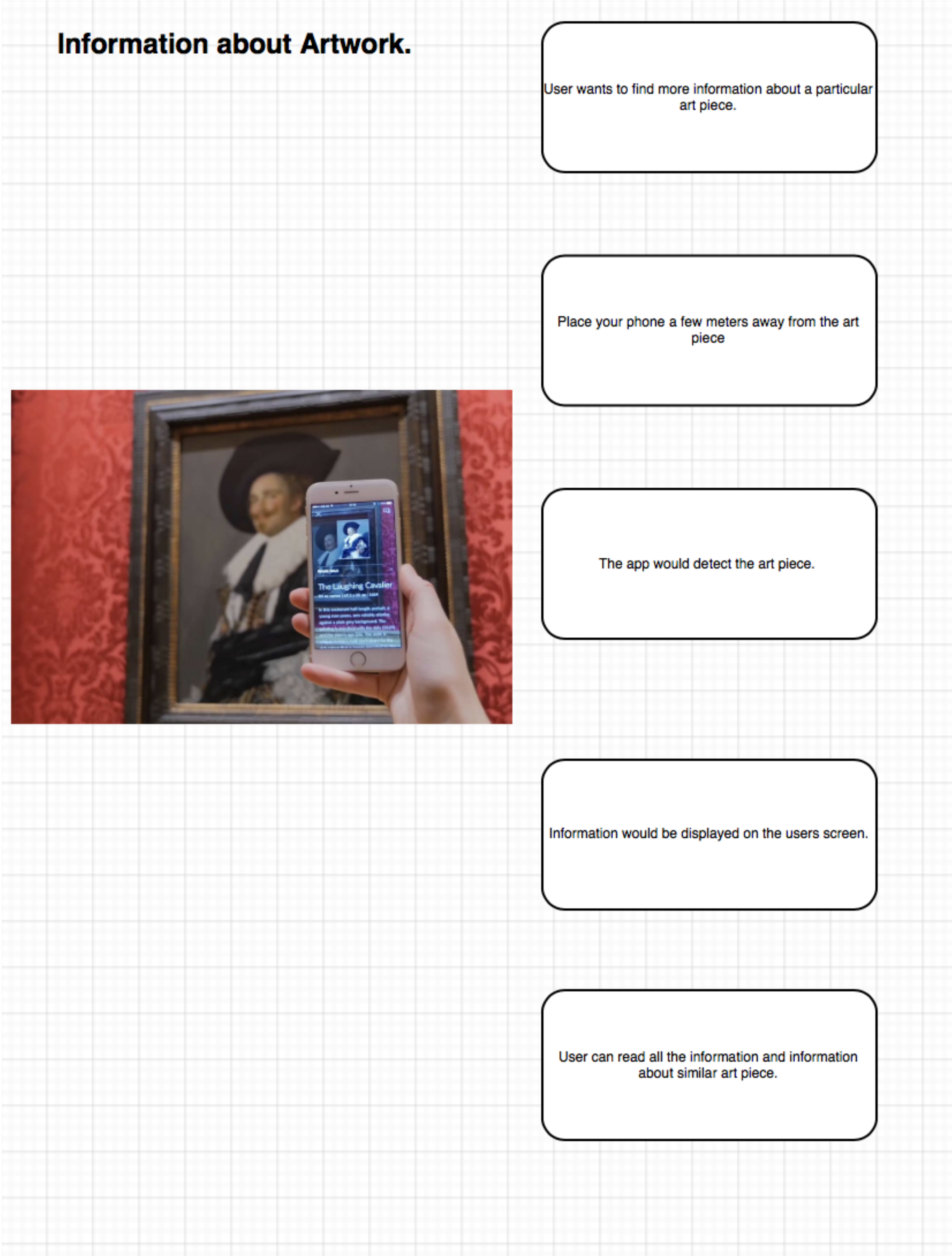


Figure A.4: Getting information from exhibition

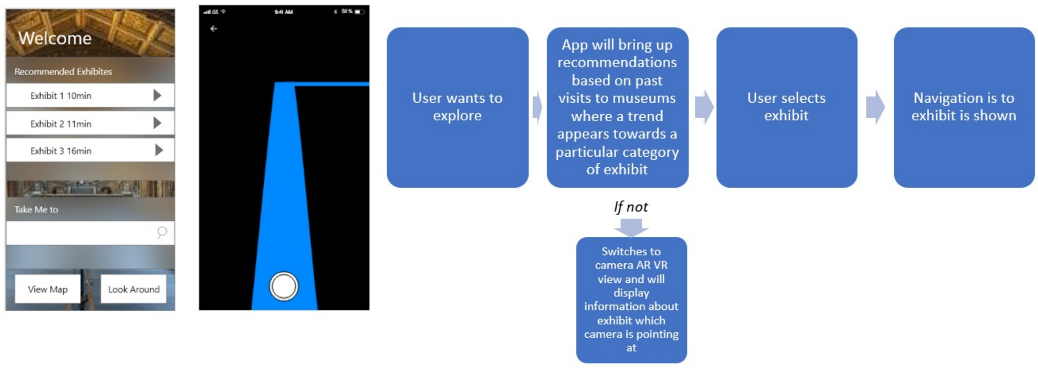


Figure A.5: Exploring the museum

A.7 Functional requirements

1. Needs to be able to navigate the user from point A to B.
2. The system should be able to display navigational routes in real-time.
3. It should be able to calculate the quickest route.
4. A 3D line should be superimposed to display navigation route to the user's destination.
5. Camera recognition on artwork/exhibits, displaying further information about the exhibit.
6. When user arrives at destination, the system should give a recommendation based on their route.

A.8 Non-functional requirements

1. **Performance**: The system should respond quickly to user input, e.g user wants to find more information about an art piece or whenever they search up a location. The system should not require extensive CPU usage, it should not slow the device down inconveniencing the user.
2. **Usability**: The system should have a simple layout, with appropriate colour used in appropriate contexts. The language used on the app should be easy to understand for the users. Having done research based on the user preference, it was discovered that users dislike too much text on their menu screen.
3. **Data Usage**: Data usage should be kept to a minimum, only querying the relevant information (user location and exhibit information). Also, the app would require internet connection in order to calculate the real-time distance of the final destination from the user's current location.

4. **Safety:**

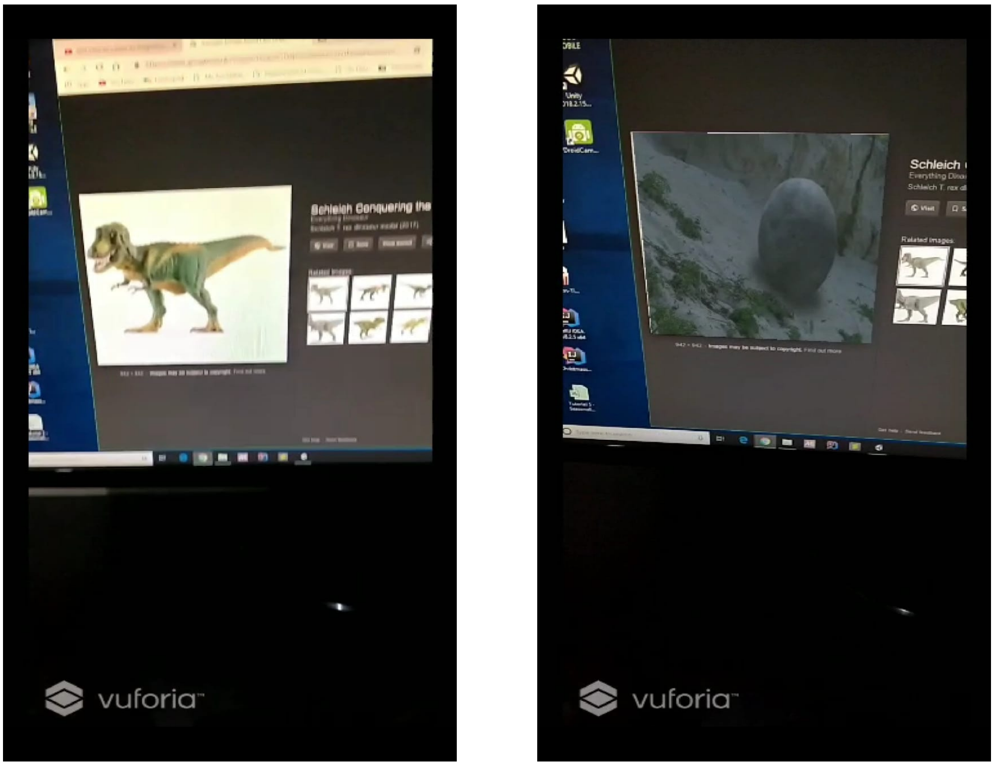
Appendix B

Figures

B.1 Prototyping

B.1.1 AR Prototypes

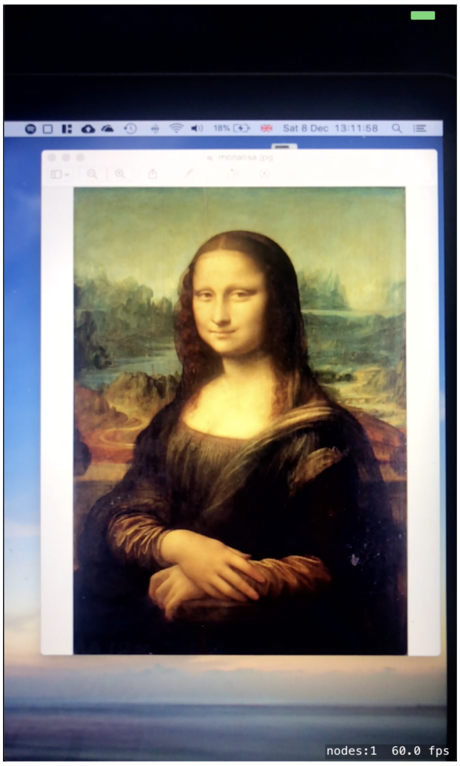
Vulforia



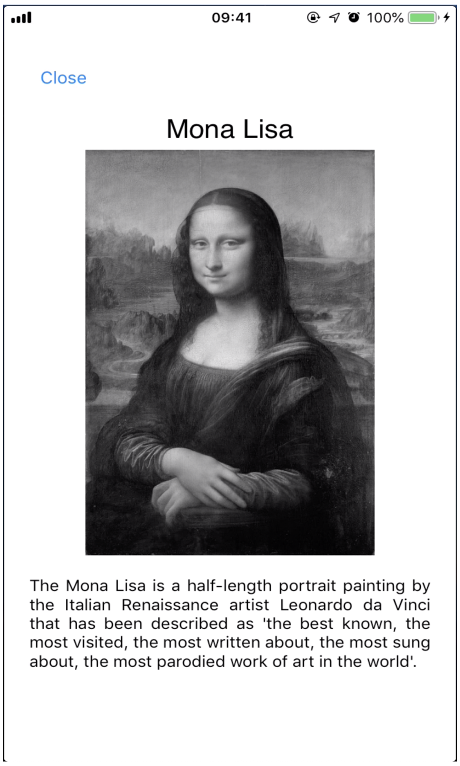
(a) Camera over image (b) Video superimposed on top of image

Figure B.1: Vulforia prototyping on Android device

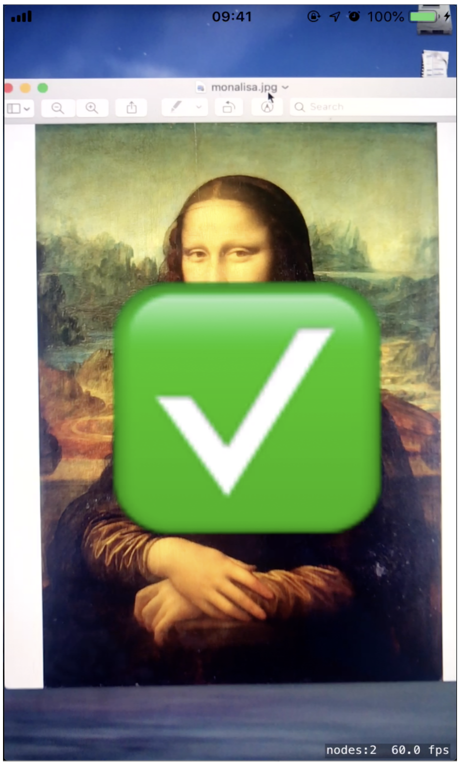
ARKit



(a) Camera over image



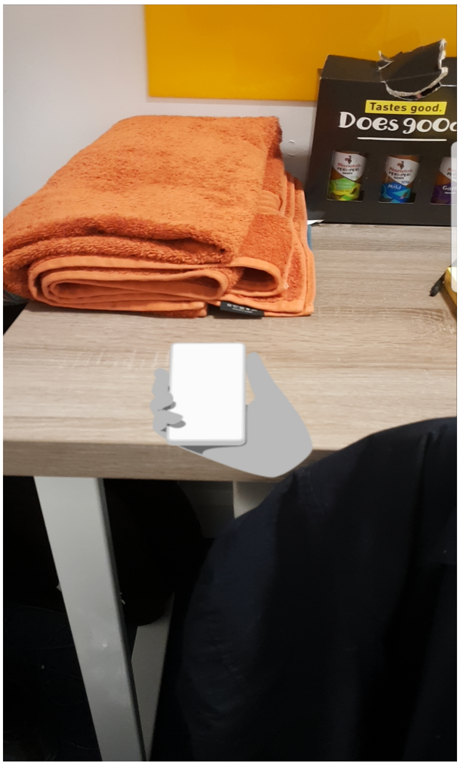
(b) Image recognised and displaying information



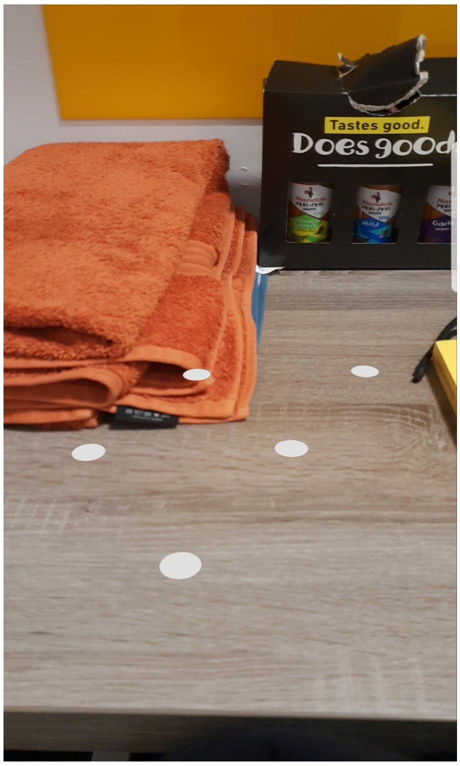
(c) Image scanned before; showing the green tick

Figure B.2: ARKit prototyping on iOS device

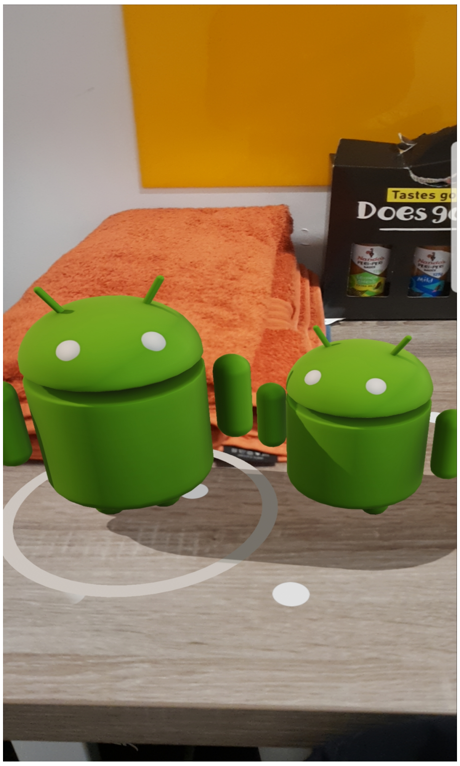
ARCore



(a) Initial view



(b) Detection of surface



(c) Objects superimposed on surface

Figure B.3: ARCore prototyping on Android device

Android Sensors Logging

File - unknown

```
12-09 21:27:37.766 22767-22767/sp14.androidsensors I/MyActivity: Sensors & GPS - Longitude: -0.233472 Latitude : 51.5864779
12-09 21:27:37.896 22767-22767/sp14.androidsensors I/MyActivity: Sensors & GPS - Accelerometer: X: 0.15203181 Y:-0.006584055 Z: 10.422559
12-09 21:27:37.896 22767-22767/sp14.androidsensors I/MyActivity: Sensors & GPS - Gyroscope: X: 0.0077231675 Y:-0.013848438 Z: -0.0018642128
12-09 21:27:38.016 22767-22767/sp14.androidsensors I/MyActivity: Sensors & GPS - Accelerometer: X: 0.16579847 Y:-0.021547815 Z: 10.41777
12-09 21:27:38.016 22767-22767/sp14.androidsensors I/MyActivity: Sensors & GPS - Magnetometer: X: -32.58 Y:22.68 Z: -7.38
12-09 21:27:38.016 22767-22767/sp14.androidsensors I/MyActivity: Sensors & GPS - Gyroscope: X: 0.005060006 Y:-0.010652645 Z: -0.0018642128
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12-09 21:27:38.556 22767-22767/sp14.androidsensors I/MyActivity: Sensors & GPS - Magnetometer: X: -22.14 Y:17.22 Z: -14.7
12-09 21:27:38.556 22767-22767/sp14.androidsensors I/MyActivity: Sensors & GPS - Gyroscope: X: 0.004261058 Y:-0.010918961 Z: -0.0026631611
12-09 21:27:38.736 22767-22767/sp14.androidsensors I/MyActivity: Sensors & GPS - Accelerometer: X: 0.142455 Y:-0.019752163 Z: 10.431537
12-09 21:27:38.746 22767-22767/sp14.androidsensors I/MyActivity: Sensors & GPS - Magnetometer: X: -18.66 Y:15.42
```

Page 1 of 24

Figure B.4: GPS, accelerometer, magnometer, and gyroscope sensor data from an Android device over 1 second period

B.1.2 UI/UX Prototypes

Storyboard

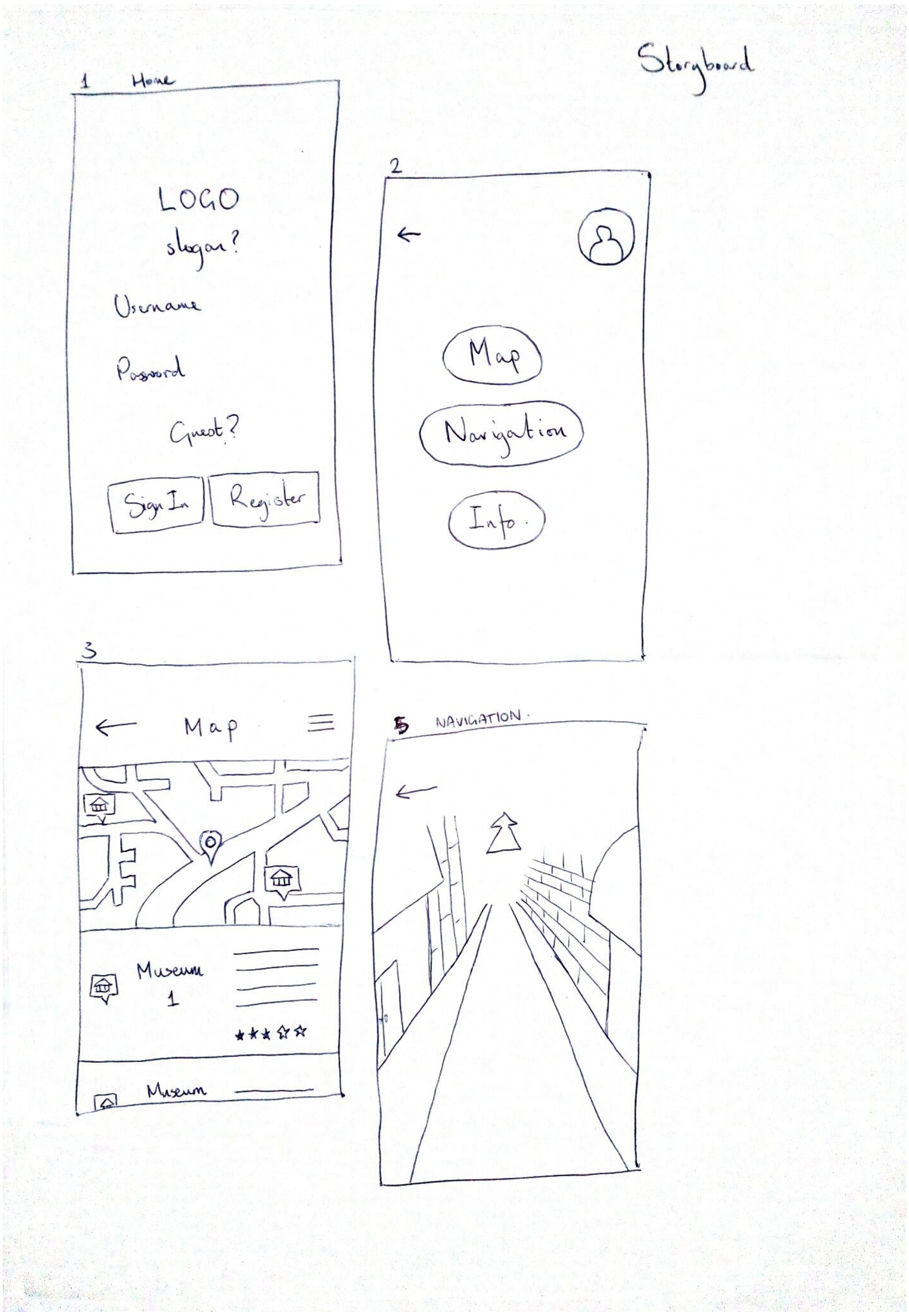
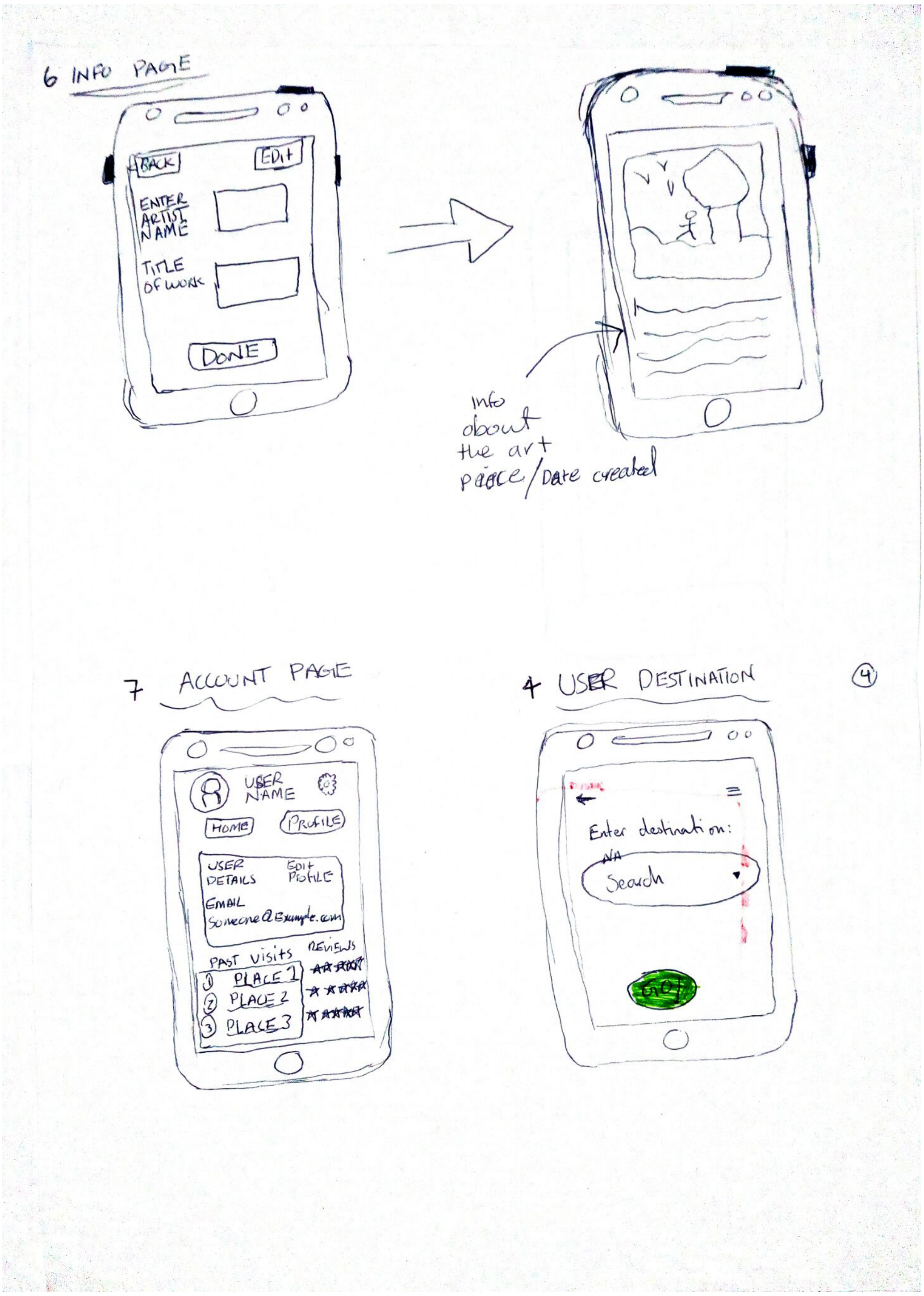


Figure B.5: Storyboard UI Drawings


6 INFO PAGE
BACK
EDIT
ENTER ARTIST NAME
TITLE OF WORK
DONE
Info about the art piece/Date created
7 ACCOUNT PAGE
USER NAME
HOME
PROFILE
USER DETAILS
EDIT PROFILE
EMAIL
Someone@Example.com
PAST visits
REVIEWS
1 PLACE 1
2 PLACE 2
3 PLACE 3
4 USER DESTINATION
4
Enter destination:
Search
GO!

1 HOME PAGE

Upon loading the application, the user is faced with the homepage. This page will allow/request the user to input/login with their email/username or continue as a guest.

2 SERVICE SELECTION.

Once the user has successfully signed in to the application, they can select the service they wish to utilise. Which can either be a map of their current location detailing nearest museums/exhibitions, the navigation feature* which navigates the user to their desired destination (a museum or exhibition) and finally an "info" page which the user can find out further information about a specific exhibit.

* The navigation will take the user to the "user destination" page (4).

Figure B.6: Storyboard UI Descriptions

3 MAP.

This page will show the user their current location and also the whereabouts of surrounding museums / exhibitions. This page will have a map.

5 NAVIGATION.

This will load the camera and include ~~an~~ a directive arrow leading the user to their desired destination.

6 INFO PAGE

The information page on the app allows users to enter the details of a specific artist and their work. This allows the app to calculate and workout the exact piece of work.

Once the details have been entered, the app will move on to the next page where the art work would displayed. As well as that, the information about the work would be written underneath. It would contain all the small details.

7 ACCOUNT PAGE

The account page contains all the information about the user such as their name, email address and past visits. On the same page, the reviews of each and every place would be displayed and the app would allow you to edit any information which you wish to change.

4 USER DESTINATION

The user destination page is in the page in order to allow the user to enter their given destination. Also, this page has a search bar, and a dropdown menu which allows the user to search and look for other nearest museums. Once the user is happy they can then press the 'Go!' button.

Prototype 1

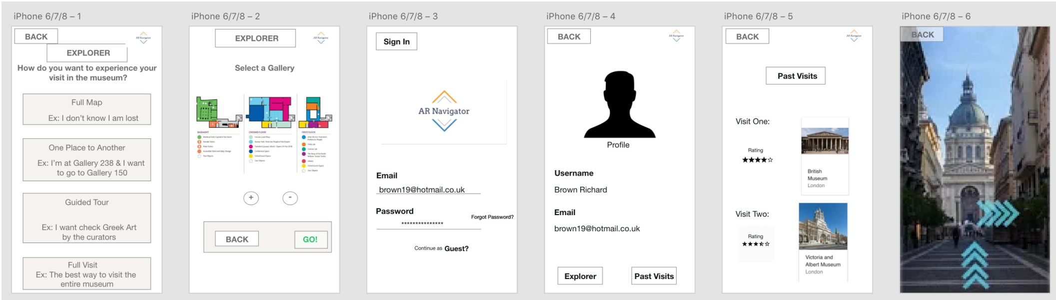


Figure B.7: Overview of UI Prototype 1

Prototype 2

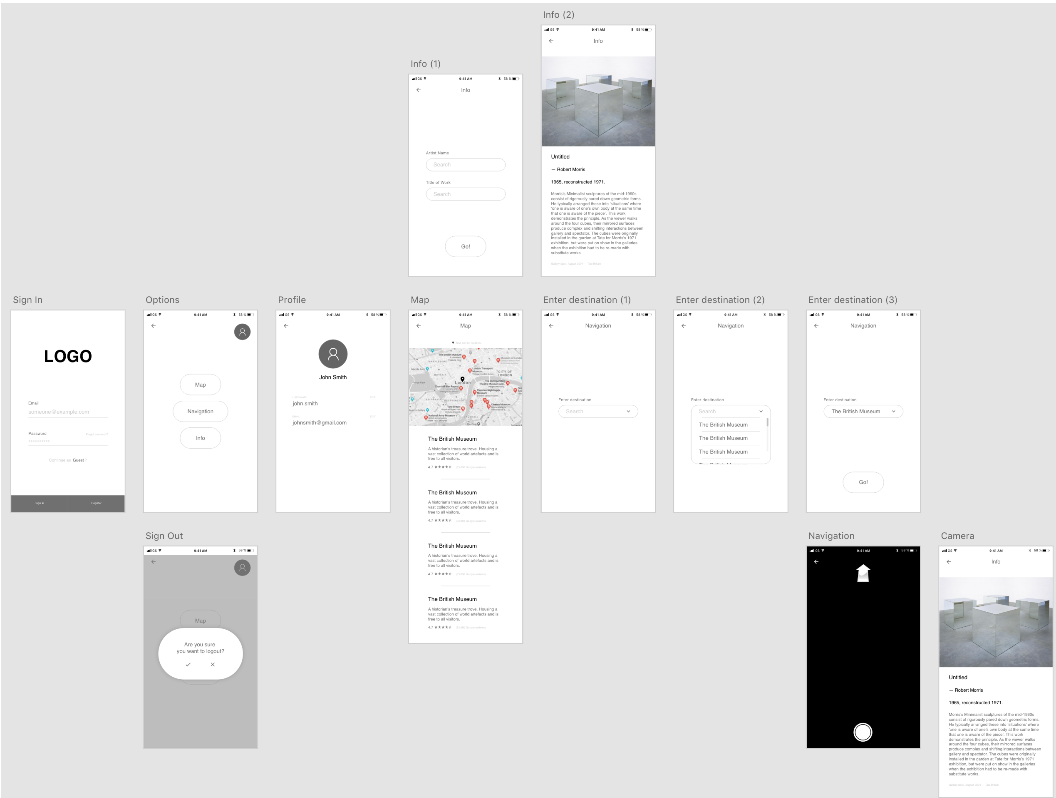


Figure B.8: Overview of UI Prototype 2

Prototype 3

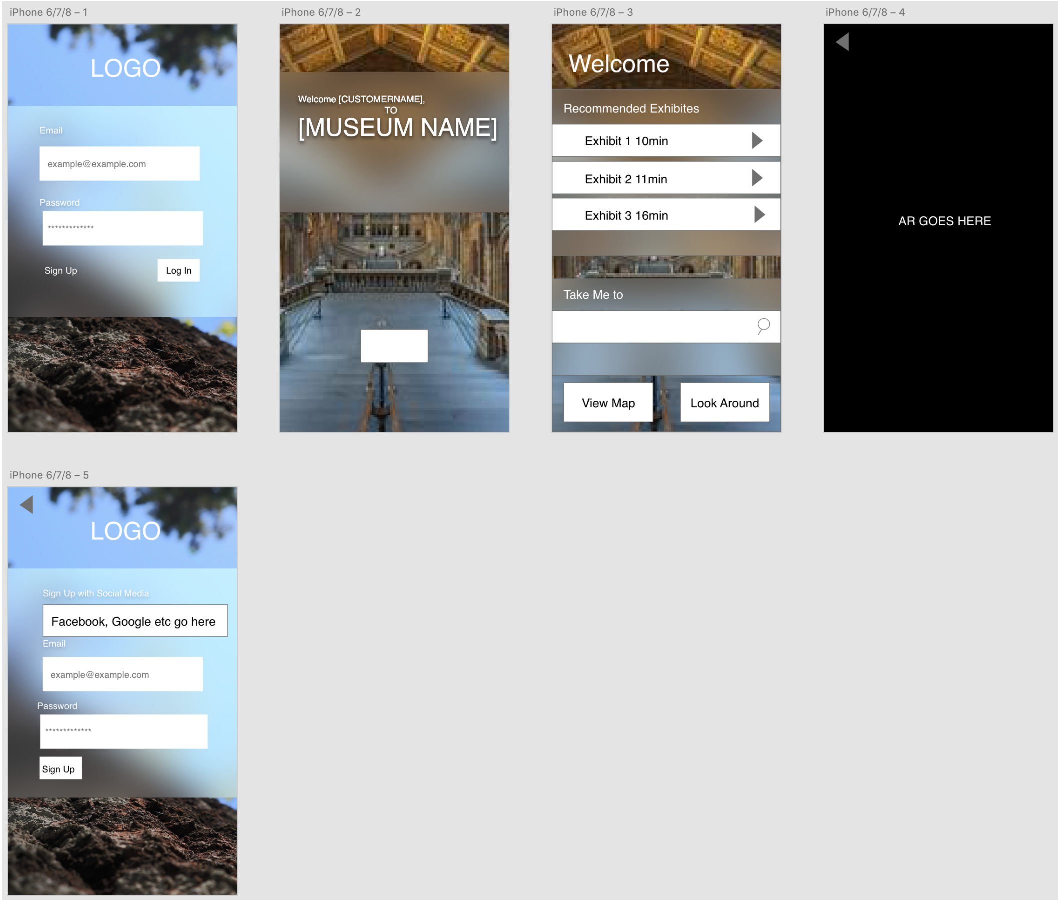


Figure B.9: Overview of UI Prototype 3

Final Prototype

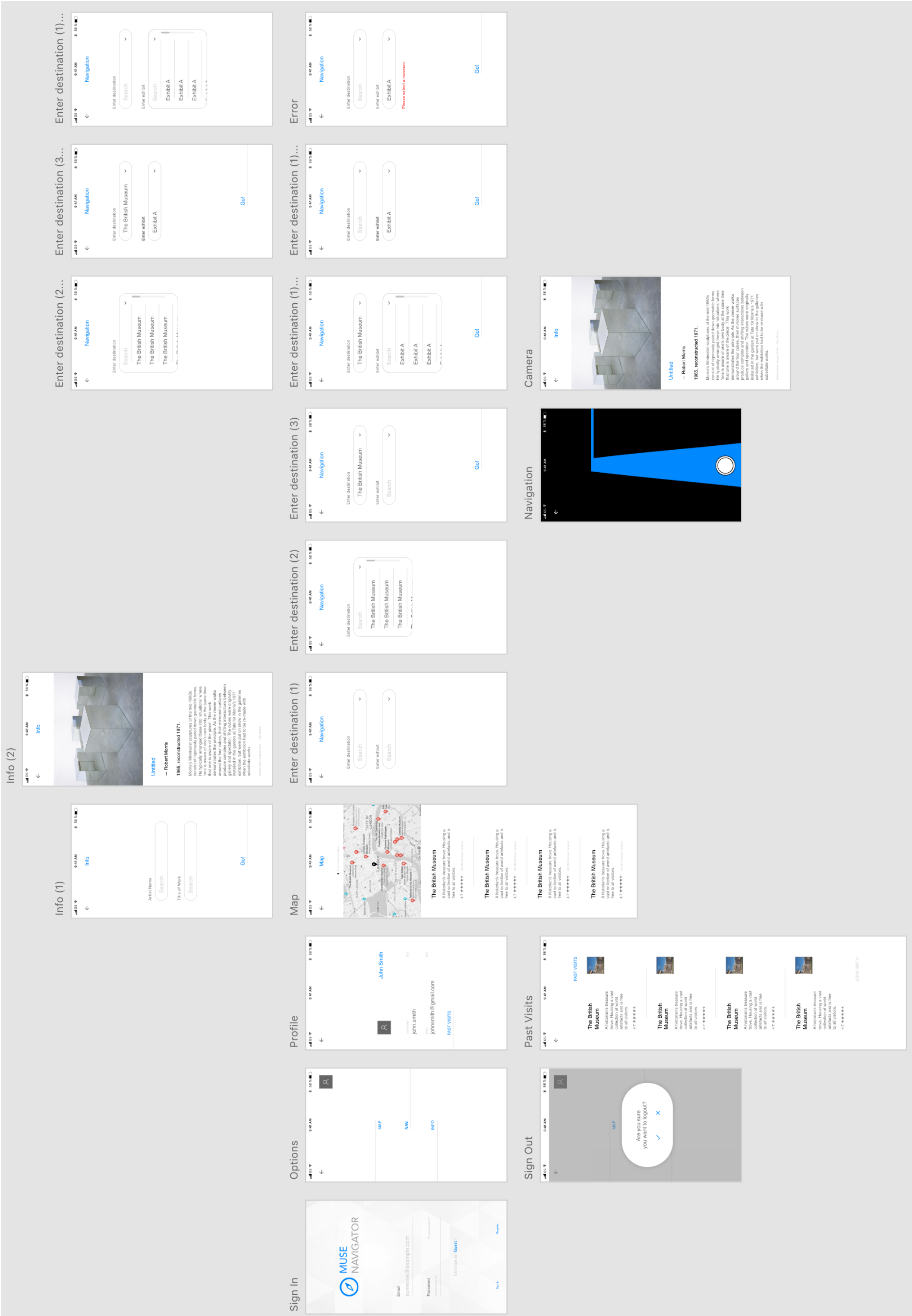
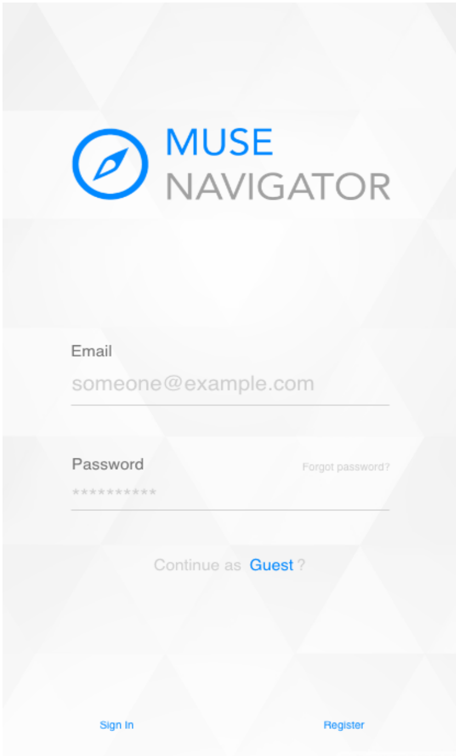
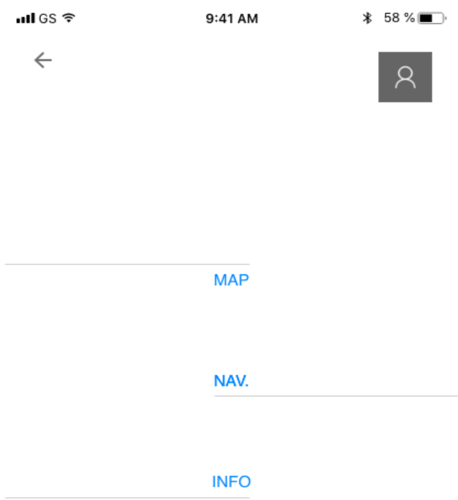


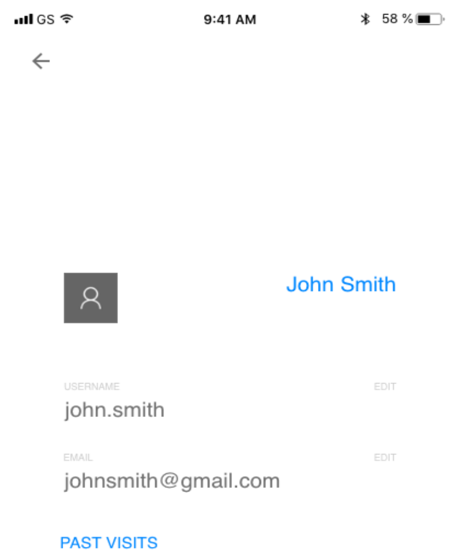
Figure B.10: Overview of final UI prototype



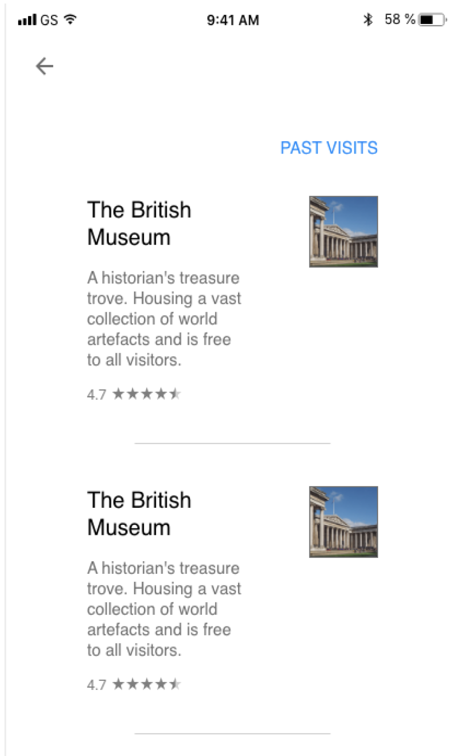
(a) Sign in



(b) Options

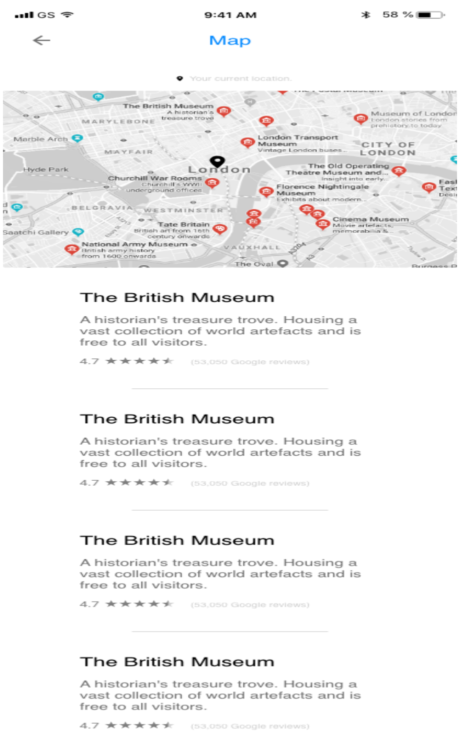


(c) Profile

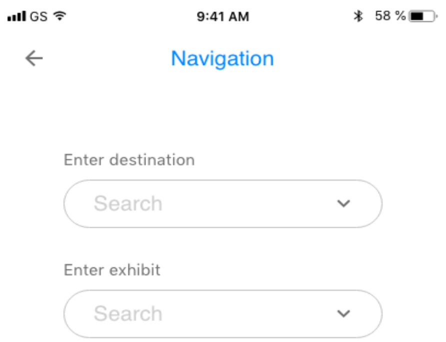


(d) Past visits

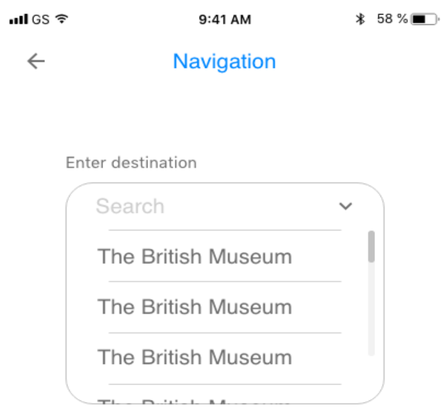
Figure B.11: Final UI Designs of App



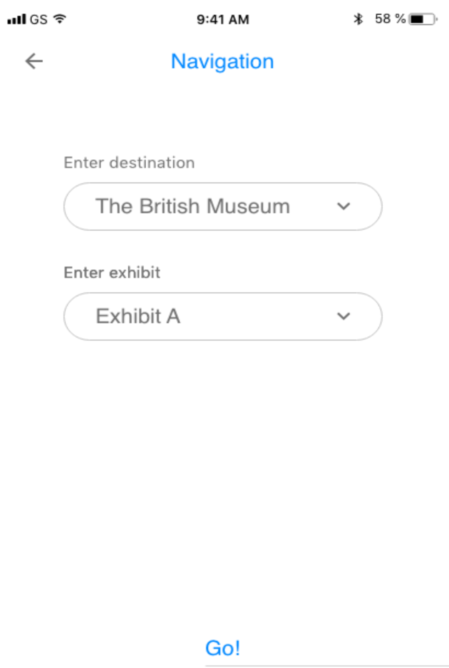
(e) Map of museums



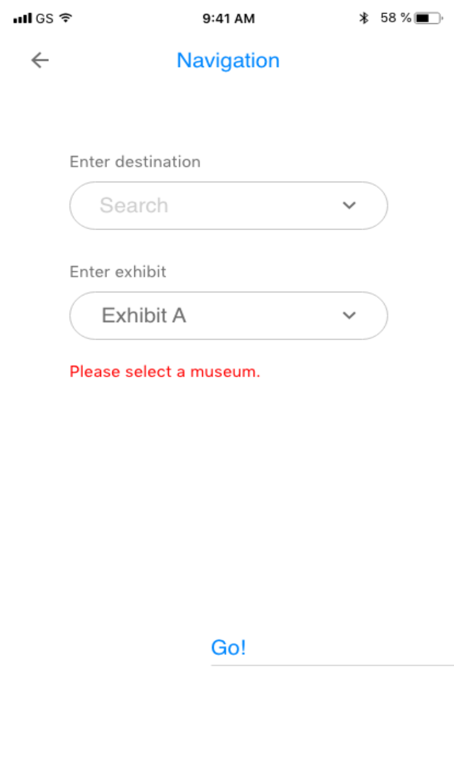
(f) Destination



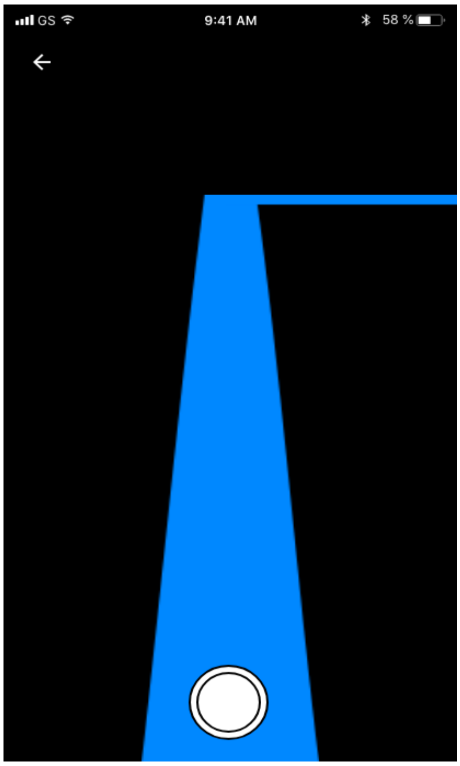
(g) Destination Dropdown



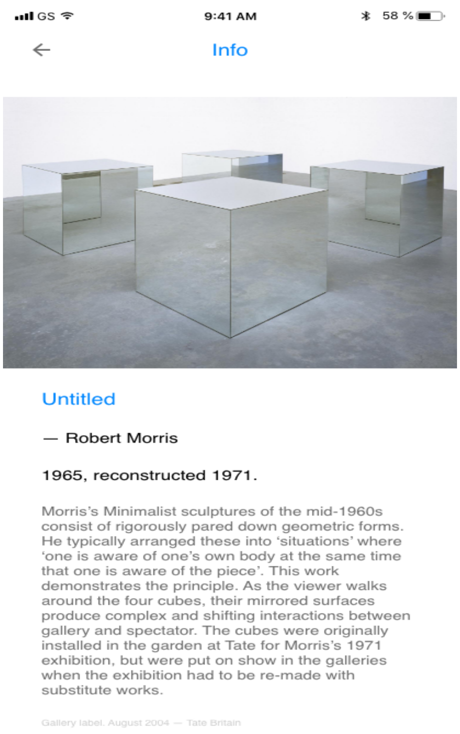
(h) Filled



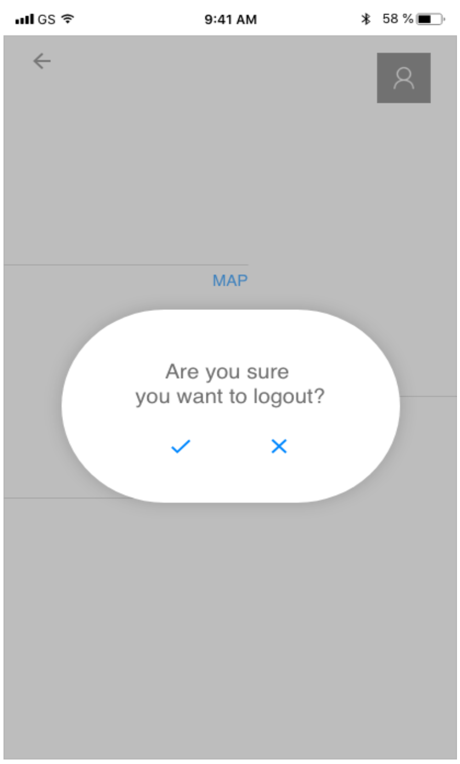
(i) Error message



(j) AR Navigation



(k) Artwork description



(l) Sign out

B.2 Technical Architecture

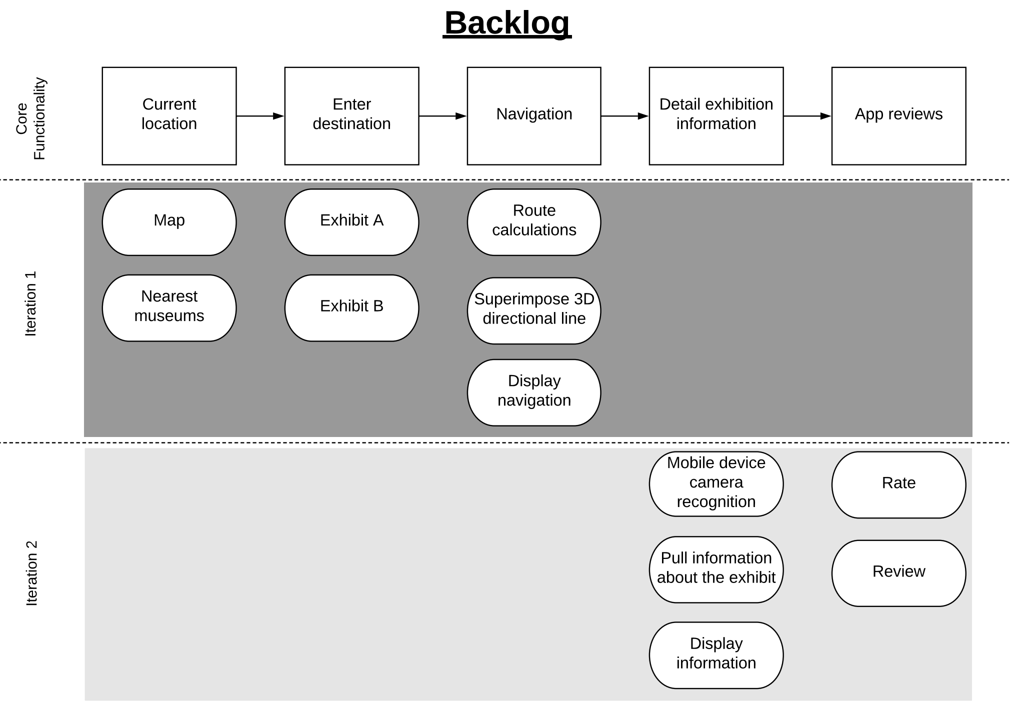


Figure B.12: Backlog Diagram

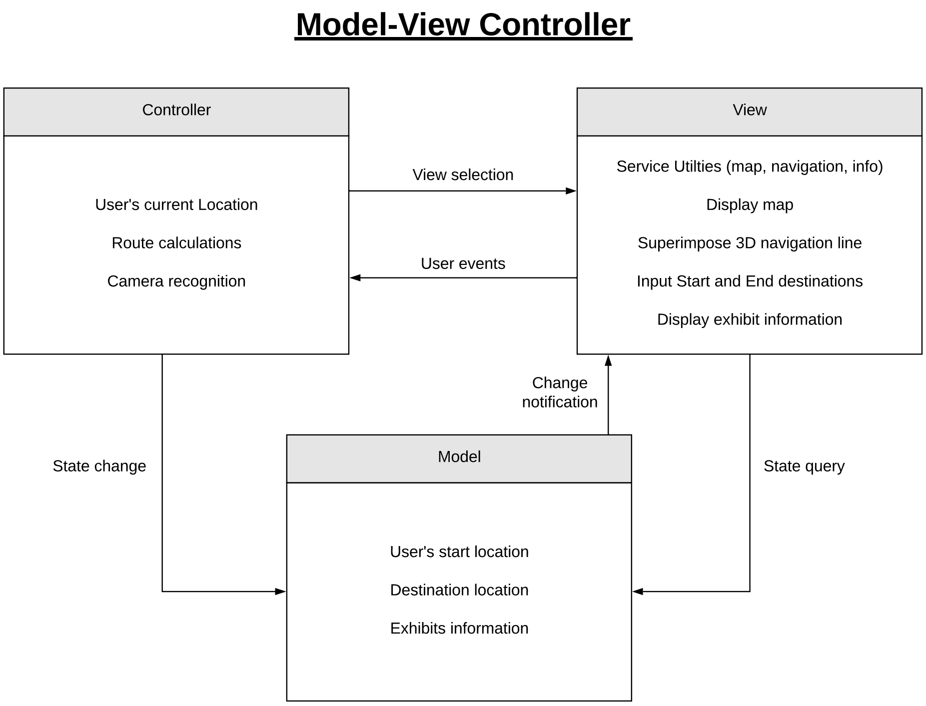


Figure B.13: Model-View Controller Diagram

Appendix C

Prototype Reviews

Prototype 1

This prototype again is very plain but this is made to look it as it looks more professional and although the prototype has a lot of buttons, this greatly considers the end user and what things we would want to do on the application making the potential of it greater. The search function and the map feature makes it a lot more personal to the user with potential options that they may select. Overall, because it considers the user more, this type of format at least should be used in the final version. One suggestion would be to maybe include colour as well as improve the logo because it is not very clear what the application is from looking at this, so have a logo to reflect this. The separate page for the use of AR is very good but one concern is how the the app will detect will where the user is or whether they can use the AR feature anywhere even without visiting the museum.

Prototype 2

The prototype at first glance looks very plain and with not much information or scope for the user to explore the app and seems very limited. One of the key things which could improve the app is simply to add colour to make it more appealing and engaging to users. Also, it is not very clear what the application is used for and how it can improve the existing method of visiting a museum - which I now know what the app's purpose is - where a visitor can just have a guided tour from an expert or even an auditory tour. Certain features of the prototype were good such as the search feature and the clarity making the app user-friendly. As well as this, the fact that the app shows the closest museum to the input given is very helpful, showing the rating given by visitors making easier to choose which museum to visit. The fact that it also has logout confirmation page and a page showing the users account where they can add favourite museums and add ratings and reviews gives other users better choice where they can make a more informed decision.

Prototype 3

The prototype is quite plain at first glance although the use of colour through the background is good. It is more appealing and engaging. However, use of the application seems very basic and limited with little function. The prototype consists mainly of buttons and doesn't allow much user input, that being said, the search function is a good addition. Overall, this prototype is very limited and use of the prototype 2 should be used over this one.

Appendix D

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

- Submission of 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

- Submission of 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

- Updating project tracking form
- Reviewing use sequence model
- Reviewing activity model
- Reviewing service model

Friday 26 October 2018

- Submission of 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
- Reviewing project tracking form

Friday 2 November 2018

- Showed our storyboard
- Submission of 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
- Updating project tracking form

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

Thursday 15 November 2018

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

Friday 16 November 2018

- Submission of 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

- Updating project tracking form
- Review final android prototype
- Review final UX/UI prototype

Friday 23 November 2018

- Submission of 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

- Updating project tracking form
- Reviewing backlog
- Reviewing open questions so far
- Reviewing design chapter

Friday 30 November 2018

- Submission of project tracking form
- Presentation of open questions
- Presentation of backlog
- Spoken about fuse comapany
- Progress of framework of technical architecture
- Finish user stories by next week
- Finish off technical architecture (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

- Updating project tracking form
- Reviewing written chapters of proposal
- Reviewing user stories
- Reviewing all technical architecture work

Friday 7 December 2018

- Submission of project tracking form
- Submission of technical architecture work
- Explanation about open questions, backlog, MVC and user stories
- One-to-one discussion for how things are going within the group
- Discussion about 5 minutes presentation which going to take place on Monday next week

Week 11 (10)

Monday 10 December 2018

- Reviewing Gantt chart
- Reviewing concept presentation notes
- Finishing systems requirements specification
- Creating Christmas plan
- Tidying up scrum board

Wednesday 12 December 2018

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

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