Outdoor Augmented Reality

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Contents

1 Introduction **4**
1.1 Brief of Project 4
1.2 Aims & Objectives 4
1.3 Functionality Developed 4
1.3.1 The Application 4
1.3.2 The API Server 4

2 Background Research **5**
2.1 Location Data & Augmented Reality 5
2.2 Google ARCore & Unity Technologies 5
2.3 Augmented Reality & Tourism 5

3 Implementation Details **6**
3.1 The Server 6
3.1.1 Location Updates 6
3.2 Location Service 6
3.3 Close Landmark Menu 6
3.4 Augmented Reality Mode 6
3.5 Other AR Techniques 7
3.5.1 Plane detection 7
3.5.2 Image Recognition & Augmented Images 7

4 Evaluation & Analysis **8**
4.1 Testing Performed 8
4.1.1 Landmarks AR Information Panel 8
4.1.2 Augmented Images 8
4.2 Potential Testing 8
4.2.1 Independent Variables 8
4.2.2 Dependent Variavles 9
4.2.3 Questionnaires 9

5 Conclusion **9**
5.1 Future Work 9

1 Introduction

1.1 Brief of Project

This project aims to delve into the effects of the exploitation of Augmented Reality Techniques on tourism and heritage.
A system is to be developed using Google's ARCore, enabling complex computer vision-based functions to be easily embedded within an andorid app.

1.2 Aims & Objectives

There are three main objectives to this project, which are to be explored and implemented to analyse the effects of their combination. Firstly, Augmented Reality is to be used and implemented in the setting of an outdoor environment, using several technologies provided by ARCore, we may explore different ways that this can be exploited for the best experience. This may even be combined with other sensory data such as the location for a better touch with reality. Secondly, an android application is to be developed, which will allow ease of use by most people, avoiding hurdles of installations and such. This application is to provide some method of direction to landmarks, and also incorporate the AR experience when appropriate. The application is to get information from a server, which will allow for a centralised and controlled method of managing landmarks, descriptions and their locations.

1.3 Functionality Developed

1.3.1 The Application

An android app was developed that the users can easily install and access. The app constantly uses the location service to consult the API server, providing the device's current location and retrieving a list of explorable landmarks. These landmarks are displayed on the application, as a list of potentially explorable landmarks, also giving a general bearing of where the 4user should head to reach the site.
When the user is within a (relatively small) proximity of a landmark (geofence defined server-side), the app enables a landmark to be selectable, which when selected, the device enters an AR mode.
When in AR mode, the user can get a floating 3D informational window that contains details about the landmark selected.

1.3.2 The API Server

The server is to contain a list of landmarks, including their names, locations, a description and maybe even a set of images. The server should allow a device to consult it with location-based information and a list of landmarks (within some proximity) is returned to the device, where the device uses the information given and lists them as potential landmarks to explore.

The landmark information is to be stored on the server, so anything can be easily changed by changing the configurations of the server, and the mobile apps simply obtain newer information, without needing to rebuild or update the applications. As this technology may be adopted to other uses, such as games, it would be really useful to be able to have an idea of where players are.

2 Background Research

2.1 Location Data & Augmented Reality

In modern smartphones, the GPS system is fast and accurate, especially for purposes of landmark geofencing, as utmost accuracy is not a requirement. The advancement in smartphone technologies also enable richer AR experiences, as higher quality experiences may be included with less concern with device processing power.

When these two technologies are combined, the experience is taken to another level, as the Augmented Reality experience can shift based on the device's real conditions and positioning. A level of immersion is reached, as users need to move and visit heritage sites in order to experience the Augmented Reality effects, and in return, they gain context and heritage information about the landmarks visited.

2.2 Google ARCore & Unity Technologies

Google ARCore framework greatly facilitates the implementation of AR experiences, without the need of reinventing everything from scratch. A simplified framework enables lower-cost projects, lower-qualified developers and faster integration of AR projects, providing a gateway to the mainstream acceptance of AR.

Unity 3D technologies combined with Google ARCore enhance the usability of ARCore, as developers are enabled to keep using existing, familiar tools to develop an Augmented Reality Experience.

2.3 Augmented Reality & Tourism

Augmented Reality has seen its success in the IT industry, as can be seen in []. However, according to [] in 2017, the potential of AR in the tourism domain is still not explored enough, and thus the envelope is still to be pushed for further integration.

3 Implementation Details

3.1 The Server

An api server was written in python, as due to the small scale of the application, this was ideal to meet the requirements whilst keeping the implementation simple enough. The server provides several endpoints which may be pinged, but only two particular endpoints are used.

3.1.1 Location Updates

The server keeps track of a list of active devices, (though a unique identifier provided on requests), and their last known location. The device regularly updates the sever wit lcoation infromation, and then requests nearby landmark data. The server loops through all landmarks, and calculates the distance between the device longitude and latitude positioning, and the landmark. If the distance is below some threshold, it is added to a list of potnetially explorable landmarks, which is returned as a JSON response to the device. Each landmark entry also contains a geofence region, which when is larger than the distance, the landmarks is considered near the user, and the device can knmow that the AR mode can be enabled.

3.2 Location Service

On the device, the location is updated every second, with an intended accuracy of 0.1 metres (usually not met, but we try to be as accurate as possible).
The integrated unity function is used, and a listener is used to check for updates, which update the server, and the landmarks list accordingly.

3.3 Close Landmark Menu

A scrolable list is used to show a list of the landmarks returned by the server. The title, a short description, the distance and the bearing is shown for each entry, so the user may have some basic location info. Whenever the landmarks is very close, the entry become interactable, and the user can press it to enter AR mode near the landmark.

3.4 Augmented Reality Mode

In this mode, the camera is shown to the user, and a 3D transluscnet floating window is spawned in 3D space. The user may move around the panel, and observe the panel stays locked in 3D space. The panel shows some deeper description about the near landmark. A carousel allows the userto see some images of the place (as provided through the API).

3.5 Other AR Techniques

A couple of other Augmented Reality techniques were explored during the development of this app. These tecniques were implemented and worked really well as sandalone, yet when combining the features the standalone applications do not have an yuses, and thus there is no way of using them.

3.5.1 Plane detection

Although raw plane detection was not used in the final version, under the hood google uses it to keep the floating infromation panel in place. Through goggle's AR Core it is made possible to detect vertical and horizontal planes, to which other game opbjects can be anchored to!

In an example, plane detection was used to find a stable surface, and when the user clicks on a plane, a 3D Game model is spawned in place, and anchored to the plabe. The user is also to walk around in the room, whilst the objects stays anchored to plane!

3.5.2 Image Recognition & Augmented Images

Image Recognition was also a really interesting feature to use. In this projects case, a quick database manager was created in which a list of images could be inserted. And actions would be taken according to the image detected!

In an example, an image of the earth was used as a key, and when this image is detected, a 3D spinning globe would be overlayed on it, where the user is able to go around the globe! This may have been abnle to implemented in the app, yet as the landmark menu and the ARMode switching works, It did not have much room to be used. (As in the near landmark menu, there is not access to the camera), and the user may only use AR Mode when near a landmark. However, this feature is also fully working, and may easily be implemented if a better use is identified.

4 Evaluation & Analysis

Due to the domain of this project and the technologies adopted, it was not as straightforward to test the raw performance of the system. As there is no performance metric or such that can be analysed and compares to other instances.

$https://ieeexplore-ieee-org.ejournals.um.edu.mt/stamp/stamp.jsp?tp=\&arnumber=8120326$

4.1 Testing Performed

4.1.1 Landmarks AR Information Panel

After finalizing the system (application and server), testing took place in the real locations of the landmarks. Through this on-site testing an idea of how the application performs was obtained.
Since the floating information panel stays in place using plane detection and sensory data, care was given to push the limits of these technologies. Plane detection struggles when there are no close discernable attributes (the floor has a regular pattern for example), which the tests have shown that also effects the stability of the position of the panel.

4.1.2 Augmented Images

As augmented images were implemented (yet mever used) some basic testing was also involved, which turned out to be quite succesful. The image was recognized from different angles and light settings whilst tracking also was really responsive to even moving the image.
Further testing is shown in the video, as it's the easiest way to show off the experience.

4.2 Potential Testing

Three key points mentioned in

$https://ieeexplore-ieee-org.ejournals.um.edu.mt/stamp/stamp.jsp?tp=\&arnumber=8120326$

may be used to give a more formal idea of the performance of such sustems.

4.2.1 Independent Variables

The variation of independant variables can be used as a perfomance metric and help analyse the experience of the user, these variables include things which are not varied by the user during the test. Examples of such variables include the device size and the field of view of a device's camera.

4.2.2 Dependent Variavles

These variables give a robust metric of how the users react to the application presented, such as the number of attempts taken to carry out an action. Yet this is very application specific, and does not allow for comparison between other systems, as tasks in an application usually are specific to it.

4.2.3 Questionnaires

Questionnaires were mentioned as another performance metric, which allows a subjective metric. In applciations such as the tourism domain this is of utmost importance, as it follows that from the user-centric nature, the ultimate goal is the users' experience.

5 Conclusion

In this project, I managed to meet the intended aims and objectives and during the process also obtained hands-on experience of using the latest technologies to apply the theories learnt into practice. Augmented Reality and computer vision as a domain also turned out to be very rewarding, as the effort done is immediately reflected into tangible progress.

5.1 Future Work

During development, it was made sure to keep the system as open as possible. Through the centralised API, unity engine and other technologies used, the system is meant to be dynamic and expandable.
With minimal effort, it can be easily be adapted to different uses such as an AR game, using google APIs for international standardized locations or even showing 3D models in AR mode.

References