# Implementation of an Augmented Reality-based Tour Guide Application in Cloud

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***Abstract***: Augmented reality applications are gaining popularity in recent times. Also, due to the pandemic, many industries have digital services and so augmented reality can be used to enhance the digital user experience of clients and customers across industries. One of the many industries in which augmented reality can be applied is the tourism industry. In this study, a way to completely digitize the touring experience is proposed. The application which has been developed will allow users to view 3D models of tourist spots, listen to historical facts about the tourist spots and view information about the spots and stored in cloud. The application was demonstrated to a wide variety of audiences and feedback was received from them. The application uses surface tracking and image tracking. Several tools such as Unity 3D Game Engine, MagicaVoxel, EasyAR Software Development Kit, Mixamo, Adobe Premiere Pro, Figma, C# programming language and Aseprite were used to create this application.

***Keywords:*** *Unity 3D Game Engine, Augmented Reality, Tourism, Tour Guides, Tourist Spots*

## I. INTRODUCTION

Augmented reality has made its way into many mobile applications. Some mobile applications are solely based on AR whereas some applications have certain features that use AR and others that don't. So, creating an application solely based on AR can prove to be immensely positive in terms of growth of the application. Moreover, AR technology can be used in many industries and one such industry is the tourism industry [1]. And so, we propose an application that will provide information about tourist spots once the image of the tourist spot is scanned through the application [2]. The application will also allow users to look at the 3D models of the tourist spots, resize the tourist spots and move the tourist spots around their physical space. Furthermore, users can listen to tour guides that explain about the significance of each tourist spot [3]. We created this application for European tourist spots and thus we named the application – Eutouria. The application provides the above-mentioned services for fictional tourist spots, famous tourist spots and damaged tourist spots [4]. This is helpful because people cannot actually visit fictional tourist spots because they do not exist in the real world. Also, people cannot actually visit damaged tourist spots because even they do not exist in the current world as they have been destroyed in the past during wars or natural calamities. Also, famous tourist spots are located in exotic regions which are expensive to visit. So, this application will bring the tourist spots to the people instead of people going to the tourist spots. We used the C# scripting language to make this app. We used MagicaVoxel to create the 3D models of the tourist spots and tour guides. Also, Aseprite was used to make 2D graphics of the tourist spots. Mixamo was used to animate the tour guides.

The information given by the tour guides was recorded by actual humans using a recording application available on android phones. These recordings were then edited using Adobe

Premiere Pro to enhance the sound quality. The integrated development environment used was the Unity 3D Game Engine. We used EasyAR SDK to implement surface tracking and image tracking [5]. The tour guide feature and tourist spots feature use surface tracking. The spots info feature uses image tracking. Figma was used to create the UI designs for the app [6]. So, in this app, people are able to engage in 3 different modes: listening to tour guides, viewing tourist spots and gathering information about such spots [7]. Image tracking application is done where an image of a tourist spot is scanned through the application and then information about the tourist spot is augmented on top of the image. These images are known as image targets and image tracking is also known as marker-based AR or target tracking. Surface tracking is done in which the user first selects the feature they want to use – tour guide or tourist spot, then they have to choose the type of tourist spot - fictional tourist spot, famous tourist spot or damaged tourist spot and then they have to choose the specific tourist spot that they want to view or know about and finally, if they selected the tour guide feature, a tour guide appears on the surface visible through the camera of the mobile phone used by the user and the tour guide starts talking about the tourist spot chosen by the user, note that by tour guide we mean a virtual 3D model of a tour guide. Alternatively, if the user selected the tourist spot feature, the tourist spot appears on the surface visible through the camera of the mobile phone of the user. The user can move the tourist spot or tour guide around their surface and also resize the tour guides and tourist spots. By demonstrating this app to a group of engineering students, we found that AR can indeed improve the touring experience [8]. This app is unique because most other AR tour guide apps require the user to be in the tourist spot physically in order to get the AR experience whereas in this app, users can get the AR experience without physically being in the tourist spot [9]. Additionally, the main concentration is not only to provide AR features but to also to make the 3D models of tour guides and tourist spots to look relatively pleasing to the eyes in order to improve user experience and user satisfaction [10].

## II. RELATED WORK

The key research studies related to augmented reality based tour guides, highlight the following points. The first study focused on an audio augmented reality tour guide which can be used in museums [11]. Audio will describe about the artifact as soon as a group of people walk up to a particular monument. The audio will stop as soon as the people walk away from the exhibit. Transmitters, receivers, and microcontrollers were used to implement this idea. In another study a virtual AR tour guide for heritage sites was proposed [12]. A prototype version was made and tested in a popular heritage site in Korea. Several tourists were allowed to use the AR tour guide and they answered a series of questions relating to the performance, usefulness, and device compatibility of the software. The tour guide software enabled realistic 3D virtual characters to be superimposed on the heritage site. Further, another study was about a tour guide which would augment information about the tourist spots if the user scanned the images of the tourist spots which are available in an offline tour booklet [13].

Similarly, an AR tour guide was made using HTML/CSS, JavaScript, PHP, and SQL [14]. The tour guide proposed demonstrated that the authors had created a prototype of an application that would augment information about events, their venue and availability of tickets for the event. A tour guide application was created specifically for Malaysia in order to increase the profits made by the Malaysian tourism industry [15]. The application made recommendations to users based on the budget and objectives of the tourists. The application made use of C#, AI, and AR technologies. Another study had a prototype version of an application which was made using C#, Vuforia SDK and Wikitude SDK. In this application, image tracking was used [16]. So, information about the tourist spot was augmented on the image of the tourist spot. Also, a 3D model of a cube having the image of the tourist spot was augmented on the image of the tourist spot.

A study proposed an AR application which allows the user to scan the environment and then the application renders an older image (say an image from the 1900s) of the tourist spot which is visible in the environment which is being scanned by the user. Unity 3D Game Engine and Vuforia Software development kit were used to create this application [17]. Another study focused on intelligent tour guide android applications and how they can enhance user experience [18]. The study also explained about the implementation stages of the intelligent tour guide mobile app in detail. The next study proposed a geolocation system powered by AR [19]. Finally, the last study reviewed was about a system which can be applied in entertainment and education industries and the system used an offline tour booklet along with AR at a reduced computational cost [20].

## III. IMPLEMENTATION

The programming language used to develop this application is C#. We used C# mainly to allow navigation from one scene to another and to allow navigation to different screens within a scene. We also used C# to enable and update the animations and audio of the tour guides. The IDE which was used to create this application is Unity. In Unity, we used several assets such as: scripts, scenes, materials, plugins, audios, graphics, streaming assets, fonts, 3D models, etc. to implement the app. Scripts were used to enable functionalities such as navigation, animation etc. The scripts were written in C# as mentioned above. Audios used were the audios which people can listen to when they choose the tour guide feature. The streaming assets are basically the images which the user will be scanning in order to get the info about the tourist spots. Graphics used were mainly images which we needed to make the UI of the software. We converted all these images into sprites which can be used in the UI. 3D models which we used were the 3D models of the tour guides and 3D models of the tourist spots. The fonts which we used were Notable, Montserrat, etc. The plugins which we used were EasyAR plugins and Android plugins. We used materials to give colours to the models which would display information about the spots while the spots info feature is being used. To develop the UI of the mobile app, we used several game objects available in Unity such as canvas, panels, images, text mesh pro, text, buttons, etc. We used Ctrl+D to reuse screens as and when required. Other game objects used were SceneManager, Directional Light, Main Camera and Event System. We created one separate scene which had most of the UI elements of the application. We created individual scenes for each of the tourist spots and tour guides. The spots info feature was covered in the initial scene which had all the UI elements. For the tour guides feature and tourist spots feature, surface tracking was used and for the scenes which involved surface tracking, additional game objects such as: EasyARSurfaceTracker, WorldRoot and TouchRoot were used. For image tracking, the extra game objects used were: ImageTracker, WorldRoot, RenderCamera and VideoCameraDevice. In order to implement surface tracking and image tracking in our application, we needed advanced computer vision algorithms through EasyAR. So, in order to use EasyAR, we first created an account on the EasyAR website and then we created a new sense license key by giving details such as the name of the application, the platform on which it is going to be deployed etc. Then we got the license key which we then used in Unity in order to access the services provided by EasyAR in our app, we also had to setup EasyAR in Unity. The next step was designing the 3D models. For creating the 3D models of the tourist spots, we first created 2D models using Aseprite because these models needed an extra amount of detailing which was possible with the help of Aseprite. In Aseprite, we can change the sprite size, canvas size, brush size, etc. and choose different colours from the colour palette, erase by clicking on E on the keyboard or choosing the eraser option on the screen, go to brush mode by either clicking on B on the keyboard or by choosing the brush from the screen, also draw lines by clicking on L on the keyboard, marquee by clicking on M, copy and paste by first using the marquee tool to select the area to copy and then clicking on Ctrl+C followed by Ctrl+V, and finally placing the pasted portion in the specific area of the workspace as required. After creating 2D graphics of the tourist spots, these 2D graphics were inserted into MagicaVoxel to convert

them into 3D. Note that we used this procedure only for some of the tourist spots, for most of the tourist spots, we directly made the 3D models in MagicaVoxel. In MagicaVoxel, we can click on Alt and click on the colour to select, this enables us to choose colours from the 3D models. We can also attach, erase and paint by choosing those on the screen. In MagicaVoxel, we can select all the different 3D models on the screen by clicking on All, we can increase the size of the 3D model by using 2X, we can decrease the size of the 3D model by using ½, marquee, move the 3D model backward, forward, left, right, top or bottom, also change the height, width etc. of the workspace, change the view, such as perspective view, orthogonal view etc. apply different effects such as emit, diffuse etc. take pictures of the 3D model. We can change the background, sky, intensity, ground etc. of the backdrop of the 3D model before clicking an image of it or duplicate an entire file. The files which we make in MagicaVoxel have an extension of .vox but we can export the voxel models in other formats as well such as obj. Voxel models are trending in the NFT world, gaming market and many such industries, thus we decided to make all the tourist spots and tour guides using voxel art.

**Fig. 1** *Fictional Spot Info*


**Fig. 2** *Fictional Tourist Spot*


**Fig. 3** *Male Tour Guide*

For making the 3D models of the tourist spots, we referred to several images, portraits, paintings, 3D models etc. of the tourist spots. For making the 3D models of the tour guides, we first created a base human model with a face, body, hands and legs. Then we used this base model to create all the tour guides. We added clothes, facial features, hair and accessories to make different models from the base model. We made three types of 3D models, they are: normal male 3D models, normal female 3D models and famous fictional 3D models. We used the male and female 3D models for the various famous tourist spots and damaged tourist spots. We used the 3D models of famous fictional characters to speak about the fictional place that they were associated to. For example, Willy Wonka was the tour guide for the Willy Wonka's Chocolate factory in our app. We initially created the rough UI designs with paper and pen. Then we converted those designs into more professional looking app designs using Figma. These designs had colours, fonts, images, effects, text etc. which we actually used in the application. Figma also helped us to collaborate and work on the same file at the same time which was incredibly useful.




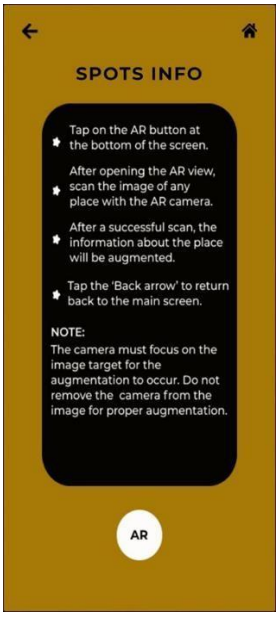


**Fig. 4** *Main Screen* **Fig. 5** *Tour guide page* **Fig. 6** *Tourist spot page* **Fig. 7** *Spots info page*

We used Adobe Premiere Pro to edit the audios of the tour guides. To do this, we first uploaded the audio in the Adobe Premiere Pro software in mp3 format, then we increased the decibels of the audio as and when required. Lastly, we used Mixamo for animations. Here we have to first upload the 3D model which we want to animate. Next, we have to mark specific parts of the 3D model such as the chin, groin, knees, elbows and wrists. Then the website performs auto-rigging after which we can choose several animations. For our tour guides, we chose three different animations for each character: a standing animation, talking animation and a waving animation.





**Fig. 8** *Famous spot page* **Fig. 9** *Fictional spot page* **Fig. 10** *Damaged spot page* **Fig. 11** *About page*

## IV. RESULTS

The application was shown to a group of engineering students from various branches of engineering and the concept of the application was explained in detail. At the end of the demonstration, a feedback form in which various questions about the application were asked was distributed among the students. We asked a total of seven questions. For the first five questions, there were four options from which the user can choose their response, the four options were: Excellent, Good, Satisfactory and Can be improved. Table 1 shows the first five questions which were asked in the form and the different responses that we received:

**Table 1.** Questions asked and feedback received

| Question Number | Question | Excellent | Good | Satisfactory | Can be improved |
|---|---|---|---|---|---|
| 1 | How was the user interface? | 61.9% | 38.1% | 0% | 0% |
| 2 | How was the tourist spot feature? | 66.7% | 33.3% | 0% | 0% |
| 3 | How was the spots info feature? | 52.4% | 47.6% | 0% | 0% |
| 4 | What do you think about the tour guide feature? | 52.4% | 47.6% | 0% | 0% |
| 5 | How was the user experience? | 47.6% | 52.4% | 0% | 0% |

For the next question, there were three options from which the user can choose their answer. The three options were: Tourist Spot feature, Spots Info feature and Tour Guide feature. For the last question, we gave users two options to choose from, those two options were: Yes and No. The questions were asked to know about things like which feature was most liked by the users, do the users believe that augmented reality can replace tourism completely, how the users found the individual features, and whether the users like the user experience and user interface etc. of the application. These questions allowed us to understand more about user expectations and mindset. We also created pie charts based on the responses received so that we can know the results visually without going through a lot of data. The sixth question which we asked in the form was: Which feature did you like the most? For this question, there were three options, namely: Tourist Spot feature, Spots Info feature and Tour Guide feature. 57.1% of the students chose the Tourist Spot feature as their response, 33.3% of the students chose the Spots Info feature whereas 9.5% of the students responded by selecting the Tour Guide feature. The last question was: Do you think Augmented reality can replace the real-life touring experience? For this question, there were two options: Yes and No. 52.4% of the people responded with a No and 47.6% people responded with a Yes.

## V. DISCUSSION OF RESULTS

For the last question, which was if augmented reality can replace the tourism experience, majority of the people said no, the difference between the number of people who said yes and no was relatively small though. Yet, a slightly higher number of people seemed to think that AR cannot

replace tourism, this might be because through this application people cannot actually experience travelling in a train, plane, ship or boat, they cannot actually experience the weather – snow, sun or rain of the tourist spot, they cannot actually taste the local food available in the tourist spot, they cannot listen to the local languages spoken in the area, etc. Also, during the demonstration we had hinted at these facts which are true to a great extent and must have influenced the responses of the users.

For the second last question, in which users had to choose their favourite feature of the application, majority of the people selected the tourist spots feature and this is because this is the main feature of the application – to actually look at the tourist spots. The second highest response was the spots info feature whereas the least chosen response was the tour guide feature. The reason for the tour guide feature to be the least liked feature might have been that during the demonstration of the application, we did not show the tour guide feature to the audience since the feature was not fully ready and so we only explained about the concept of the feature. Since users did not actually experience this feature, they could not perhaps imagine it and thus could not vouch for it.

For the fifth question, in which users had to rate the user experience of the application, majority of the people selected 'good' whereas the rest of the people selected 'excellent' which naturally suggests that the user experience was as per the expectations of an average user. For the rest of the questions in which users had to rate the user interface and individual features of the application, majority of the people selected 'excellent' whereas the rest of the participants selected 'good' which implies that the features and the UI were positively received by the participants.

## VI. CONCLUSION

In this study, we have explained in detail about the idea and implementation of our augmented reality based tour guide application – Eutouria. The application shows 3D models of tourist spots and 3D models of tour guides which explain about the tourist spots. Also, users can move around the tourist spots and tour guides and resize them. The application also augments information about each tourist spot. In future, we plan to implement this application in virtual reality headsets as well, so that users can go inside the tourist spots instead of just looking at them from the outside. This application will be helpful for people who want to visit tourist spots without physically going to the tourist spots. This application will also help people to visit places which have been destroyed by natural calamities and man-made disasters. Furthermore, the application enables people to visit fictional tourist spots which do not exist in the real world. Moreover, the application can prove to be immensely useful for older people because they might not be physically fit to take long vacations to distant lands as the weather, food, etc. of the unknown region might harm their health. Further, this app can prove to be beneficial for people who cannot afford expensive trips abroad or people who do not have the time to take a vacation. Also, due to the pandemic, many countries have closed their borders to tourists and have many travel restrictions, so in such scenarios, this application can aid people who want to travel to different places. The demerit of this application is that even though the tourist spot comes to the user's place of choice, the user cannot get the experience of being in the tourist spot. The advantages of this application are that it is simple to use, it saves time and provides accurate information and good user experience along with a seamless user interface.

## REFERENCES

1. Střelák, D., Škola, F., & Liarokapis, F. (2016, June). Examining user experiences in a mobile augmented reality tourist guide. In *Proceedings of the 9th ACM international conference on pervasive technologies related to assistive environments* (pp. 1-8). https://doi.org/10.1145/2910674.2935835
2. El Choubassi, M., Nestares, O., Wu, Y., Kozintsev, I., & Haussecker, H. (2010). An augmented reality tourist guide on your mobile devices. In *Advances in Multimedia Modeling: 16th International Multimedia Modeling Conference, MMM 2010, Chongqing, China, January 6-8, 2010. Proceedings 16*(pp. 588-602). Springer Berlin Heidelberg. doi:10.1007/978-3-642-11301-7_58.
3. Sriman, B., Wise, D. J. W., Silviya, S. A., & Bruhathi, S. (2023, January). Robust Smart Face Recognition System Based on Integration of Local Binary Pattern (LBP), CNN and MTCNN for Attendance Registration. In *2023 International Conference on Artificial Intelligence and Knowledge Discovery in Concurrent Engineering (ICECONF)* (pp. 1-5). IEEE.
4. Fino, E. R., Martín-Gutiérrez, J., Fernández, M. D. M., & Davara, E. A. (2013). Interactive tourist guide: Connecting web 2.0, augmented reality and QR codes. *Procedia Computer Science*, *25*, 338-344. doi:10.1016/2013.11.040
5. Schmalstieg, D., & Wagner, D. (2005, June). A handheld augmented reality museum guide. In *Proceedings of IADIS International Conference on Mobile Learning* (Vol. 49).
6. Yovcheva, Z., Buhalis, D., & Gatzidis, C. (2012). Smartphone augmented reality applications for tourism. *E-review of tourism research (ertr)*, *10*(2), 63-66.
7. Wei, X., Weng, D., Liu, Y., & Wang, Y. (2016, March). A tour guiding system of historical relics based on augmented reality. In *2016 IEEE Virtual Reality (VR)* (pp. 307-308). IEEE. doi:10.1109.20167504776.
8. Shin, C., Kim, H., Kang, C., Jang, Y., Choi, A., & Woo, W. (2010, July). Unified context-aware augmented reality application framework for user-driven tour guides. In *2010 International Symposium on Ubiquitous Virtual Reality* (pp. 52-55). IEEE. doi: 10.1109/2010.22.
9. Kanbara, Masayuki; Tenmoku, Ryuhei; Ogawa, Takefumi; Machida, Takashi; Koeda, Masanao; Matsumoto, Yoshio; Kiyokawa, Kiyoshi; Takemura, Haruo; Ogasawara, Tsukasa; Yokoya, Naokazu, (2004). Nara palace site navigator: A wearable tour guide system based on augmented reality.
10. Ritsos, P., Johnston, D. J., Clark, C., & Clark, A. F. (2003, September). Engineering an augmented reality tour guide. In *2003 IEE Eurowearable* (pp. 119-124). IET. doi:10.1049/20030157.
11. Bederson, B. B. (1995, May). Audio augmented reality: a prototype automated tour guide. In *Conference companion on Human factors in computing systems* (pp. 210-211).
12. Seo, B. K., Kim, K., & Park, J. I. (2011). Augmented reality-based on-site tour guide: a study in Gyeongbokgung. In *Computer Vision–ACCV 2010 Workshops: ACCV 2010 International Workshops, Queenstown, New Zealand, November 8-9, 2010, Revised Selected Papers, Part II 10* (pp. 276-285). Springer Berlin Heidelberg.
13. Sriman, B., Silviya, S. A., Shriram, S. K., Kumar, S. R., Shriya, R., & Sujitha, A. (2022, September). Virtual Assistant for Automatic Emotion Monitoring using Perceived Stress Scale (PSS). In *2022 4th International Conference on Inventive Research in Computing Applications (ICIRCA)* (pp. 1529-1534). IEEE.
14. Anithakshi, Nirmala Y Bariker. (2016). Augmented Reality based Virtual Tour Guide.
15. Kasinathan, V., Mustapha, A., & Subramaniam, T. (2016, November). SmartG:

Spontaneous Malaysian augmented reality tourist guide. In *IOP Conference Series: Materials Science and Engineering* (Vol. 160, No. 1, p. 012103). IOP Publishing.
16. Kumar, S. G., Murugan, A., Muruganantham, B., & Sriman, B. (2020). IoT–smart contracts in data trusted exchange supplied chain based on block chain. *International Journal of Electrical and Computer Engineering*, *10*(1), 438.
17. Cibilić, I., Poslončec-Petrić, V., & Tominić, K. (2021, December). Implementing augmented reality in tourism. In *Proceedings of the ICA* (Vol. 4, p. 21). Göttingen, Germany: Copernicus Publications.
18. Yu, Y. H. (2014). Study on intelligent augmented reality tourist guide application based on android smart phone. *Applied Mechanics and Materials*, *668*, 1399-1402.
19. Díez-Díaz, F., González-Rodríguez, M., & Vidau, A. (2007). An accesible and collaborative tourist guide based on augmented reality and mobile devices. In *Universal Access in Human-Computer Interaction. Ambient Interaction: 4th International Conference on Universal Access in Human-Computer Interaction, UAHCI 2007 Held as Part of HCI International 2007 Beijing, China, July 22-27, 2007 Proceedings, Part II 4*(pp. 353-362). Springer Berlin Heidelberg.
20. Choi, H., Han, G. C., & Kim, I. J. (2014, January). Smart Booklet: Tour guide system with mobile augmented reality. In *2014 IEEE International Conference on Consumer Electronics (ICCE)* (pp. 353-354). IEEE. doi: 10.1109/2014