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Location based Augmented Reality – GeoAR

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Abstract

This study aims to research on immersive and interactive experience to users by using augmented reality and GPS technology. The system will be built using the Vuforia engine or ARcore support, and will be able to detect the user's location and device location using GPS. Once the system is initiated, it will check for GPS support in the user's device and ask for camera access. Then, using Vuforia's markerless tool and AR+GPS package, the system will detect the user's location and search for the rendered scene for the respective location. Each building will be labelled with AR objects for better understanding of the place and tracking where the user is. The AR objects will provide information about the building, such as its name, purpose, and history. This will enhance the user's experience and enable them to navigate the campus more easily. The application will create a scene that renders the real environment image and the rendered AR scene image, providing an interactive output. Users will be able to interact with the AR objects by clicking on them to access more information, such as photos and videos. Overall, the proposed system will be a useful tool for navigating the campus, providing users with a unique and immersive experience.

Keywords: Augmented Reality, AR core, Vuforia, GeoAR, Location-based AR.

1. Introduction

Augmented reality (AR) is a technology that enables users to experience virtual objects or content in the real world environment in an interactive manner. The process of AR involves

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detecting the target using a sensor, processing the target to fetch the rendered scene, integrating or projecting the rendered scene onto the target, and allowing the user to experience and interact with the augmented scene in real-time. AR requires a sensor, a designing software, a developer tool, a database, and a device.

There are two main types of AR: marker-based AR and marker-less AR. In marker-based AR, the target is well-defined and fixed, and if the sensor detects the target, it immediately augments the rendered scene onto it. On the other hand, in marker-less AR, the target is not defined and fixed, and the sensor looks for a pattern, surface, colour, or GPS coordinates to augment the rendered scene.

AR has various applications in different industries, including urban construction planning, education, visual art and entertainment, healthcare, and gaming. One of the biggest challenges in GeoAR, which is a type of marker-less AR, is visualizing navigation in the real world. However, GeoAR can be used to label landmarks and build an interactive scene that increases tourism and helps people navigate unfamiliar places.

Despite the many benefits of AR, it faces several challenges, including lack of proven business models, lack of development standards, and security risks. As AR is a new technology, it does not have standard development methods or a universal language for application. Additionally, since there are no regulations for designing an AR application, the technology can be used in unethical ways, potentially causing physical accidents.

Other related technologies include mixed reality (MR), extended reality (XR). and virtual reality (VR).

2. Literature Survey

The study[1] titled "Location-Based Augmented Reality for Mobile Learning: Algorithm, System, and Implementation" was authored by Q. Tan and W. Chang and was published in the "Electronic Journal of e-Learning" in 2015.. The authors describe the algorithm and system used in the development of the application and highlight its implementation in a real-world scenario. “The paper presents the results of a pilot study conducted to evaluate the effectiveness of the system in enhancing the learning experience. The study involved a group of undergraduate students who used the system for a geography lesson. The authors found that the use of the location-based augmented reality system significantly improved the students' learning outcomes and engagement. The studyconcludes by discussing the potential of location-based augmented reality technology in the field of education and the need for further research in this area. Overall, this paper provides valuable insights into the development and implementation of location-based augmented reality systems for mobile learning and its potential to enhance the learning experience

The research [2] titled "An effective approach to develop location-based augmented reality information support" highlights the limitations of traditional location-based systems, which lack the ability to provide visual and interactive information to users. The authors propose a solution that leverages AR technology to provide users with an immersive and interactive experience by augmenting real-world objects with digital information.The proposed approach, involves a combination of GPS, digital compass, and image recognition technologies to identify the user's location and orientation. The system then overlays relevant digital information, such as text, images, and videos, onto the real-world objects in the user's field of view. The authors also discuss the implementation of the proposed approach, which involves developing a mobile application that utilizes AR technology.The study concludes by discussing the potential applications of the proposed approach, including education, tourism, and advertising. The authors also highlight the benefits of the proposed approach, including increased user engagement and interaction, improved information delivery, and enhanced user experience. Overall, the study provides a valuable contribution to the field of location-based AR and offers insights into the development of effective AR information support systems

The paper[3] titled "Sensors for Location-Based Augmented Reality: The Example of Galileo and EGNOS" is authored by Pagani, Henriques, and Stricker, The paper discusses the use of location-based augmented reality (LBAR) and the role of sensors in its implementation. Specifically, the study focuses on the use of Galileo and EGNOS (European Geostationary Navigation Overlay Service) as sensors for LBAR applications. The authors explain the benefits of using these systems, such as increased accuracy and availability, and present case studies that demonstrate their effectiveness in various LBAR scenarios and also discusses the limitations and challenges associated with the use of Galileo and EGNOS as sensors for LBAR. Overall, the study provides valuable insights into the use of sensors for LBAR and highlights the potential benefits and challenges associated with their use.

The article [4] "Relations between student motivation, immersion and learning outcomes in location-based augmented reality settings" by Kiili and Kyza (2018) examines how learning results in location-based augmented reality contexts relate to student motivation, immersion, and learning. The study involved 78 students who used an AR application to learn about the history and culture of a local area. The authors found that student motivation and immersion in the AR environment were positively correlated with learning outcomes, and that immersion partially mediated the relationship between motivation and learning outcomes. The study suggests that location-based AR can be an effective tool for enhancing student learning, but that careful consideration must be given to student motivation and engagement in the AR experience

In this study[5], the author, Richardson, explores the potential of a location-based augmented reality game for language learning. The study involved a small group of participants who played the game and were evaluated based on their language learning outcomes. Theresearch discusses the design of the game and how it incorporated location-based elements and augmented reality to create an immersive language learning experience. The results of the study showed that the game was effective in improving participants' language skills and that they enjoyed the game. The author concludes that location-based augmented reality games have the potential to be a valuable tool for language learning and that further research is needed to fully explore their effectiveness

The study [6] "A Survey of Augmented Reality", gives a thorough introduction of the augmented reality (AR) field. The author presents a survey of existing AR systems, their key components, and applications at that time. In his introduction, Azuma defines augmented reality as a technology that allows users to interact and perceive their surroundings more effectively by fusing virtual and real-world data in real-time. He outlines the three essential characteristics of AR: it combines real and virtual information, it is interactive in real-time, and it is registered in 3D. The paper discusses various aspects of AR, including its historical background, fundamental techniques, tracking and registration methods, display technologies, and interaction techniques. The author highlights the importance of accurately registering virtual objects in the real world and identifies different tracking technologies such as fiducial markers, inertial sensors, and computer vision-based approaches. Azuma also explores the different display technologies used in AR, including head-mounted displays, handheld devices, and spatial displays. He explains the advantages and limitations of each type of display and their suitability for different AR applications. Furthermore, the author provides an extensive overview of various applications of AR, ranging from medical, manufacturing, and entertainment to education and military domains. He discusses specific AR systems and prototypes developed for each application area, highlighting their contributions and challenges. In conclusion, Azuma's survey paper provides a comprehensive overview of augmented reality, covering its definition, key components, techniques, display technologies, interaction methods, and diverse application areas. This paper serves as an important foundational work for understanding the early development and state of the field of augmented reality in 1997.

The article [7] titled "Scaffolding augmented reality inquiry learning: The design and investigation of the TraceReaders location-based, augmented reality platform" was published in the Interactive Learning Environments journal in 2019. The paper outlines the development and analysis of TraceReaders, a location-based augmented reality platform intended to support scientific inquiry learning. The study involved 100 5th and 6th-grade students who participated in a 10-day learning activity using the platform. The results showed that the use of the platform significantly improved the students' scientific inquiry skills and knowledge, as well as their motivation and engagement in the learning process. The study concludes by discussing the implications of the findings for the design and use of location-based augmented reality platforms in inquiry-based learning

The research caried out in [8] is an experiment on the indoor-outdoor navigation of “Lingang campus of Shanghai University of Electric Power”.

The paper [9] titled "Augmented reality based campus guide application using feature points object detection" by Pawade et al. (2018) presents a system for campus navigation using augmented reality (AR) and feature point object detection techniques. The authors propose an AR-based mobile application that can guide users through the campus by detecting and tracking feature points of buildings, landmarks, and other objects. The system detects and recognises the feature points in real-time by combining image processing and machine learning methods. The authors also conduct experiments to evaluate the performance of the system in terms of accuracy and efficiency. The results show that the proposed system can effectively guide users through the campus and provide them with relevant information about the buildings and landmarks. The authors conclude that the proposed system can be useful for new students, visitors, and tourists to explore and navigate the campus

The paper [10] "Mobile Guide to Augmented Reality for Campus of the Autonomous University of Nayarit" by Iriarte-Solis et al. (2016) presents the development of an augmented reality (AR) mobile application to provide a guide to the campus of the Autonomous University of Nayarit in Mexico. The application uses marker-based AR technology to overlay information on the camera view of the campus. The authors describe the development process of the application and its features, which include the display of information about buildings and services on the campus, as well as the creation of a virtual treasure hunt game. The authors also report on the results of a user study that evaluated the usability and user satisfaction of the application. The study found that the application was considered useful and easy to use by the participants, and that they appreciated the additional information provided by the AR technology.

This study [11], conducted by Javornik et al. in 2019, explores the role of augmented reality (AR) content type in an outdoor site exploration. The authors conducted an experiment with 50 participants, in which they tested three different AR content types: visual, textual, and mixed. The participants were divided into three groups, each of which explored an outdoor site using one of the three AR content types. The study found that the mixed AR content type led to the highest level of engagement and satisfaction among the participants, as well as the highest level of learning outcomes. The authors suggest that the mixed AR content type, which combines both visual and textual information, may be the most effective for outdoor site exploration and learning.

The paper [12] titled "Augmented reality smartphone environment orientation application: a case study of the Fu-Jen University mobile campus touring system" by Chou and ChanLin was published in the Procedia-Social and Behavioral Sciences journal in 2012. The paper presents a case study of an augmented reality smartphone application developed for the Fu-Jen University mobile campus touring system. The app utilizes augmented reality technology to provide visitors with an immersive and interactive experience while touring the university campus. The paper discusses the design and implementation of the application and evaluates its effectiveness in enhancing the visitors' learning experience. The study concludes that the augmented reality application can enhance the visitors' understanding and appreciation of the campus environment and encourages further development and deployment of such applications in other educational settings.

In study [13] describes a “campus navigation system based on mobile augmented reality”. The system is designed to help users find their way around a university campus by displaying virtual information overlaid on the real-world view of the campus captured by a smartphone camera. The authors propose a three-tier architecture for the system, consisting of a client-side application running on a mobile device, a server-side application running on a cloud server, and a database storing information about the campus layout and points of interest. They also describe the algorithms used to track the user's location and orientation and to display the augmented reality information in a user-friendly way. The system was tested on a real university campus, and the results show that it can accurately guide users to their desired destinations.

In this research [14], the authors explores the “adoption of mobile augmented reality as a campus tour application”. The study focuses on the perceptions and attitudes of users towards the use of this technology as a tool for campus tours. A survey was conducted with 300 participants, and the results showed that the majority of the participants had positive perceptions and attitudes towards using mobile augmented reality for campus tours. The study also found that ease of use, usefulness, and enjoyment were significant factors in influencing users' attitudes towards the technology. The authors conclude that mobile augmented reality has great potential as a tool for campus tours and that institutions should consider adopting it to enhance their campus tours.

In this study [15] A "Developing Augmented Reality Mobile Application: NEU Campus Guide" is a doctoral dissertation written by Muhammad S.T. in 2019 for the Near East University. “The aim of the study was to design and develop an augmented reality (AR) mobile application that provides a guide to the university campus”.

The study utilized a design and development methodology, and the AR mobile application was developed for Android devices. The application provides information about the buildings and facilities on the campus, as well as directions and navigation tools.

The study involved user testing and evaluation, which revealed that the application was easy to use and provided helpful information for navigating the campus. The study also highlighted the potential of AR technology for enhancing the user experience and providing a new level of interaction with physical environments.

Overall, the paper demonstrated the feasibility and usefulness of developing an AR mobile application for university campus guides, and provided insights into the design and development process for such applications.

3. Proposed Methodolody

In the proposed system as shown in Figure 1, the location data i.e the GPS coordinates of the targets are feeding in the system and the respective AR scene is embedded under the GPS object and the system is built using the Vuforia engine or ARcore support. When the system is initiated, the system checks for the GPS support in the device the application being installed and asks for camera access. Then the uses Vuforia marker less tool and AR+GPS package to detect the users location and device location and searches for the rendered scene for the respective location. The application has to create a scene rendering the real environment image and rendered AR scene image and gives an interactive output.

In this case each and every building is labelled with AR objects for better understanding of places or tracking the user.

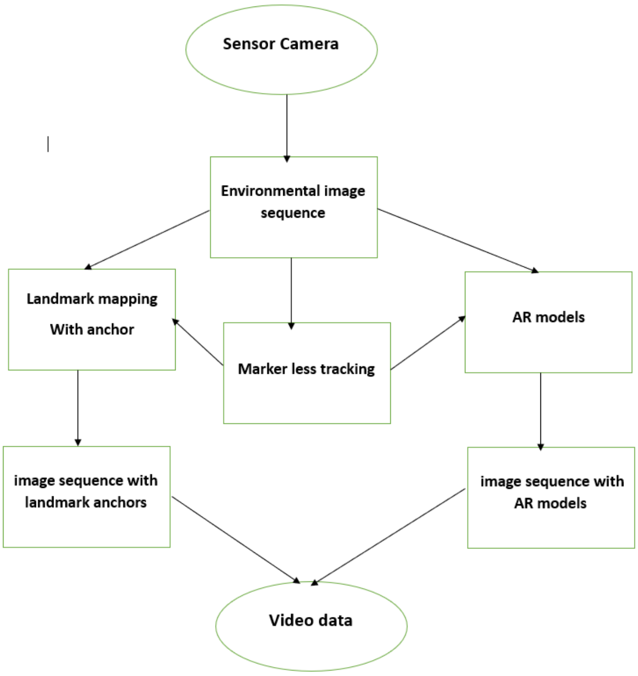

Figure 1. Proposed System

a. Capturing Device

In this phase the device uses camera to capture the environment and surroundings where the user is located. It generates a real environment image sequence which are the frames. Then markerless tracking tool is enabled.

b. Real Time Sequence

Real time image sequence is nothing but the video captured by the mobile camera.

c. Landmarks Mapping

In this phase the device tries to find the landmark with the help of GPS service provided by the device and places an anchor in the coordinates to render the AR scene using the AR+GPS packages GPS state and hotspot function. It generates image sequence with landmark.

d. Augmentation Module

In this phase the device processes theGPS coordinates and finds the respective AR scene to render and generates image sequence with augmented 3D objects.

e. Image Sequence with Augmented 3d Objects

Tracking the anchors placed in the landmark mapping, the fetched 3D objects are placed in the place of anchors and rendered into an image sequence.

f. Video Data

In final phase both landmark mapping and AR mapping combine with image sequence and gets rendered into an interactive AR scene and delivered as a video data in the sensor screen.

4. Experimental Setup and Evaluation Process

Set up the unity environment as shown in figure2.

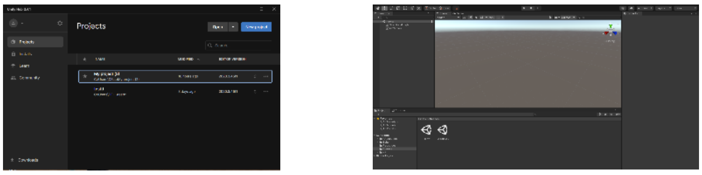

Figure 2. Environment Setting

Install all the package and dependency like vuforia and import it as shown in Figure 3.

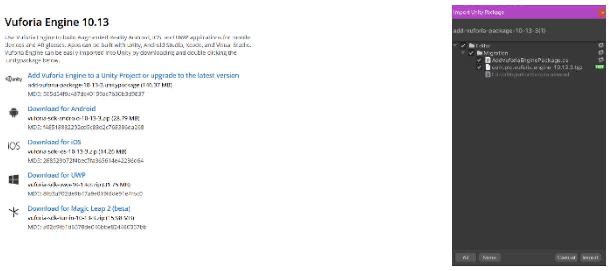

Figure 3. Installation of Packages

Set up the configurations as shown in figure 4.

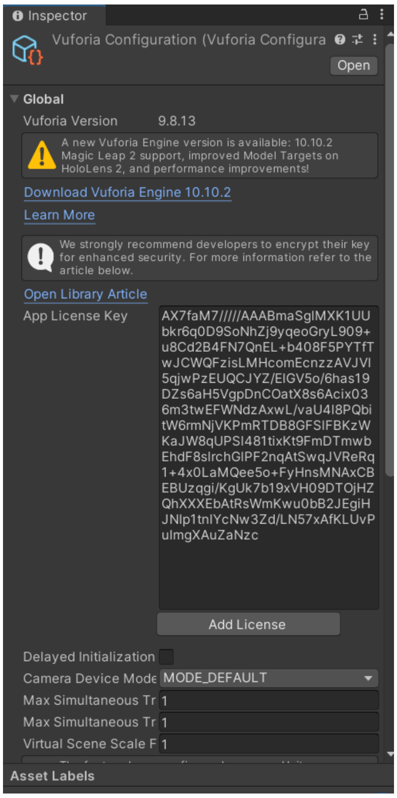

Figure 4. Set up Configurations

Create the basic scene from the AR+GPS package as shown in Figure 5.

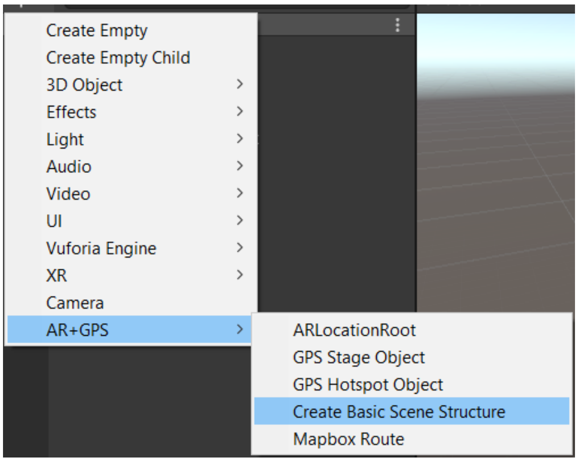

Figure 5. Set up Basic Screen

Place the labels of the building upon the targets on GPS coordinates as shown in Figure 6.

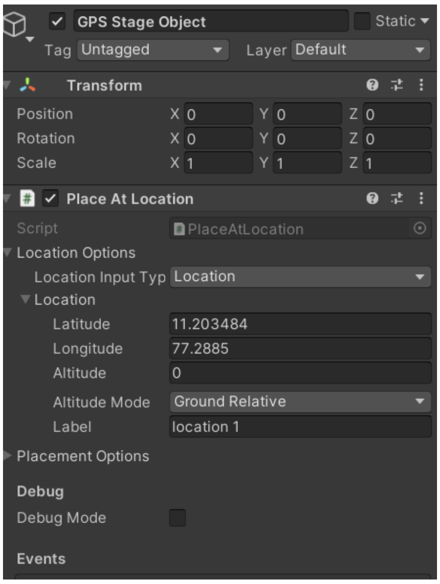

Figure 6. Placing the Labels

5. Results

Once the apk file is installed it initiates the unity app and asks for permission to access camera and GPS of the mobile device as shown in Figure 7.

Figure 7. Unity App

Here is the screenshot of the camera sensor analyzing the GPS coordinates and rendering the scene as shown in Figure 8.

Figure 8. Final Output

6. Conclusion

In summary, the proposed system aims to use GPS coordinates to embed augmented reality scenes into real-world environments using the Vuforia engine or ARcore support. The system requires the user to grant camera and GPS access to initiate, and then use the Vuforia marker-less tool and AR+GPS package to detect the user and device location and search for the rendered scene for the respective location. The application provides an interactive output by rendering the real environment image and AR scene image. Future work involves implementing a navigation system, and the use of AR objects to label buildings for better understanding of places or tracking the user's location. Overall, this system has the potential to enhance the user experience by providing an interactive and informative environment.

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