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An Augmented Reality Application to Enhance Visitor Experiences

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***Abstract*—In the present times, the proliferation of digital technology has become an imperative for the tourism industry and contemporary tourist destinations to stay ahead of the competition. Virtual Communities and Augmented Reality (AR) are two new types of digital technologies that are being employed in public. Tourists are often unaware of the natural and cultural wonders of their cities. Hence, this study was conducted to develop an Android application that uses augmented reality technology to deliver information on tourism in towns. With extra visual and tracking information content, the system provided visitors with a more informative, engaging, and user-specific information experience. This paper presents how user needs are important when developing an Augmented Reality (AR) application to attract visitors. The goal of this study is to highlight tourism related AR technology. The system proposed will scan and recognize monuments and artifacts using image processing. After scanning, a repository of information, including videos, images, and audio, will be played for the tourist. The utilization of augmented reality technology in the proposed application improves the overall experience for tourists through the provision of interactive content. This enables visitors to fully immerse themselves in the sites they are visiting, leading to a greater understanding and appreciation of the cultural and historical significance of these locations.**

***Index Terms*— Tourism, Augmented Reality (AR), Image Recognition.**

I. INTRODUCTION

Tourists who visit historical monuments often encounter an issue with local guides and residents who aggressively offer their services for a high fee. In addition, tourists may desire to learn more about the heritage site but may lack access to the necessary information. While booklets and tour maps are commonly used, the information provided is frequently in the local language, which may not be comprehensible to tourists. Multimedia solutions like interactive displays, video walls and touch kiosks are being increasingly deployed at tourist hotspots, hotels, and visitor centers to address this problem. These technologies aim to assist tourists in accessing important information about the places they are visiting. Multimedia tour guides have become increasingly popular due to their visually appealing video content, which makes them user-friendly for tourists.
Reference [1] Techniques like Optical character recognition (OCR) and text identification that involve document analysis are negatively impacted by noise. The traditional image processing task of denoising and restoration of noisy scanned document pictures tries to remove these kinds of artifacts from provided noisy images. An augmented reality-based travel management software has the potential to revolutionize museum experiences.

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Using interactive content like real-time videos, holograms, and exhibit stories, visitors can now have a distinctive travel experience, allowing them to appreciate the rich cultural history of tourist places.
The use of image recognition features in various apps has made it possible for tourists to access complete information about a monument by simply scanning it. The mobile-based application proposed in this study aims to provide tourists with assistance during their visits to cultural heritage sites. The proposed application employs AR technology to provide visitors with a guided tour and showcase information and historical context about the monument in English. This feature enhances the understanding and appreciation of the cultural significance of the site for tourists, making their travel experience more enriching and rewarding. Additionally, the application will allow tourists to search for nearby tourist places by uploading images, providing a comprehensive tool for exploring cultural heritage sites.
The primary aims of this paper are:

1. to investigate the significant potential of Augmented Reality technology in contemporary society, specifically in the context of the tourism industry.
2. elucidate the utilization of AR in rekindling the interest of masses in historical monuments in the most appealing manner.

The objective of implementing this system is to introduce cutting-edge technological advancements in the travel industry to enhance the visitor exploration, particularly for those traveling from international locations.
The proposed system centers around leveraging AR technology and Image Recognition for artifact/sculpture detection. Reference [1] A deep learning pipeline will aid in denoising and smoothening scanned document images, thus improving their quality. By providing a better experience, this project will indirectly contribute to the growth of the tourism economy through increased footfalls.

II. Literature Review

Future information development and software applications will increasingly combine smartphones and Internet access. Early mobile tourist apps typically included features like voice-based information providers, location identifiers, virtual tours of significant locations, and path selection functions using maps to find the best route to a certain area inside the facility.
Reference [1] The proposed system in the paper explained that document images often contain various types of noise which can affect their readability and quality. The proposed approach uses a patch-based autoencoder to learn the features of clean and noisy patches from the input image. The autoencoder then uses these learned features to generate a denoised image. Additionally, it also introduces a smoothing term to the loss function of the autoencoder, which helps to reduce the blocky artifacts that can occur in denoised images. It also presents experimental results on the effectiveness of their approach on benchmark datasets and compares it with other cutting-edge methods. The results indicate that the proposed system outperforms other methods in terms of denoising performance and image smoothing.
Reference [2] The paper proposed a method for precise recognition of multiple physical objects and estimation of their 3D positions in augmented reality (AR) applications, demonstrating high accuracy in experiments. The proposed system utilizes a deep learning model to recognize objects in the real world and estimate their positions in 3D space. The system involves three stages: object detection, feature extraction, and 3D position estimation. First, object detection is performed using a deep learning model that is trained on a large dataset of object images. Next, feature extraction is carried out on the detected objects to obtain a feature vector that represents each object. Finally, 3D position estimation is performed by comparing the feature vector of the detected object with the feature vectors of the objects in a pre-constructed 3D model of the real world. Based on the experimental results, the proposed system has demonstrated a high level of accuracy in recognizing objects and estimating their 3D positions, making it a highly promising solution for augmented reality applications that demand precise object recognition and positioning.
Reference [3] The paper proposed an AR system developed to improve visitors' experience at the Sangiran Museum in Indonesia. The proposed system utilizes the Vuforia technology, which provides image recognition and tracking, to display 3D models, videos, and textual information on the visitors' mobile devices. The system aims to enrich the visitors' understanding and appreciation of the exhibits in the museum by providing interactive multimedia content. It also describes the steps involved in creating the system, such as preparing the 3D models, designing the user interface, and integrating the Vuforia technology. The study also includes an evaluation of the system's effectiveness in engaging visitors and enhancing their understanding of the exhibits. The results show that the system is effective in providing an interactive and immersive experience for visitors, which can increase their interest in the museum and encourage them to learn more about the exhibits.

Reference [4] The paper presented a system for recognizing Indian monuments using image-based classification with Convolutional Neural Networks (CNN). The system utilizes a publicly available dataset of Indian monuments to train and test the CNN model, achieving high accuracy in recognizing different types of monuments. In comparison to the hand-crafted features, it was able to reach an accuracy of 92.7%, which is a far higher percentage. The results of the studies demonstrated the value of constructing an efficient monument recognition system employing representations of monument images. It was observed that the model's performance improved with CNN.
Reference [5] The paper is aimed at the Omani tourism industry. Only FOSS software was used to create and implement the suggested system. The process starts with snapping a picture of the landmark with the camera. The frame resolution and pixel bit representation supported by image sensors, which are found in smart mobile devices, differ. Using the OpenCV library, the program preprocesses the images by scaling them to the standard frame size. Along with other data, the software uploads the altered image to the cloud (such image size). The software initiates a timer to wait for a response from the cloud after sending a query, allowing the client to decide whether to continue or stop the process if there is no response within a specified time. Upon receiving a response from the cloud, the software updates the corresponding captured image with the information provided. This process is repeated for all images taken.
Reference [6] The proposed system in the paper is a smartphone application called "AR City" for the purpose of promoting cultural tourism. The application is designed with a two-part architecture, consisting of the Service Consumer and Service Provider components. The user interface and server logic are tightly integrated in the proposed system, with JSON messaging serving as the means of communication between them. Additionally, both the user interface and server logic are hosted on the same PaaS platform along with the database engine, creating a highly efficient and streamlined architecture for the application. The quasi-experiment execution approach is then used to validate the results. The benefit of PaaS services is utilized by this application to enhance performance. It also includes features such as text-to-speech, which allows the user to hear information about the tourist attraction, and social media integration, which allows the user to share their experience with friends and family.
Reference [7] The paper presented a mobile augmented reality application for Yilan tourism, serving as a guide. The system is composed of two distinct components:
1. The map feature, which enables users to search for information regarding geothermal springs, and corresponding data is retrieved using Google Maps.
2. The module for augmented reality offers two features. The first one uses a 2D virtual picture and a point of interest (POI) to direct the user to their goal. One may access Yilan's official website by scanning the Quick Response code for each POI using the second feature. This program also offers tools for taking images, recording videos, etc. as supplementary functionality.
The literature review reveals that the reviewed papers discuss the implementation of augmented reality (AR) in tourism. The proposed systems provide a range of functionalities including real-time object recognition, 3D object tracking, location-based services, and personalized experiences for tourists. The integration of augmented reality technology into tourism provides a heightened level of engagement for tourists, immersing them in interactive experiences and making learning more enjoyable while also adding entertainment value to their visit. However, challenges include the need for reliable and fast internet connectivity, the need for high-quality content, and compatibility with a range of devices and the need for accurate and reliable recognition and tracking of cultural heritage sites and landmarks in the real world. Overall, the papers highlight the potential of AR in revolutionizing the tourism industry by creating unique experiences and enhancing the overall value for tourists.

III. Implementation Overview

The goal is to create a tourist guide app to assist both domestic and foreign travelers. The application will have a straightforward, user-friendly GUI (Graphical User Interface) so that anyone may use it.
Figure [1] The proposed project is an Android application that utilizes augmented reality technology to create an interactive viewing experience for the user. The app acts as a tourist guide, providing an immersive and engaging experience to enhance the user's understanding and enjoyment of the site. The camera that is enabled inside the program assists in object detection when augmented reality technology is used.
The user must first download, install, and grant the necessary permissions to the application. If the user is a first-time user, they must register in order to create an account before they may log into the app. The database contains information about all the different users. Their history and information about numerous locations are both stored in the database. The information connected to the object (target) is then presented on the screen

utilizing augmented reality after the camera has been opened in the application and if the object is discovered. The seen content is interactive for the user.
The following primary implementation processes are mentioned:

1. Scanning the desired building or monument
2. Comparing the scanned and target images
3. Displaying a richly visual AR view

The application's functioning can be described as follows:

1. Vuforia was used as the AR library while the application was being developed in the Unity3D programming environment.
2. Images that Vuforia can recognize and track are represented by Image Targets. As long as an Image Target is discovered and at least partially visible in the camera, it will be tracked.
3. Vuforia Target Manager is used to extract an image's features and store them in a database in order to construct an Image Target.
4. A rating of the target's anticipated detection and image performance
   will also be given by Vuforia. An image must receive at least 4 stars in order for the SDK to effectively detect it.
5. Next, a 3D model of the discovered tourist attraction is rendered using the image target or the text as an anchor position, allowing the user to view the model on their smartphone's display.

The user has the option of playing a video file that the speaker uses to describe a tourist attraction.

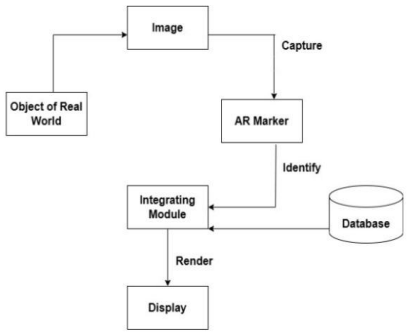

Figure 1: Proposed System

The user can also utilize the mobile application to search for a specific tourist destination. If the database matches the search query, the application will show textual details about the tourist destination.

IV. Results

The implementation may be momentarily seen on a laptop. When the application detects the target object while viewing it through the camera, it recognizes it and displays an interactive object in the form of a video outlining the location's history.
Figure [2] illustrates the application of image target technology in Unity Editor. It showcases an image target selected as a reference point for a virtual object in Unity editor. The image target serves as a marker that enables precise placement of virtual objects in the AR environment. The virtual object interacts with the real world by tracking the image target.
Figure [3] displays a video being played on an image target. The video playback is real-time and synchronized with the image target. This application of image targets provides an immersive experience by blending the virtual and real-world environments. The tracking of the image target ensures accurate alignment of the virtual content with the real-world environment, resulting in a seamless AR experience.
Figure [4] The types of users who utilized the proposed application were analyzed, and the results showed that the system attracted a diverse range of users, including students, tourists, researchers, and history enthusiasts. Among the users, tourists were the largest group, accounting for 45% of the total user base. Students, comprising 25% of the user base, found the application helpful for their studies and research. The application's ability to provide detailed information on historical sites and artifacts was particularly useful for their coursework and research projects. Researchers made up 20% of the user base, and they found the application to be a valuable tool for their work. The system's ability to provide accurate and detailed information on historical artifacts and sites

was especially helpful for their research. Finally, the application was found to be an enthralling and enlightening resource for history enthusiasts, who accounted for 10% of the user base, to gain deeper insights into the region's history and cultural heritage.

Figure [5] The recognition accuracy of our proposed system was evaluated on image sizes ranging from small to large, in both indoor and outdoor settings. The system achieved an overall accuracy of 83% for small indoor images, 69% for small outdoor images, 90% for medium indoor images, 79% for medium outdoor images, 95% for large indoor images, and 85% for large outdoor images. The results showed that the proposed system performed best on large indoor images, with a recognition accuracy of 95%, and worst on small outdoor images, with a recognition accuracy of 69%. The system was also more effective at recognizing images in indoor settings, with accuracy rates ranging from 83% to 95%, compared to outdoor settings where accuracy rates ranged from 69% to 85%.

Figure [6] The results of the proposed system's response time for different image sizes are shown. The graph shows the response time in seconds for small (indoor and outdoor), medium (indoor and outdoor), and large (indoor and outdoor) image sizes. The results showed that the response time generally increases with larger image sizes. Specifically, the response time for small indoor images was the fastest at 5 seconds, while large outdoor images had the slowest response time at 25 seconds.

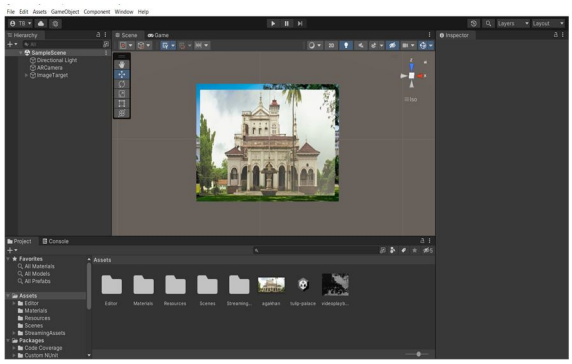

Figure 2: Unity Editor

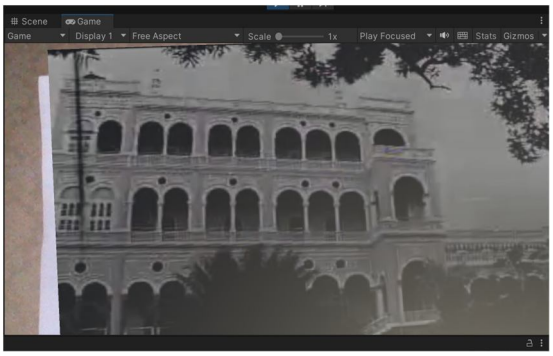

Figure 3: Video playing on Image Target

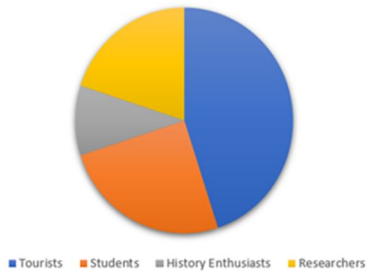

Figure 4: Types of Application Users

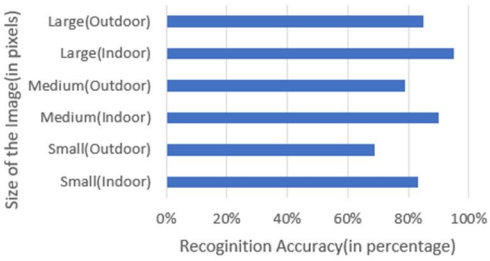

Figure 5: Recognition Accuracy of the System

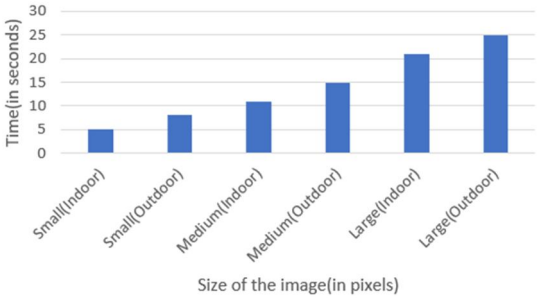

Figure 6: Response Time of the System

These findings suggest that the system may require more processing time for larger image sizes, particularly for outdoor scenes which tend to have more complex visual information. This finding suggests that the proposed system may require additional optimization for large image sizes to reduce the response time.

However, the values presented here may be affected by other factors such as network connectivity and device performance. The collected data has offered valuable insights into potential system limitations, which may prove useful in guiding future improvements and enhancing its overall performance.

V. Conclusion

The developed augmented reality mobile application is designed to cater specifically to the travel industry. By merging reality with digital information and insider knowledge of tourist resources, users can benefit from an upgraded and improved experience. The Android-based project selects information in accordance with the specified objectives and user expectations, with options for both 2D and 3D formats available following careful vetting of content.

This app is suitable for both local visitors and foreign travelers, offering a superior alternative to comparable mobile Augmented Reality applications through the implementation of advanced computer vision techniques to improve target recognition accuracy. The initial prototype has been completed and can deliver interactive and enriched content to provide a more informative and engaging tour experience. The potential to attract a broader range of visitors, particularly younger, technology-savvy generations, could lead to an overall improvement in the tourism industry. Future plans include expanding the system to other historical and cultural sites and incorporating user feedback to continuously enhance the user experience, or the integration of location-based services to provide information about nearby landmarks, hotels, and restaurants, further improving the overall experience.

In summary, the augmented reality mobile application represents a significant advancement in the use of AR technology in tourism. By using the proposed system, tourists can gain a deeper understanding and appreciation of the culture and history of the places they visit, leading to a more fulfilling and memorable travel experience. This study serves as a blueprint for the future advancements in tourism technology. The ultimate goal is to make this application the new interactive media for the tourism industry.

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