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Smart Tourism with AR Navigation: Bridging Cultural Exploration and Technology

[1]Dr.Shabina Modi, [2]Utkarsha Santosh Patil, [3]Rutika Vinod Shelar, [4]Shrikrishna Subhash Thodsare, [5]Chinmay Deepak Pol

[1,2,3,4,5] Computer Science and Engineering, Karmaveer Bhaurao Patil College Of Engineering, Satara, India.
Email: [1]shabina.sayyad@kbpcoes.edu.in, [2]patilutkarsha975@gmail.com, [3]shelarutika21@gmail.com, [4]shrikrishnathodsare7@gmail.com, [5]chinmaypol04@gmail.com

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Abstract

VeezAR **is a mobile-based** AR-AI **solution for smart travel planning, integrating** AR **for real-time navigation. Developed for Android using** Java **and** Firebase, **it leverages** AR-Core, **and** Unity**, for immersive navigation and an** AI personalized recommendation. **Key features include** hybrid 2D-AR mapping, AI travel planner, and interactive gesture controls. **AI chatbots ensure scalability, while Firestore caching supports real-time updates. Preliminary results indicate** accurate recommendations and an engaging experience. **despite challenges like** device compatibility and internet dependency.

Introduction

The travel industry is full of great potential, but travelers are not able to access authentic cultural experiences with immersive experience. Current travel apps do not solve standalone issues, such as lack of booking or navigation, and instead only provide a complete apprehensive that creates deeper connections with the destination. This lack often deprives tourists of local stories, myths, and insights that enrich their travels.

VeezAR seeks to fill this void using new technologies such as Augmented Reality (AR) and Artificial Intelligence (AI) to enhance travel planning to be more immersive and interactive. The application integrates an AI-powered itinerary builder with AR-driven navigation, enabling users to experience destinations in an interactive manner. The application also enables locals to provide information regarding their localities, making the application a people-powered platform enhancing the travel experience. This study presents VeezAR as a mobile platform that uses AI and AR to provide a more interactive and culturally richer traveling experience.

Literature review

Research paper by Hwang et al. [1] discusses the effect of AI-based recommendation systems in tourism applications, where machine learning algorithms scan user preferences to create customized travel itineraries. The research also focuses on the use of chatbots and voice assistants to improve user experience, enabling real-time travel planning more effectively. Their study determines that AI integration enhances customer engagement and decision-making in tourism applications by a significant margin.

The research by Pandey et al. [2] analyzes the contribution of augmented reality (AR) to enriching tourist experience, highlighting the application of AR navigation overlays to orient visitors. Their work is centered on using Google Maps API, AR-Core, and Unity to develop an interactive tour experience. The research

concludes that live AR visualizations of monuments and points of interest enhance tourist interaction and minimize reliance on physical maps.

Another valuable contribution is that of Sharma et al. [3], who explored hybrid navigation strategies in smart tourist applications. In their work, they combine 2D mapping with AR navigation to give the user a fluid wayfinding experience. Using Mapbox and Firestore caching, their work illustrates how offline capabilities can be realized in order to enable access in rural areas with minimal internet connectivity.

Kumar et al. [4] describe cloud-based AI chatbots for tourism use cases, highlighting the benefits of cloud computing in enhancing travel assistance system scalability and efficiency. Their work examines integrating Docker-based microservices and IBM Kubernetes Service (IKS) to deploy AI-driven chatbots that give context-aware suggestions based on user inputs in real-time. The work illustrates that optimization through the cloud cuts down on the processing burden on mobile devices considerably, rendering AI applications more efficient for travelers.

In a work by Gupta et al. [5], the authors discuss the limitations and shortcomings of AR in tourism, naming device compatibility, high battery drain, and hardware constraints as major hurdles. Based on their study, edge computing and cloud computing are proposed as ways to reduce these problems to make AR apps perform more smoothly on lower-end smartphones. The research ends on a note that future innovations in cloud optimization and AI-powered interactions will even more increase the viability of AR-based tourism solutions.

A study by Singh et al. [6] emphasizes the significance of AI-based budget-based suggestions in tourism planning. The research is directed towards machine learning models categorizing user budgets into Premium, Gold, and Silver, recommending tours based on economic constraints. The research indicates that classification enhances user satisfaction and decision-making, enabling tourism to be more inclusive for a wide variety of travellers.

A study by Verma et al. [7] explains the incorporation of gesture-based AR controls in tourist apps, exploring how voice guidance and tap-to-navigate capabilities improve usability. Their study discovers that interactive AR features make travel apps more interactive and easier to use, especially for senior travelers and those who are not familiar with digital navigation aids.

Lastly, a paper by Chakraborty et al. [8] examines the future possibility of AI and AR integration for tourism, with an expectation that multi-modal AI models will be able to provide real-time travel suggestions using user behaviour analysis within no time. From their research, they conclude that virtual tour guides with AI and real-time AR overlays will completely change the travel business by providing users with a totally immersive and interactive experience.

Özkul and Kumlu [9] investigate how augmented reality (AR) can change the tourism experience by superimposing digital information like cultural information and virtual tours over real environments. Their work highlights the learning and engagement potential of AR in heritage destinations and city exploration, enhancing tourism as an interactive and contextual activity.

Williams et al. [10] describe the creation of an AR tourism application through a user-centered design (UCD) approach. They combined elements such as live maps and AR browsers within a handheld platform and demonstrated conclusively how engaging with tourists during the design stage greatly improves usability and functionality.

In a companion study, Williams et al. [11] present "ToARist," an AR tourism app developed via iterative user feedback. The app shows annotated points of interest (POIs) on smartphone screens, facilitating intuitive discovery and providing a reproducible model for user-centered AR app development.

Kounavis et al. [12] address the opportunities and challenges of applying mobile AR in tourism, specifically how it can provide immersive content and historical storytelling on site. They also touch on major technical challenges like device compatibility and user interface limitations in providing smooth AR experiences.

Yovcheva et al. [13] evaluate smartphone-based AR capability for tourist apps, noting context awareness for users and real-time localization as major success factors in an app. The authors mention that location-dependent, information-intensive tools designed for mobile travelers are important due to the impact of the iPhone.

Han et al. [14] introduce "Dublin AR," an AR-oriented project to engage urban heritage tourism. The application, with its participatory design through engagement by tourists, actually overlays physical space with historical data in an efficacious way and makes cultural telling more interesting and accessible.

Chung and Han [15] examine how AR facilitates novelty-seeking behavior among tourists, finding a strong relationship between AR use, increased satisfaction, and destination loyalty. Their findings suggest that AR can be an

effective strategy for destinations seeking to maintain visitors and generate repeat visits.

Tom Dieck and Jung [16] suggest a theoretical model of mobile AR acceptance in urban tourism. Their model identifies perceived usefulness, enjoyment, and ease of use as primary predictors of tourists' intentions to use AR applications, providing direction for developers and tourism marketers.

Rauschnabel et al. [17] develop a general framework of adoption for mobile AR through Pokémon Go as a case study. While game-oriented, their results—on enjoyment, sociality, and usefulness—are applicable to tourism AR apps that try to combine enjoyment with utility.

Kounavis et al. [18] revisit the use of AR in cultural tourism, demonstrating how interactive overlays can enhance site interpretation and visitor experience. The authors posit that AR bridges the gap between physical heritage spaces and digital technology.

Liu et al. [19] create an AR-based travel planning system that utilizes interactive, real-time overlays to help users plan travel itineraries. Their research highlights the ability of AR to simplify travel logistics while maintaining the experience interesting and user-friendly.

Yung and Khoo-Lattimore [20] perform a systematic literature review of AR and VR in tourism, with immersive experiences, personalization, and technological integration emerging as the prevailing themes. Their review urges more empirical research on user behavior, long-term adoption, and cross-cultural effectiveness of AR applications in tourism.

Methodology

The VeezAR system is developed as an AR travel buddy, providing a customized and immersive means of navigating destinations. Fundamentally, the system is designed to take users' travel needs like destination, interests, and time from them and supply a customized travel itinerary, including suggested plan and notable attractions to see. The experience is complemented with AR-based navigation that visually directs users along the way. Built as a mobile app using Java for Android, VeezAR provides seamless performance and integrates perfectly with AR capabilities. Firebase enables the system by handling user preferences and storing corresponding trip data to enhance personalization.

1. AI-Powered Itinerary Companion

At the center of VeezAR is an AI travel itinerary buddy that assists users in creating customized travel itineraries according to their individual preferences. Users only need to enter information like their destination, interests, available time, budget, and weather conditions. On the basis of these inputs, the system provides a full-day travel itinerary according to their requirements. The planning process guarantees that the recommendations are context-specific and synchronized with the user's decisions. The platform has a neat and interactive user interface where users input their preferences and receive a suggested travel itinerary instantly. Integration supports real-time synchronization between the mobile application and the AI model so that it becomes convenient for the users to obtain updates or adjust as and when required. This provides an uninterrupted, tailor-made travel experience without having to concern oneself with the underlying technological intricacies

2. Augmented Reality (AR)-Based Navigation

Apart from AI-driven itinerary creation, VeezAR enriches the travel experience with AR-based navigation. The Unity engine is combined with AR-Core and Mapbox to enable users to see landmarks, routes, and points of interest in real-time. The Geospatial Creator provides accurate location-based AR overlays so that travelers can explore cities with immersive AR directions.

Major characteristics of AR navigation are:

- AR Wayfinding: People can navigate using virtual direction arrows and 3D pointers to their destinations.
- Geospatial Mapping: It integrates Google Maps API and Mapbox to use hybrid navigation where users can switch between normal 2D maps and AR-based navigation.
- Marker less AR Experiences: In contrast to conventional marker-based AR, VeezAR supports marker less discovery, where users can view floating labels and 3D place models in real-world environments.

3. Deployment & Scalability

To support real-time processing of data and high scalability. The AI flight itinerary generation, AR data processing, and user authentication services are deployed as microservices, minimizing latency and enhancing efficiency.

Firebase Firestore Holds user preferences, itinerary history, and AR map overlays to allow real-time data refreshing and offline capabilities.

4. AI Integration

The AI technology implemented in VeezAR is created to provide users with customized and useful travel recommendations based on their

preferences including destination, dates of travel, time available, interest, and budget. According to the user's input, the system gives back a structured and useful itinerary that is suitable for the traveler. The AI operates by taking input data and producing corresponding travel plans, such as destinations to visit, approximate time lengths, and recommendations based on the user's interest. The operation of this feature is driven via an external API, which allows for instant and dynamic travel plan creation. The user engages with the AI system via a neat and interactive interface integrated into the VeezAR mobile app, getting immediate travel plans that can be viewed, edited, or saved for future use.

5. User Interaction & Experience

VeezAR is designed to be intuitive and user-friendly, offering multiple modes of interaction:

- Mobile App (Android): Developed in Java, which ensures easy integration with AR-Core, Firebase, and AI elements.
- Offline Mode: Firestore caching allows people to view stored itineraries and AR directions even without internet.
- Personalized Recommendations: The AI model continuously learns from user interactions, improving itinerary suggestions over time.
- Immersive UI/UX: The interface of the app is made for convenient navigation, less user input, and engaging AR discovery.

6. Evaluation & Performance Analysis

To validate the effectiveness of VeezAR, multiple evaluation criteria are considered:

- User Testing: Real-world testing is conducted with travellers to assess the accuracy and usability of AI-generated itineraries and AR navigation.
- Response Time Analysis: Measuring AI processing time using external LLM model APIs.
- AR Navigation Accuracy: Testing geospatial overlays for landmark positioning, route precision, and real-world alignment.
- User Satisfaction Surveys: Gathering feedback on AI recommendations, navigation ease, and interactive elements.

7. Comparative Analysis of Relevant AR Frameworks and the Advantages of the Proposed Approach

The suggested AR-based travel planning application differs by providing novel features unavailable in conventional AR platforms like ARCore and Vuforia. Although these platforms excel in motion tracking, environmental recognition, and object detection, they are primarily designed to serve general navigation and augmented purposes. ARCore, say, is built-in with Android platforms, including motion tracking and surface detection, but it's missing a general, user-focussed means of planning journeys. Vuforia, another leader in AR solutions, is also supported on Android and iOS but has a heavy emphasis on product and object AR usage and leans more towards full AR product and object-based implementations than a comprehensive journey planning experience. The suggested application, however, exceeds these frameworks in that it incorporates real-time navigation that is personalized to the user's own travel requirements, including budget limitations, time management, and health-focused eating. In contrast to current solutions, it merges AR navigation with dynamic, context-aware recommendations, so travelers have all the information they need—such as local points of interest, restaurants, hotels, and real-time transportation information—available directly in their surroundings through engaging AR overlays. In addition, the app is specifically designed for Android, maximizing its functionality on Android-based devices with seamless integration into Android's native features. Through its seamless AR navigation that not only directs users to their destinations but also provides interactive information about locations around them, the suggested app greatly improves the travel experience. The real-time capabilities are complemented by the incorporation of AI and data analytics to provide personalized recommendations according to the user's budget, location, and preferences, a major improvement over the shortcomings of ARCore and Vuforia. The personalized experience combined with budget-friendly travel arrangements and user-oriented design makes the suggested approach significantly better than the current solutions, revolutionizing the manner in which travelers plan and navigate their travels in real-time.

Experimental work

The experimental effort for the VeezAR project is the end-to-end development, integration, and testing of an AI-driven augmented reality (AR) tourism guide. The system integrates Android app development, Unity for AR-based visualization, Firebase for user authentication and cloud data storage, and an externally hosted AI model for generating itineraries. The main objective is to improve the overall travel experience through personalized travel plans

and engaging, real-time AR navigation. Each module was tested separately and then integrated into a smooth mobile platform to test performance, usability, and the efficacy of AI-driven travel suggestions.

1. System Implementation

The evolution of VeezAR is governed through a methodical pipeline that starts with the Android app, which serves as the main platform through which users engage with the AI-driven itinerary planner and AR-powered navigation system. Developed using Java, the app incorporates Unity to facilitate augmented reality visualization of points of travel and landmarks. Firebase is used to manage user authentication and cloud storage of data, enabling users to safely store their preferences and retrieve their itineraries across sessions.

AR feature, driven by Unity and ARCore, provides real-time 3D rendering of local landmarks, directions, and points of interest. This immersive strategy helps users explore new places with AR-based navigation. For navigation along routes, the app also uses the Mapbox API, combining 2D maps with AR markers for more intuitive and precise travel directions.

To help with trip planning, VeezAR features an AI itinerary companion that creates personalized travel plans from user inputs of destination, interests, time available, and budget. The system gathers these inputs and processes them through an external API fueled by a language model, which provides real-time customized travel recommendations. Customers just input essential trip information, and they get a well-presented itinerary with location suggestions, time predictions, and travel advice that match their wishes.

2. Hosting and Deployment

The VeezAR's machine learning model is run on an external API host that enables access through a friendly user interface. The users input generalized travel requirements like destination, interests, time, and budget, and in turn, obtain a customized travel itinerary based on their inputs. The model is run in a cloud environment to ensure it is accessible and responsive to multiple users simultaneously without any glitches.

3. Evaluation and Testing

In order to assess the efficiency of VeezAR, a number of experiments are performed with respect to itinerary correctness, real-time AR navigation speed, and overall user satisfaction. A set of test users use the app by choosing destinations and examining AI-computed travel itineraries. They then navigate landmarks and places of interest using the AR navigation functionalities. User feedback is collected using surveys and direct usability testing. Core performance indicators—such as relevance of suggestions, correctness of instructions, and responsiveness of the system—are scrutinized to enhance the overall experience. Early results indicate that the AI companion successfully aids travel planning, while the AR element introduces a creative and interactive dimension to tourism.

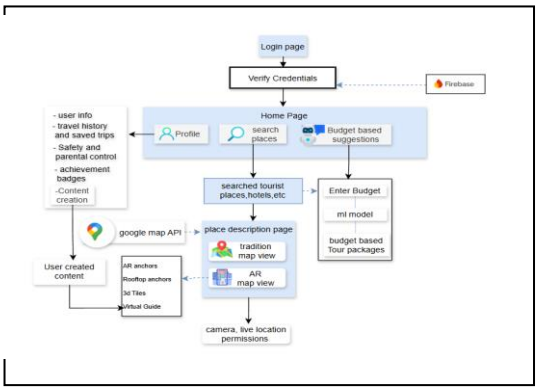


Fig – Architecture Diagram

Result

The assessment of VeezAR emphasizes its potential to rev up tourism with intelligent itinerary planning and immersive AR-based exploration. The AI itinerary assistant creates customized travel plans from basic user inputs like destination, interests, duration, and budget. The users get day-wise trip recommendations as per their interests, making the planning and discovery process more effective.

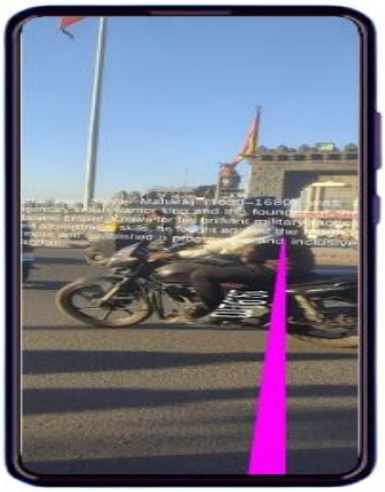
The AR navigation feature, integrated into the mobile app, provides an enriched travel experience by visually navigating users with overlays of real-world landmarks and directions. Real-world testing has ensured that waypoints and points of interest are displayed accurately, enabling travelers to move around unfamiliar regions with greater ease. The use of traditional maps with AR markers ensures a smooth and interactive experience.

Data handling and user login are managed through cloud-based services, keeping trip data secure and available between sessions. User feedback shows high satisfaction with the personalized recommendations and immersive guidance capabilities. Although minor issues like occasional delay in AR display and the requirement of internet connectivity were noted, overall performance verifies that VeezAR provides a worthwhile and interactive tourism

experience by integrating artificial intelligence with augmented reality.

I. VeezAR HomePage

II. AR NavigationPage



III. Search Location Screen

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Conclusion

The VeezAR platform combines intelligent itinerary planning and augmented reality navigation to enhance the travel experience. Through the application of AI to create customized travel plans from user inputs like destination, interests, time, and budget, VeezAR enables users to maximize their trips. The app integrates conventional 2D maps with AR overlays to offer real-time navigation, allowing users to navigate new destinations visually. Cloud-based services are utilized for seamless execution and safe data management, whereas Unity and ARCore drive the engaging AR capabilities. The testing reveals that VeezAR enhances the precision of travel planning and maintains users' engagement during their journey. Despite small setbacks such as internet reliance and occasional AR lag, the system emerges as a potential tool for contemporary tourism. Future updates might include offline capabilities, quicker response times, and multi-language support to further increase accessibility and user-friendliness.

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