**Project Title:**

**An Architecture for Mobile Outdoors Augmented Reality for Cultural Heritage**

**Abstract**

In this project, we present the software architecture of a mobile tourist guide for cultural heritage site located in the old town of Delhi, India. This includes gamified components that motivate the user to traverse the suggested interest points, as well as technically challenging outdoors augmented reality (AR) visualization features. The main focus of the AR feature is to superimpose 3D models of historical buildings in their past state onto the real world, while users walk around the part of heritage site, exploring historical information in the form of text and images. We examined and tracking mechanisms based on commercial AR frameworks in the challenging outdoor, sunny environment of, addressing relevant technical challenges. A 3D model displaying the monument in its past state is visualized onto the mobile phone’s screen at the exact location of the real-world monument, while the user is exploring the area. A location-based experience could be designed and integrated into the application, enveloping the 3D model with real-world information at the same time. The users are urged to explore interest areas and unlock historical information.By combining AR technologies with location-aware and gamified elements, we aim to promote the technologically enhanced public appreciation of cultural heritage sites and showcase the cultural depth of the city of Delhi.

**Introduction**

Augmented reality (AR) is the act of superimposing digital artifacts onto real environments. Across the reality–virtuality continuum [[1](#_bookmark16),[2](#_bookmark17)], AR is part of the broader mixed reality spectrum. It enables real-time mixing of computer generated content and real content and has already been employed for medical, military, manufacturing, and robotics training applications [[3](#_bookmark18)]. In contrast to virtual reality (VR), where the user is completely immersed in a synthetic environment, AR aims to supplement reality [[4](#_bookmark19),[5](#_bookmark20)]. While early research limited the definition of AR in a way that required the use of specialized head-mounted-displays (HMDs), a taxonomy introduced by the authors of [[6](#_bookmark21)] defined that any system that combines virtual and real imagery, accurately registering (aligning) real and virtual objects with each other, and running interactively in three dimensions and in real-time, is considered an AR system. AR software development kits (SDKs) are available to develop AR applications [[7](#_bookmark22)]. Current advances based on novel, commercial AR displays such as Microsoft Hololens and MagiLeap, as well as the huge investment drawn towards their development, showcase AR’s potential for integration into the every-day life of the consumer.

Based on mobile phones’ current technical specification enabling them to render 3D content and combine it with camera input, we developed the proposed mobile AR (MAR) application for Android mobile phones, offering a real-time, on-site, 3D depiction and visualization of historical monuments of the old town of Delhi, India. We would present a location-based AR application for Android devices that provides a sightseeing experience that aims to challenge and motivate the visitors to further explore and uncover the city’s underlying history. In this paper, we present the software architecture of the system, which seamlessly incorporates AR features for the challenging, sun-wrenched outdoor environment. The system proposed includes gamified scenarios and advanced AR features that enhance user experience while the visitor walks around interest points. The main functionality is incorporated in a digital map including the AR camera view. The main focus of the AR feature is to superimpose 3D models of historical buildings in their past state onto the real world, while users hold their consumer-grade mobile phones while walking on-site. Historical information in the form of text and images is available at the same time.

The old heritage part of the city of delhi was selected as the main spatial location for its rich history, enriched by influences from other cultures. Adverse climate conditions, modern city planning, and rapid expansion have slowly compromised the state of these sites, thus endangering their historical value over time, as well as their original beauty. For this work, a specific route around the heritage part of the city of Delhi would be selected as the main route that a tourist holding a mobile phone would traverse in relation to AR visualization.



Figure 1. A heritage site model showing in delhi, India

**Literature Survey**

In comparison with older see-through AR displays, which were head-mounted, based on cumbersome hardware and complicated software modules, a recent emergence in mobile technology has led to an integrated platform, ideal for the development of AR experiences, often referred to as mobile AR (MAR). MAR is a concept first conceived in the late 1990s, producing early AR systems for cultural and archaeological sites, mainly indoors. However, today’s modern smartphones have brought AR to a wider audience. The presence of high processing power, cameras, and inertial and global positioning system (GPS) sensors provides the necessary components of an AR system in an ergonomic hand-held device.

In past years, AR has been utilized for a number of applications in cultural heritage. *Archeoguide* was first presented using AR for personalized tours in cultural heritage sites [1]. The system allowed users to experience a VR world featuring computer generated 3D reconstructions of ruined sites without isolation from the real world. Two years later, an extended version presented a personalized mobile guide for outdoor archaeological sites [[3](#_bookmark28)], employing the site of Ancient Olympia as a test case [[4](#_bookmark29)]. The system provided on-site help and AR reconstructions of ancient ruins. It made use of a compass, a DGPS (differential global positioning system) receiver integrating images streamed from a webcam, and the users’ location and orientation. Visitors carried a backpack computer that performed the calculations, and wore a see-through head-mounted-display (HMD) to display the digital content. By today’s standards, the system was cumbersome and heavy. Despite the ergonomic restrictions, it was very well-received by the visitors as it provided a unique site-seeing experience [[4](#_bookmark29)].

A MAR application representing a historical tour guide including old photographs and information about a historical street has been reported in the work of [[5](#_bookmark30)]. An early overview of AR in cultural heritage highlighted the technical problems of AR development, mostly centered on registration and rendering issues, as well as having to rely on black and white markers for correct alignment [[6](#_bookmark31)]. Other AR approaches aimed to connect the excavation site with the artifacts in the museum in order to enable contextual awareness of the visitor [7]. The Augmented Representation of Cultural Objects ARCO system combined VR and AR, enabling museums to display their 3D, digitized

collections on the web [[8](#_bookmark33)]. The users could interact with sensor-enhanced physical objects while their digital reconstructions were simultaneously manipulated [[9](#_bookmark34)]. An AR framework for on-site visualization of archaeological data employed visual tags, overlaying 3D models on images provided in real-time by the phone camera, aiming to display accurately positioned information [2].

With the emergence of smart mobile devices, sophisticated AR experiences were made possible. The system superimposed3D reconstructed buildings on the actual site, visualizing their past and present state.

Putting forward a mobile, personalized, location-aware MAR experience taking place in the historical part of Delhi, India, we aim to enhance user experience and interaction with cultural heritage sites and showcase the city’s cultural wealth, as well as to address technical challenges related to registration techniques for AR outdoors. The mobile AR application presented features a database that holds records of historical monuments on-site. The database stores users’ documentation of their visits and interactions in their areas of interest, available to each user that signs in. AR development of a city poses significant technical, as well as user interaction, challenges. Reliable position and pose tracking is paramount so that the 3D content representing the monuments in their past state.

**Objective**

In this work, we would present the design and implementation of a MAR (mobile augmented reality) application for Android devices that provides on-site 3D visualization of historical buildings located in the historical part of Delhi, India. These are superimposed over their real-world equivalent, as part of a smart AR tourist guide. Further to 2D images and text often presented by mobile tourist guides, we aim to enrich the sightseeing experience by providing a means to visualize the past glory of these sites in the context of their real-world surroundings. Taking into consideration the historical significance of the monuments, our approach offers the opportunity to interact with them in non-intrusive ways, without physically interfering with the remains and on-going archaeological research. In order to accurately record the geo-location of the monument and provide real-time tracking, the standard sensors of a mobile phone are used. The implementation of the software does not require any physical contact with the monument.

**Research Methodology**

1. AR methodology
2. 3D depiction of historical monument
3. Geo location
4. Client server implementation
5. Mobile application
6. AR activity
7. Interface and User experience

**Gantt Chart**

Idea Phase

Req. Gathering

24/3/19 to 7/4/19

10/3/19 to 23/3/19

24/2/19 to 9/3/19

14/2/19 to 23/2/19

Testing

Interface

User experience

AR Activity

Mobile application

3D depiction

Sight seeing

Functions

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