AUGMENTED REALITY IN TOURISM

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ABSTRACT

Augmented reality is a complex interdisciplinary field utilizing technologies in diverse areas such as education, architecture, industry, tourism and others, augmenting the real-time, real-world view with additional superimposed information in chosen format.

SAFRAAN consists of a set of software services that act on mobile distributed hardware and can communicate via wireless networks. This communication allows to carry personalized mobile devices with embedded services, while intelligent environments provide location based services. The services discover each other and dynamically cooperate to provide desired functionality. This study uses Wikitude SDK modeling to create a three-dimensional model of the scene and to detect and track the functions. Interactions between virtual buttons and virtual reality can also be created as virtual buttons. The AR application in the Wikitude SDK is a hub that connects the virtual world with reality.

A critical issue of Augmented Reality is the large quantity of data, which must be managed in a distributed system. This data must be reliably delivered to services that provide user access on that data. The handled data must be in a consistent state all over the system. Database systems can be used for parts of the management of data to guarantee persistence and efficient handling.

A comprehensive analysis resulted with the identification, compilation and categorization of the key factors having the most relevant impact on the success of utilization of augmented technology in tourism domain.

1 Introduction

1.1. Introduction

Tourism is one of the fastest growing economic sectors in the world. There certainly is a special fascination about traveling. Discovering new places, tasting new food or drinks, learning about inspiring cultures and customs, getting to know about fauna and flora of a region, meeting people from all over the world, becoming acquainted with thrilling history and culture, listening to an enthralling foreign language, experiencing different climates and weather, marvelling at creative and diverse fashion, discovering foreign art, enjoying festivals and cultural events and last but not least indulging in a relaxing and amusing time. Imagine adding to this joy with future-oriented technology by simplifying traveling aspects and enabling tourists to explore and experience more than is currently possible. Augmented reality technology is advancing and several use cases could be of great interest within the tourism sector, for example:

• Presenting the attraction from a different perspective (e.g. from an aerial view)
• Depicting buildings, rooms etc. which are not accessible
• Virtually rebuilding historic places
• Presenting a specific scenario (e.g. a battle)
• Guiding a tourist and offering further information (as text or audio)

AR mainly enhances the user's perception of the real world based on the information offered by computer system and reality can be “augmented” by means of overlaying the computer-generated virtual objects, scenarios and system prompts to the real scene. It primarily assists human beings in displaying the unreachable scenes in the real world.

AR is a technology that seamlessly integrates real-world and virtual information. The physical information that is not easy to experience in the real world in a certain time and space is simulated and superimposed by using computing technology. Virtual information is applied to the real world and perceived by human beings. So the experience surpassing the reality is achieved. Real environment and virtual objects are superimposed on the same screen or space in real time.

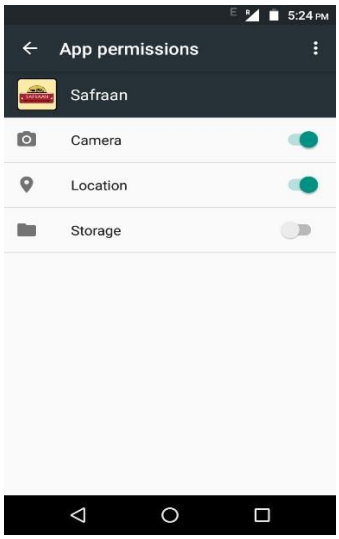
1.2 **Scope**

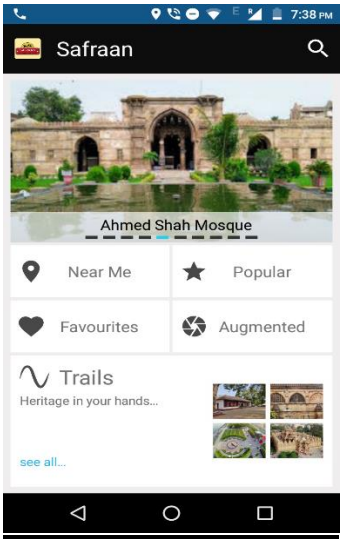
Information and Communication Technologies are becoming one of the most important information tools in the 21st century. Their impact affects the lifestyle, the way of learning and working of the people, as well as the way in which institutions interact with society. Technology has transformed the search for information into a more interactive and fast process, but also has increased the expectations for an information system.

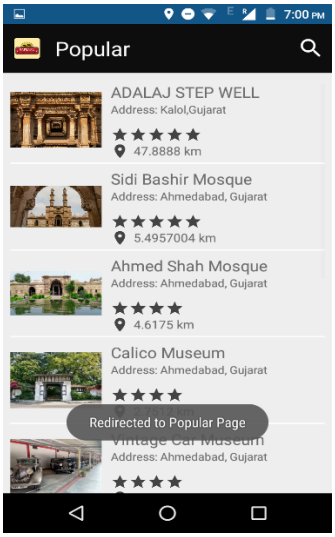
Furthermore, there is a huge amount of information in digital format, including audiovisual content, electronic texts, multimedia applications or geographical information systems. Up to now, this information is barely used by electronic guides, staying unreachable for the visitor. Moreover, existing multimedia presentations are far away from the real environment which means that tourists need to leave the tourist site to gain additional information. If tourist organizations want to reach wider audiences, they would have to build attractive multimedia content that attracts tourists. Therefore, new systems that support these innovative applications and provide added-value content are required.

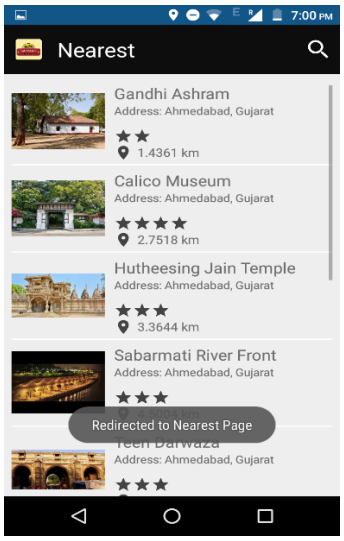
The main objective of Safraan is to combine the needs of tourists in real environments and Augmented Reality technologies. The use of these technologies will allow the users retrieving personalized and interactive multimodal information about monuments and historical buildings of a city.

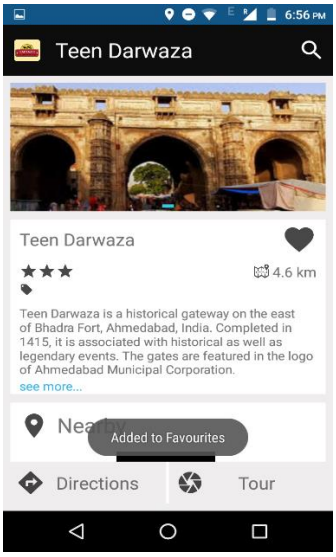
1.3 **Project Summary**

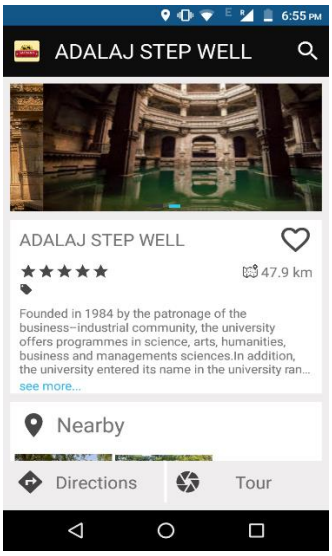


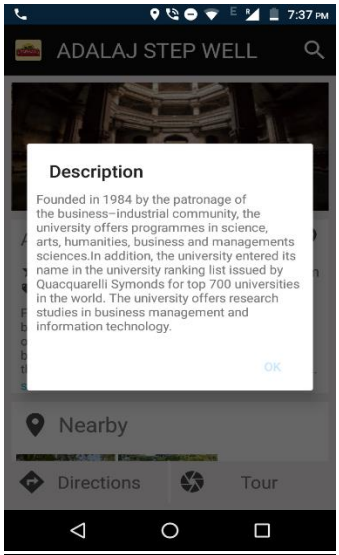


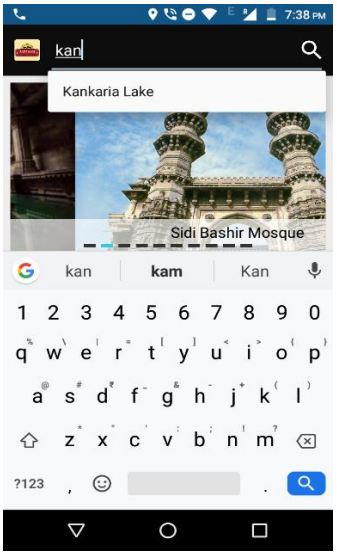


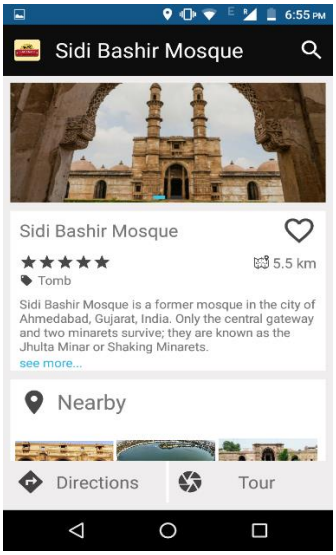


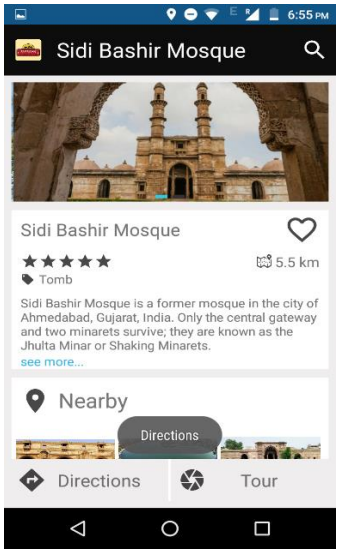








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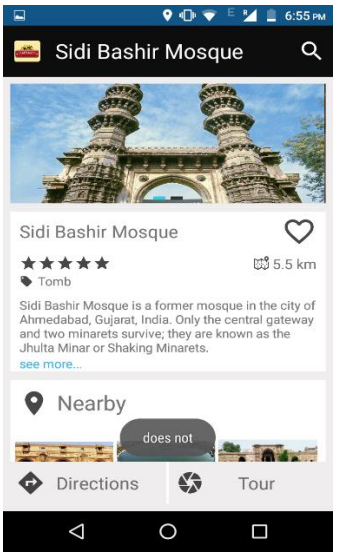
Sidi Bashir Mosque
Sidi Bashir Mosque
5.5 km
Tomb
Sidi Bashir Mosque is a former mosque in the city of Ahmedabad, Gujarat, India. Only the central gateway and two minarets survive; they are known as the Jhulta Minar or Shaking Minarets.
see more...
Nearby
Directions
Directions
Tour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Sidi Bashir Mosque
Sidi Bashir Mosque
5.5 km
Tomb
Sidi Bashir Mosque is a former mosque in the city of Ahmedabad, Gujarat, India. Only the central gateway and two minarets survive; they are known as the Jhulta Minar or Shaking Minarets.
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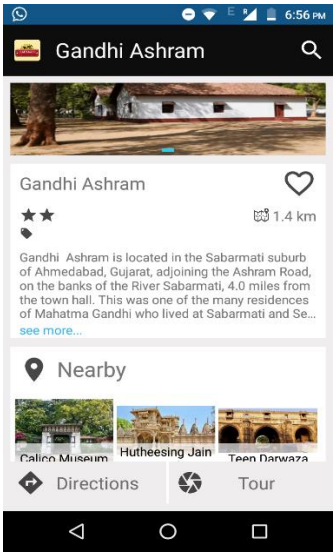
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Gandhi Ashram
Gandhi Ashram
1.4 km
Gandhi Ashram is located in the Sabarmati suburb of Ahmedabad, Gujarat, adjoining the Ashram Road, on the banks of the River Sabarmati, 4.0 miles from the town hall. This was one of the many residences of Mahatma Gandhi who lived at Sabarmati and Se...
see more...
Nearby
Calico Museum
Hutheesing Jain
Teen Darwaza
Directions
Tour


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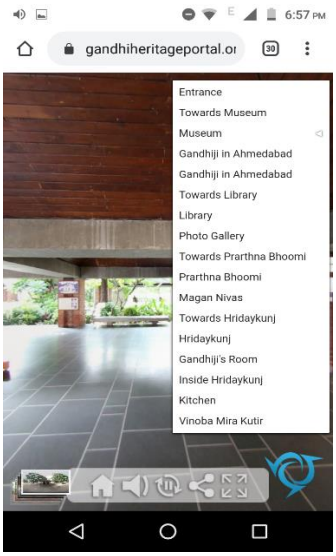
andhiheritageportal.org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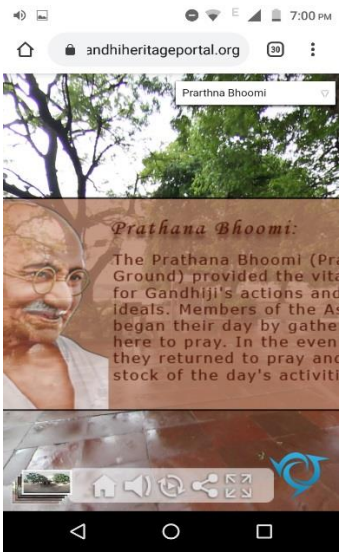
gandhiheritageportal.or
Entrance
Towards Museum
Museum
Gandhiji in Ahmedabad
Gandhiji in Ahmedabad
Towards Library
Library
Photo Gallery
Towards Prarthna Bhoomi
Prarthna Bhoomi
Magan Nivas
Towards Hridaykunj
Hridaykunj
Gandhiji's Room
Inside Hridaykunj
Kitchen
Vinoba Mira Kutir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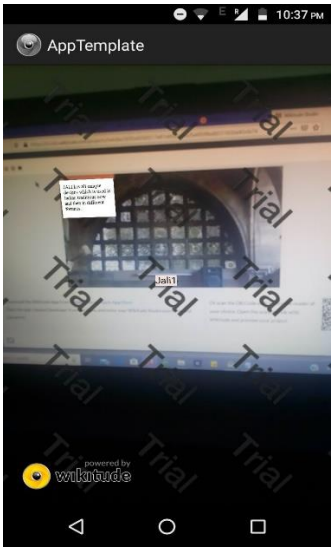
Gandhiji in Ahmedabad


10:37 PM
AppTemplate
Trial
powered by
wikitude

1.4 **Overview of the project**

Using technology to superimpose information - Image/ Video/ 3D Model/ Label/ Button, on the world we see is Augmented Reality.

People want to visit and move in the city or countryside. If only a few people can be provided with a service at once (to experience a complex and interactive room scale scenario), the tourist needs to book an appointment. This is an annoyance since the whole day or trip must be scheduled around this appointment. For tourism an important aspect must be taken into account: **How many users can be served at once?**

To overcome above aspect SAFRAAN provides a virtual guide which serve many people at the same time.

The vision is to enable the customers to discover more than possible and experience new locations while gaining knowledge and having fun.

The mission is to enable the customer to discover more in one visit in a convenient and fun way.

The goal is to enhance what already exists.

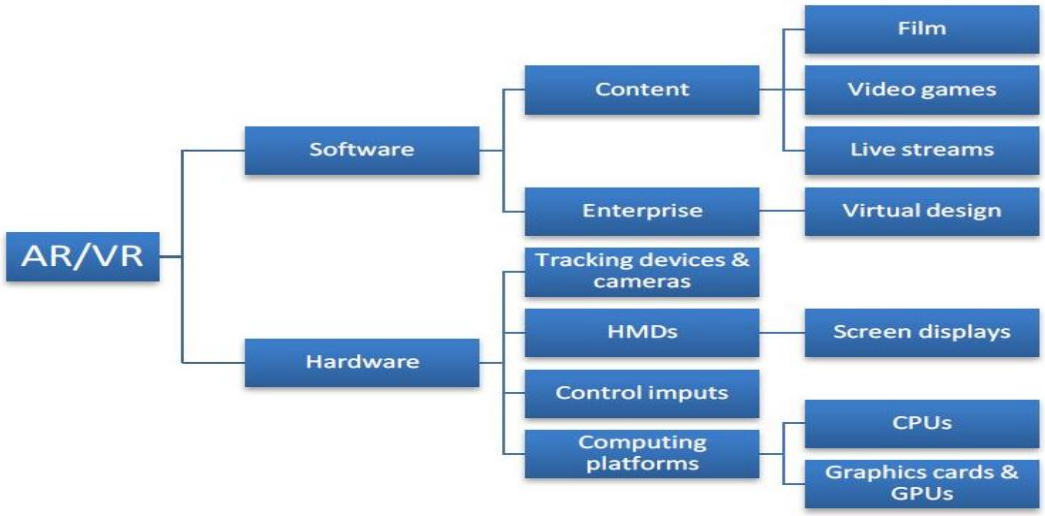


Fig.1 (a)

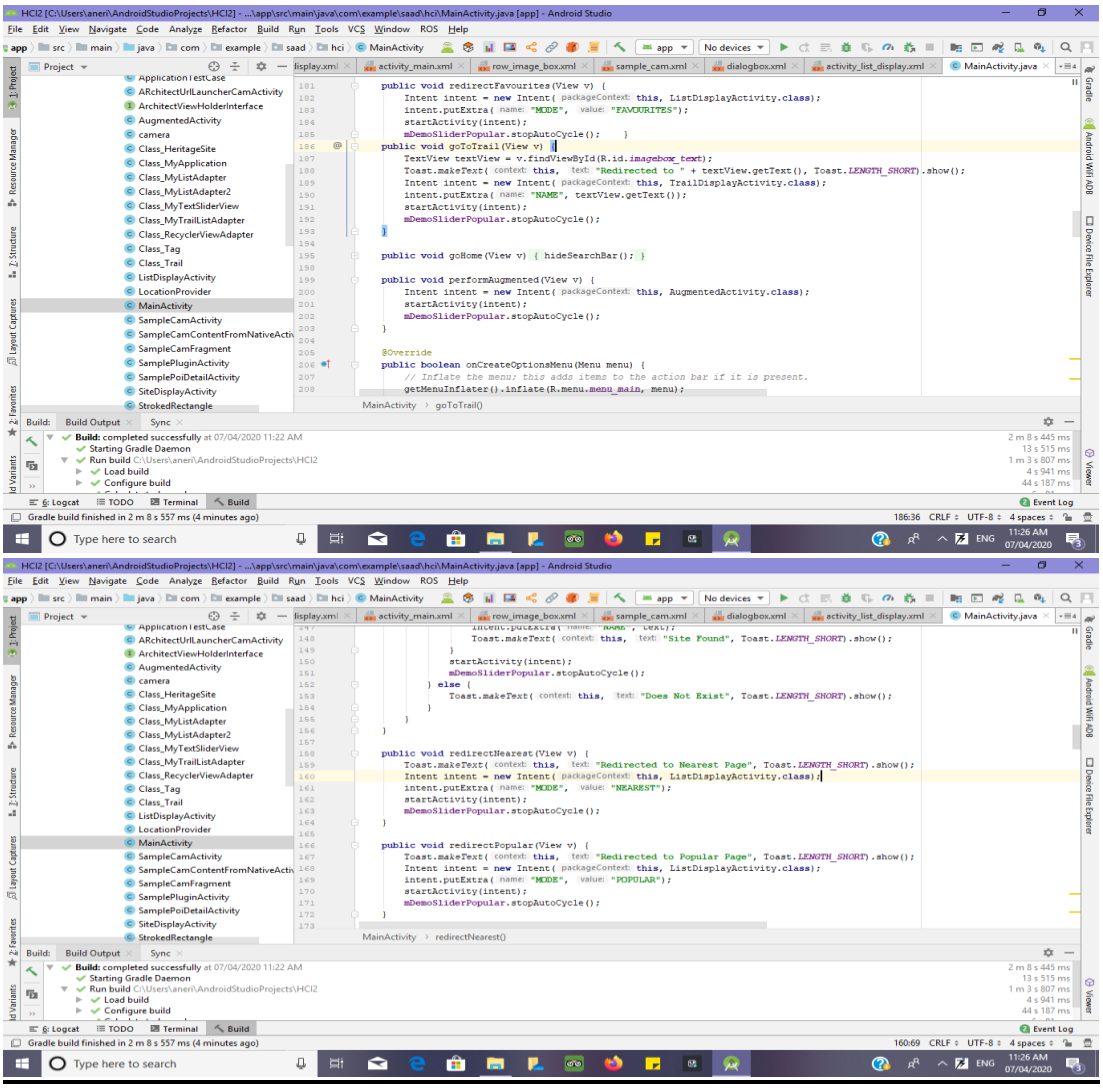
2 Technology and Literature Review

2.1 About Tools and Technology

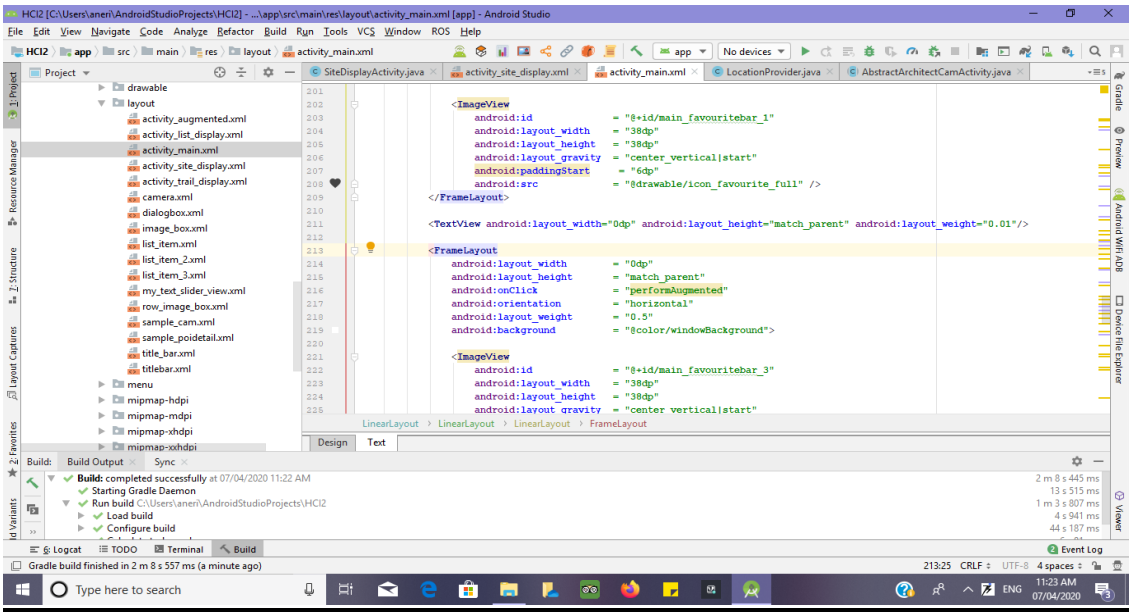
Android studio for Application Development
Wikitude for making AR objects
Mapbox for Directions
OpenGL ES
ARCore

2.2 Brief History of Work Done

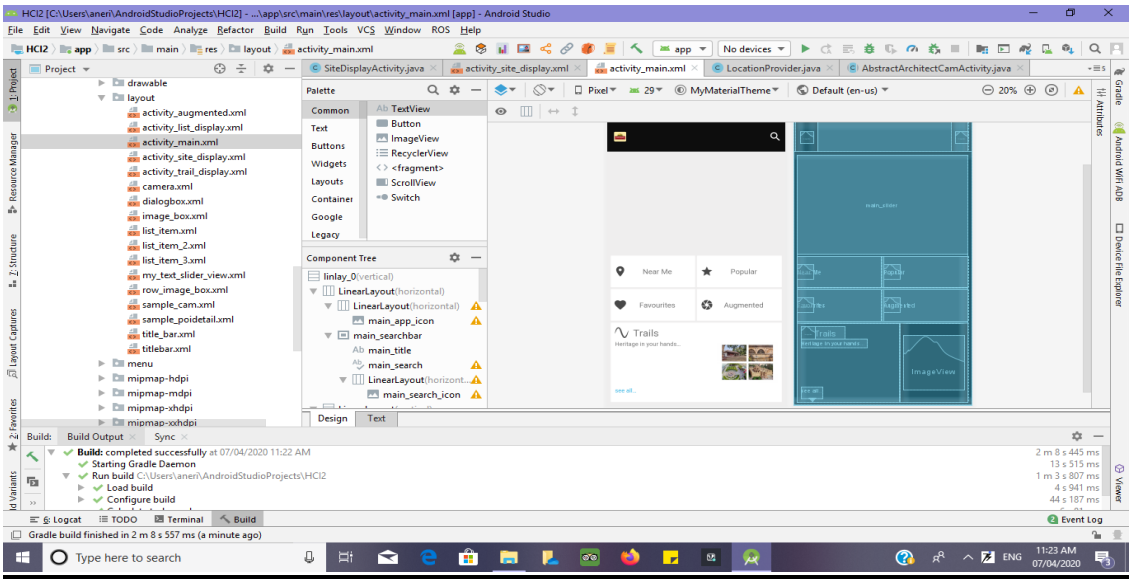
2.2.1 Developing the Application



MainActivity.java

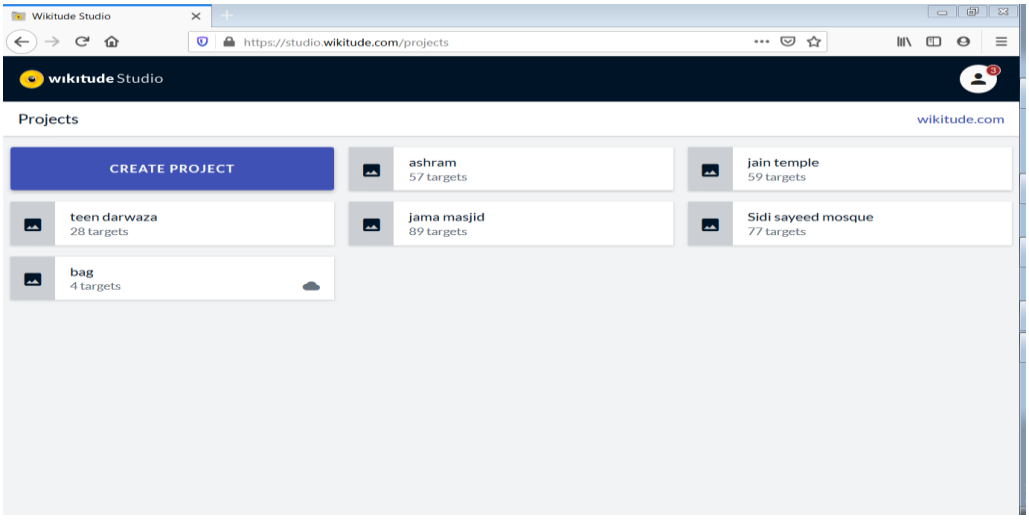


activity_main.xml
Text format

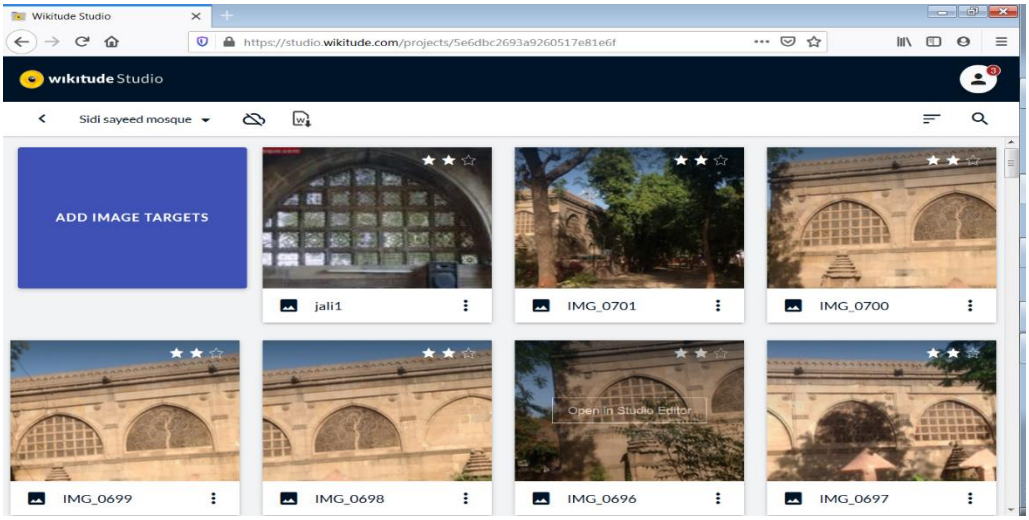


activity_main.xml
Design Format

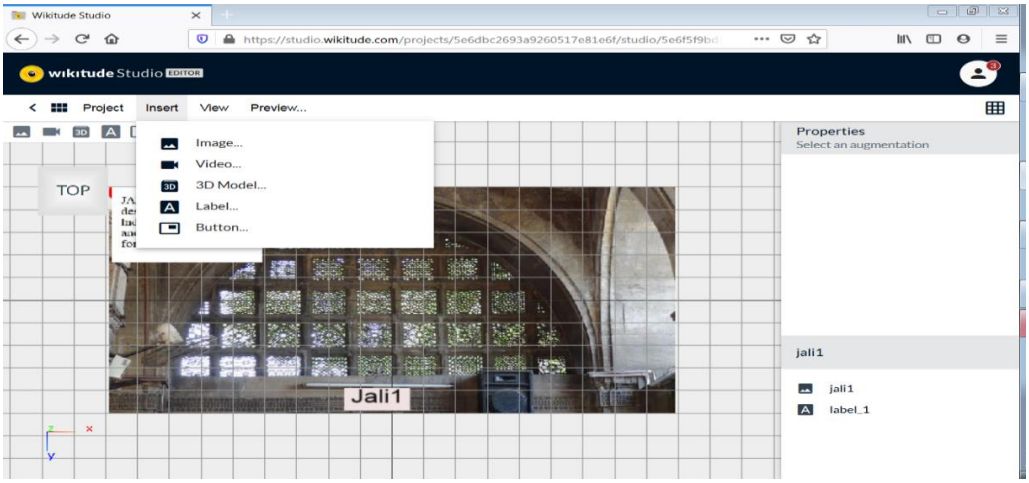
2.2.2 Developing Augmented Objects



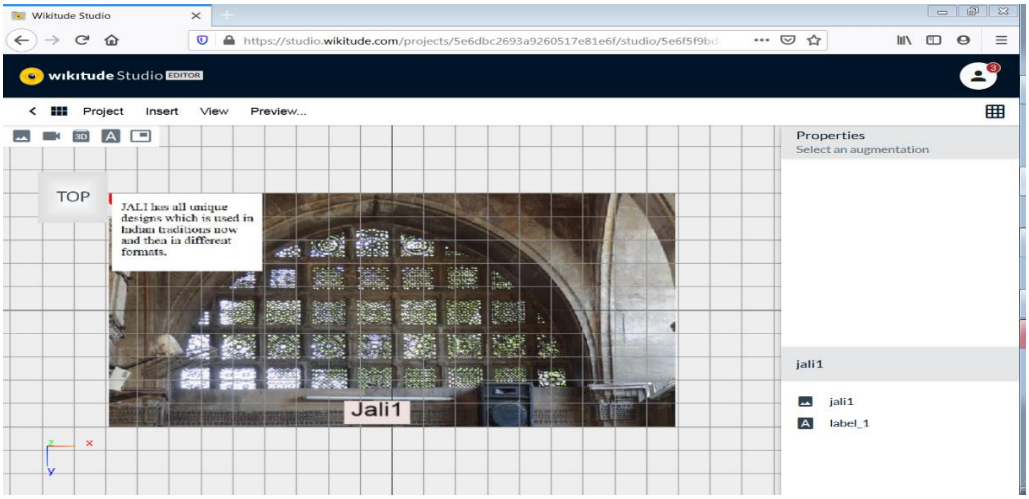
Create a project in Wikitude Studio.



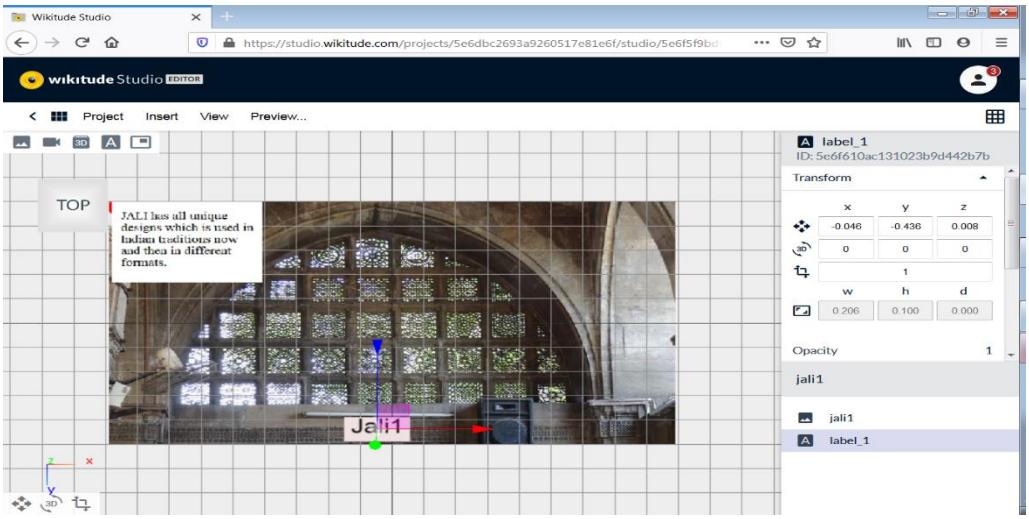
Add Image Targets



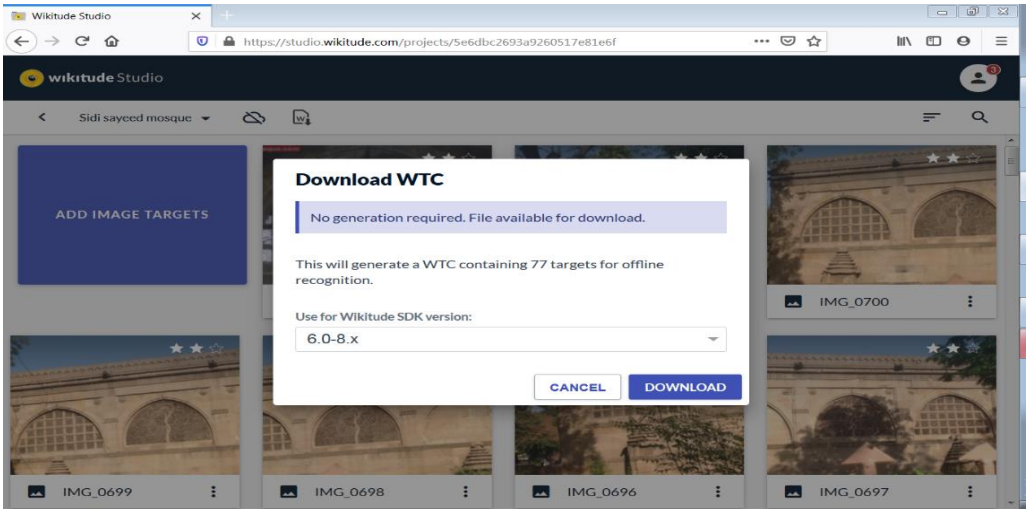
In the Studio Editor, Add Image/ Video/ 3D Model/ Label/ Button to make AR Object.



It will look like this.



Position the AR Objects according to the way you want to display.



Download WTC (Wikitude Target Collection). Add the WTC file in the assets folder in Android Studio Project for offline recognition.

2.2.3 Integrating Augmented Objects with the Application

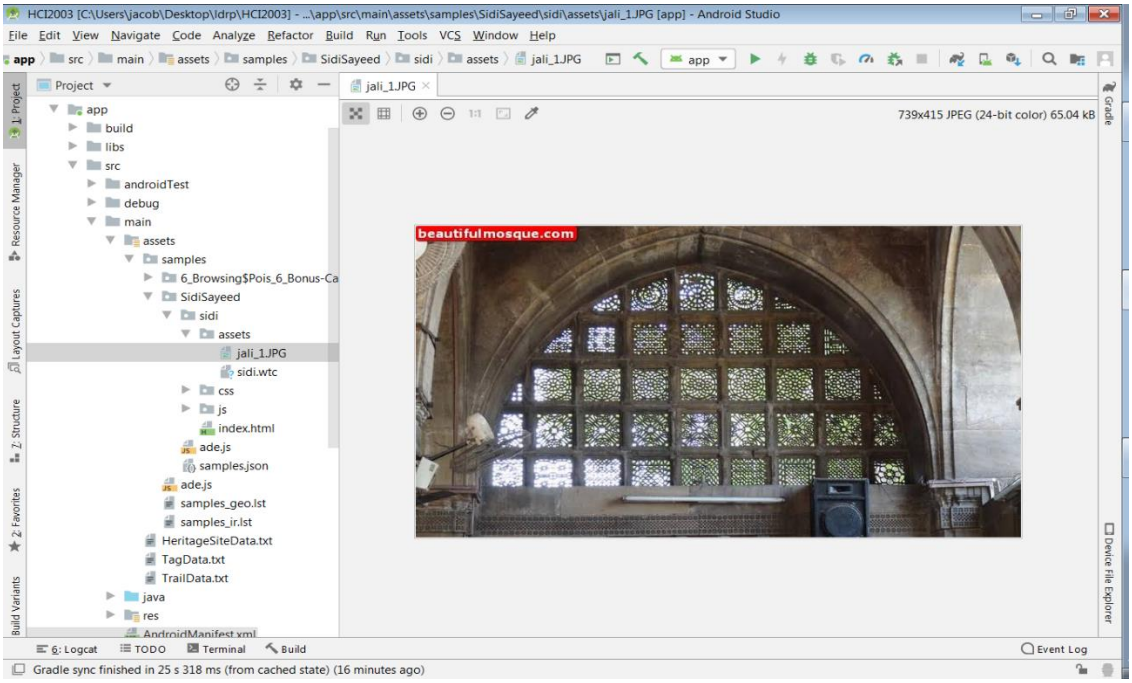
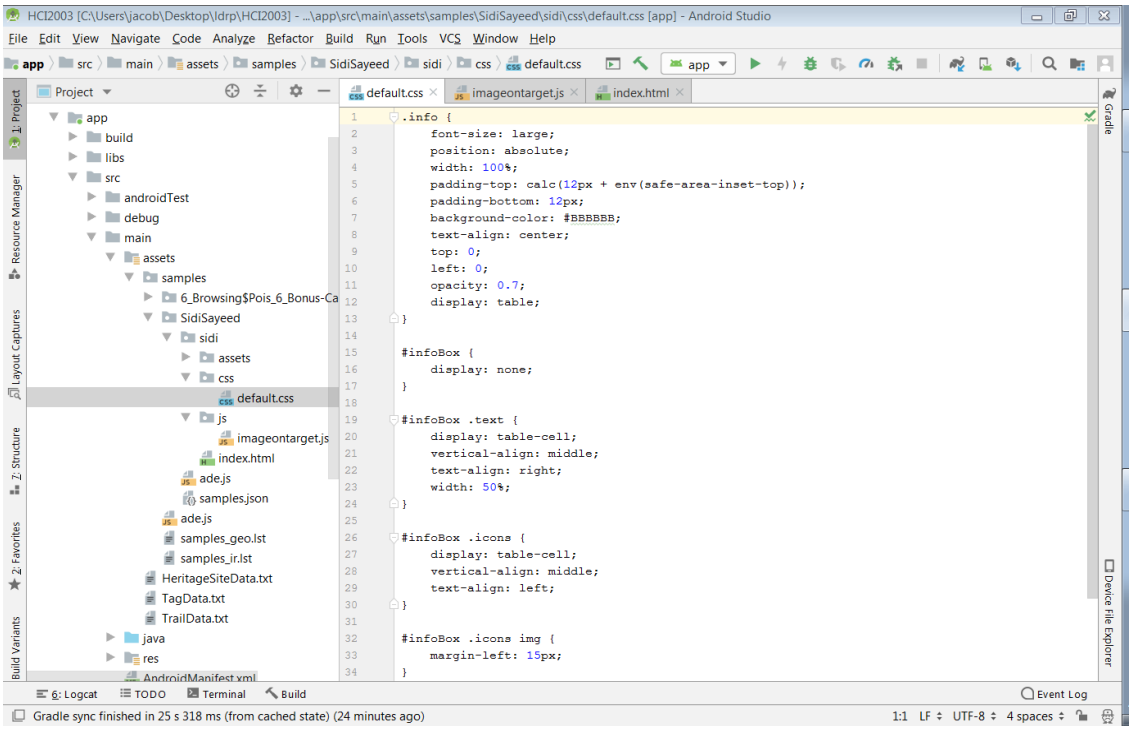
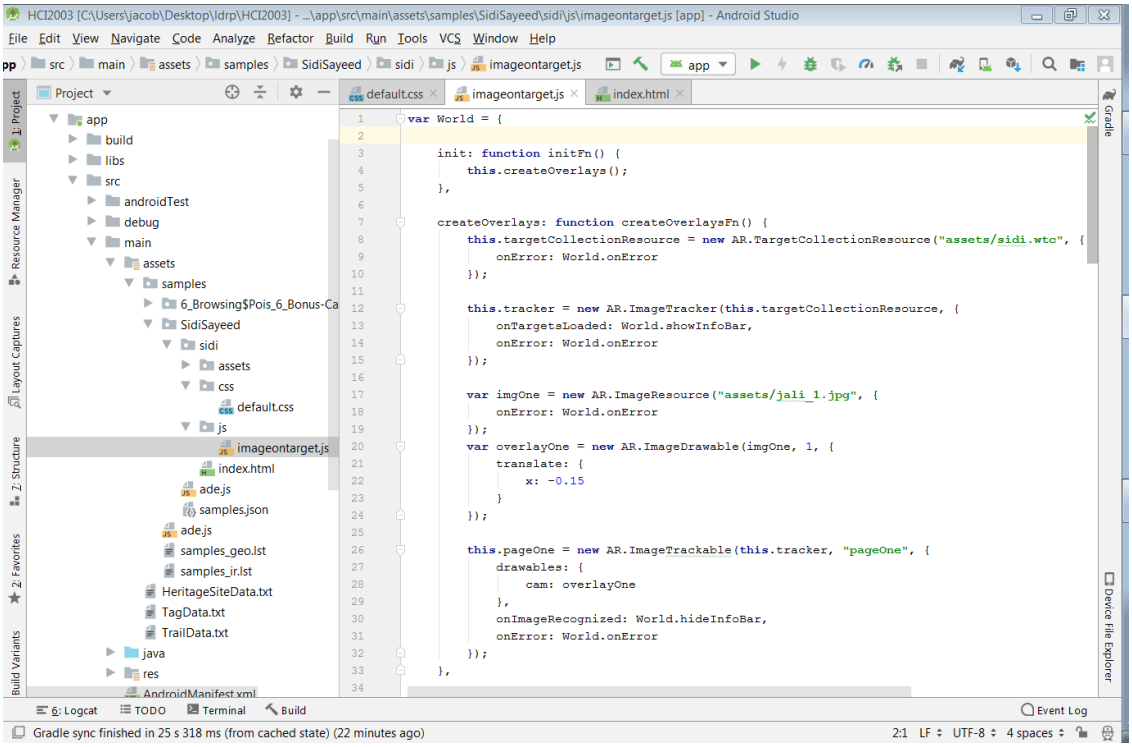


Image to be Augmented through the Application.
Add the WTC file in assets folder.

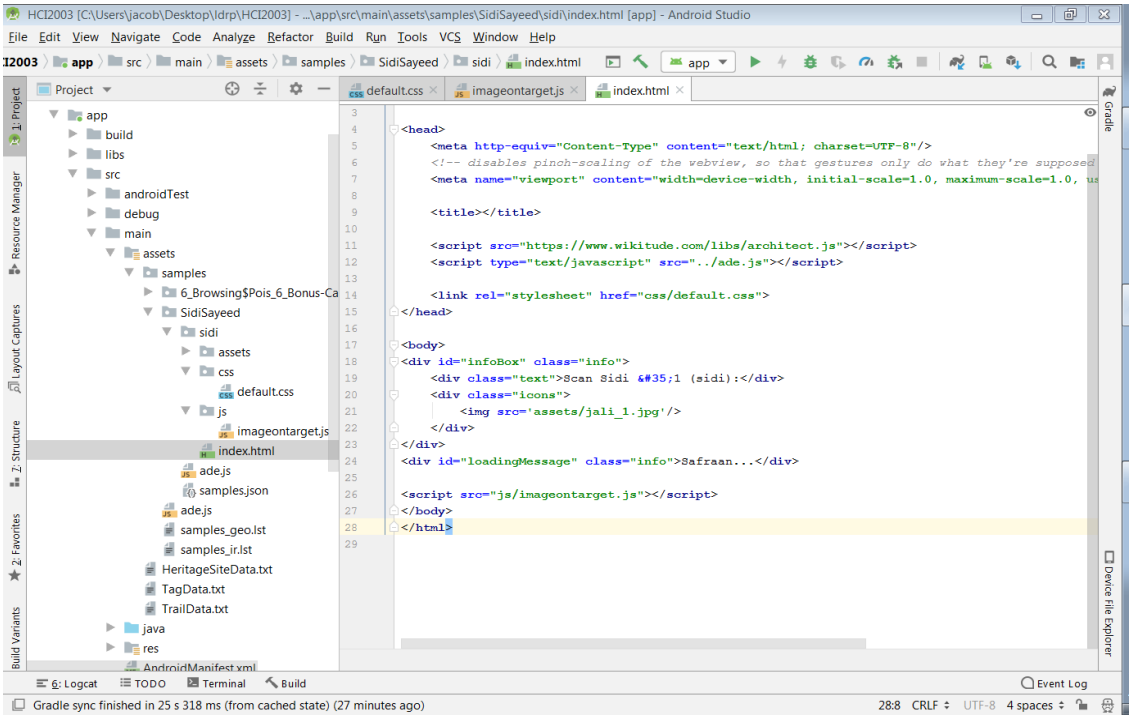


Default.css
Layout file for the view



imageontarget.js

Code for placing the augmented object on the image.



index.html

It will launch when the Augment button is clicked.

3. System Requirement Study

3.1 User Characteristics

The physical environment is enhanced in real-time with virtual elements, so that the real world is enriched with further information. This digital information can be Image, Video, 3D Model, Label, Button. The goal is to enhance what already exists.

The software is supposed to provide detailed information to the user about the concerned place where the marker is there. It is intended for tourist seeking additional information about the place they are visiting. It uses the camera, a module of the mobile phone to identify markers and uses the display to present the information about spot. A database is used to match the marker detected against the defined markers. If a match is found, the relevant data is fetched from the database. If no match is found, the marker is ignored.

3.2 Software and Hardware Requirements:-

3.2.1 Software Requirements:-

Customer:-

- Access to camera.
- Access to location
- Access to storage

Database Management System:-

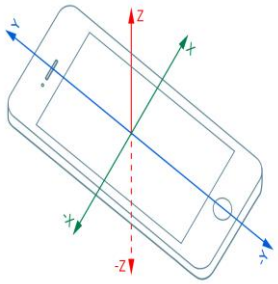
- OpenGL ES
- Wikitude Studio
- Mapbox
- AR Core

3.2.2 Hardware Requirements :-

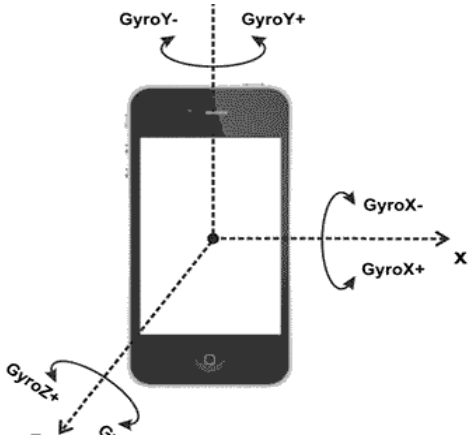
As our project is developed for mobile application the minimum requirements are:

- Android Device
    - Android version: 5.1.1 or above
    - Display screen: For Viewing real world with AR objects. It displays 3D rendered assets.

- For Motion Tracking an Android device having
    - Camera: supplies live feed of surrounding world.
    - Accelerometer: measures acceleration



    - Gyroscope: measures and maintains orientation and angular velocity. It measures rotation of phone and ensures that digital assets respond correctly.



- For Location Based AR an Android device having
    - Magnetometer: Device always knows direction of north, allowing it to autorotate digital maps depending on physical orientation.
    - GPS: provides geolocation and time information to GPS receiver.

- Computer
    - RAM:4GB
    - Memory:20MB

3.3 Functional Requirements

- **Moving and Placing Objects**: Rotating and moving functions for 3D models should resemble the real world physics.
- **Interrupted Work**: Must preserve the modeling states when the user switches back and forth between different applications.
- **Creating objects**: Virtual objects must be creatable on specified positions with a specified type.
- **Relocating Objects**: Every change must be processed by the registering service, that information must be stored.
- **Relative Positions**: Object storing components have to provide means to compute these transformations relative to an arbitrary other object.
- **Changing Properties**: To handle variability in general framework components, it must be possible to store an arbitrary amount of arbitrary properties associated to each object.
- **Different Appearance**: The same object can appear in different views.
- **Searching**: A component holding information about the real world and augmented virtual scenes must provide interfaces to access information about required objects.
- **Grouping Virtual Components**: Items may belong to other things, so a grouping mechanism is required combining several objects to handle them as a whole object.
- **User Interface**: Only software interfaces that are used by other components shall provide functionality.
- **Consistency**: After every change on objects, all services working on these data must receive a notification about the details of the change. The update mechanism must be efficient and to preserve data in cases of component failures.
- **Privacy:** The data must remain in the user private environment and only be accessible to him. Changes on private data shall not be distributed to other system components.

3.4 Non-functional Requirements

- **User-friendly:** The application must be designed so that it is easy for the users to use.
- **Response Time:** The application should have minimum response time.
- **Informative data:** The content displayed must provide more information about the subject than the image
- **Correct in Place Alignment of Virtual Objects**: The viewing display must be calibrated so that virtual graphics are rendered in the position and orientation corresponding to the real world.
- **3D Augmentation**: Spatial impressions of the outer shape of constructions such as buildings require three dimensional views on the virtual model.
- **Real-time**: The view must update rendered objects at a high speed and accuracy so no significant differences can be seen compared to real objects in behavior.
- **Mobility**: The user's Augmented Reality device should support mobility and provide the execution of the application wherever possible without requiring additional setup steps. This encourages better collaboration between participants.
- **Robustness**: The system has to differentiate input devices by users to avoid ambiguous data streams.
- **Quality of Service**: Changes done by a user in a collaborative session must propagate to views of the colleagues.

3.5 Assumptions and Dependencies

- The phone used to access this application must have internet connectivity.
- The phone used to access this application must have GPS connectivity
- Information which has been already uploaded can only be shown.
- Self-learning is not possible in AR.

4. System Analysis

4.1 Study of Current System

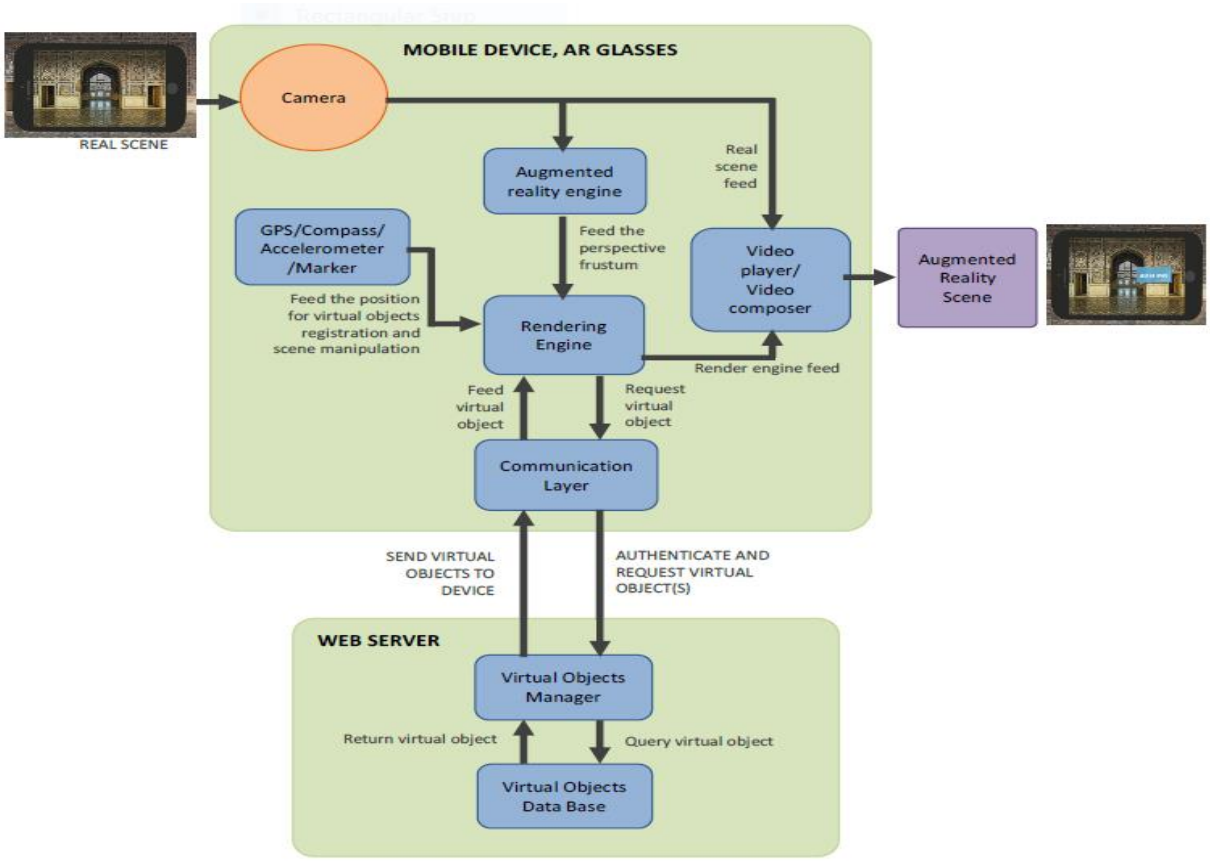


Fig.3 (a)

Generally, there are two basic steps to generate AR: detection and overlay. First the camera needs to detect the object or reference point which indicates that AR should be applied. In second step the virtual content will be overlaid on the camera feed according to the detected reference point. Normal information needs to be triggered manually. The advantage of AR is that the information is displayed automatically. The AR device needs to know where the users are and what they are looking at. The detection problem is known as tracking and can be split in two categories: marker-based and markerless. Marker-based systems use physical-world symbols as a reference point. These can be two dimensional printed markers like barcodes or data-matrix codes which the user can scan with the camera so the computer can interpret the symbol and overlay virtual objects or get positioning data without GPS.

Markerless systems use a combination of GPS, compass and accelerometer to determine the position in the physical world, the way the device is pointing and on which axis the device is operating. The data gathered from these resources can be compared to a database to identify what the device is looking at and provide the appropriate information or graphics to be shown on the display.

Image Recognition

Shows how to recognize images in the viewfinder and overlay it with images. Furthermore it shows how to recognize multiple different images and how to react on user clicks on the overlaid elements.

- **Target**: A target image and its associated extracted data that is used by the tracker to recognize an image.
- **Target collection**: An archive storing a collection of targets that can be recognized by the tracker.
    - Plain: A regular ZIP file containing images in plain JPG or PNG format
    - Pre-processed: Regular images that are converted into a WTC file (Wikitude Target collection) for faster processing and storing more images offline.
- **Image Tracker**: The tracker analyzes the live camera image and detects the targets stored in its associated target collection. Multiple trackers can be created, however only one tracker can be active for recognition at any given time.

Instant Tracking

It immediately starts tracking in an arbitrary environment. This enables very specific use cases to be implemented.

Object and Scene Recognition

Object Recognition and Tracking extend the capabilities of the Wikitude SDK to recognize and track arbitrary objects for augmented reality experiences. The feature is based on Wikitude's SLAM(Simultaneous Localization And Mapping) engine that is used throughout the SDK for any kind of tracking the environment. Object Recognition and Tracking let you detect objects and entire scenes, that were pre-defined by you. Suitable objects include

- Toys
- Monuments and statues
- Industrial objects

Recognition works best for objects that have only a limited number of changing/dynamic parts.

SLAM analyzes, understands and orients themselves to the physical world. It uses camera, Depth sensor, light sensor, gyroscope, accelerometer.

Geo AR (Points of Interest)

The Point Of Interest (POI) will show how you can create a marker that is placed at a specific geolocation. You will have a complete and reusable marker at the end of the series which has a title, description, a selected and an idle state which animates smoothly from one to another.

Cloud Recognition

The Wikitude Cloud Recognition service is a cloud-based service provided by Wikitude, which recognizes images sent from Android and iOS apps using the Wikitude SDK. The recognized images are then tracked in the live camera feed and can be used for augmented reality experiences.

3D Rendering

This example shows how to augment a target image with 3D content. It starts by displaying a 3D model on a target and advances by adding displayed animations, interactivity and demonstrates the snap-to-screen functionality.

Video Drawables

Videos in an augmented reality scene are an effective way to provide a spectacular experience to your users. Videos can run in **three modes** and can come from **different sources**. In general you can't upload videos to the Wikitude backend but need to use self-hosted videos or videos from an online video service (like YouTube).

Available modes:

- Fullscreen Videos
- Overlay Videos
- Overlay Videos with transparency

Supported video sources:

- Self-hosted video
- YouTube
- Vimeo

4.2 Problem & Weakness

- Designed for one specific scenario with pre-defined model hardcoded
- Mainly developed on one platform only. The lack of multi-platform support limited the usage of the system.
- Most of the system lacks effective and intuitive interaction method. The system was only used for visualizing the results.

4.3 Feasibility Study

4.3.1 Technical Feasibility:-

- This is concerned with specifying and software that will successful satisfy the user requirement the technical needs of the system may vary considerably, but might include:
    - The facility to produce outputs in given time.
    - Response time under certain conditions.
    - Ability to process a certain volume of tasks at a particular speed.
    - Facility to communicate data to distant location.
- In examining technical feasibility, configuration of the system is given more importance than the actual make of hardware. The configuration should give the complete picture about the system's requirements.
- At the feasibility stages, it is desirable that two or three different configuration will be pursued that satisfy the key technical requirement but which represent different levels of ambition and cost. Investigation of these technical alternatives can be aided by approaching a range of supplies for preliminary discussion out of all types of feasibility. Technical feasibility generally is the most difficult to determine.

4.3.2 Operational Feasibility :-

- It is mainly related to human organizational and political aspects. The points to be considered are:

    1. What change will be brought with the system?

    2. What organizational structures are distributed?

    3. What new skills will be required? Do the existing staff members have these skills?

    4. If not, can they be trained in due course of time?

- Generally, Project will not be rejected simply because of Operational infeasibility but such consideration is likely to critically affect the nature and scope of the eventual recommendation. This feasibility study is carried out by a small group of people who are familiar with information system techniques who understand the parts of the business that are relevant to the project and are skilled in system analysis and design process.

4.3.3 Economical Feasibility :-

- More commonly known as Cost/benefits analysis: the procedure is to determine the benefits and savings that are expected from a proposed system and compare them with costs. If benefits outweigh costs, a decision is taken to design and implement the system. Otherwise further justification or alternative in the proposed system will have to be made if it is to have a chance of being approved. This is an on-going effort that improves in accuracy at each of the system life cycle.

4.3.4 Social Feasibility :-

- Social feasibility is a determination of whether a proposed project will be acceptable to the people or not. This determination typically examines the probability of the project being accepted by the group directly affected by the proposed system change.

4.4 Use Case Diagram

4.4.1 Use Case of user

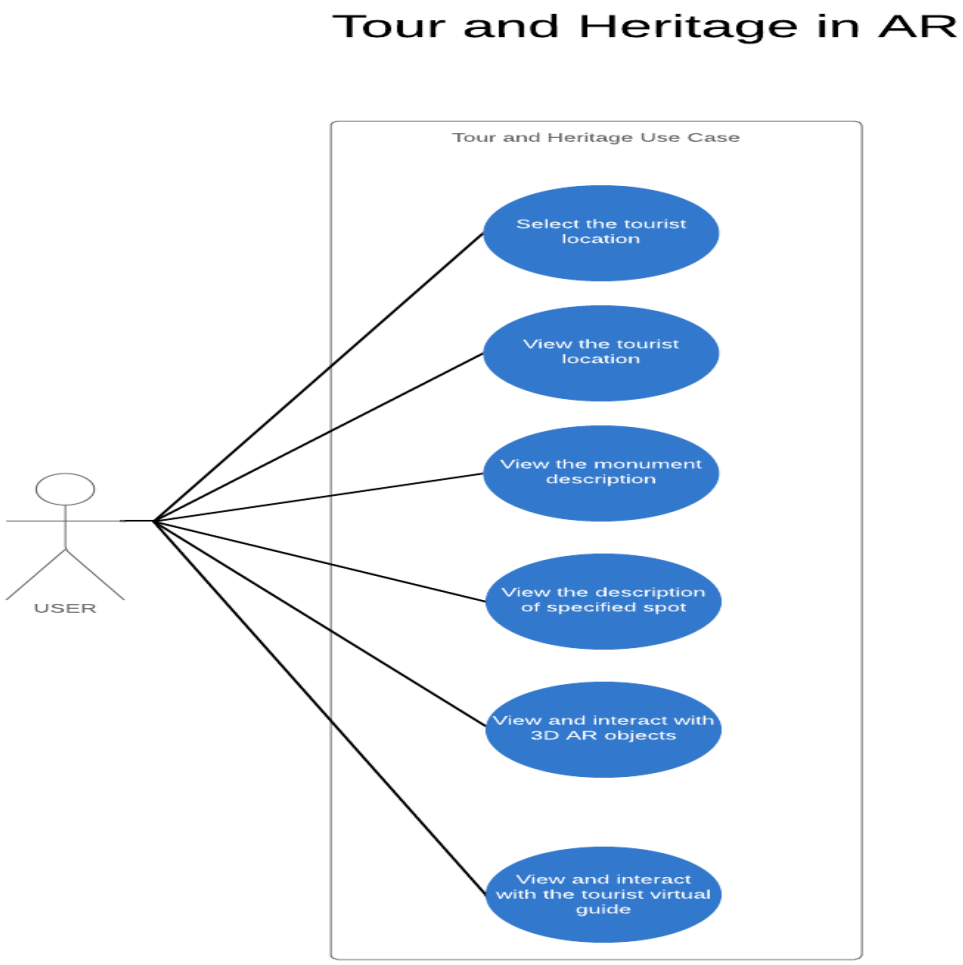


Fig.4 (a)

- Introduction: This use case describes how a user interacts with the application using AR.
- Actors : (i)user
- Pre Conditions: User must be at one of the location specified by the application.
- Post Conditions: If the use case is successful, the user will be able to interact with AR objects and view the virtual tour.
- Basic Flow: This use case provides the user with information about the visiting monument.

4.4.2 Use case of member, user and admin

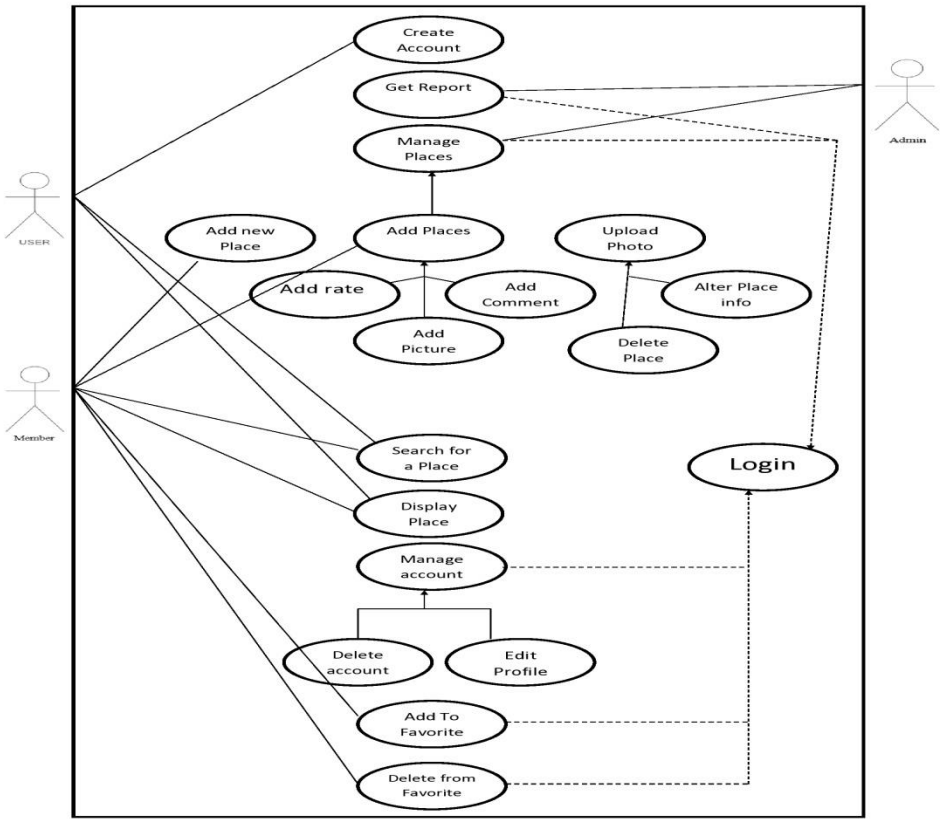


Fig.4 (b)

- Introduction: This use case describes how a user, member and admin interact with the application using AR.
- Actors : (i)user
  (ii)member
  (iii) admin
- Pre Conditions: User must be at one of the location specified by the application.
- Post Conditions: If the use case is successful, the user will be able to interact with AR objects and view the virtual tourist guide. The admin will be able to edit the AR objects.
- Basic Flow: This use case provides the user with information about the visiting monument.

5. System Design

5.1 System Application Design

5.1.1 Method Pseudo code

In the Front End(Application)

1. Slider for the places included in Augmented Tour.
2. Sort the nearest places according to user's current location in nearest section.
3. Sort the popular places according to rating in popular section.
4. Sort the places that are added in favorites.
5. Sort the places according to their tags and trails.
6. In the specific monument page,
    - show the slider of the monument
    - rating and tags of the monument and a favorite toggle button
    - distance from the user's current location
    - information about the monument
    - show places near to that monument
    - In the directions button show the map layout for the directions to the monument from the user's location.
    - Live Tour of the monument in the augmented reality mode when clicked on the Tour button.
7. On clicking Augmented button
    - Detect location or monument.
    - Display the respective AR Object on detection of the monument in the form of Image/Video/3D Model/Button/Label.
    - Click on the AR object for more information.

In the Back End(Wikitude Studio)

8. Create Database in the form of project.
9. Add Targets.
10. Create its Augmented Object (Image/Video/3D Model/Button/Label).
11. Add desired AR object with proper scaling according to the desired output.
12. Add components according to user requirements.
13. Import the Target in the Database using WTC file.

Bringing AR to life

1. Surface detection: Ability to detect and generate flat surfaces.
2. Featured points: Visually distinct features in environment.
3. User interaction by testing.
4. Placing with anchor points: User defined points of interests upon which AR objects are placed.
5. Occlusion between virtual assets: When one 3D object blocks other.
6. Matching Virtual light to real light: Behaviour of colors, shading, shadows created by virtual objects relative to environment in which they exist.
7. Depth Mapping.

5.2 Input/output and Interface Design

5.2.1 State Transition/ UML Diagrams

5.2.1.1 Activity diagram

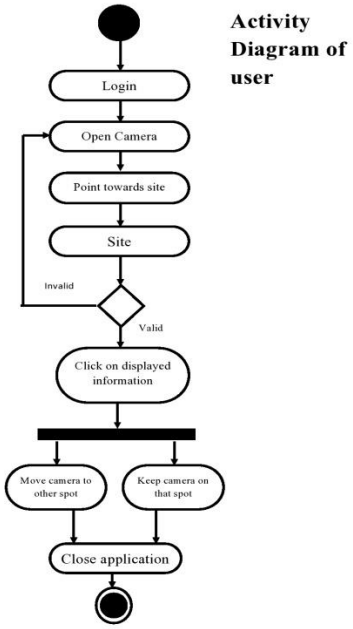


Fig.5 (a)

5.2.1.2 Sequence diagram

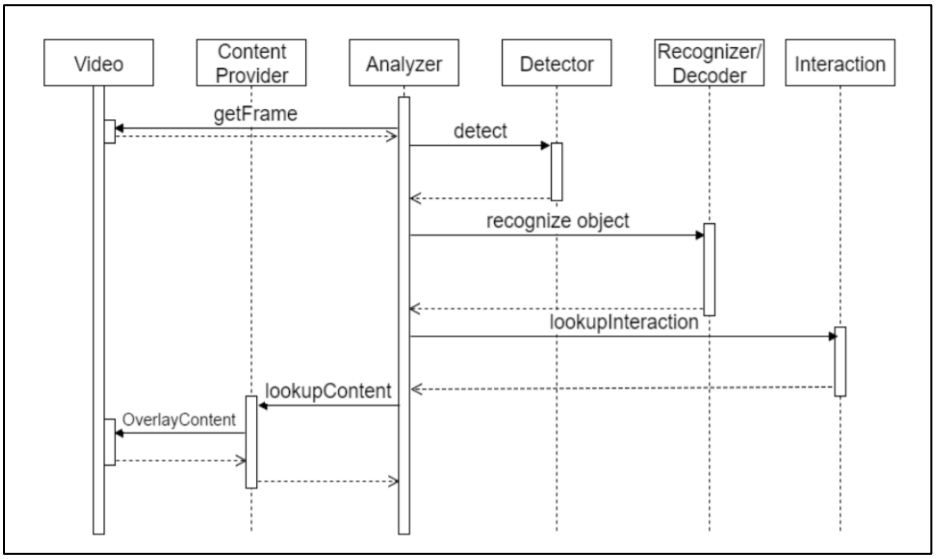


Fig.5 (b)

6. System Testing

6.1 Test Cases

The more sophisticated and futuristic the software, the more extensive the testing needs to be. This is especially true for augmented reality apps, which deal with reality so closely, that many real-world issues infiltrate them and complicate testing. The lack of generally approved augmented reality testing standards adds to the problem. However, drawing upon the state of the art in software testing research, paying attention to the weakest points of AR apps, and ensuring wide-scale device coverage is a good start for testers striving to assure the impeccable quality of an AR app.

- **Variability of hardware**

  There are a plethora of different devices, operating systems, screen sizes, camera resolutions, and numerous other variables that can make testing AR applications something of a nightmare. An AR application renders differently on each screen for each device. While this is a typical challenge for software testing in general, with AR applications, cross-platform testing is aggravated by the variety of possible devices. AR apps can also run on smart glasses, trade show displays, interactive kiosks, etc. There are few emulators to test augmented reality apps, so testing engineers usually need access to the device itself to test all components of the new technology. As AR works in real time interacting with physical objects, it is often necessary to walk with the actual device in a physical location. Device clouds are possibly the best type of emulator, allowing remote access to physical devices. However, testers are still not interacting with the device in the same way that users would. So, it is best to do testing with a mixture of real devices and emulators.

- **Motion Testing**

  Motion testing means assuring accurate super imposition of digital data onto an image of the real world in motion. To achieve that, the movement and rotation of a smartphone have to be perfectly translated from the physical camera to its virtual representation. So, it’s crucial to check for augmented objects starting to float from their intended positions when the user moves the device in different, unexpected ways.

- **Non-standard interfaces and 3D space**

  Checklists for GUI testing cover such basic elements as window, icon, menu, and pointing device. But augmented reality apps go far beyond the standard interface model allowing users to interact with the app in a wide range of creative ways, including interactions in 3D space. This also makes standard heuristics for usability testing inefficient in the case of AR app testing. But there's a growing avalanche of AR apps that should be tested here and now. So, for the time being, testing engineers have to invent their own heuristics.

- **Legal Implications**

  A comprehensive legal framework with regard to AR application testing has not been created yet. The physical nature of the application aside, it will soon become necessary to test how one AR application interacts with another so that privacy is maintained. Data privacy is an important legal issue that is increasing in prominence as the world becomes more digitalized and cybercrime continues to proliferate. The legal implications have not yet surfaced but this will be a huge issue as the industry becomes more developed.

- **More Testing Required**

  Right now, testers are ensuring that no obvious bugs are visible and that the application runs smoothly. However, they may need to check that the application is an accurate representation of reality and that dangerous areas render a warning to the user. An augmented reality testing application is going to need far more testing than a regular mobile or web application. Because there is a physical element involved, testers will have to access how the movement will affect user experience. Testing engineers may need to take into account how usable the device is to the physically impaired or those who suffer from motion sickness.

7. Conclusions:

7.1 Advantages

- The system is easy to install.
- The system is user-friendly.
- It is cost-effective.
- It maximizes accuracy and reduces energy usage.

7.2 Limitations

- Designed for one specific scenario with pre-defined model hardcoded
- Mainly developed on one platform only. The lack of multi-platform support limited the usage of the system.
- Most of the system lacks effective and intuitive interaction method. The system was only used for visualizing the results.
- It does not respond on low light environment.
- There is low availability of powerful mobile processors in devices.
- The phone device drains battery on use of AR application.
- The phone device generates lots of heat on use of AR application.

7.3 Future Scope

- Develop new features to overcome latest effective challenges.
- Open doors for business opportunities.

This project presents an overview of past and present research and applications in utilizing the augmented reality technologies in tourism context, while identifying and categorizing key factors having the most significant impact on the successful utilization of such applications. Identified factors are listed within several appropriate categories: general requirements, functionalities, issues, overlay types, technologies, and present a clear starting point for the future overviews, research and developments within the area.

While the research and applications are oriented towards augmented visual overlays, but with the potential to have considerably less distracting elements in comparison with the visual overlays, thus positively affecting, for example, the safety requirement. Such technologies are currently in need of further development and research in order to reach the availability and utilization level of visual-based applications and devices, but certainly have the potential in the field domain.

The Augmented Reality in Tourism section provides a comprehensive literature overview of research, technology and application developments in the context of utilizing the augmented technology in tourism domain.

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