MUSEUM TOUR GUIDE

BY

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In

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In the

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Zimbabwe

Supervisor

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Abstract

With the introduction of the latest features, mobile devices have become more widespread and convenient. In addition to the basic functionality so far, mobile apps have been used in a variety of ways to support consumers. For example, when identifying spots in daily activities. With advances in smartphone and cellular technology augmented reality-based applications are becoming more important in everyday life. Augmented reality (AR) is a technology that integrates the virtual environment of a smartphone with the real environment of the neighborhood from the user's point of view.

Augmented reality graphics are computer-generated images that overlay the physical world. AR and Position Dependent Services are becoming more important for these features and are now included in various solutions for mobile devices. The augmented reality smartphone app is a handy tool for improving user experiences. Using the combination of the AR and a physical location, the application can view the details of the location which the user would like to view and experience.

This project describes the development of a museum tour guide application that utilizes augmented reality technology to enhance the visitor experience. The project involved the design and implementation of a normalized database to store information about the artifacts in the museum, as well as the development of a user-friendly mobile application for visitors. The application allows visitors to view information about the artifacts, as well as 3D images and AR renderings.

KEYWORDS: Augmented Reality, Interactive tourism

Preface

This project was undertaken to address the need for a modern, user-friendly museum tour guide application that utilizes cutting-edge technology to enhance the visitor experience. The project involved extensive research and development, including the design of a normalized database and the development of a mobile application.

Acknowledgements

First and foremost, I want to express my gratitude to the Almighty God for His constant direction in my life and for providing me with the skills and knowledge that I employed in the development of this system. I would also want to express my gratitude to my family for their help and support during the process. Thank you Blessing Chusaru, Kudakwashe Koti, and everyone who helped me finish the project by providing me with the essential information and direction. Finally, I'd like to express my gratitude to my project supervisor, Miss S Zindove, for her direction and consistent monitoring, which helped me complete this project

Dedication

I would like to dedicate this project to my parents, who have always supported me throughout my academic journey. Their unwavering encouragement, guidance, and love have been the driving force behind my success.

I also want to express my gratitude to my friends and colleagues for their support and motivation. Their belief in me has given me the strength to persevere and overcome any obstacles along the way.

To the museum staff and curators who generously shared their time and knowledge, I offer my heartfelt appreciation. Their insights and feedback were invaluable in shaping this project.

Finally, I dedicate this project to all the museum visitors who have inspired me to create an application that will enhance their experience and provide them with a deeper understanding of the artifacts on display. It is my hope that this project will spark their curiosity and encourage them to continue exploring the rich history and culture preserved within these walls.

As Maya Angelou once said, "You can't use up creativity. The more you use, the more you have." This project has been a true test of my creativity and determination, and I am proud to have completed it.

Thank you all for being a part of this incredible journey with me. Your support, encouragement, and kindness have made all the difference.

Certificate of Declaration

This is to certify that work entitled Museum Tour Guide is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology in Software Engineering, Harare Institute of Technology. It is further certified that no part of research has been submitted to any university for the award of any degree.

(Supervisor)

Date : …… Signature : ……

(Mentor)

Date : …… Signature : ……

(Chairman)

Date : …… Signature : ……

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CHAPTER 1- INTRODUCTION

1.1 Background and problem statement

Imagine being in a museum with all the historic artifacts and not being allowed to touch them thus not living or feeling the real experience of how your ancestors lived thousands of years ago. Augmented Reality, AR in short, is an interactive experience of the real-world environment where real life objects are enhanced by a computer-generated perceptual information. This is what our museums are lacking and it's really having a great impact on the number of visitors to Zimbabwean tourism industry as it directly falls under it.

According to Zimbabwe Tourism Authority (ZTA) statistics, the number of visitors from both outside the country and locally have been falling and minimum activity is experienced in the tourism industry. The Zimbabwe Economic Policy Analysis and Research Unit (ZEPARU) has completed a research study entitled "Positioning the Zimbabwe Tourism Sector for Growth: Problems and Challenges". The main purpose of this study was to identify factors that could drive tourism growth and to provide policy recommendations on how to put the industry in a long-term growth path that supports the country's economic goals. This study acknowledges that this sector faces many challenges that impede growth. This includes poor marketing, lack of institutional coordination, skill and experience limitations, and lack of domestic tourism promotion, unfriendly visa policies, and restrictions on the use of ICT.

Traditionally museums make use of people who tour guide the visitors through the historic artifacts and explaining in details. However, this method is efficient but it have a down side which can do more damage to the museum. For example, if the staff tours come to work not in a good mood because of personal issues they might not handle clients professionally and hence driving away visitors and crippling the tourism industry and the economy at large.

The goal of this research is to develop a mobile augmented reality museum application that can tackle the challenges mentioned earlier. The mobile application should give users the

experience by adding the augmented reality technology, which adds 3D view of images and animations to artifacts.

1.2 Objectives

- To develop a mobile application that allows users to search for items they want to explore in the museum.
- To develop a mobile application which detect images and give full information to user.
- To develop a mobile application that allows visitors to find relevant adequate information about artifacts listed in the museum.

1.3 Hypothesis, Justification, Proposed Tools

1.3.1 Hypothesis

The hypothesis of this project is that the implementation of an augmented reality museum tour guide application will enhance the visitor experience and increase visitor engagement.

1.3.2 Justification

The traditional museum tour guide experience is often limited and does not allow visitors to fully engage with the exhibits. By utilizing augmented reality technology, visitors will be able to view information about the artifacts in a more interactive and engaging way, leading to a more enriching and enjoyable museum experience. Additionally, the use of a mobile application will provide visitors with a more flexible and personalized experience, allowing them to choose their own route through the museum and view information at their own pace.

1.3.3 Proposed Tools

The proposed tools for this project include Unity for the development of the augmented reality features, MySQL for the database management, and Android Studio for the mobile application development. The application will also utilize Google's AR Core platform for AR rendering. Additionally, the application will make use of location services to help visitors navigate the museum and provide relevant information based on their location within the museum.

1.4 Feasibility Study

The goal of a feasibility study is to determine whether or not the proposed system can be developed. It is carried out in order to determine the most effective methods for developing the desired software system. Two feasibility criteria were utilized to assess the project's viability: Economic feasibility - determining if the system will be cost-effective to develop and deploy. Technical feasibility - this analysis focuses on whether the system can be built technically and whether it will have the support of relevant parties.

1.4.1 Technical Feasibility

Technically, all of the resources needed to create the intended museum tour mobile application are already in place. The technology that will be used to construct the mobile application is included in these technical resources. It is possible to purchase powerful computers capable of running the project development software. Furthermore, the essential software may be obtained online, making the endeavor technically feasible.

1.4.2 Economic Feasibility

Table 1: *Economic Feasibility Study*

Component	**Cost**
Laptop	Approximately $900.00
Mobile Phone	$250.00
External Mouse	$10.00
External SSD Drive	$150.00
WIFI	$100.00
Total	**$1 410**

The costs of the required resources do not pose a threat to the online auction system's development. The costs of an online action system were calculated based on the phase in which they occur. System development expenditures are typically one-time expenses that do not reoccur after the project is finished. The cost-benefit analysis

also reveals that the proposed system's advantages outweigh its expenses, indicating that the system is economically viable.

1.5 Project Plan

Table 2: *Project Plan*

Activity	Tentative Date
Investigation	20/08/22
System Requirements Analysis	03/09/2022
System Development and Design	26/09/2022
System Testing	12/01/23
Integration and System Testing	21/02/23
Miniature Roll-out for Training	29/05/23

1.6 Gantt Chart

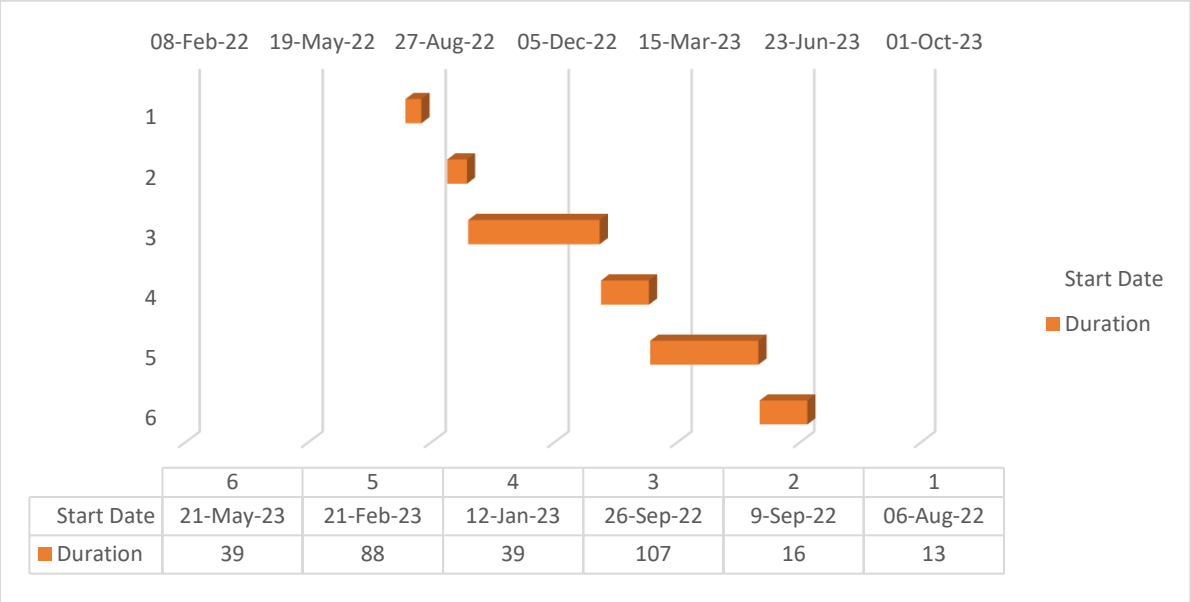


Figure 1: *Gantt Chart*

CHAPTER 2- LITERATURE REVIEW

2.1 Introduction

There are many possibilities for the use of AR in museums. The most straightforward way is to use it to add explanations of pieces. This means visitors will get more information when they view exhibitions using AR. Museums could even use it to display digital versions of artists next to their work. AR gives an opportunity to add a third dimension to displays, bringing objects or scenes to life. There are already many institutions around the world using AR. These projects bring something new to existing collections and attract wider audiences. Here are some interesting ways that museums are using augmented reality.

As already said, museums represent important institutions that have become a growth industry and have emerged as one of the most important leisure-time venues in the developed and, increasingly, the developing world. However, museums are facing various challenges to still justify their existence towards their investors and the public as well as finding their position in the dual reality of tangible objects, digital technologies and social media. Consumers and especially tourists are not satisfied with ordinary products or services anymore, but expect experiences that create emotions and everlasting memories. Therefore, also museums have to adapt to these developments and try to create special experiences for their visitors.

It is important to use digital technology in museums as a meaningful value-added service but not at the expense of the core competence of a museum to preserve human cultural heritage. With the usage of digital technologies as a tool to provide information to the visitors, the autonomy of the visitors can also be boosted as they can explore the museum on their own without any dependency on a guided tour. Due to its interactivity, visitors also often see benefits for their children and teenagers as they can engage themselves with scientific content in a playful but meaningful way.

Museums often cannot show their whole collections to the visitors due to limited space and resources or due to the fragility and high value of different objects. AR technology offer users the possibility to deploy phones as pocket-sized screens through which surrounding spaces become the stage for endless extra layers of information. With advancements and developments over the recent years, AR can be seen as a flexible and practicable tool with high visual quality to overcome these problems and support the quality of the museum content. For museum purposes, AR is at the beginning of its usage but can be seen as a well-accepted technology among the scientific community and the public (Woods et al., 2004; Noh et al., 2009).

AR applications in museums allow the visitors to interact with the content of the museum exhibition intuitively. Therefore, museums are starting to present their collections in a more exciting and appealing way to their visitors, by supplementing real objects with virtual additional information. AR on mobile devices is easy to use for the visitors, as they have already been accustomed to holding up the camera of the mobile device to take pictures. Therefore, scanning an AR object with the device is a very natural gesture and can lead to an organic museum experience. AR mobile applications for museums also work with automated image recognition to realize the scanning of real-world objects in contrast to a manual tracking systems such as QR codes. A survey by Wein (2013) shows that museum visitors show a clear preference for automated visual recognition. Therefore, the user is again not distracted from his natural interaction with the museum objects.

Moreover, the natural distance between the visitor and the displayed object can also be kept, whereas numbers and QR codes have to be scanned directly at the object itself. Another advantage of AR applications is that also museums with limited financial resources can make use of such systems. No expensive hardware systems have to be acquired and many AR software providers offer solutions that can be implemented and applied by museum professionals without any IT expertise.

The technology of AR can also be a challenge for museums and the communication with their visitors. Visitors who have no former experience with AR, mobile devices or ICTs in general, need help and assistance when using an AR application. An additional personal

support person can be useful near the augmented objects and to support the visitors in the case of problems or difficulties. In general, the visitors should be able to use the application intuitively and easily, as everything that is not understood by the visitors can also not be accepted by them.

With the right usage of AR, museums can increase the number of visitors and also attract new visitors by creating curiosity about an innovation used in a museum. Therefore, some visitors will only come and visit the museum because of AR. This segment represents potential visitors of the future, if only the museum can fulfil their needs and satisfy their expectations.

2.2 Related work

Augmented Reality as an Interactive Museum Guide in Zimbabwe

Augmented reality technology has been widely used in various applications, including museums, tourism, and education. In Zimbabwe, a project was conducted to create an interactive museum guide using augmented reality technology for the National Museum of Zimbabwe (1). The project utilized AR to create 3D models of the museum's artifacts, which visitors could interact with through a mobile application. However, the project did not incorporate real-time object recognition and object-specific information.

To complement this project, a new museum tour guide application can be developed that incorporates real-time object recognition and object-specific information. Visitors can use their mobile devices to scan objects and view 3D models of the artifacts, providing them with a more immersive experience. The museum tour guide can also include educational materials and quizzes that test visitors' knowledge of the artifacts. This application can provide visitors with a deeper understanding of Zimbabwean history and culture.

Ghana Heritage AR Tour

In Ghana, an augmented reality application was developed for tourism, allowing users to explore historical sites and landmarks using AR technology (2). The application showcased Ghana's cultural and historical artifacts. The museum tour guide application can build upon this project by incorporating AR technology to create an interactive museum tour that

showcases Zimbabwe's cultural and historical artifacts. Visitors can use their mobile devices to scan objects and view 3D models of the artifacts, providing them with a more interactive and engaging experience. The application can also incorporate information on the history and significance of the artifacts.

Augmented Reality for Science Education (AR4SE)

In South Africa, an augmented reality-based application was developed to enhance teaching and learning (3). The application allowed students to interact with 3D models of scientific concepts and historical artifacts. This project can be adapted to create an AR-powered museum tour that provides visitors with an interactive and engaging experience. The museum tour can include 3D models of artifacts and interactive exhibits that teach visitors about African history, art, and culture. The AR technology can also incorporate quizzes and interactive activities that test visitors' knowledge of the artifacts and encourage further exploration of the museum.

Augmented Reality for Museums and Exhibitions (ARME)

In Uganda, a project explored the use of augmented reality technology in exhibitions (4). The study examined the benefits of using AR technology in enhancing visitors' engagement and learning experience in the museum. The museum tour guide application can complement the use of AR technology in exhibitions by creating an AR-powered museum tour that showcases Ugandan artifacts and specimens. Visitors can use their mobile devices to scan objects and view 3D models of the artifacts, providing them with a more interactive and engaging experience. The application can also incorporate information on the history and significance of the artifacts.

In conclusion, an augmented reality-powered museum tour guide application can provide visitors with a more interactive and immersive experience. By incorporating real-time object recognition, object-specific information, educational materials, and interactive activities, the application can enhance visitors' understanding and appreciation of African history, art, and culture.

2.3 Conclusion

From the review done above, there are so many relevant systems that are in use all over the world and some of them are even more advanced. However, there are so many factors that are being omitted in these systems and they will cater for. Most of the applications out there being used in other museums they are either off the shelf systems and they are expensive to consider as an option to solve the problems that are being faced by Zimbabwean museums. Moreover, these systems may not solve all the problems that's are being faced thus wasting scarce resources.

CHAPTER 3- ANALYSIS

3.1 Information Gathering

Assessment is about gathering the necessary information about who you are as a literacy agency, your current strengths, weakness, opportunities and threats. Remember, at this point, you are simply gathering information on the current internal and external environment facing your literacy agency; you are not making any judgments or drawing any conclusions about what the information means for the future. To gather information three (3) methods were used and these are documentation review, Observation, and Focus group. The document review is used to gather information on current practices without interrupting the program by examining program monitoring reports, program statistics, learner progress reports, annual reports, performance appraisals, board evaluations, written policies and procedures, memos, minutes, financial records, etc., and the observation to watch the Bulawayo museum in operation to gather information about what actually happens day-to-day.

3.2 Description of System

The system is a mobile application for museums which is going to be equipped with Augmented reality. Augmented reality (AR) is an enhanced version of the real physical world that is achieved through the use of digital visual elements, sound, or other sensory stimuli delivered via technology. It is a growing trend among other companies involved in mobile computing and business applications in particular. The mobile application's main goal is to help the visitors navigate in the museum and aiding in and advancing the experience in

museums. Since the main thing that people visit museums is the experience they have. Imagine being in a museum with all the historic artifacts and not being allowed to touch them thus not being able to touch them thus not living of feeling the real experience of how your ancestors lived thousands of years ago. This is what our museums are lacking and it's really having a great impact on the number of visitors to Zimbabwean tourism industry as it directly falls under it. Hence this application aims to help in that area and its aims and objective are, to develop a mobile application that allows users to search for items they want to explore in the museum, to develop a mobile application which detect images and give full information to user, to develop a mobile application that allows visitors to find relevant adequate information about items listed in the museum, to develop a mobile application which direct users to items in the museum.

3.3 Data analysis

3.3.1 DFD Context Diagram for Existing System

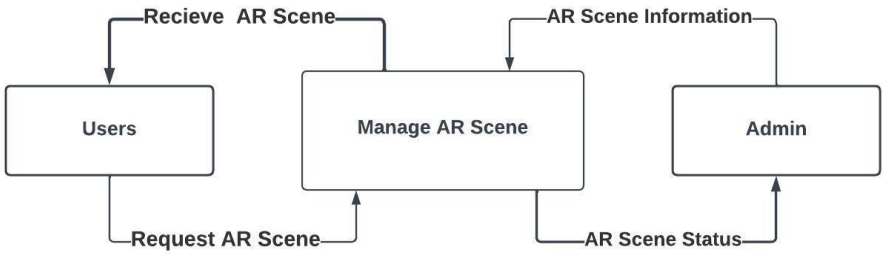


Figure 2: Level 1 DFD Diagram for Existing System

3.3.2 Use Case Diagram for Existing System

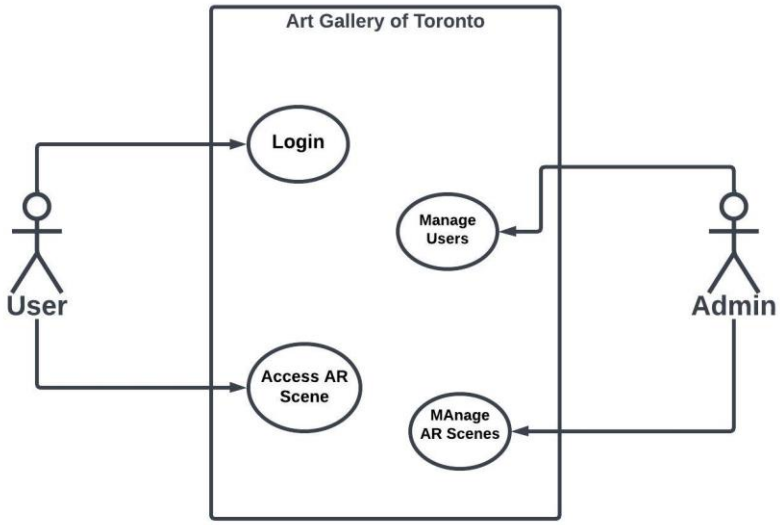


Figure 3: Use Case Diagram for Existing System

3.3.3 DFD of Existing System

The Art Gallery of Ontario, Toronto

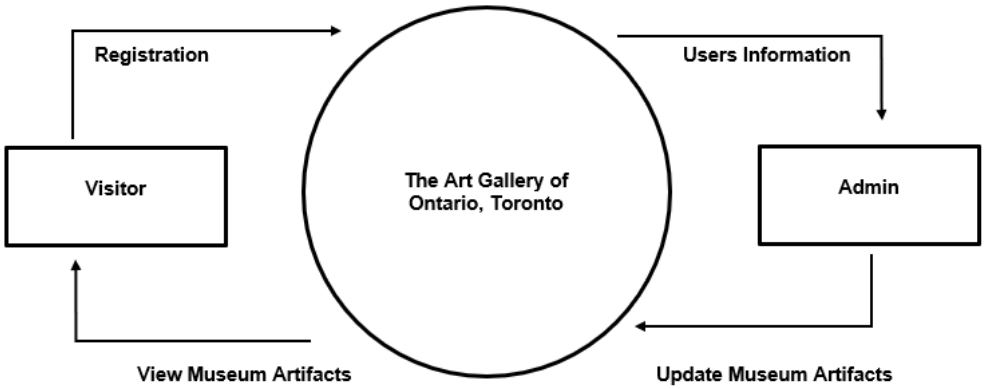


Figure 4:DFD Diagram for Existing System

3.3.4 Evaluation of Alternative Systems

Table 3: Evaluation of Alternative Systems

System	Functionality	Cost	Ease of Use	Maintenance	Customization
Off the shelf	Provides basic functionality	High	Require training for non-technical	Regular updates and support provided by vendor	Minimum
Other Museum AR Systems	May offer less or more advanced functionality which may not be applicable	High	Require training for non-technical	Regular updates and support provided by vendor	Minimum

3.4 Requirements Analysis

It is vital to provide an intuitive grasp of what the system will accomplish, how it will work, and under what restrictions it will be expected to perform at this point of the project. The system for this project will be multi-tech, in the sense that it will integrate numerous technologies. In this light, the system's quality attributes are vital, and messing with the system's quality characteristics is critical. With this in mind, we bring to light the system's various expectations.

4.4.1 Functional Requirements

- The proposed application shall have the following functionalities:
- The mobile app should allow visitors to browse and search for artifacts by category, artist, or time period.
- The mobile app should display information about each artifact, including its history and significance.
- The mobile app should use augmented reality to enhance the visitor's experience by displaying 3D models of artifacts and related information.

3.4.2 Non-Functional Requirements

- The mobile app should be fast and responsive, with minimal lag time between interactions.
- The mobile app should be easy to use, with clear navigation and intuitive controls.
- The mobile app should be compatible with a wide range of mobile devices and operating systems.
- The mobile app should be secure, with user data protected by encryption and other security measures.

3.5 User Case Diagrams

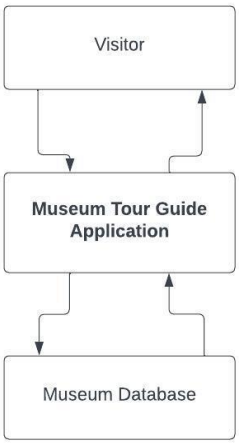


Figure 5: User Case Diagram

CHAPTER 4 - DESIGN

4.1 Systems Diagrams

4.1.1 UML Context Diagrams

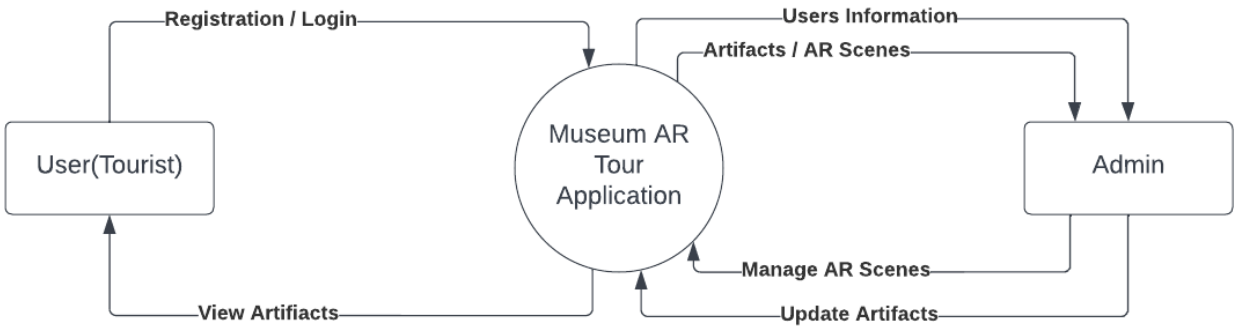


Figure 6: UML Context Diagrams

4.1.2 UML Activity Diagrams

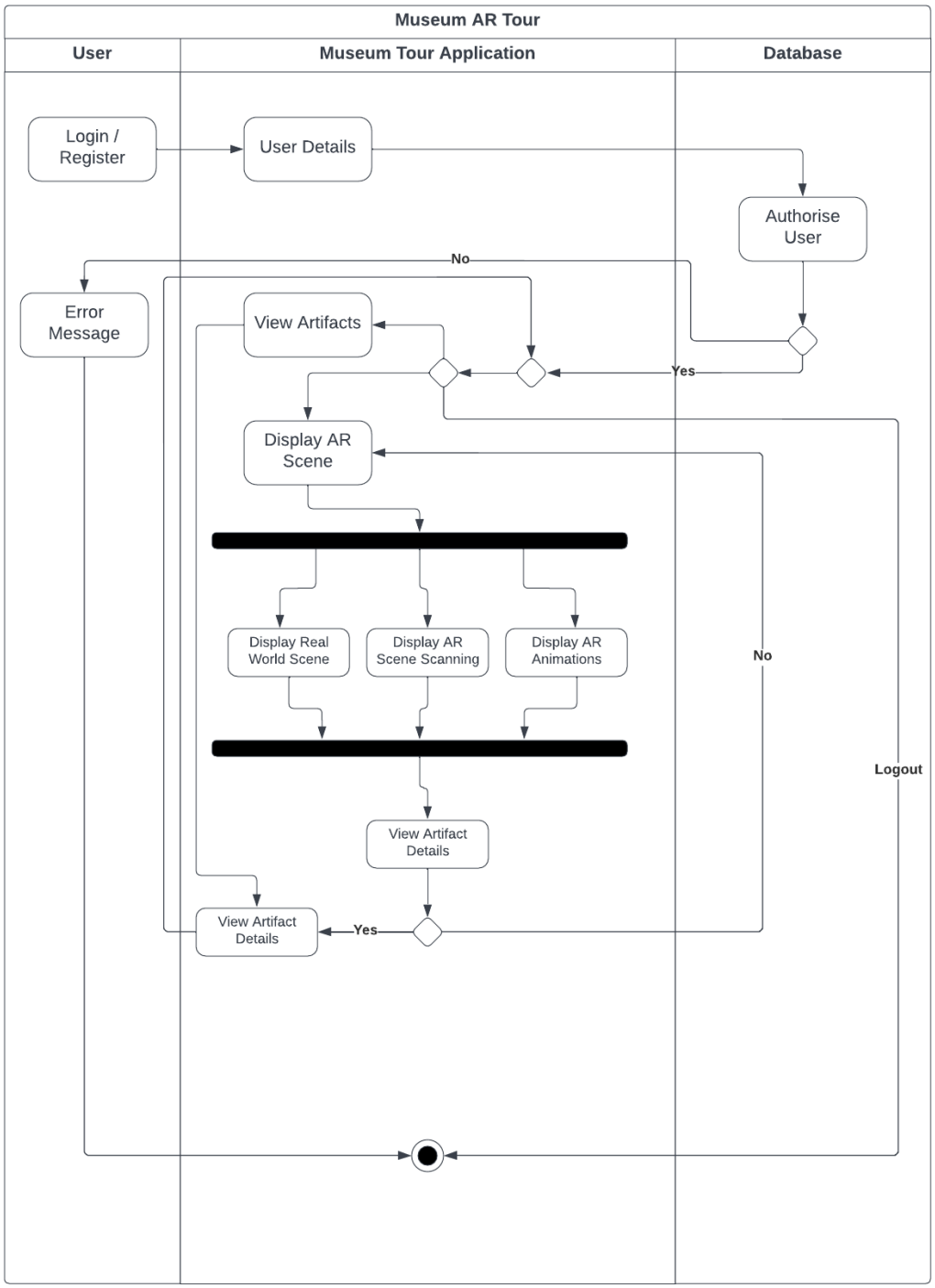


Figure 7: UML Activity Diagram

4.1.3 UML Deployment Diagram

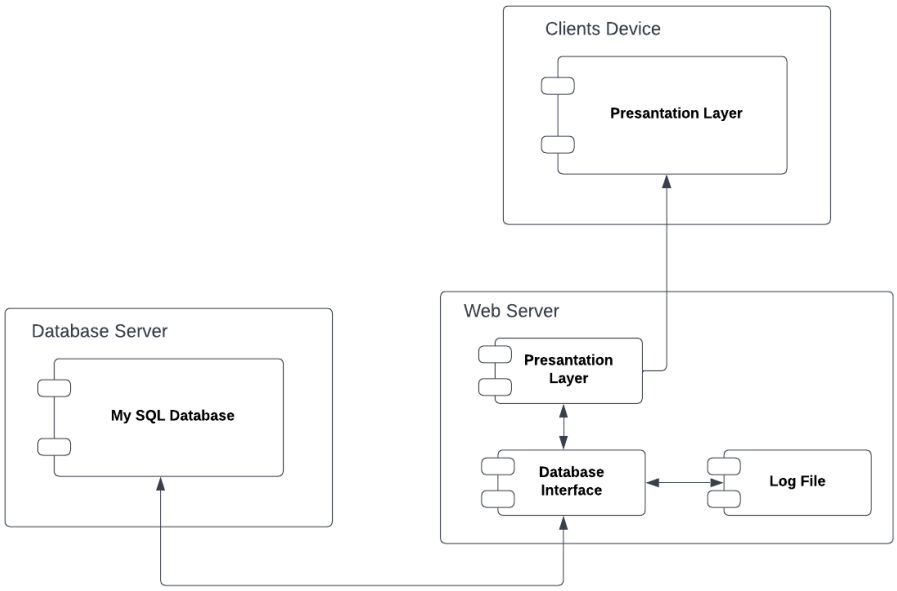


Figure 8: UML Deployment Diagram

4.1.4 DFD

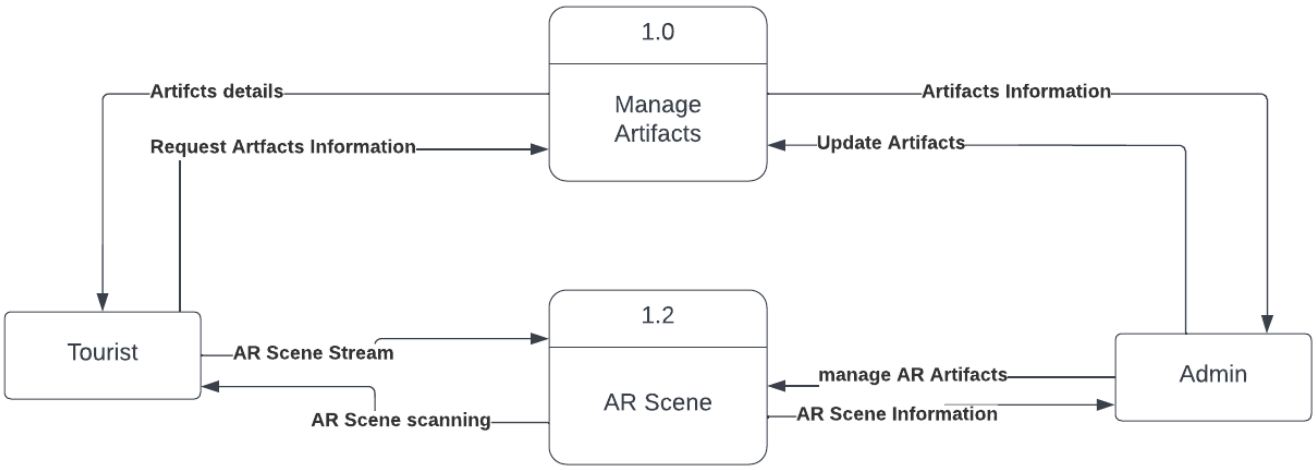


Figure 9: DFD Diagram

4.2 Architectural Design Diagram

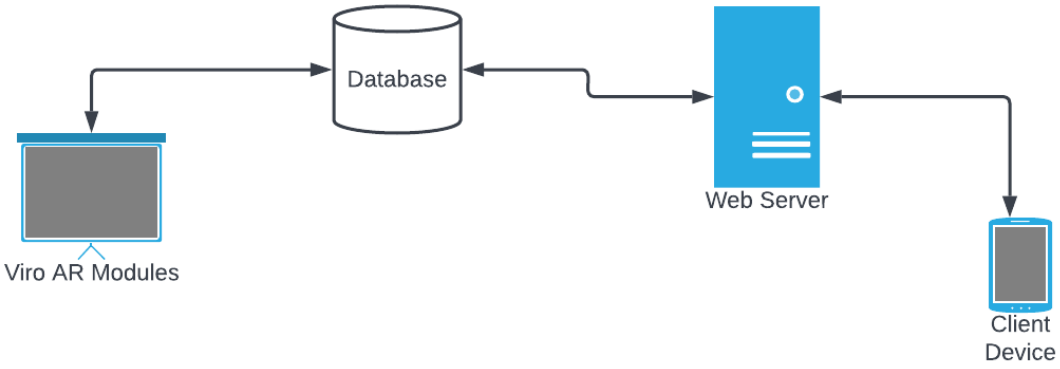


Figure 10 Architectural Design Diagram

4.3 Database Design

4.3.1 ER Diagram

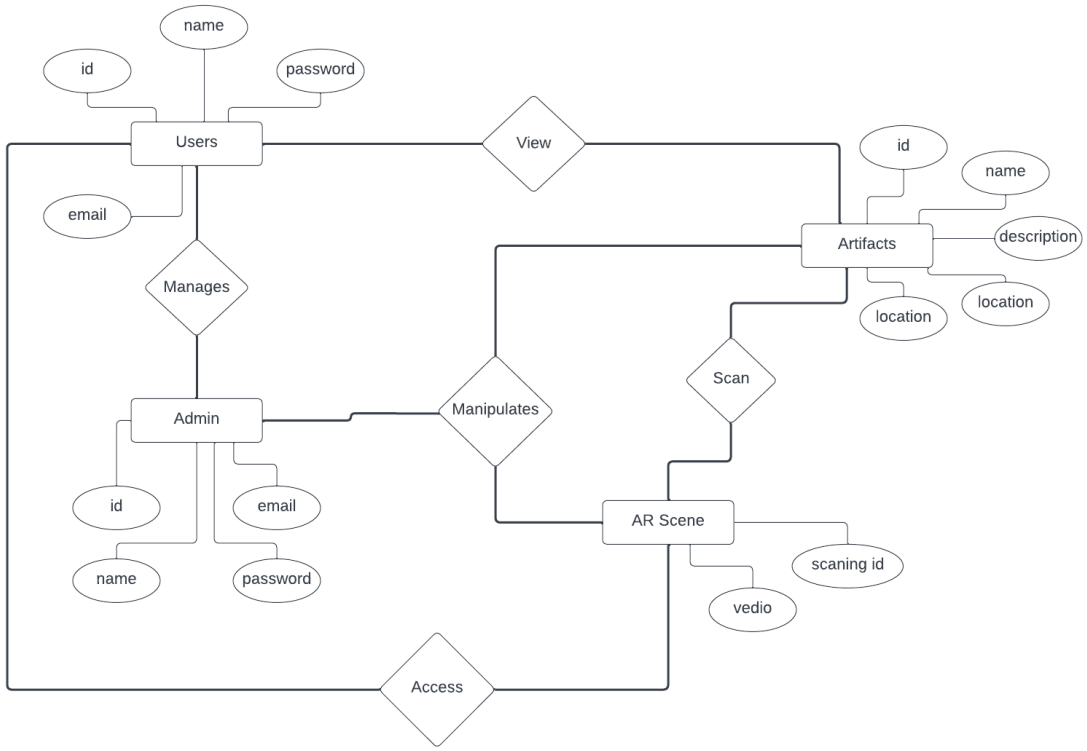


Figure 11: ER Diagram

4.4 Normalized Databases

4.4.1 1NF

First Normal Form (1NF): The first normalization form requires that each column of a table should contain atomic values, that is, a column should not contain multiple values or repeating groups of values. To bring the Artifact table to 1NF, we can separate the categories of artifacts and their location on different floors into separate columns. The resulting table would be:

Artifact table

Table 4: 1NF Artifact Table

Id	*Name*	*Description*	*Image*	*3d Model*	*Category*	*Floor*
101	Lobengula	Lobengula Khumalo (1845 – presumed January 1894)	Image-file	3d-file	Archaeology	1
102	Black Mamba	The black mamba is a highly venomous snake found in Africa.	Image-file	3d-file	Herpetology	2
103	Engraving Tool	Engraving tools have been used since ancient times for various purposes	Image-file	3d-file	Archaeology	3
…..	…..	…..	…..	…..	…..	…..

4.4.2 2NF

Second Normal Form (2NF): The second normalization form requires that each non-key column of a table should depend on the entire primary key, not just a part of it. To bring the Artifact table to 2NF, we can separate the category and floor information into separate tables, and create foreign keys to link them with the Artifact table. The resulting tables would be:

Artifact table:

Table 5: 2NF Artifact Table

Id	*Name*	*Description*	*Image*	*3d Model*	*Category_Id*	*Floor_Id*
101	Lobengula	Lobengula Khumalo (1845 – presumed January 1894)	Image-file	3d-file	1001	1
102	Black Mamba	The black mamba is a highly venomous snake found in Africa.	Image-file	3d-file	1002	2
103	Engraving Tool	Engraving tools have been used since ancient times for various purposes	Image-file	3d-file	1003	3
…..	…..	…..	…..	…..	…..	…..

Category table:

Table 6: 2NF Category Table

Category_id	*Name*
1	Archaeology
2	Herpetology
3	Geology and Paleontology
...	...

Floor table:

Table 7: 1NF Artifact Table

Floor_id	*Name*	*location*
1	1st	East Wing
2	2nd	West Wing

4.4.3 3NF

Third Normal Form (3NF): The third normalization form requires that each non-key column of a table should depend only on the primary key or other non-key columns, but not on non-key columns. To bring the tables to 3NF, we can remove any transitive dependencies.

The resulting tables would be:

Artifact table:

Table 8: 3NF Artifact Table

Id	*Name*	*Description*	*Image*	*3d Model*	*Category_Id*	*Floor_Id*
101	Lobengula	Lobengula Khumalo (1845 – presumed January 1894)	Image-file	3d-file	1001	1
102	Black Mamba	The black mamba is a highly venomous snake found in Africa.	Image-file	3d-file	1002	2
103	Engraving Tool	Engraving tools have been used since ancient times for various purposes	Image-file	3d-file	1003	3
…..	…..	…..	…..	…..	…..	…..

Category table:

Table 9: 3NF Category Table

Category_id	*Name*
1	Painting
2	Sculpture
3	Statue
...	...

Floor table:

Table 10: 3NF Floor Table

F*loor_id*	*Name*
1	1st
2	2nd

4.5 Program Design

4.5.1 Class Diagram

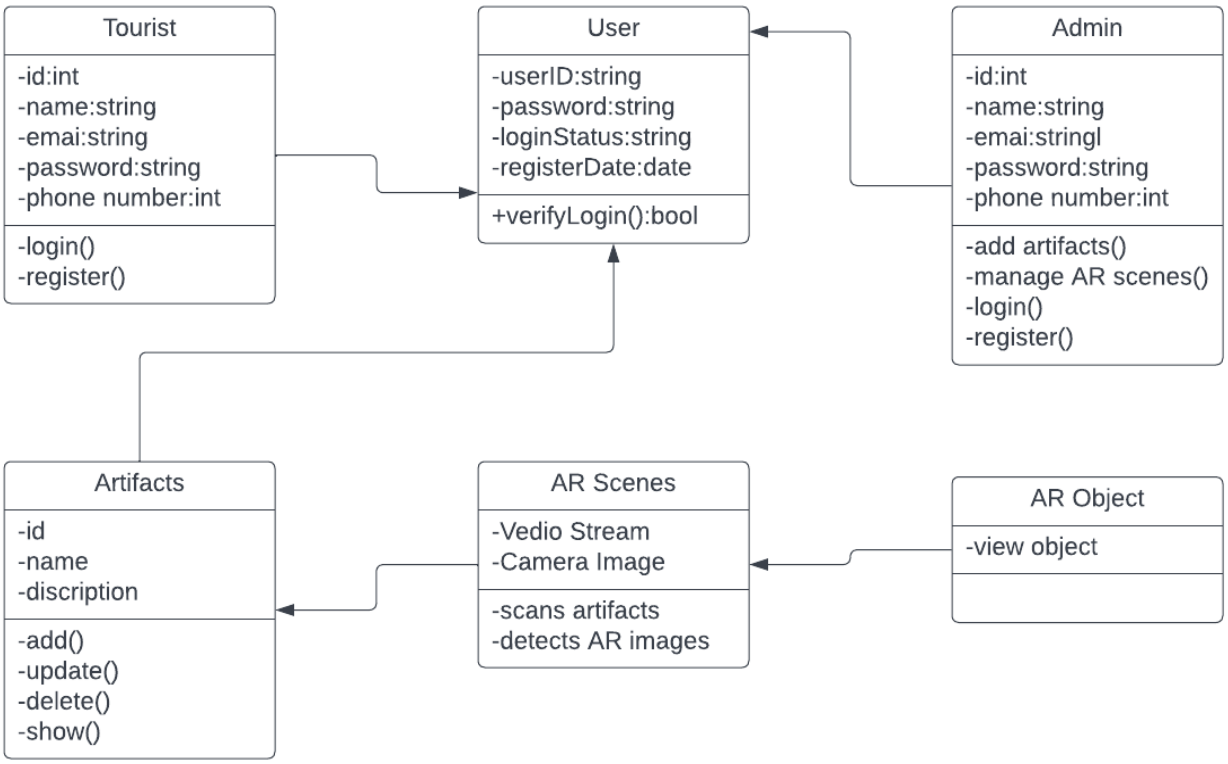


Figure 12: Class Diagram

4.5.2 Sequence Diagram

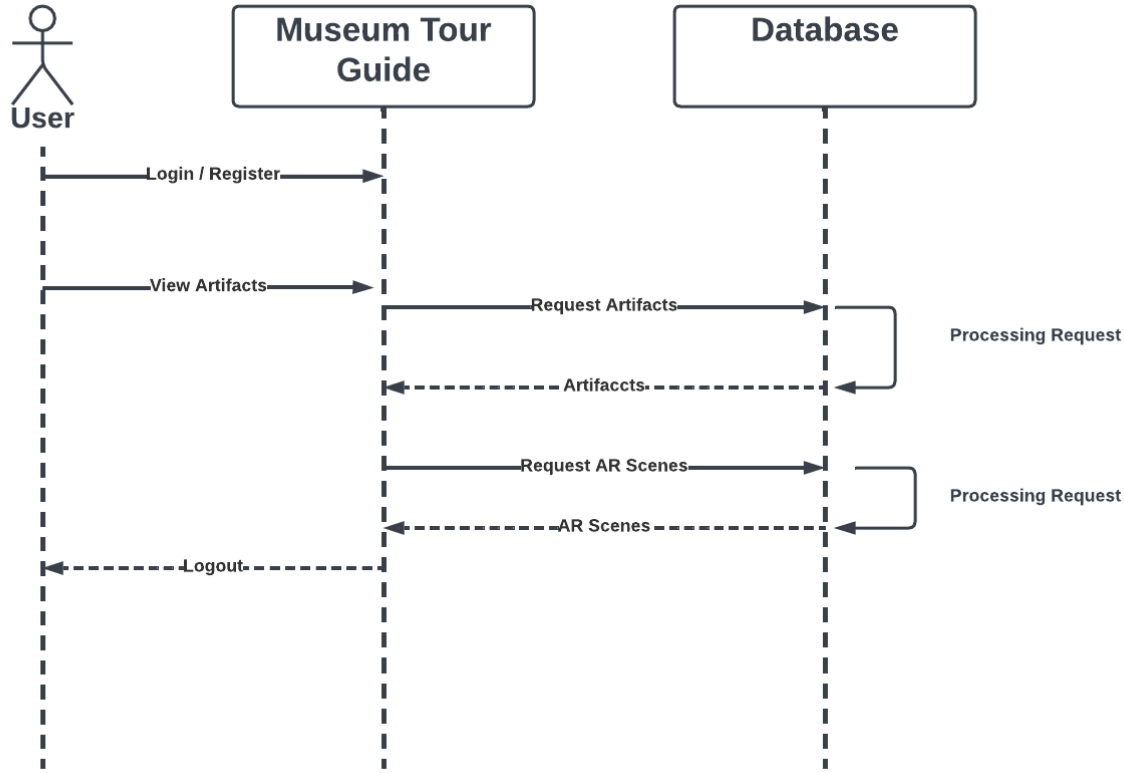


Figure 13: Sequence Diagram

4.5.3 Package Diagram

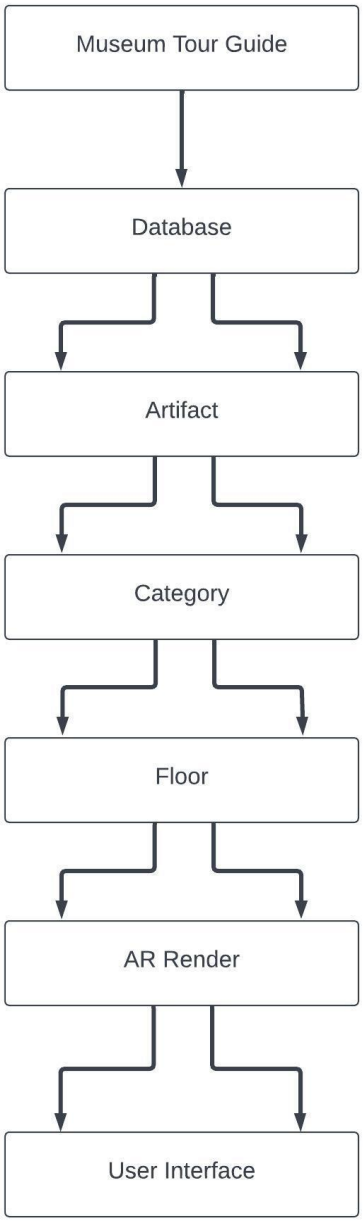


Figure 14: Package Diagram

4.5.4 Pseudo Code

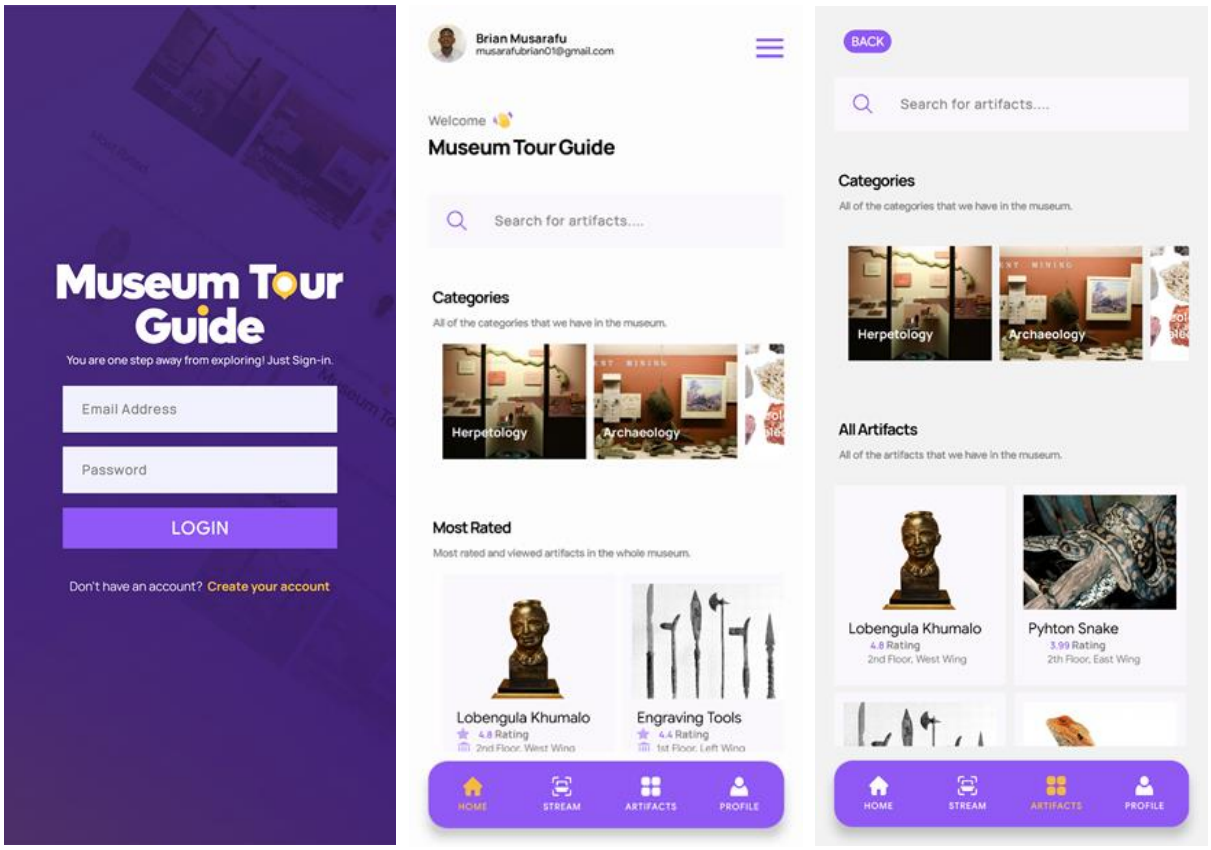
```
// Define the database schema
class Artifact {
  int id, string name, string description,
string image, int category_id, int floor_id;
}

class Category {
  int id, string name;
}

class Floor {
  int id, string name;
}

```

```
1
2  // Define the DAO classes for each table
3  class ArtifactDao {
4    void addArtifact(Artifact artifact);
5    void updateArtifact(Artifact artifact);
6    void deleteArtifact(int id);
7    List<Artifact> getAllArtifacts();
8    Artifact getArtifactById(int id);
9    List<Artifact> getArtifactsByCategory(int
   category_id);
10   List<Artifact> getArtifactsByFloor(int
   floor_id);
11 }
12
13 class CategoryDao {
14   void addCategory(Category category);
15   void updateCategory(Category category);
16   void deleteCategory(int id);
17   List<Category> getAllCategories();
18   Category getCategoryById(int id);
19 }
20
21 class FloorDao {
22   void addFloor(Floor floor);
23   void updateFloor(Floor floor);
24   void deleteFloor(int id);
25   List<Floor> getAllFloors();
26   Floor getFloorById(int id);
27 }
```

```
// Define the service classes for each table
class ArtifactService {
  ArtifactDao artifactDao;

  void addArtifact(Artifact artifact);
  void updateArtifact(Artifact artifact);
  void deleteArtifact(int id);
  List<Artifact> getAllArtifacts();
  Artifact getArtifactById(int id);
  List<Artifact> getArtifactsByCategory(int
category_id);
  List<Artifact> getArtifactsByFloor(int floor_id
);
}

class CategoryService {
  CategoryDao categoryDao;

  void addCategory(Category category);
  void updateCategory(Category category);
  void deleteCategory(int id);
  List<Category> getAllCategories();
  Category getCategoryById(int id);
}

class FloorService {
  FloorDao floorDao;

  void addFloor(Floor floor);
  void updateFloor(Floor floor);
  void deleteFloor(int id);
  List<Floor> getAllFloors();
  Floor getFloorById(int id);
}
```

4.6 Interface Design

4.6.1 Screenshots of user interface



CHAPTER FIVE - IMPLEMENTATION & TESTING

5.1 Sample code for the Stream screen

```
import {AppState, StyleSheet, Text, View} from 'react-native';
import React, {useEffect, useState} from 'react';
import {
  ViroARScene,
  ViroARSceneNavigator,
  ViroAmbientLight,
  Viro3DObject,
  ViroARTrackingTargets,
  ViroARImageMarker,
  ViroText,
  ViroNode,
} from '@viro-community/react-viro';
import artifacts from '../data/artifacts.data';
import {useNavigation} from '@react-navigation/native';

const LiveStream = () => {
  const [scale, setScale] = useState([0.02, 0.02, 0.02]);
  const [rotation, setRotation] = useState([90, 0, 100]);

  const navigation = useNavigation();
  const toDetails = artifact => {
    navigation.navigate('StreamDetails', {artifact});
  };
  // Register targets
  useEffect(() => {
    if (artifacts.length > 0) {
      const targets = {};
      artifacts.forEach(artifact => {
        targets[artifact.title] = {
          source: artifact.imgUrl,
          orientation: 'Down',
          physicalWidth: 0.165, // Real world width in metres
          type: 'Image',
        };
      });

      ViroARTrackingTargets.createTargets(targets);
    }
  }, [artifacts]);

  const anchorFound = (anchor, _) => {
    // const detectedArtifact = artifacts.find(
    //   artifact => artifact.title === anchor.anchorId,
    // );
    // if (detectedArtifact) {
    //   toDetails(detectedArtifact);
    // }
    console.log('Anchor/Image Detected:', anchor);
  };
```

```
const trackingUpdated = (state, reason) => {
  console.log(`AR Tracking Updated: ${state} - ${reason}`);
};
useEffect(() => {
  // Add AppState listener
  AppState.addEventListener('change', handleAppStateChange);

  // Remove AppState listener on component unmount
  return () => {
    AppState.removeEventListener('change', handleAppStateChange);
  };
}, []);

const handleAppStateChange = async nextAppState => {
  if (nextAppState === 'background') {
    // Release AR resources when app is going to background
    const status = await ViroARSceneNavigator.getARStatusAsync();
    if (status === ViroARSceneNavigator.ARTrackingInit) {
      await ViroARSceneNavigator.resetARSession(true, true);
    }
  }
};

return (
  <ViroARScene onTrackingUpdated={trackingUpdated}>
    {artifacts.map(artifact => (
      <ViroARImageMarker
        key={artifact.id}
        target={artifact.title}
        onAnchorFound={anchorFound}>
        <ViroAmbientLight color="#FFFFFF" />
        <ViroNode>
          <Viro3DObject
            source={artifact.ar_imgUrl}
            scale={[0.015, 0.015, 0.015]}
            rotation={[90, 0, 100]}
            type="GLB"
            onPinch={(pinchState, scaleFactor) => {
              // Update the scale value based on the pinch gesture
              setScale([scaleFactor, scaleFactor, scaleFactor]);
            }}
            onRotate={(rotateState, rotateFactor) => {
              // Update the rotation value based on the rotate gesture
              setRotation([
                rotation[0],
                rotation[1] + rotateFactor,
                rotation[2],
              ]);
            }}
          />
          <ViroText
            onClick={() => toDetails(artifact)}
            text={artifact.title}
            textAlign="left"
```

```
              textAlignVertical="top"
              textLineBreakMode="justify"
              textClipMode="clipToBounds"
              color="#ffffff"
              style={{
                fontSize: 9,
                fontFamily: 'ExtraBold',
              }}
              position={[-0.1, -0.9, -1.2]}
              extrusionDepth={2}
              rotation={[90, 0, 180]}
            />
          </ViroNode>
        </ViroARImageMarker>
      ))}
    </ViroARScene>
  );
};
export default () => {
  return (
    <ViroARSceneNavigator autofocus={true} initialScene={{scene: LiveStream}} />
  );
};
```

5.2 Sample code for the Login Screen

```
import React, {useState} from 'react';
import {
  Text,
  View,
  TextInput,
  ActivityIndicator,
  ImageBackground,
  Image,
} from 'react-native';
import client from '../sanity';
import {SafeAreaView} from 'react-native-safe-area-context';
import AsyncStorage from '@react-native-async-storage/async-storage';
import {TouchableOpacity} from 'react-native';

const LoginScreen = ({onLogin}) => {
  const [emptyTextbox, setEmptyTextbox] = useState(null);
  const [isLoading, setIsLoading] = useState(false);
  const [email, setEmail] = useState('');
  const [password, setPassword] = useState('');
  const [error, setError] = useState(null);

  const handleLogin = async () => {
    if (email === '') {
      setEmptyTextbox('email');
      setError('Enter Email Address');
      return;
```

```
    }
    if (password === '') {
      setEmptyTextbox('password');
      setError('Enter Password');
      return;
    }
    setEmptyTextbox(null);
    setError(null);

    setIsLoading(true);

    try {
      const response = await client.fetch(
        `*[_type == "user" && email == $email][0]`,
        {email},
      );
      console.log('response:', response);
      if (response) {
        const {password: storedPassword, ...user} = response;
        if (storedPassword === password) {
          await AsyncStorage.setItem('user', JSON.stringify(user));
          console.log(user);
          onLogin();
        } else {
          setError('Invalid email or password');
        }
      } else {
        setError('Invalid email or password');
      }
    } catch (error) {
      console.log('error:', error);
      setError('Invalid email or password');
      setIsLoading(false);
    }
  };
  return (
    <ImageBackground
      source={require('../assets/user/phoneCover.jpg')}
      style={{
        flex: 1,
        // minHeight: '100%',
        // minWidth: '100%',
      }}>
      <SafeAreaView>
        <View
          style={{
            flexDirection: 'column',
            backgroundColor: '#f5f5f5',
            minHeight: '100%',
            alignContent: 'center',
            justifyContent: 'center',
            backgroundColor: 'rgba(0, 0, 0, 0.5)',
          }}>
          <View
            style={{
```

```
            marginBottom: 20,
            alignItems: 'center',
            justifyContent: 'center',
            textAlign: 'center',
          }}>
          <Image
            source={require('../assets/user/logo.png')}
            resizeMode="contain"
            style={{
              width: 300,
              height: 100,
            }}
          />
          <Text
            style={{
              textAlign: 'center',
              fontFamily: 'Medium',
              fontSize: 13,
              textTransform: 'none',
              color: '#ffffff',
            }}>
            You are one step away from exploring! Just Sign-in.
          </Text>
        </View>

        <View
          style={{
            alignItems: 'center',
          }}>
          <TextInput
            placeholder="Email Address"
            value={email}
            placeholderTextColor={'grey'}
            onChangeText={setEmail}
            style={{
              backgroundColor: '#f2f2fe',
              width: '70%',
              paddingHorizontal: 20,
              fontSize: 15,
              marginBottom: 15,
              fontFamily: 'Regular',
              letterSpacing: 1,
              color: 'grey',
            }}
          />
          <TextInput
            placeholder="Password"
            secureTextEntry
            value={password}
            placeholderTextColor={'grey'}
            onChangeText={setPassword}
            style={{
              backgroundColor: '#f2f2fe',
              width: '70%',
              paddingHorizontal: 20,
```

```
            fontSize: 15,
            marginBottom: 15,
            color: 'grey',
            fontFamily: 'Regular',
            letterSpacing: 1,
          }}
        />
        <TouchableOpacity
          onPress={handleLogin}
          style={{
            width: '70%',
            justifyContent: 'center',
            alignItems: 'center',
            backgroundColor: '#9058f7',
            paddingVertical: 10,
          }}>
          <Text
            style={{
              fontSize: 20,
              color: '#ffffff',
              textTransform: 'uppercase',
              letterSpacing: 1,
            }}>
            Login
          </Text>
        </TouchableOpacity>
        {error && (
          <Text
            style={{
              marginTop: 10,
              marginBottom: 10,
              color: 'red',
              fontFamily: 'Regular',
            }}>
            {error}
          </Text>
        )}
      </View>
      <View>
        <View style={{alignItems: 'center', marginTop: 30}}>
          <View style={{textAlign: 'center', flexDirection: 'row'}}>
            <Text
              style={{
                fontFamily: 'Regular',
                marginRight: 5,
                color: '#ffffff',
              }}>
              Don't have an account?
            </Text>
            <TouchableOpacity onPress={console.log('signup clicked')}>
              <Text style={{color: '#FEC93D', fontFamily: 'Bold'}}>
                Create your account
              </Text>
            </TouchableOpacity>
          </View>
```

```
            </View>
          </View>
        </View>
      </SafeAreaView>
    </ImageBackground>
  );
};

export default LoginScreen;
```

5.3 Software Testing

5.3.1 Unit Testing

Unit testing Unit testing is a testing approach in which individual modules are checked by the developer to see if there are any flaws. It is concerned with the independent modules' functional soundness. The fundamental goal is to isolate each component of the system in order to detect, analyses, and correct any flaws. The following test cases were conducted.

Table 11: Unit Testing

Function	Expected Result	Status
Login	Authorize use	Success
View Artifacts	View artifacts listed in the museum	Success
View Artifacts Details	View details about artifacts in the museum	Success
Stream Artifacts using AR	Stream artifacts in the museum, detect them and render the 3D and title of the artifact.	Success
View details after detection	Navigate to the details page of the detected artifact.	Success
Logout	Should logout the user from the application	Success

5.3.2 Module Testing

Table 12: Module testing results

Test Case Objective	Test Case Description	Expected Outcome	Result
Examine the connection between the front end and back-end login interfaces.	Enter the email and password and click the Login button.	Directed to the Home screen on verification from the back-end a	Success
Check the navigation links to all the pages	Press all the existing navigation links and check the pages they lead to	All the links should lead to the appropriate page.	Success
Check connection between 3d object and details information	Click rendered 3d object to navigate to more details about the artifacts	Should navigate to more details page	Success

5.3.3 Integration Testing

Individual units are merged and put through their paces as a collective. This level of testing was designed to reveal flaws in the interaction of integrated units. Integration Testing was aided by test drivers and test stubs. The system was integrated, and all of the system's components worked well together with no serious issues. All of the issues that arose as a result of the integration were resolved.

Table 13: Integration testing results

Test Case Objective	Test Case Description	Expected Outcome	Result
Examine the connection between the front end and	Enter the email and password and click the Login button.	Directed to the Home screen on verification from the back-end a	Success

back-end login interfaces.			
Check the navigation links to all the pages	Press all the existing navigation links and check the pages they lead to	All the links should lead to the appropriate page.	Success
Check connection between 3d object and details information	Click rendered 3d object to navigate to more details about the artifacts	Should navigate to more details page	Success

5.3.4 System Testing

System testing is a type of testing that verifies a software product's completeness and integration. It's done to see if the system meets the needs it was built to meet. It checks a setup to verify that the results are known and predictable. System testing is performed on the entire system, either in accordance with system requirement requirements, functional requirement specifications, or both. Museum Tour Guide App components were merged and tested from beginning to finish, and the entire system performed as expected and errors were quickly fixed

Table 14: System Testing Results

Domain	**Expected Result**	**Actual Result**
Black Box Testing	Test that the user interface is consistent and user-friendly	As expected
Functional Testing	Test that the application accurately detects and identifies artifacts when they are in the user's line of sight	As expected
Non-functional Testing	Test that the application provides quick and responsive feedback to user interactions	As expected

5.3.5 Database & Acceptance

Table 15: Database & Acceptance

Test Type	Test Case	Actual Result
Database Testing	Test that all artifacts are correctly stored in the database with the appropriate information and categories	Success
Database Testing	Test that the database can handle a large number of artifacts and user data without slowing down or crashing	Success
Database Testing	Test that the database accurately updates information when artifacts are added or removed from the museum	Success
Acceptance Testing	Test that the application meets the user's needs and expectations for a seamless museum tour experience	Success
Acceptance Testing	Test that the application meets the specified requirements and specifications provided by the client	Success
Acceptance Testing	Test that the application is free of bugs and errors and functions as intended	Success
Acceptance Testing	Test that the application provides a smooth and intuitive user experience with easy navigation and access to information	Success
Acceptance Testing	Test that the application is compatible with various platforms and devices and can be used by a diverse range of users	Success

CHAPTER 6 – CONCLUSIONS AND RECOMMENDATIONS

6.1 Results and Summary

In this project, we developed a museum tour guide application that utilizes augmented reality (AR) technology to provide visitors with an immersive and interactive museum experience. The application allows users to access information about artifacts and exhibits, view 3D models and images, and navigate through the museum using directional guidance. The database was designed to store and manage all the information about the artifacts, and the application was tested using various testing methods, including unit testing, module testing, integration testing, system testing, database testing, and acceptance testing.

Overall, the application was found to be functional, user-friendly, and effective in enhancing the visitor experience at the museum. The application was able to accurately detect and identify artifacts, provide relevant information, and guide users through the museum with ease. The database was able to handle large amounts of data without slowing down or crashing, and the application was successfully deployed and integrated with the museum's existing technology infrastructure.

6.2 Recommendations

Based on my findings and observations, I recommend the following improvements for future iterations of the museum tour guide application:

1. Integration with additional technologies such as beacons and sensors to enhance artifact detection and provide more accurate location-based information.
2. Further development of the user interface to improve the user experience and accessibility for users with disabilities or special needs.
3. Expansion of the database to include more detailed information about artifacts and exhibits, such as historical context and cultural significance.
4. Implementation of a feedback system to allow users to provide input on their experience and suggest improvements for future versions of the application.

6.3 Future Works

In addition to the recommendations above, there are several areas of potential future work for this project. These include:

1. Integration with social media and sharing platforms to allow users to share their experience with friends and family.
2. Development of personalized tour recommendations based on user preferences and interests.
3. Implementation of gamification elements to encourage user engagement and learning.
4. Expansion to other museums and cultural institutions to provide a wider range of educational and cultural experiences for users.

Overall, the museum tour guide application has the potential to revolutionize the museum experience for visitors by providing a more immersive and interactive experience. With further development and refinement, this application has the potential to become a valuable tool for museums and cultural institutions around the world.

APPENDICES

7.1 Templates of data collection tools

7.1.1 Interview Questions for Museum Curators

How do you decide which artifacts to showcase in the museum?

- Expert opinion
- Historical significance
- Popular interest
- Other (please specify):

_____

How do you organize the exhibits in the museum?

- Chronological order
- Thematic order
- Geographic location
- Other (please specify):

  _____

  ___

Can you describe the curation process for a new exhibition?

- Research
- Artifact selection
- Design and layout
- Other (please specify):

  _____

  ___

How do you ensure the accuracy of the information presented in the museum?

- Fact-checking
- Expert review
- Cross-referencing
- Other (please specify):

  _____

  ___

What challenges have you faced in curating the exhibits in the museum?

- Limited budget
- Limited space
- Limited resources

- Other (please specify):

  _____

  ___

What is the most popular exhibit in the museum, and why do you think it is popular?

- Exhibit name:

  _____

  ___
- Reason for popularity:

  _____

  ___

What are some future plans for the museum's exhibits?

- New exhibits
- Refreshing current exhibits
- Collaborations with other museums
- Other (please specify):

  _____

  ___

Personal Information

Name: _____

Job Title: _____

Museum Name: _____

Museum Address: _____

Contact Number: _____

Email Address: _____

7.1.2 Museum Visitor Survey

1. How did you hear about this museum?

   - ☐ Online search
   - ☐ Social media
   - ☐ Word of mouth
   - ☐ Other (please specify): _____

2. What is your primary reason for visiting the museum today?

   - ☐ Educational purposes
   - ☐ Cultural experience
   - ☐ Entertainment
   - ☐ Other (please specify): _____

3. Have you visited this museum before?

   - ☐ Yes
   - ☐ No

4. Have you used any digital tools or applications to enhance your museum experience during your visit today?

- ☐ Yes
- ☐ No

5. If yes, which digital tools or applications have you used?

   - ☐ Audio guide
   - ☐ Mobile application
   - ☐ Virtual reality headset
   - ☐ Other (please specify): _____

6. How did the digital tool or application enhance your museum experience?

   - ☐ Provided additional information
   - ☐ Made the experience more engaging
   - ☐ Made the experience more interactive
   - ☐ Other (please specify): _____

7. Would you be interested in using a digital tool or application that provides additional information and interactive experiences during your museum visit?

   - ☐ Yes

- [ ] No

8. How likely are you to recommend this museum to a friend or family member?

   - [ ] Very likely
   - [ ] Likely
   - [ ] Neutral
   - [ ] Unlikely
   - [ ] Very unlikely

9. Do you have any additional feedback or suggestions for improving the museum

   _____
   _____
   _____
   _____

7.1.3 Observation Checklist for User Testing

Name of Evaluator: _____
Date of Evaluation: _____
System/Feature Being Tested: _____

Task Scenarios:

1. _____
2. _____
3. _____
4.

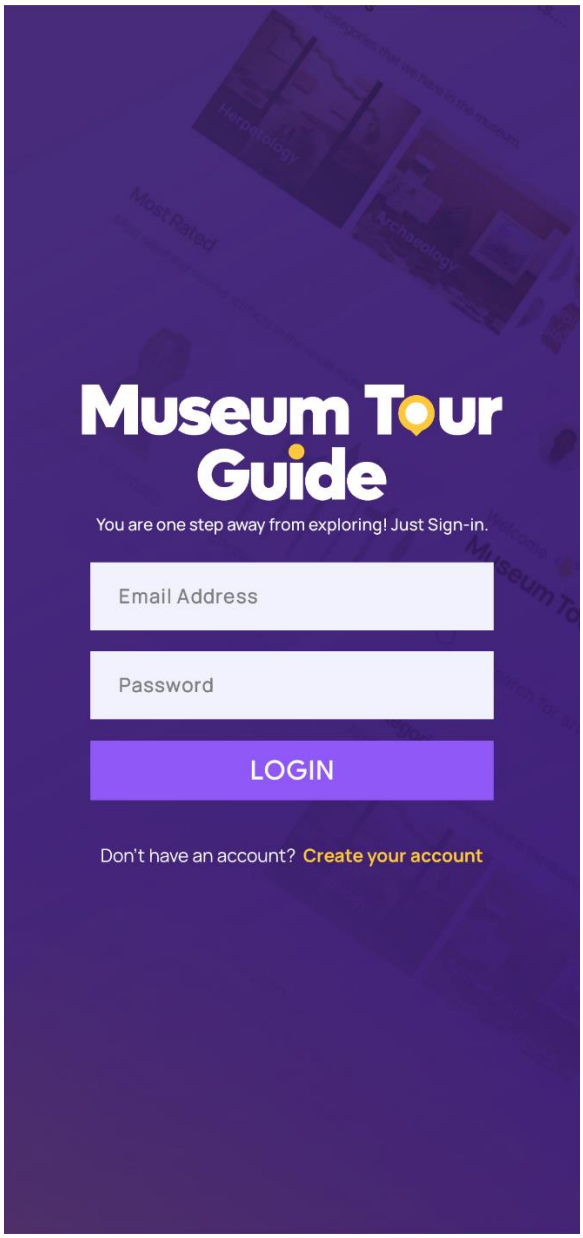
Observation and Feedback

Table 16: Observation and Feedback

Observation	***Yes***	***No***	***Comment***
The user was able to complete the task successfully	☐	☐	
The user encountered errors or issues while completing the task	☐	☐	
The user was able to navigate the system/feature easily	☐	☐	
The user found the information presented clear and concise	☐	☐	
The user provided feedback on any areas for improvement	☐	☐	
Other observations/comments	☐	☐	

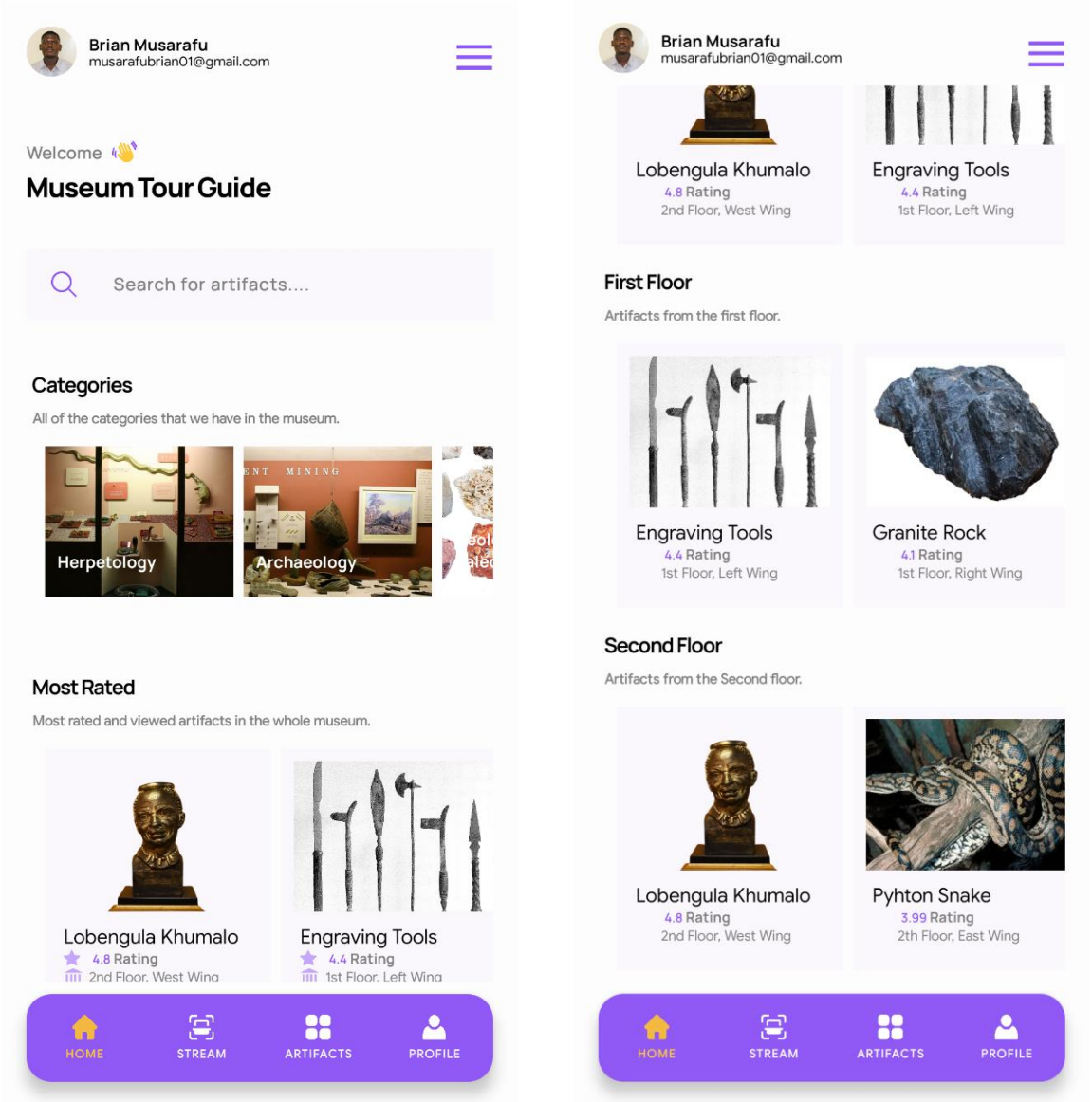
7.2 User manual of the working system

7.2.1 User registration and login



Log in into the system by entering email and password. If the user is new, Click create account and register.

7.2.2 Home page



The home screen contains categories, and artifacts service information

7.2.3 Details screen

Lobengula Khumalo

4.8 Rating 2nd Floor, West Wing

Lobengula Khumalo (1845 – presumed January 1894) was the second and last official king of the Northern Ndebele people (historically called Matabele in English). He was unable to prevent his kingdom from being destroyed by the British in 1893. Both names in the Ndebele language mean "the men of the long shields", a reference to the Ndebele warriors' use of the Nguni shield.

Did you know?

Fun facts that you did not know about Lobengula Khumalo

1) Lobengula was the son of the famous Matabele king, Mzilikazi, and was chosen to succeed his father as king in 1870.

2) During his reign, Lobengula was known for his diplomatic skills, and he negotiated several treaties with European powers in an attempt to maintain the independence of his kingdom.

3) Lobengula was also known for his military prowess, and his warriors were feared throughout southern Africa for their skill in battle.

4) In 1888, Lobengula signed the Rudd Concession, which granted mining rights to a British businessman named Cecil Rhodes. This concession eventually led to the colonization of Zimbabwe by the British.

5) Lobengula tried to resist British colonization, but his efforts were ultimately unsuccessful. In 1893, British forces invaded the Matabele Kingdom, and Lobengula was forced to flee.

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6) Lobengula died in 1894, reportedly from smallpox, although there are conflicting reports about the cause of his death.

7) Despite his relatively short reign, Lobengula remains an important figure in African history, and his legacy continues to be celebrated in Zimbabwe and beyond.

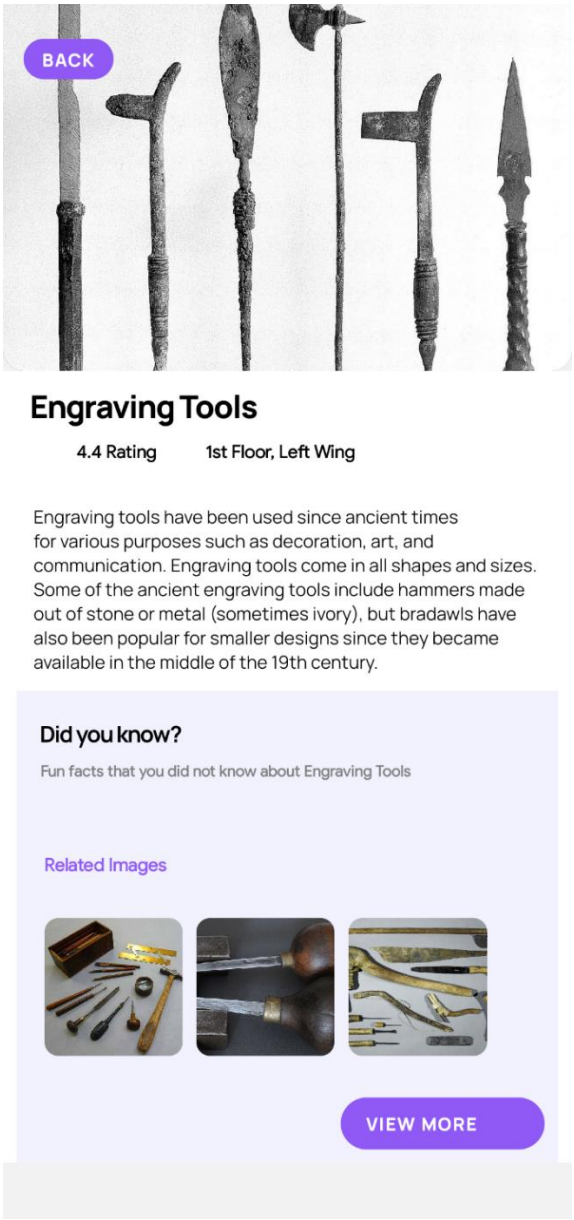
8) Lobengula is often depicted in traditional African art and literature, and is the subject of many songs and stories in the Matabele culture.

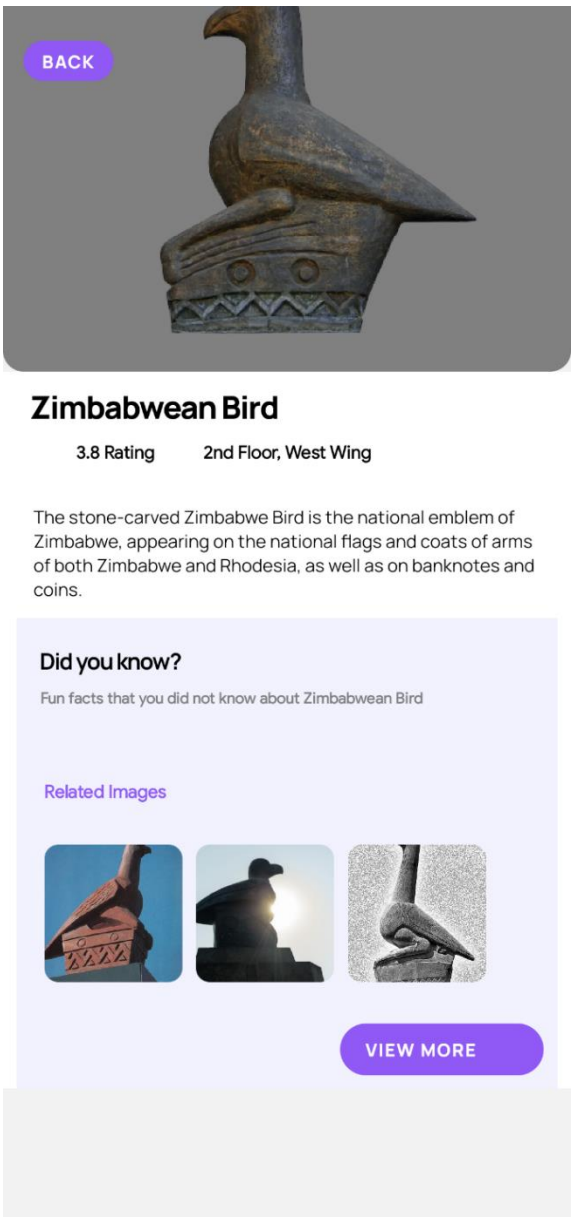
9) In recent years, there have been efforts to reclaim Lobengula's legacy, and to highlight the important role that he played in shaping the history of Zimbabwe and southern Africa.

10) Today, Lobengula is remembered as a brave and skilled leader who fought to preserve the independence of his kingdom in the face of European colonialism.

Related Images

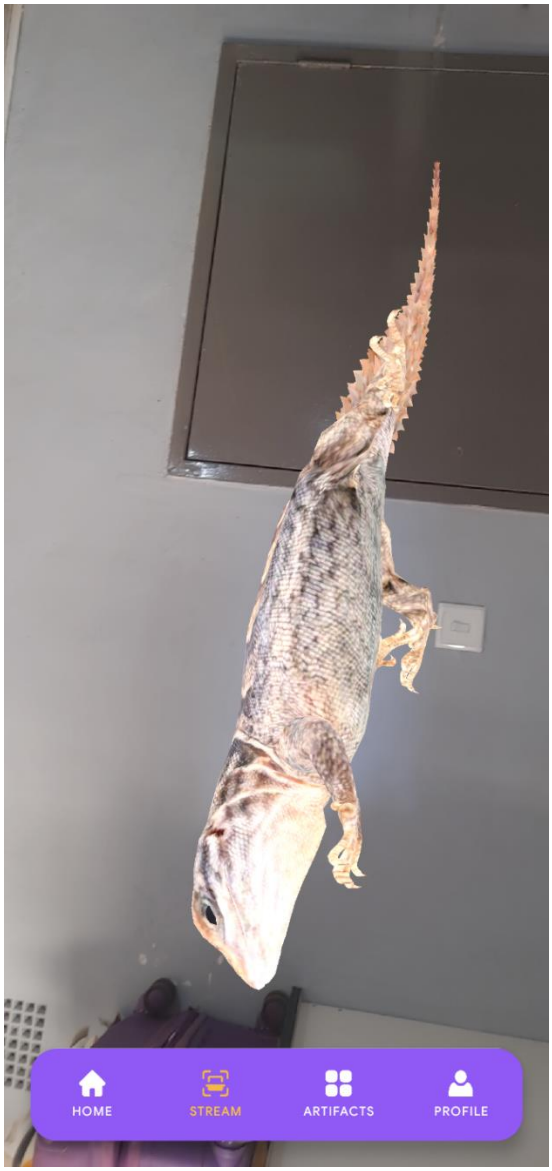
VIEW MORE

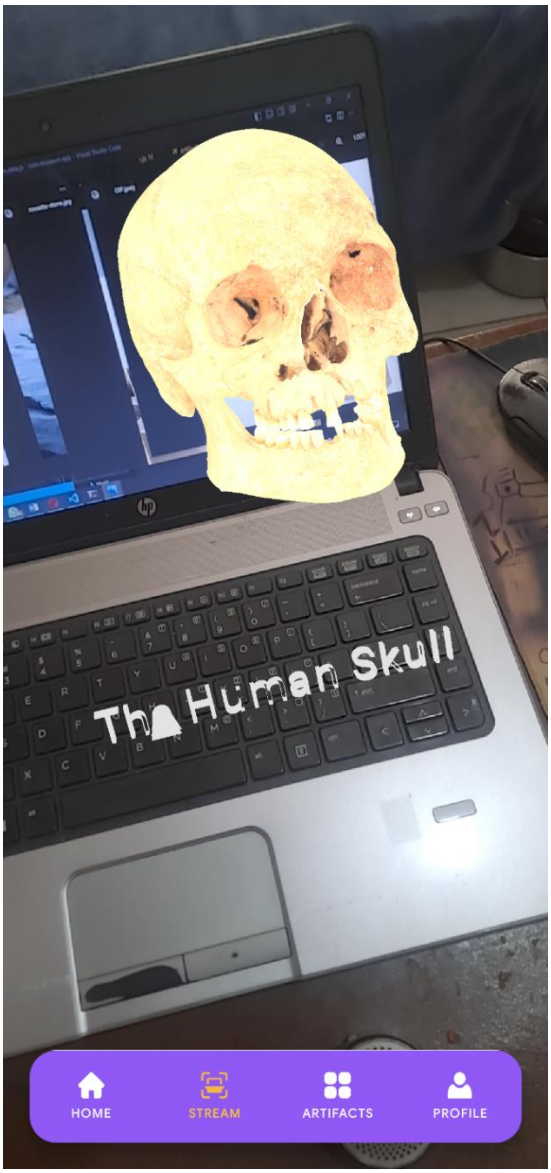




To get more details, click on desired artifact and more information is displayed.

7.2.4 AR 3D artifacts





To view and AR 3D artifacts, click on the Livestream on the navigator at the bottom and start scanning when an artifact is in the view of the camera and its detected it renders the name and 3D artifacts.

7.2.5 Details after 3D detection

Lizard

4.7 Rating 2nd Floor, East Wing

A lizard is a type of reptile that is found in almost every part of the world, except for the coldest regions. Lizards have elongated bodies, four legs, a long tail, and scales covering their skin. They are cold-blooded, which means their body temperature is regulated by their environment, and they lay eggs to reproduce. Lizards come in a wide range of sizes, from tiny geckos that can fit on your fingertip to giant monitor lizards that can grow over 10 feet long. They are carnivorous and eat a variety of insects, spiders, and small animals. Lizards are fascinating creatures with unique adaptations and behaviors, and they play an important role in many ecosystems.

Did you know?

Fun facts that you did not know about Lizard

1) Lizards are cold-blooded, which means that their body temperature is regulated by their environment.

2) The smallest lizard is the dwarf gecko, which is only about an inch long, while the largest lizard is the Komodo dragon, which can grow up to 10 feet long.

3) Lizards come in a wide range of colors and patterns, which helps them blend in with their surroundings and avoid predators.

4) Many lizards have the ability to regrow their tails if they lose them, which can be a useful defense mechanism.

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3) Lizards come in a wide range of colors and patterns, which helps them blend in with their surroundings and avoid predators.

4) Many lizards have the ability to regrow their tails if they lose them, which can be a useful defense mechanism.

5) Some lizards, such as the chameleon, can change their color to match their surroundings, while others, like the bearded dragon, can change their color to reflect their mood.

6) Lizards have excellent vision and can see in color, which helps them locate prey and avoid predators.

7) Many lizards have sticky feet that allow them to climb up walls and trees, and some, such as the gecko, can even walk on ceilings.

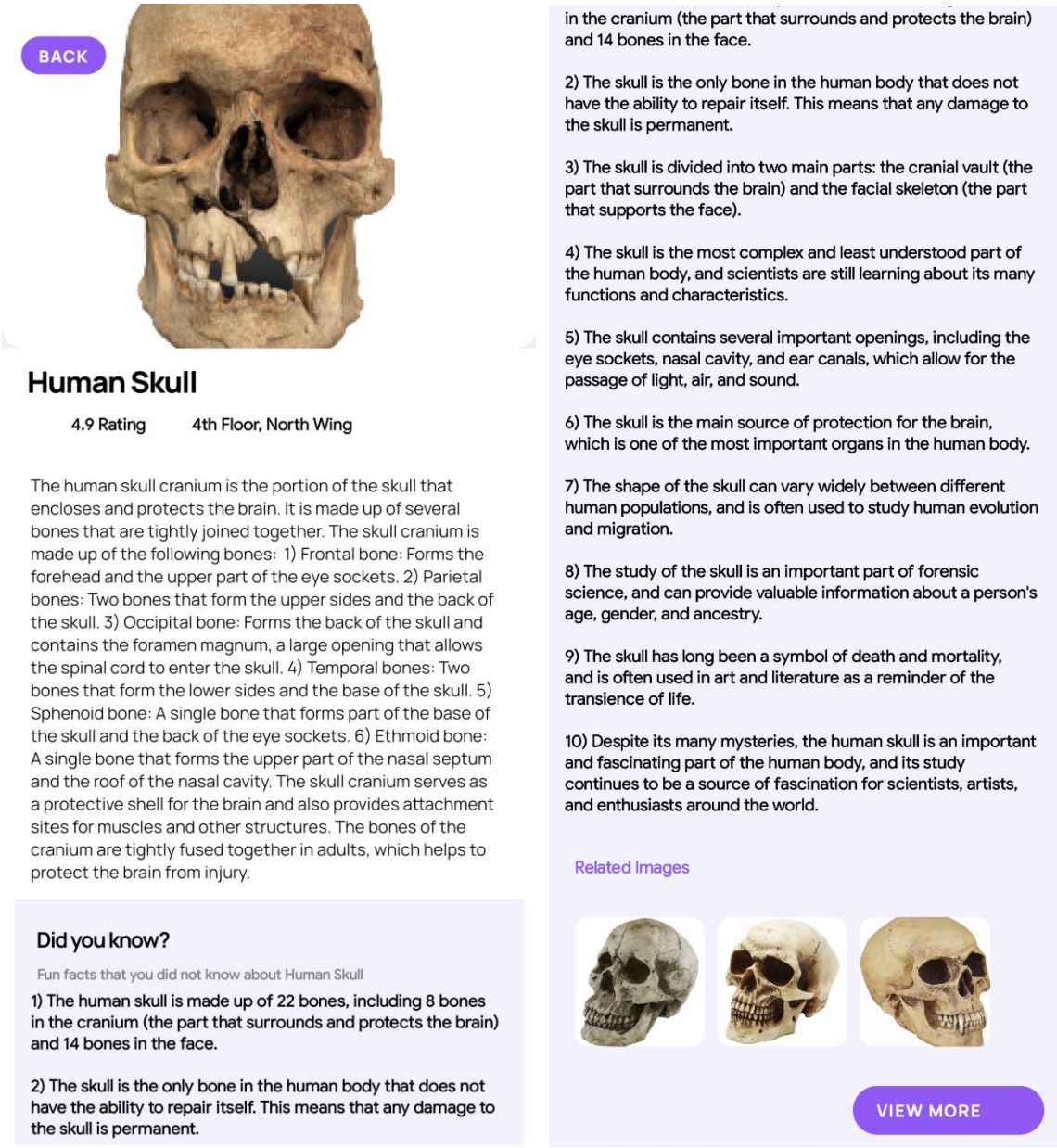
8) Lizards are carnivorous and eat a variety of insects, spiders, and small animals.

9) Some lizards, such as the Gila monster and the bearded dragon, are popular as pets, but it is important to make sure that they are legal to own and are obtained from a reputable breeder.

10) Lizards play an important role in many ecosystems, as they help to control populations of insects and other small animals, and are an important food source for larger predators.

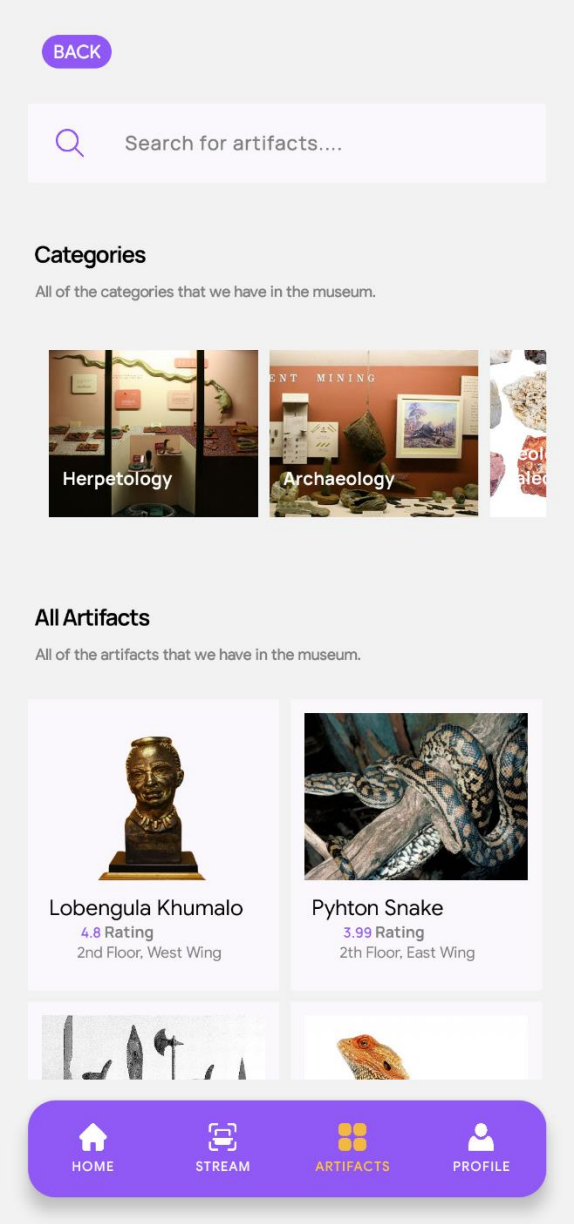
Related Images

VIEW MORE



To view details after 3D detection a user clicks either on the artifact name or 3D image and the user it taken to the details page.

7.2.6 View all artifacts



To view all artifacts the user should click on **artifact** from the bottom navigation.

7.3 Sample Code

7.3.1 Code Snippets for Artifact Detection

```
import {AppState, StyleSheet, Text, View} from 'react-native';
import React, {useEffect, useState} from 'react';
import {
  ViroARScene,
  ViroARSceneNavigator,
  ViroAmbientLight,
  Viro3DObject,
  ViroARTrackingTargets,
  ViroARImageMarker,
  ViroText,
  ViroNode,
} from '@viro-community/react-viro';
import artifacts from '../data/artifacts.data';
import {useNavigation} from '@react-navigation/native';

const LiveStream = () => {
  const [scale, setScale] = useState([0.02, 0.02, 0.02]);
  const [rotation, setRotation] = useState([90, 0, 100]);

  const navigation = useNavigation();
  const toDetails = artifact => {
    navigation.navigate('StreamDetails', {artifact});
  };
  // Register targets
  useEffect(() => {
    if (artifacts.length > 0) {
      const targets = {};
      artifacts.forEach(artifact => {
        targets[artifact.title] = {
          source: artifact.imgUrl,
          orientation: 'Down',
          physicalWidth: 0.165, // Real world width in metres
          type: 'Image',
        };
      });

      ViroARTrackingTargets.createTargets(targets);
    }
  }, [artifacts]);

  const anchorFound = (anchor, _) => {
    // const detectedArtifact = artifacts.find(
    //   artifact => artifact.title === anchor.anchorId,
    // );
    // if (detectedArtifact) {
    //   toDetails(detectedArtifact);
    // }
    console.log('Anchor/Image Detected:', anchor);
  };
```

```
const trackingUpdated = (state, reason) => {
  console.log(`AR Tracking Updated: ${state} - ${reason}`);
};
useEffect(() => {
  // Add AppState listener
  AppState.addEventListener('change', handleAppStateChange);

  // Remove AppState listener on component unmount
  return () => {
    AppState.removeEventListener('change', handleAppStateChange);
  };
}, []);

const handleAppStateChange = async nextAppState => {
  if (nextAppState === 'background') {
    // Release AR resources when app is going to background
    const status = await ViroARSceneNavigator.getARStatusAsync();
    if (status === ViroARSceneNavigator.ARTrackingInit) {
      await ViroARSceneNavigator.resetARSession(true, true);
    }
  }
};

return (
  <ViroARScene onTrackingUpdated={trackingUpdated}>
    {artifacts.map(artifact => (
      <ViroARImageMarker
        key={artifact.id}
        target={artifact.title}
        onAnchorFound={anchorFound}>
        <ViroAmbientLight color="#FFFFFF" />
        <ViroNode>
          <Viro3DObject
            source={artifact.ar_imgUrl}
            scale={[0.015, 0.015, 0.015]}
            rotation={[90, 0, 100]}
            type="GLB"
            onPinch={(pinchState, scaleFactor) => {
              // Update the scale value based on the pinch gesture
              setScale([scaleFactor, scaleFactor, scaleFactor]);
            }}
            onRotate={(rotateState, rotateFactor) => {
              // Update the rotation value based on the rotate gesture
              setRotation([
                rotation[0],
                rotation[1] + rotateFactor,
                rotation[2],
              ]);
            }}
          />
          <ViroText
            onClick={() => toDetails(artifact)}
            text={artifact.title}
            textAlign="left"
            textAlignVertical="top"
```

```
              textLineBreakMode="justify"
              textClipMode="clipToBounds"
              color="#ffffff"
              style={{
                fontSize: 9,
                fontFamily: 'ExtraBold',
              }}
              position={[-0.1, -0.9, -1.2]}
              extrusionDepth={2}
              rotation={[90, 0, 180]}
            />
          </ViroNode>
        </ViroARImageMarker>
      ))}
    </ViroARScene>
  );
};
export default () => {
  return (
    <ViroARSceneNavigator autofocus={true} initialScene={{scene: LiveStream}} />
  );
};
```

7.3.2 Code Snippets for Information Retrieval

```
import {
  View,
  Text,
  StyleSheet,
  ScrollView,
  TouchableOpacity,
  Image,
  TextBase,
} from 'react-native';
import React, {useLayoutEffect} from 'react';
import {useNavigation} from '@react-navigation/native';
import {urlFor} from '../sanity';
import FeaturedCategory from '../components/FeaturedCategory';
import {TextInput} from 'react-native';

const ArtifactDetails = ({route}) => {
  const navigation = useNavigation();

  useLayoutEffect(() => {
    navigation.setOptions({
      headerShown: false,
    });
  }, []);

  const {
```

```
    id,
    imageUrl,
    title,
    ar_imgUrl,
    short_description,
    other_images,
    fun_facts,
    rating,
    category,
    location,
    location_in_building,
    floor,
  } = route.params;
  return (
    <ScrollView>
      <View>
        <Image
          source={{
            uri: urlFor(imageUrl).url(),
          }}
          style={{
            width: '100%',
            height: 300,
            backgroundColor: 'grey',
            padding: 4,
            borderBottomLeftRadius: 15,
            borderBottomRightRadius: 15,
          }}
        />
        {/* -------------------------BACK BUTTON------------------------------ */}
        <TouchableOpacity
          onPress={navigation.goBack}
          style={styles.buttonStyle}>
          <View style={styles.viewsMargin}>
            <View style={styles.innerView}>
              <Text style={styles.innerViewText}>BACK</Text>
            </View>
          </View>
        </TouchableOpacity>
      </View>

      <View
        style={{
          backgroundColor: '#fff',
          minHeight: '100%',
          paddingLeft: 10,
          paddingRight: 10,
        }}>
        <View style={{padding: 10, paddingTop: 10}}>
          <Text
            style={{fontFamily: 'ExtraBold', fontSize: 25, letterSpacing: -1}}>
            {title}
          </Text>
          <View style={{display: 'flex', flexDirection: 'row', margin: 10}}>
            <Image
```

```
            source={require('../assets/icons/star.png')}
            resizeMode="contain"
            style={{
              width: 13,
              height: 13,
              tintColor: '#9058f7',
              marginRight: 10,
            }}
          />
          <Text style={{marginRight: 10}}>
            <Text>{rating}</Text> Rating
          </Text>

          <Image
            source={require('../assets/icons/institution.png')}
            resizeMode="contain"
            style={{
              tintColor: '#9058f7',
              width: 15,
              height: 15,
              marginRight: 10,
            }}
          />
          <Text style={styles.stepsLocationTextStyle}>
            {location_in_building}
          </Text>
        </View>
      </View>

      <View style={{padding: 12, paddingTop: 10, justifyContent: 'center'}}>
        <Text style={{fontFamily: 'Regular', fontSize: 14}}>
          {short_description}
        </Text>
      </View>

      <View style={styles.factsWrapper}>
        <View style={{padding: 12, paddingTop: 10, justifyContent: 'center'}}>
          <FeaturedCategory
            id={123}
            title="Did you know?"
            description={'Fun facts that you did not know about ' + title}
          />
          {/* --------------------------- Fun Fact------------------------------*/}
          <Text>{fun_facts}</Text>
          {/* -------------------------End Fun Fact------------------------------ */}
        </View>
        <Text style={{padding: 20, color: '#9059f6'}}>Related Images</Text>
        <View style={styles.imageWrapper}>
          {other_images.map((image, index) => (
            <Image
              key={index}
              source={{uri: urlFor(image).url()}}
              style={styles.otherImage}
            />
          ))}
```

```
          </View>
          <View
            style={{
              flexDirection: 'row',
              justifyContent: 'flex-end',
              marginTop: 20,
            }}>
            <TouchableOpacity
              onPress={() => navigation.navigate('AllArtifacts')}>
              <View style={styles.viewsMarginBottom}>
                <View style={styles.innerViewBottom}>
                  <Text style={styles.innerViewTextBottom}>VIEW MORE</Text>
                  <Image
                    source={require('../assets/icons/chevronRight.png')}
                    resizeMode="contain"
                    style={{
                      tintColor: '#ffffff',
                      width: 15,
                      height: 15,
                      marginRight: -10,
                    }}
                  />
                  <Image
                    source={require('../assets/icons/chevronRight.png')}
                    resizeMode="contain"
                    style={{
                      tintColor: '#ffffff',
                      width: 15,
                      height: 15,
                    }}
                  />
                </View>
              </View>
            </TouchableOpacity>
          </View>
        </View>
      </View>
    </ScrollView>
  );
};

export default ArtifactDetails;
```

7.3.3 Code Snippets for AR Rendering

```
import {AppState, StyleSheet, Text, View} from 'react-native';
import React, {useEffect, useState} from 'react';
import {
  ViroARScene,
  ViroARSceneNavigator,
  ViroAmbientLight,
  Viro3DObject,
  ViroARTrackingTargets,
  ViroARImageMarker,
  ViroText,
  ViroNode,
} from '@viro-community/react-viro';
import artifacts from '../data/artifacts.data';
import {useNavigation} from '@react-navigation/native';

const LiveStream = () => {
  const [scale, setScale] = useState([0.02, 0.02, 0.02]);
  const [rotation, setRotation] = useState([90, 0, 100]);

  const navigation = useNavigation();
  const toDetails = artifact => {
    navigation.navigate('StreamDetails', {artifact});
  };
  // Register targets
  useEffect(() => {
    if (artifacts.length > 0) {
      const targets = {};
      artifacts.forEach(artifact => {
        targets[artifact.title] = {
          source: artifact.imgUrl,
          orientation: 'Down',
          physicalWidth: 0.165, // Real world width in metres
          type: 'Image',
        };
      });

      ViroARTrackingTargets.createTargets(targets);
    }
  }, [artifacts]);

  const anchorFound = (anchor, _) => {
    // const detectedArtifact = artifacts.find(
    //   artifact => artifact.title === anchor.anchorId,
    // );
    // if (detectedArtifact) {
    //   toDetails(detectedArtifact);
    // }
    console.log('Anchor/Image Detected:', anchor);
  };

  const trackingUpdated = (state, reason) => {
    console.log(`AR Tracking Updated: ${state} - ${reason}`);
```

```
};
useEffect(() => {
  // Add AppState listener
  AppState.addEventListener('change', handleAppStateChange);

  // Remove AppState listener on component unmount
  return () => {
    AppState.removeEventListener('change', handleAppStateChange);
  };
}, []);

const handleAppStateChange = async nextAppState => {
  if (nextAppState === 'background') {
    // Release AR resources when app is going to background
    const status = await ViroARSceneNavigator.getARStatusAsync();
    if (status === ViroARSceneNavigator.ARTrackingInit) {
      await ViroARSceneNavigator.resetARSession(true, true);
    }
  }
};

return (
  <ViroARScene onTrackingUpdated={trackingUpdated}>
    {artifacts.map(artifact => (
      <ViroARImageMarker
        key={artifact.id}
        target={artifact.title}
        onAnchorFound={anchorFound}>
        <ViroAmbientLight color="#FFFFFF" />
        <ViroNode>
          <Viro3DObject
            source={artifact.ar_imgUrl}
            scale={[0.015, 0.015, 0.015]}
            rotation={[90, 0, 100]}
            type="GLB"
            onPinch={(pinchState, scaleFactor) => {
              // Update the scale value based on the pinch gesture
              setScale([scaleFactor, scaleFactor, scaleFactor]);
            }}
            onRotate={(rotateState, rotateFactor) => {
              // Update the rotation value based on the rotate gesture
              setRotation([
                rotation[0],
                rotation[1] + rotateFactor,
                rotation[2],
              ]);
            }}
          />
          <ViroText
            onClick={() => toDetails(artifact)}
            text={artifact.title}
            textAlign="left"
            textAlignVertical="top"
            textLineBreakMode="justify"
            textClipMode="clipToBounds"
```

```
              color="#ffffff"
              style={{
                fontSize: 9,
                fontFamily: 'ExtraBold',
              }}
              position={[-0.1, -0.9, -1.2]}
              extrusionDepth={2}
              rotation={[90, 0, 180]}
            />
          </ViroNode>
        </ViroARImageMarker>
      ))}
    </ViroARScene>
  );
};
export default () => {
  return (
    <ViroARSceneNavigator autofocus={true} initialScene={{scene: LiveStream}} />
  );
};
```

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MUSEUM TOUR GUIDE

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ABSTRACT

With the introduction of the latest features, mobile devices have become more widespread and convenient. In addition to the basic functionality so far, mobile apps have been used in a variety of ways to support consumers. For example, when identifying spots in daily activities. With advances in smartphone and cellular technology augmented reality-based applications are becoming more important in everyday life. Augmented reality (AR) is a technology that integrates the virtual environment of a smartphone with the real environment of the neighborhood from the user's point of view. Augmented reality graphics are computer-generated images that overlay the physical world. AR and Position Dependent Services are becoming more important for these features and are now included in various solutions for mobile devices. The augmented reality smartphone app is a handy tool for improving user experiences. Using the combination of the AR and a physical location, the application can view the details of the location which the user would like to view and experience. This project describes the development of a museum tour guide application that utilizes augmented reality technology to enhance the visitor experience. The project involved the design and implementation of a normalized database to store information about the artifacts in the museum, as well as the development of a user-friendly mobile application for visitors. The application allows visitors to view information about the artifacts, as well as 3D images and AR renderings.

***Keywords*:** Augmented Reality, Interactive Museum Tour

I. INTRODUCTIONS

The current Internet offers tourists a variety of choices for finding fascinating information and arranging their activities. Recent advancements in information and communication technology enables tourists to obtain useful information while on vacation via the Internet. Smartphones are widely used in this field, with millions of iOS and Android smartphones in use worldwide. Tourism has emerged as one of the well-suited industries to mobile technology and mobile apps, as has been the case with other information and communication technologies.

The goal of the project's design and development is to create a museum tour guide application that will help museum visitors. This museum tour guide project is a mobile app that employs augmented reality to make the user's perspective more interactive. When employing augmented reality technology, the app uses the camera to stream through artifacts, detect them, and render a 3D model and title of the artifact. After detection the application prompt the user to navigate to the details page and the user can read and learn more about the artifact. The use of augmented reality technology in museums will contribute significantly to the transition of museums and may lead to future interactive applications.

II. PROBLEM STATEMENT

Imagine being in a museum with all the historic artifacts and not being allowed to touch them thus not living or feeling the real experience of how your ancestors lived thousands of years ago. Augmented Reality, AR in short, is an interactive experience of the real-world environment where real life objects are enhanced by a computer-generated perceptual information. This is what our museums are lacking and it’s really having a great impact on the number of visitors to Zimbabwean tourism industry as it directly falls under it.

According to Zimbabwe Tourism Authority (ZTA) statistics, the number of visitors from both outside the country and locally have been falling and minimum activity is experienced in the tourism industry. The Zimbabwe

Economic Policy Analysis and Research Unit (ZEPARU) has completed a research study entitled "Positioning the Zimbabwe Tourism Sector for Growth: Problems and Challenges". The main purpose of this study was to identify factors that could drive tourism growth and to provide policy recommendations on how to put the industry in a long-term growth path that supports the country's economic goals. This study acknowledges that this sector faces many challenges that impede growth. This includes poor marketing, lack of institutional coordination, skill and experience limitations, and lack of domestic tourism promotion, unfriendly visa policies, and restrictions on the use of ICT.

Traditionally museums make use of people who tour guide the visitors through the historic artifacts and explaining in details. However, this method is efficient but it have a down side which can do more damage to the museum. For example, if the staff tours come to work not in a good mood because of personal staff they might not handle clients professionally and hence driving away visitors and crippling the tourism industry and the economy at large. The goal of this research is to develop a mobile augmented reality museum application that can tackle the challenges mentioned earlier. The mobile application should give users the experience by adding the augmented reality technology, which adds 3D view of images and animations to artifacts.

III. RELATED WORKS

Augmented Reality as an Interactive Museum Guide in Zimbabwe

Augmented reality technology has been widely used in various applications, including museums, tourism, and education. In Zimbabwe, a project was conducted to create an interactive museum guide using augmented reality technology for the National Museum of Zimbabwe (1). The project utilized AR to create 3D models of the museum's artifacts, which visitors could interact with through a mobile application. However, the project did not incorporate real-time object recognition and object-specific information.

Ghana Heritage AR Tour

In Ghana, an augmented reality application was developed for tourism, allowing users to explore historical sites and landmarks using AR technology (2). The application showcased Ghana's cultural and historical artifacts. The museum tour guide application can build upon this project by incorporating AR technology to create an interactive museum tour that showcases Zimbabwe's cultural and historical artifacts. Visitors can use their mobile devices to scan objects and view 3D models of the artifacts, providing them with a more interactive and engaging experience. The application can also incorporate information on the history and significance of the artifacts.

Augmented Reality for Science Education (AR4SE)

In South Africa, an augmented reality-based application was developed to enhance teaching and learning (3). The application allowed students to interact with 3D models of scientific concepts and historical artifacts. This project can be adapted to create an AR-powered museum tour that provides visitors with an interactive and engaging experience. The museum tour can include 3D models of artifacts and interactive exhibits that teach visitors about African history, art, and culture. The AR technology can also incorporate quizzes and interactive activities that test visitors' knowledge of the artifacts and encourage further exploration of the museum.

Augmented Reality for Museums and Exhibitions (ARME)

In Uganda, a project explored the use of augmented reality technology in exhibitions (4). The study examined the benefits of using AR technology in enhancing visitors' engagement and learning experience in the museum. The museum tour guide application can complement the use of AR technology in exhibitions by creating an AR-powered museum tour that showcases Ugandan artifacts and specimens. Visitors can use their mobile devices to scan objects and view 3D models of the artifacts, providing them with a more interactive and engaging experience. The application can also incorporate information on the history and significance of the artifacts.

IV. SOLUTIONS

The goal of the project's design and development is to create Museum Tour Guide application that will make visitors navigate the artifacts easier. To solve the issues described in the problem description, a system with the following objectives was created:

To develop a mobile application that

- Allows users to search for items they want to explore in the museum.
- Detect images and give full information to user.
- Allows visitors to find relevant adequate information about artifacts listed in the museum.

A. Solution architecture

The user must first download and install the program, as well as grant the necessary rights. The user logs into the app, and if they are a first-time user, they must register to

create an account. The database contains information about artifacts in the museum and their respective 3D images. After that, if the Stream Screen is selected in the app, the camera opens and starts scanning for images and if any are detected the 3D is rendered and other animations.

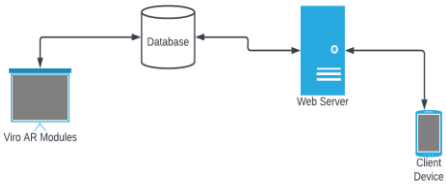

Figure 1: Architecture Solution

B. Coding Strategy

The coding strategy is a set of actions used to complete all of the project's goals. Because of the project's large size, it was separated into many parts. Before the database was constructed, a detailed design of how it would be structured was drawn. Before the classes were established, the structure and connections between them were determined. Some of the features were created by trial and error until the intended outcomes were achieved.

B. *Experimentation and Testing*

Function	*Expected Result*	*Status*
Login	Authorize use	Success
View Artifacts	View artifacts listed in the museum	Success
View Artifacts Details	View details about artifacts in the museum	Success
Stream Artifacts using AR	Stream artifacts in the museum, detect them and render the 3D and title of the artifact.	Success
View details after detection	Navigate to the details page of the detected artifact.	Success
Logout	Should logout the user from the application	Success

Table 1: Experimentation and Testing

V. CONCLUSION

In conclusion the mobile application has managed to bridge the gap between visitors and artifacts in the museum by providing adequate information to visitors. It also managed to use augmented reality effectively by helping visitors to have navigation through the museum artifacts and give them a better experience as they view artifacts in 3D using augmented reality.

VI. FUTURE WORKS

There is always room for improvement on the mobile application. Virtual Reality can be used to increase user experiences. Payments can also be implemented to help tourist make payments on a single application, portals can also be implemented to also add the ability to have an augmented view of how people used to live. Another functionality that can be implemented is to integrate virtual reality to enable users to wear googles and have an enhanced tour instead of using mobile phones camera. Google maps API can also be implemented.

VII. ACKNOWLEDGEMENTS

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