JIMMA UNIVERSITY

JIMMA INSTITUTE OF TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATICS

DEPARTMENT OF SOFTWARE ENGINEERING

OBJECT-ORIENTED SOFTWARE ENGINEERING PROJECT

Exploring Ethiopia: A Virtual Reality Tour Application

Submitted to: Mrs. Kasech Ts

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Chapter One Introduction

1.1 Background

The collaborative project, "Exploring Ethiopia: A Virtual Reality Tour," is currently underway in partnership with the Ethiopian Ministry of Culture and Tourism, reflecting a shared commitment to leveraging cutting-edge technology for cultural preservation and tourism promotion. This groundbreaking software application seeks to provide users with an immersive virtual reality tour of Ethiopia's cultural and natural gems, including Lalibela, Erta Ale, Axum, and Sof-omor. The Ethiopian Ministry of Culture and Tourism, as a key stakeholder, recognizes the transformative potential of virtual reality in transcending geographical barriers and attracting a global audience to the country's diverse offerings.

By investing in this innovative initiative, the ministry aims not only to showcase Ethiopia's historical and natural wonders but also to foster cultural education, awareness, and sustainable tourism development. The virtual reality experience is designed to captivate users with lifelike representations of these iconic sites, offering a deep appreciation of Ethiopia's rich heritage. The Ethiopian Ministry of Culture and Tourism, entrusted with the development, is a leading entity renowned for its expertise in software solutions and virtual reality applications, making it a natural partner for such a transformative project.

This collaboration aligns with the broader goals of the Ethiopian Ministry of Culture and Tourism, as it endeavors to position Ethiopia as a prominent and accessible tourist destination on the global stage. The application goes beyond mere promotion, contributing to the preservation of cultural treasures and the ministry's vision of fostering a deeper understanding of Ethiopia's unique identity. Through this venture, the partnership seeks to redefine cultural tourism in the digital age, reinforcing Ethiopia's global appeal and highlighting the country's commitment to technological innovation in the realm of cultural heritage and tourism.

1.2 Statement of the Problem

Tourism in Ethiopia has evolved with technological advancements, leveraging travel websites and human resources for improved efficiency. However, the current system for physically visiting tourist attractions presents considerable challenges, demanding significant investments of time and money to reach destinations like Lalibela, Erta Ale, Axum, and Sof-omor. These extraordinary sites remain inaccessible to many, particularly those with mobility issues or residing in remote areas. Physical visits entail safety concerns related to adverse weather conditions, inhospitable roads, and other travel-related difficulties, posing potential threats to the environment and wildlife. Our proposed solution, "Exploring Ethiopia: A Virtual Reality Tour," aims to revolutionize Ethiopian tourism by addressing these challenges. Through the integration of virtual reality and digitalization, the project offers a safer, more inclusive, and environmentally conscious alternative to physical visits, making cultural and natural wonders accessible globally. This transformative approach aligns with the Ethiopian Ministry of Culture and Tourism's objectives, providing a comprehensive solution to showcase the country's rich heritage while mitigating the limitations associated with traditional tourism methods.

1.3 Objectives

General Objective

Our general objective is to develop a mobile application called Exploring Ethiopia Virtual Reality Tour for Ministry of Tourism Ethiopia.

Specific Objectives

- Gathering requirements
- Analyzing requirements
- using high quality graphics and sound
- creating a Design
- developing a 3D model of tourism sites
- Validation

1.4 Methodology

We used a comprehensive approach in our project. This approach involved utilizing various techniques and tools to achieve our specific objectives and to ensure that the end product met the desired quality standards.

We utilized brainstorming techniques as a way of gathering requirements for the Exploring Ethiopia Virtual Reality Tour mobile application. This involved a collaborative effort between the development team and potential users to generate ideas and gather information about the desired features and functionalities of the application. We organized brainstorming sessions that allowed for open communication and creative thinking to ensure that we captured the full range of requirements for the application. These requirements were then prioritized and used to develop a prototype of the application for further evaluation.

In order to ensure that all requirements were properly integrated and tested, we used interaction matrices to analyze the interactions between different components or subsystems of the system. The interaction matrices were created by identifying the different components or subsystems and then mapping out the interactions between them. We used this information to identify potential issues and conflicts that might arise during development and to ensure that all requirements were properly integrated and tested.

We gathered data using photogrammetry techniques to create a 3D model of the tourism sites. We used Blender and 3ds Max, which are software designed to create 3D models, and we also used high-quality sound libraries SoundSnap and AudioJungle.

To model the system or the Exploring Ethiopia Virtual Reality Tour mobile application, we employed an Object-Oriented (OO) methodology. This meant that we represented the system as a collection of interacting objects, each encapsulating data and behaviors.

The choice of an Object-Oriented approach was driven by the benefits it offered in terms of code reuse, modularity, and adaptability to changes. It facilitated a more maintainable and extensible system, which was crucial for a project like the Exploring Ethiopia Virtual Reality Tour that might evolve over time.

To validate the effectiveness of "Exploring Ethiopia: A Virtual Reality Tour" application, we proposed to use usability testing and focus groups. Usability testing would allow us to identify any issues or challenges users might encounter while interacting with the application, while focus groups would provide us with valuable feedback from potential users. We would conduct

usability testing in a controlled environment, with participants asked to perform specific tasks within the application while their actions and feedback were recorded. This would allow us to gather quantitative and qualitative data on the usability of the application. Focus groups would be conducted with potential users to gather feedback on the overall user experience, as well as suggestions for improvements. Through these methodologies, we aimed to ensure that the application met the needs of our users.

We leveraged advanced modeling tools, specifically UML (Unified Modeling Language) tools, to create detailed visual representations of the software architecture and design. These tools allowed us to visually capture key components, relationships, and interactions within the software, aiding in the clear articulation of the application's architecture.

1.5 Feasibility

The "Exploring Ethiopia: A Virtual Reality Tour" project underscores robust economic feasibility, presenting substantial benefits for both the Ethiopian Ministry of Culture and Tourism and the end users of the system. Utilizing virtual reality technology to showcase Ethiopia's cultural and tourism assets is poised to drive increased tourist engagement, creating new revenue streams for the ministry. Simultaneously, the project offers users an immersive and accessible means to explore Ethiopia's cultural treasures remotely, expanding their cultural awareness and fostering a deeper appreciation for the nation's rich heritage. The alignment of the project with long-term economic objectives, including the attraction of a global audience and positioning Ethiopia as a desirable destination, justifies the initial investment for the anticipated economic gains and enhanced cultural promotion.

From a technical perspective, the project demands proficiency in virtual reality development, multimedia content creation, and digitalization. The Ethiopian Ministry of Culture and Tourism, with its commitment to technological innovation, possesses the requisite technical expertise or can establish collaborative partnerships with skilled professionals in the field. Successful project execution relies on integrating cutting-edge virtual reality technologies for a seamless and immersive user experience. The presence of capable technical resources and existing infrastructure substantiates the project's technical feasibility.

Meticulous attention is given to the time feasibility of the project to ensure the prompt delivery of the virtual reality tour application. The project timeline is intricately designed to align with the Ethiopian Ministry of Culture and Tourism's strategic objectives, striking a balance between expeditious development and meticulous attention to detail. The efficient coordination of project activities, collaboration with skilled professionals, and adherence to a well-structured timeline contribute to overall time feasibility. Timely implementation is crucial not only to capitalize on emerging opportunities in the tourism sector but also to meet the ministry's strategic goals in a dynamically evolving landscape.

1.6 Project Scope and Limitation

1.6.1 Scope

The "Exploring Ethiopia: A Virtual Reality Tour" is a software application that aims to provide users with a virtual reality tour of four tourism sites in Ethiopia, namely Lalibela, Erta Ale ,Axum, and the Sof-omor, without having to physically travel to those locations. The goal of this software requirements specification document is to outline the requirements and functionalities for the software. This software will provide a 360-degree virtual reality experience of the selected tourism sites, allowing users to explore different areas of the sites, learn about each location through interactive multimedia elements and interact with the virtual environment. A user-friendly interface will make navigation seamless. The software, however, will not allow users to alter the virtual environment, provide transportation or accommodation for physical travel, or provide real time updates or changes to the tourism sites. Through these services software will benefit tourists, tour agencies, and users interested in learning about Ethiopia's tourism and culture. Tourists will 1 have an immersive experience, while tour agencies can use the virtual experience as a marketing tool to attract new customers. Education users can learn about the country's historical and cultural landmarks through interactive multimedia elements.

1.6.2 Limitations

Although our project aims to deliver a transformative virtual reality experience, yet it acknowledges certain inherent limitations. Firstly, the software refrains from providing physical travel assistance, thereby not facilitating the arrangement of transportation or accommodation for users interested in physically visiting the tourism sites. Additionally, the virtual environment is designed to be immutable, ensuring users cannot alter the presented content and maintaining the integrity of the experience. Real-time updates to the tourism sites are limited, with the software presenting information as it existed at the time of content creation. Furthermore, the project does not include features for providing transportation or accommodation services to users planning physical visits to the tourism sites. Lastly, while the project has an educational focus and enhances learning experiences, it does not substitute for the comprehensive understanding that physical visits to the sites might offer. These limitations are essential considerations that define the boundaries of the project within its intended scope.

1.7 Significance of the Project

Significance Ethiopia is a country that boasts a rich cultural heritage and a diversity of ethnic groups. To enhance cultural awareness, "Exploring Ethiopia: A Virtual Reality Tour" application can offer people an immersive experience of Ethiopian culture, helping them gain a better understanding of its customs, traditions, and way of life. Through virtual reality, individuals can explore Ethiopia's rich cultural diversity and gain a better appreciation of its uniqueness. In addition to promoting cultural awareness, virtual reality can also aid in preserving historical and cultural sites in Ethiopia. Many of these sites are at risk of being lost due to natural disasters or human activities. By creating digital replicas of these sites, it can help to preserve them and allow people worldwide to access them. Furthermore, the application can also serve as an educational tool, providing students with an immersive and engaging way to learn about Ethiopia's history, geography, and culture. Finally, it can improve accessibility to Ethiopia's attractions, particularly for people with disabilities or those who are unable to travel to the country. Individuals can experience the country's natural wonders, historical landmarks, and cultural events from the comfort of their homes. Overall “Exploring Ethiopia: A Virtual Reality Tour" application can benefit users by enabling them to explore Ethiopia without the expenses of traveling while

promoting Ethiopia's cultural heritage, increasing tourism, and providing educational and accessibility benefits.

1.8 Organization of the Project

1.8.1 Project Team

Documentation Lead: **Lalisa Bula**

- Leads the creation of project documentation

System Architect: **Kuma Leta and Medhanit**

- Manages the overall system architecture and design.

Review and Maintenance: **Mikiyas, Abdulahi and Hermela**

- Review and provide feedback on project documentation.
- Responsible for the ongoing maintenance and updates of project documentation.

1.8.2 Project Hierarchy

Phase 1: Requirement Gathering and Analysis

- Identify stakeholders and gather initial project requirements.

Phase 2: System Design and Modeling

- Develop initial system design and architecture.

Phase 3: Organizing Documentation and Formatting

- Establish a structured approach for organizing project documentation.
- Ensure that all documents are well-formatted and easily accessible.

Phase 4: Implementation and Development

- Code and implement the Exploring Ethiopia Virtual Reality Tour mobile application.

Phase 5: Testing

- Conduct various testing procedures to ensure the functionality and reliability of the application.

Phase 6: Deployment and User Feedback

- Deploy the application for user testing and gather feedback for further improvements.

1.8.3 Communication Structure

The success of the "Exploring Ethiopia: A Virtual Reality Tour" project was dependent on effective and transparent communication among team members. Throughout the project, the team engaged in a structured communication approach, adapting to the unique requirements and dynamics of the project.

Team Meetings

Team meetings were conducted regularly, aligning with specific phases of the project as milestones for collaborative discussions. These sessions provided an opportunity to review progress, address challenges encountered during the respective phases, and strategize for upcoming tasks. Meeting schedules and agendas were determined and communicated in advance, allowing all team members to actively contribute to decision-making and share updates.

Project Progress Monitoring

To maintain real-time awareness of project progress, the team utilized a designated Telegram channel. This channel served as a central hub for communication, enabling team members to share timely updates, celebrate achieved milestones, and discuss challenges faced during the course of the project. Active participation in the Telegram channel ensured that the team remained well-informed and collectively contributed to the project's success.

Chapter Two Analysis

2.1 Existing System

2.1.1 Existing System Description

The existing virtual reality system operates primarily in the realm of generating simulated content for various purposes such as entertainment, gaming, and creative expression. Users are offered immersive experiences within virtual environments, which may include fictitious landscapes, interactive elements, or scenarios unrelated to authentic tourist destinations. This system often caters to diverse applications, ranging from gaming platforms to educational simulations and artistic expressions. However, a notable limitation of the existing virtual reality system lies in its divergence from providing an authentic representation of real-world tourism sites. Unlike the proposed "Exploring Ethiopia: A Virtual Reality Tour" project, which seeks to offer users an educational and culturally immersive experience of Ethiopia's tourism sites, the existing system prioritizes imaginative and synthetic content over the faithful recreation of genuine locations. While the virtual environments created by the system can be engaging and entertaining, they lack the educational depth and cultural significance associated with exploring actual tourism destinations. Furthermore, the existing virtual reality system typically thrives in industries where creativity, simulation, and entertainment are paramount. Whether utilized for gaming, artistic expression, or training simulations, the system caters to a diverse array of applications beyond the scope of tourism. Its versatility makes it well-suited for contexts where the focus is on providing users with fantastical or fictional experiences, as opposed to delivering an accurate portrayal of historical or cultural landmarks. In summary, the existing virtual reality system distinguishes itself by its emphasis on generating imaginative content for diverse applications, from gaming to educational simulations. However, its departure from faithfully replicating real-world tourism sites underscores the need for projects like "Exploring Ethiopia: A Virtual Reality Tour," which prioritizes authenticity and educational value in providing users with an immersive and culturally rich experience of actual tourist destinations.

2.1.2 Business Rules

The virtual reality system places a premium on authentic representation, ensuring accurate capture of historical and cultural landmarks at Ethiopia's tourism sites, including Lalibela, Erta Ale, Axum, and Sof-omor, to deliver a genuinely immersive user experience. With a focus on educational depth, the system integrates interactive multimedia elements, providing users with a comprehensive understanding of the historical and cultural significance inherent in each location. The creation of a user-friendly interface is mandated by business rules to guarantee seamless navigation for users with varying technical proficiency, ultimately enhancing the overall user experience. The system incorporates safety measures, offering users an emergency exit option for swift VR environment exit, displaying safety guidelines and VR-related discomfort information, and ensuring regular updates based on user feedback and emerging best practices. Environment immutability is strictly imposed, restricting users from altering the virtual environment to preserve the integrity of the educational experience and maintain consistency with the real-world representation of tourism sites. In prioritizing inclusivity and accessibility, the system ensures the active participation of individuals with mobility issues or residing in remote areas, aligning seamlessly with the project's overarching goal of providing a more inclusive alternative. Business rules underscore the significance of environmental and cultural sensitivity, guaranteeing alignment with sustainable and responsible tourism practices. Geared for global accessibility, the system facilitates users from diverse locations to virtually experience Ethiopia's tourism sites, effectively contributing to the project's aim of reaching a broad audience. Addressing cost issues, the system implements a specific pricing model, the user can use the system by simply downloading the VR application, thereby ensuring that the virtual reality tour remains an affordable alternative, removing financial barriers, and expanding access to a wider demographic.

2.2 New System

2.2.1 Non-Functional Requirements and Description

- Performance
    - The system must achieve a minimum frame rate of 90 frames per second (FPS) to ensure a seamless and immersive virtual reality experience.

- Loading times for virtual environments should not exceed 5 seconds to enhance user engagement.

- Reliability
  - The system should maintain an uptime of 99.9%, providing availability for users 24/7 across different time zones.
  - The emergency exit option must respond within 1 second, offering a reliable means for users to exit the VR environment promptly in case of discomfort or other concerns.
- Security
  - User data, including personal or sensitive information, must be encrypted using industry-standard encryption algorithms during storage and transmission.
  - Access to the system's administrative functions should be protected by multi-factor authentication to prevent unauthorized access.
- Usability
  - The user interface must follow industry best practices for virtual reality design, with clear navigation and interactive elements suitable for users with varying technical proficiency.
  - The emergency exit option should be prominently displayed within the user interface and accessible within two clicks to ensure a user-friendly and safe experience.
- Maintainability
  - The system should support over-the-air updates, enabling easy integration of new tourism sites or features without requiring user downloads.
  - Documentation for system maintenance and updates should be comprehensive and regularly updated to facilitate ongoing development.
- Compatibility
  - The virtual reality tour should be compatible with major VR devices, including Oculus Rift, HTC Vive, and PlayStation VR.
  - The platform should be compatible with popular web browsers such as Google Chrome, Mozilla Firefox, and Safari, as well as operating systems including Windows, macOS, and Linux.

- Environmental and Cultural Sensitivity
    - The system must adhere to strict guidelines for environmental and cultural sensitivity, ensuring that virtual tour content respects the natural and cultural heritage of Ethiopia.
- Global Accessibility
    - The platform should support two languages, starting with English and Amharic, to cater to a diverse global audience.
    - Cultural nuances and sensitivities specific to different regions should be considered in the development of virtual tour content.
- Cost Efficiency
        - Addressing cost issues, the system implements a specific pricing model, the user can use the system by simply downloading the VR application, thereby ensuring that the virtual reality tour remains an affordable alternative, removing financial barriers, and expanding access to a wider demographic.
- Regular Updates
    - Safety information and guidelines must be updated every six months based on user feedback and emerging best practices in virtual reality usage.
    - Users should be notified of updates through in-app notifications and email communication to ensure they stay informed about changes to safety information.

2.2.2 Functional Requirement

FR1. Virtual Reality Experience:

- The system provides an immersive virtual reality experience through the following:
- VR content is compatible with various VR devices, such as Oculus Rift and HTC Vive.
- Supports both 3D and 360-degree VR content for diverse experiences.
- Minimizes latency to ensure a smooth and immersive VR experience.

FR2: The system shall allow users to move around and interact with the virtual Environment.

- The system should allow the user to interact with virtual objects using the input device.
- The VR system should ensure that the user's movements and interactions are reflected
- Accurately in the virtual environment.

FR3. Tourist Information and Education:

- The system provides comprehensive tourist information and educational content in an engaging manner.
- Multimedia content, including images, videos, and audio, enriches the educational experience.
- Information is presented in multiple languages to cater to a diverse audience.
- A search functionality is implemented for quick access to specific information.

FR4. Interactive Features:

- The system provides interactive features to engage users effectively.
- Clickable hotspots within the VR environment trigger additional information or actions.
- Interactive elements are responsive across different devices for a seamless experience.

FR5. Accessibility Features:

- The system provides accessibility features to ensure an inclusive experience for all users.
- Voice commands are implemented for navigation and interaction, benefiting users with mobility issues.
- Alternative text for images and audio descriptions are included for visually impaired users.
- Compatibility with screen readers and assistive technologies is ensured.

F5. Navigation and Exploration:

- The system provides intuitive navigation and exploration tools within the VR environment.
- An intuitive navigation interface enhances user-friendliness.
- An interactive map is integrated for orientation and exploration.
- Guided tours with predefined paths are available for users who prefer a structured experience.

F6. Safety Measures:

- The system provides safety measures within the virtual environment.
- An emergency exit option is available for users to quickly exit the VR environment.

- Safety guidelines and information about potential discomfort related to VR usage are displayed.
- Safety information is regularly updated based on user feedback and emerging best practices.

F7. Environmental Awareness:

- The system provides environmental awareness through the following:
- Sections on environmental conservation efforts and sustainable practices are included for each tourist site.
- Users are encouraged to take a virtual pledge for sustainable tourism practices.

F8. Privacy and Data Security:

- The system prioritizes user privacy and data security by strictly adhering to data protection regulations.
- Sensitive user data and communications are encrypted using industry-standard protocols to safeguard confidentiality.

FR5: The system shall allow users to view a list of available tourism sites.

- User sends a request to view the list of available tourism sites.
- The system retrieves the list of available tourism sites from the database.
- The system displays the list of available tourism sites to the user.

2.2.3 Use Case Diagram

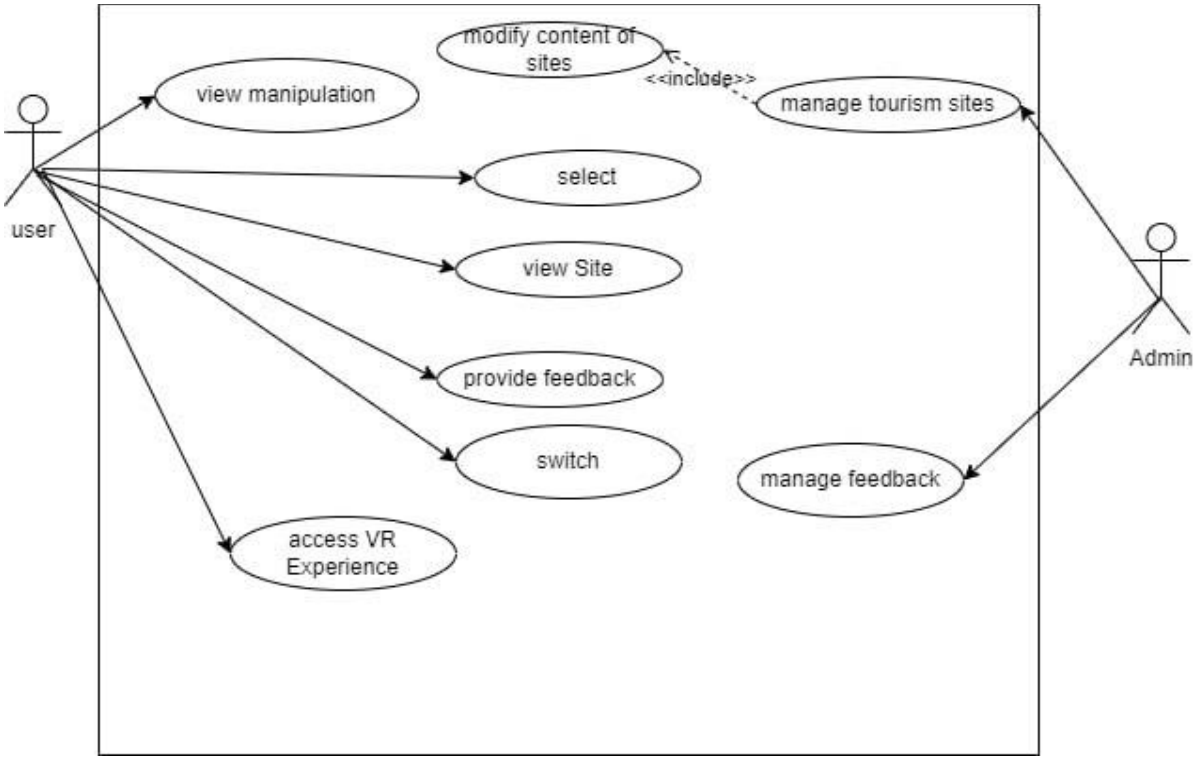


Figure 1 use case diagram

2.2.4 Use Case Documentation

Use Case Documentation for User

Use Case 1:

- Access VR Experience

Preconditions:

- The user has installed the VR application on their device.
- The VR content for tourism sites is available and pre-loaded on the user's device.
- The VR headset or compatible device is properly set up and functional.

Post Conditions:

- The user has experienced the selected tourism site in virtual reality.

Main Course of Action:

- The user launches the VR application on their device.
- The application prompts the user to wear the VR headset and ensures it is properly connected.
- The user is presented with a menu or interface to choose a tourism site for the VR experience.
- The user selects a specific tourism site from the available options.
- The VR application initiates the immersive experience, providing a virtual tour of the selected site.
- The user can explore the VR environment, with the ability to look around and interact with the virtual surroundings.

Alternate Course of Action:

- If the user encounters technical issues or the VR headset malfunctions, the application provides troubleshooting guidance and prompts the user to resolve the issue.

Use Case 2:

- Switch from One Tourism Site to Another

Preconditions:

- The user has successfully accessed the VR experience for a tourism site.
- Multiple tourism sites are available within the VR application.

Post Conditions:

- The user has transitioned from the current tourism site to the selected alternative site.

Main Course of Action:

- While experiencing a tourism site, the user decides to switch to another location.
- The user accesses the menu or interface within the VR application.
- The application displays a list of available tourism sites as options for switching.
- The user selects the desired tourism site to switch to.
- The VR application smoothly transitions the user from the current site to the newly selected site.
- The user can now explore the virtual environment of the newly selected tourism site.

Alternate Course of Action:

- If the user encounters difficulty in selecting a new tourism site, the application provides additional guidance and ensures a user-friendly interface for seamless switching.

Use Case 3:

- Provide Feedback

Preconditions:

- The user has completed experiencing a tourism site through the VR application.
- The user has access to an input method (keyboard, touchscreen, etc.) for providing feedback.

Post Conditions:

- The user's feedback is recorded and may be reviewed by the system administrator.

Main Course of Action:

- After concluding the VR experience for a tourism site, the user is prompted to provide feedback.
- The application presents a feedback form or interface, including options for rating and textual comments.
- The user selects a numerical rating or provides written feedback based on their experience.
- Optionally, the user may include additional comments or suggestions.
- The user submits the feedback through the application interface.
- The system records the feedback, associating it with the specific tourism site and user identifier.

Alternate Course of Action:

- If the user decides not to provide feedback, they can choose to skip the feedback submission step, and the application proceeds to the next phase or menu.

Use Case 4:

- View Site

Preconditions:

- The user has accessed the VR experience for a tourism site.
- The VR content for the selected tourism site is loaded and ready for viewing.

Post Conditions:

- The user has viewed the virtual representation of the selected tourism site.

Main Course of Action:

- The user selects a specific tourism site from the available options within the VR application.
- The VR application loads the content for the selected site, ensuring it is ready for viewing.
- The user is immersed in the virtual representation of the tourism site, with the ability to explore and interact.
- The application provides informative elements such as images, videos, and audio related to the site.
- The user can freely navigate and observe the virtual environment, experiencing the details of the tourism site.

Alternate Course of Action:

- If the user encounters technical issues during the loading process, the application offers troubleshooting guidance and ensures a smooth transition to the selected tourism site.

Use Case 5:

- Select Tourism Site

Preconditions:

- The user has launched the VR application.
- Multiple tourism sites are available within the VR application.

Post Conditions:

- The user has selected a specific tourism site for the VR experience.

Main Course of Action:

- Upon launching the VR application, the user is presented with a menu or interface displaying available tourism sites.
- The user reviews the list of tourism sites and their descriptions.
- The user selects a specific tourism site they wish to experience in virtual reality.
- The application confirms the user's selection and begins loading the VR content for the chosen site.
- Once the content is loaded, the user is seamlessly transitioned into the virtual representation of the selected tourism site.

Alternate Course of Action:

- If the user is uncertain about which tourism site to select, the application provides additional information or suggestions to assist in the decision-making process.

Use Case 6:

- View Manipulation

Preconditions:

- The user is actively engaged in the VR experience for a selected tourism site.
- The VR content for the tourism site is successfully loaded and being displayed.

Post Conditions:

- The user has manipulated their view within the virtual environment, enhancing their immersive experience.

Main Course of Action:

- While exploring the virtual representation of a tourism site, the user decides to manipulate their view.
- The application provides options or controls for view manipulation, such as tilting, panning, or zooming.
- The user interacts with the controls to adjust their perspective within the virtual environment.
- The application responds in real-time, updating the user's view based on their manipulation inputs.
- The user continues to explore and engage with the tourism site, enhancing their overall experience through view manipulation.

Alternate Course of Action:

- If the user encounters difficulty in using the view manipulation controls, the application offers guidance and assistance to ensure a seamless and intuitive experience.

Use Case Documentation for the "admin"

Use Case 1:

- Manage Tourism Site

Preconditions:

- The admin has logged into the admin panel of the VR application.
- The admin has appropriate permissions to manage tourism sites.

Post Conditions:

- The admin has successfully modified the content of the selected tourism site.

Main Course of Action:

- The admin logs into the admin panel of the VR application using valid credentials.
- The admin is presented with a dashboard displaying various administrative options.
- The admin selects the "Manage Tourism Site" option from the menu.
- The application displays a list of existing tourism sites along with options to modify their content.
- The admin chooses a specific tourism site to modify and selects the "Modify Content" option.
- The application provides a user-friendly interface for the admin to edit various aspects of the tourism site, such as descriptions, images, videos, and audio content.
- The admin saves the modifications, and the application updates the content for the selected tourism site.

Alternate Course of Action:

- If the admin encounters issues during the modification process, the application provides error messages or prompts for clarification to ensure accurate content modifications

Use Case 2:

- Manage Feedback

Preconditions

- The admin has logged into the admin panel of the VR application.
- The admin has appropriate permissions to manage user feedback.

Post Conditions

- The admin has successfully reviewed and managed user feedback.

Main Course of Action

- The admin logs into the admin panel of the VR application using valid credentials.
- The admin is presented with a dashboard displaying various administrative options.
- The admin selects the "Manage Feedback" option from the menu.
- The application displays a list of user feedback entries, including ratings and comments.
- The admin can filter and sort feedback based on various criteria, such as date or tourism site.

- The admin reviews individual feedback entries, taking note of user comments and ratings.
- For each feedback entry, the admin may choose to respond, mark as resolved, or take additional actions.
- The admin has the option to escalate specific feedback items for further investigation or improvement.
- After reviewing and managing feedback, the admin saves the changes, and the application updates the feedback status.

Alternate Course of Action

- If the admin encounters feedback entries that require urgent attention, the application provides a mechanism for prioritizing and addressing critical issues promptly.

2.2.4 Sequence Diagram

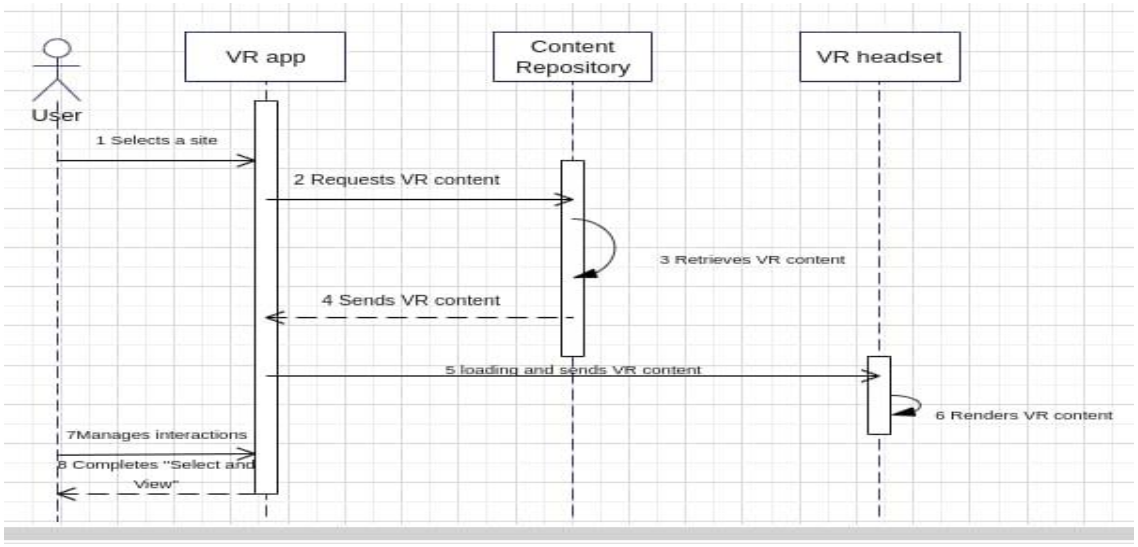


Figure 2 select and preview sequence diagram

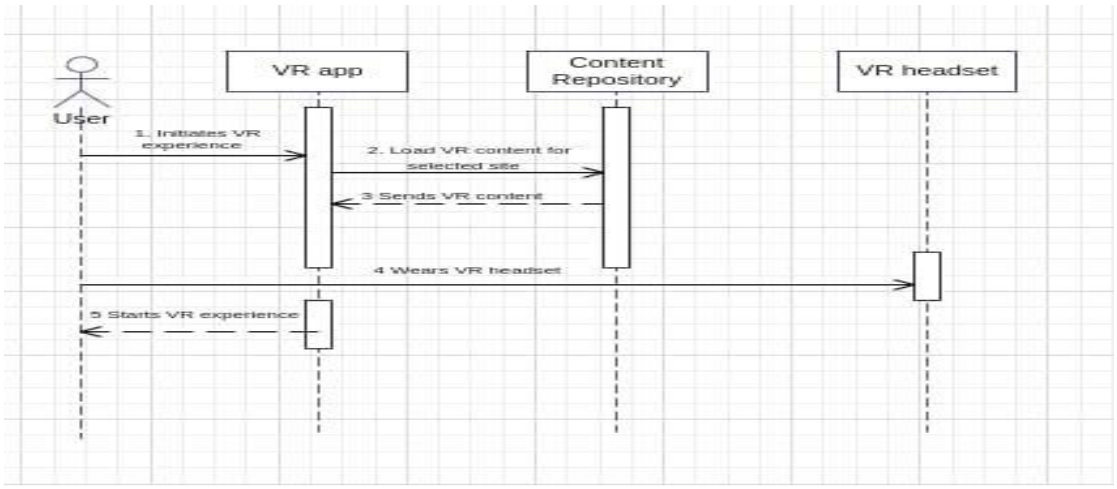


Figure 3 VR experience sequence diagram

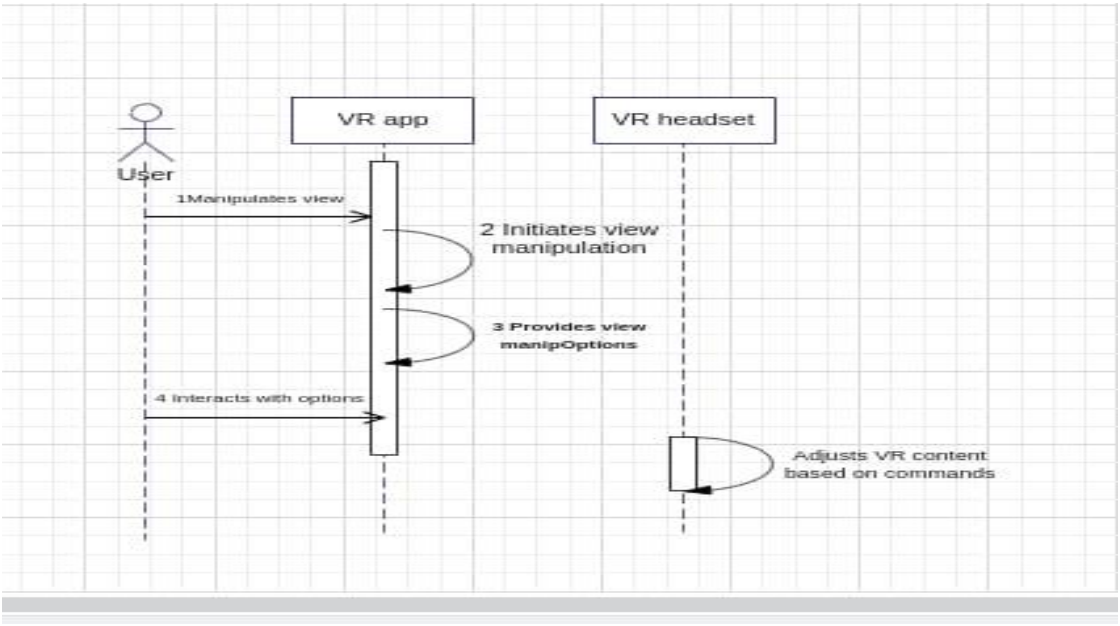


Figure 4 manipulate view sequence diagram

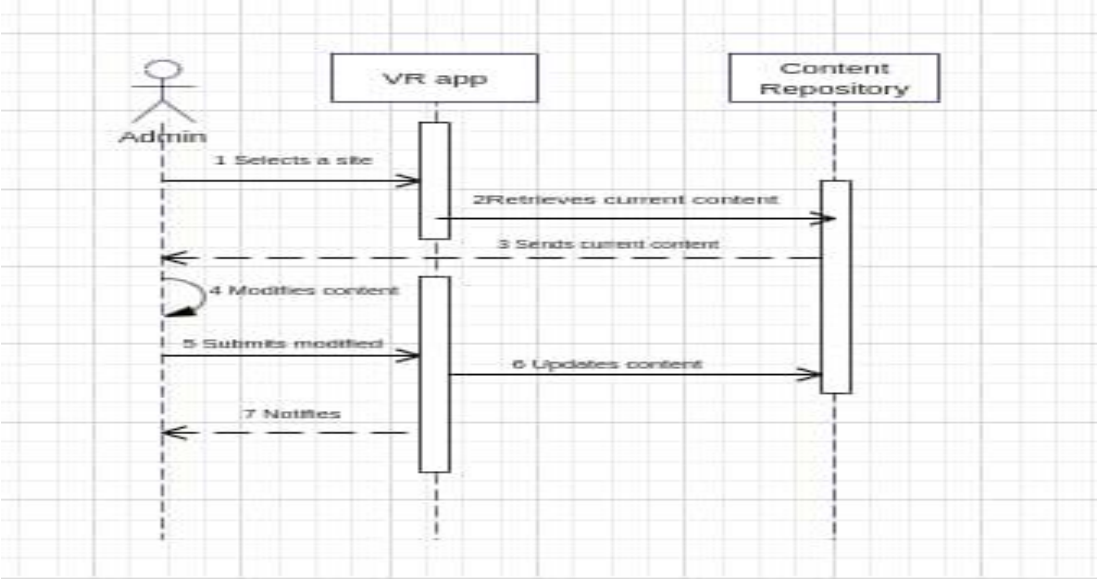


Figure 5 modify tourism sequence diagram

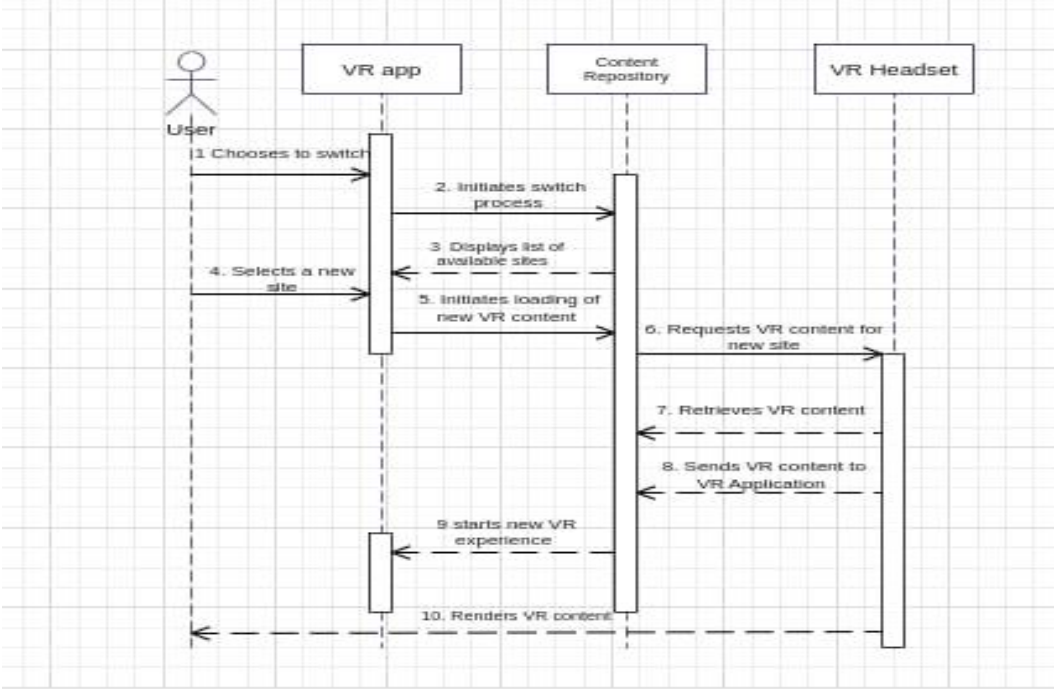


Figure 6 switch sequence diagram

2.2.5 State Chart Diagram

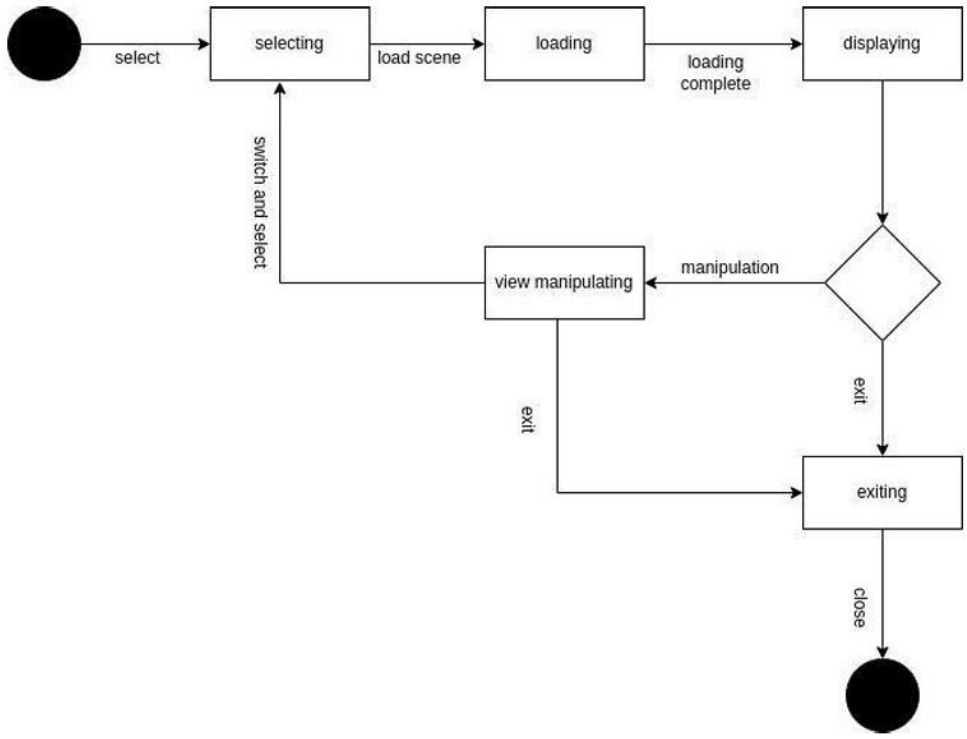


Figure 7 state chart diagram

2.2.6 Activity Diagram

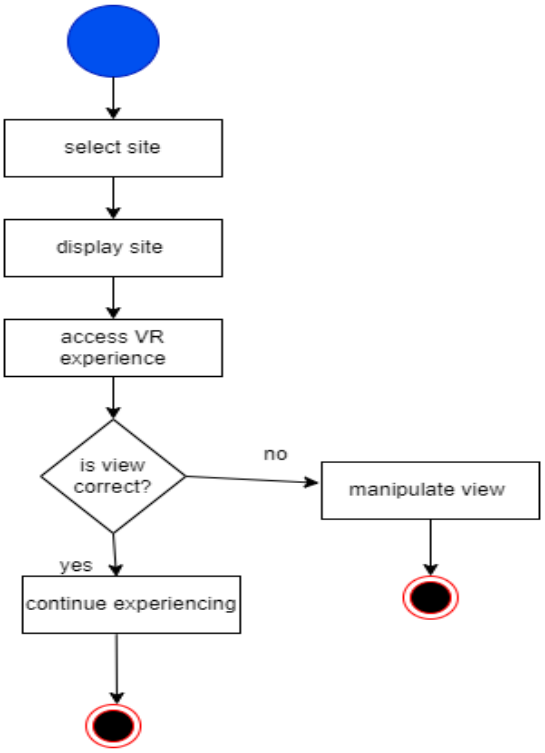


Figure 8 view manipulation activity diagram

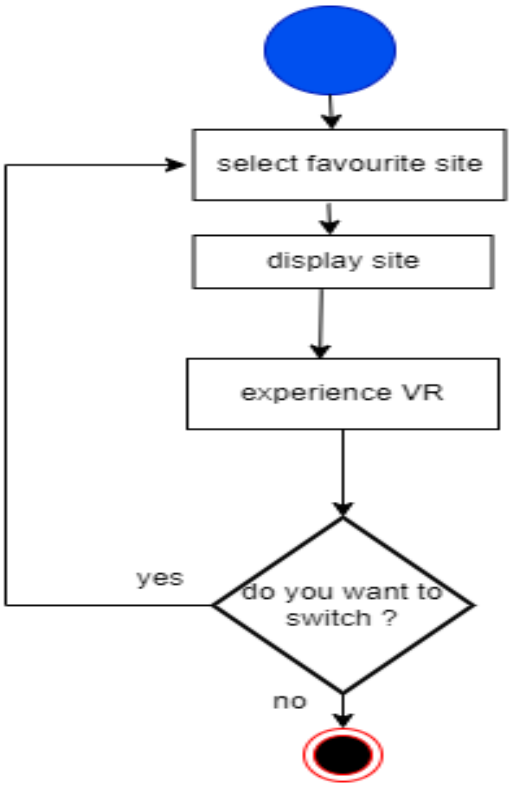


Figure 9 switch activity diagram

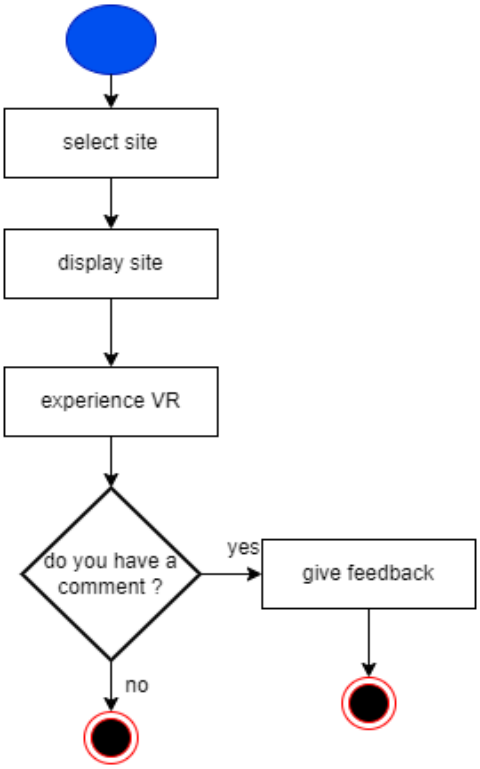


Figure 10 feedback activity diagram

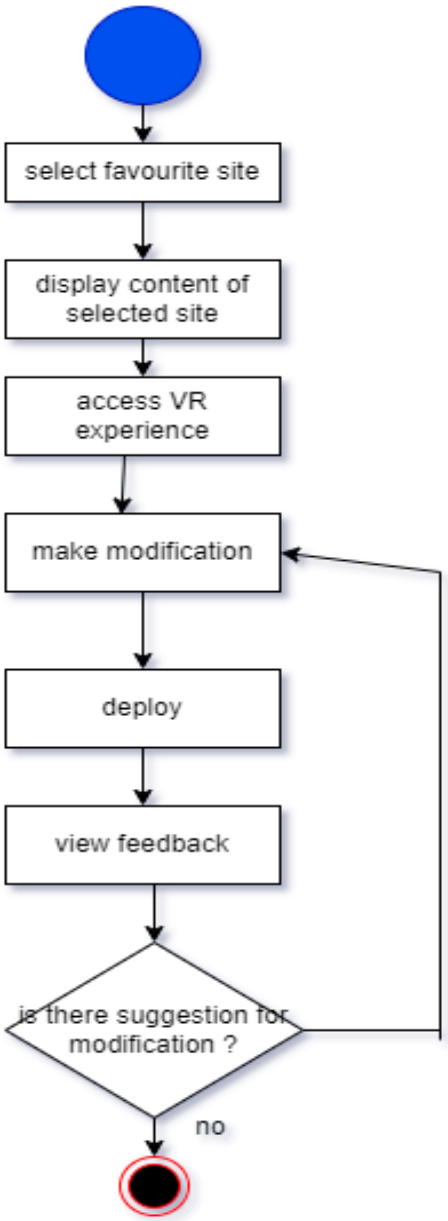


Figure 11 manage system activity diagram

2.2.7 Class Diagram

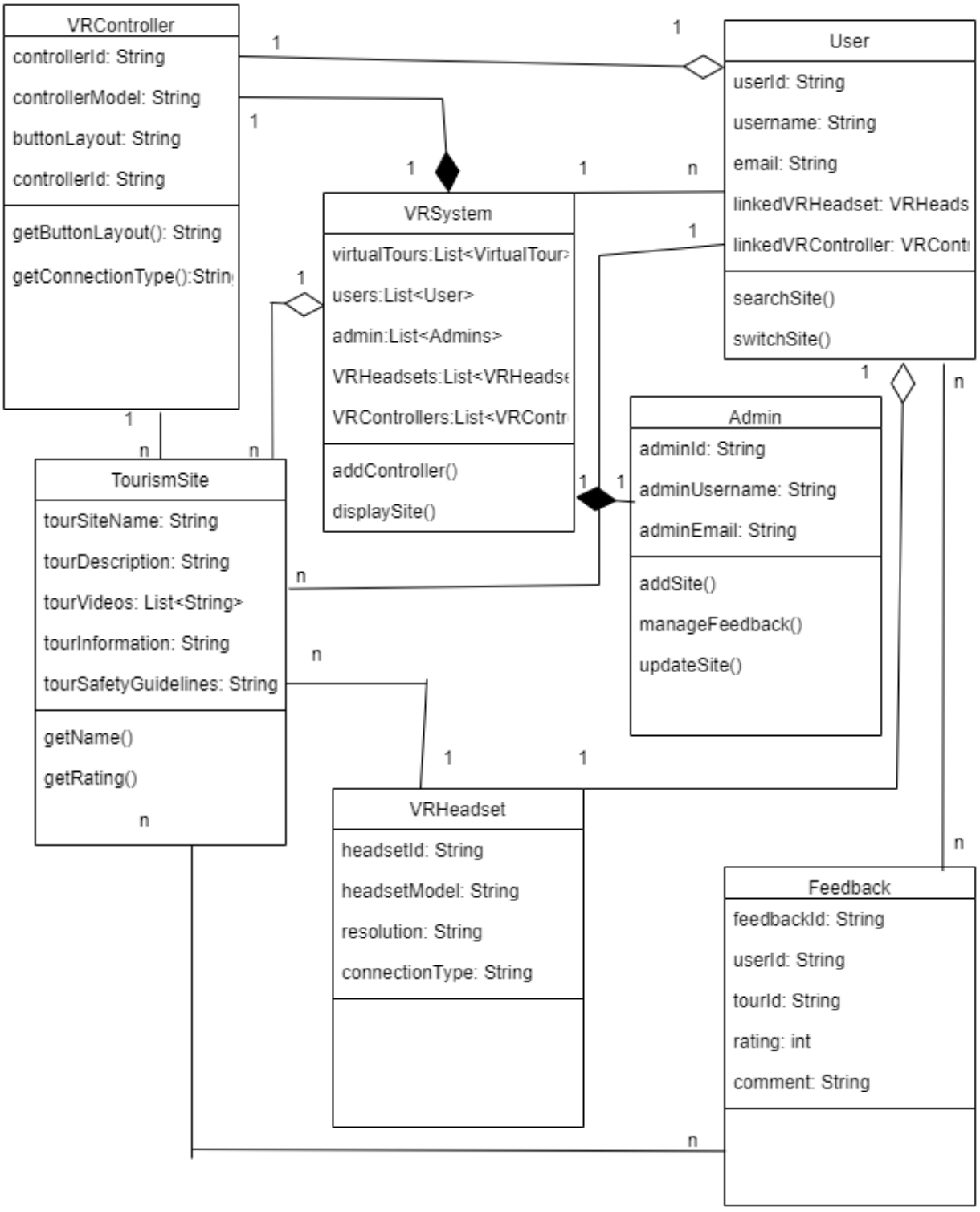


Figure 12 class diagram

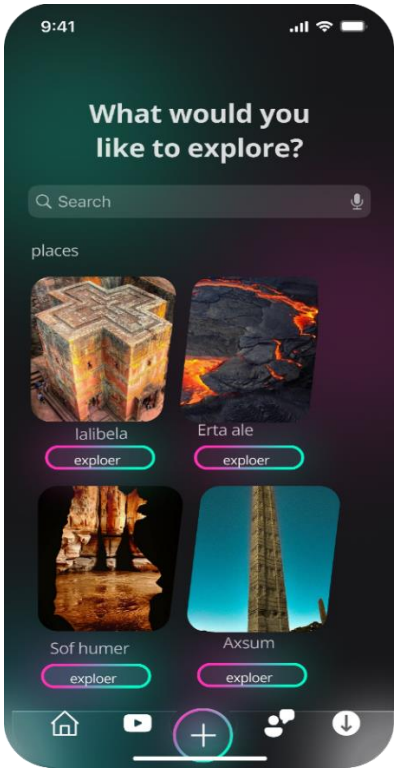
2.2.8 Identifying Change Cases

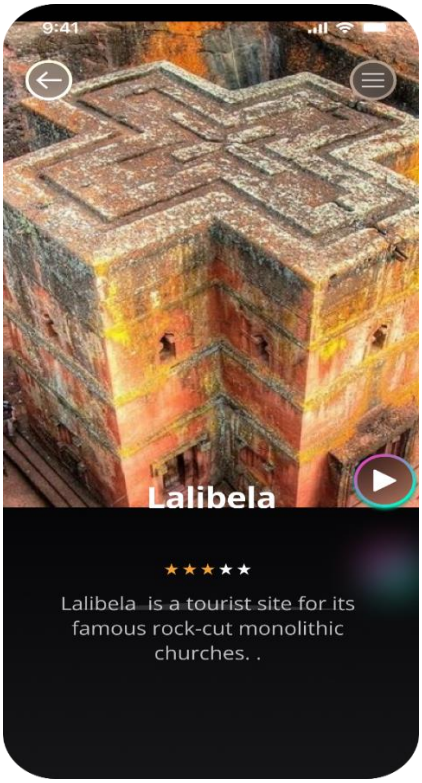
In the dynamic landscape of technology and design, the potential for requirement changes is inherent, especially in a project like the "Exploring Ethiopia: A Virtual Reality Tour." One of the key aspects that might prompt alterations in the project requirements is the evolution of the appearance of the tourism site itself. As design trends, user preferences, and technological capabilities progress, there could be a need to adapt the virtual representation of Ethiopian tourism sites to align with contemporary aesthetics or incorporate new multimedia features. These changes may be driven by user expectations for a more immersive and visually appealing experience, prompting periodic updates to enhance the overall user satisfaction.

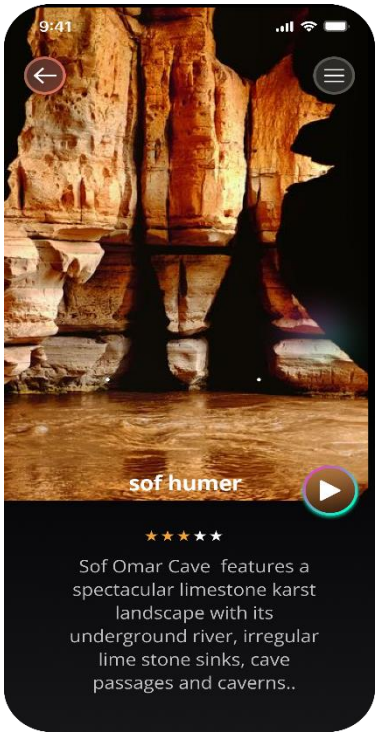
Furthermore, the quality and capabilities of VR devices, such as VR headsets and controllers, are subject to continuous advancements. Technological innovations in virtual reality hardware can result in improved performance, enhanced user interaction, and the introduction of new features. As the VR industry evolves, there is the potential for these advancements to influence the project requirements. Integrating the latest technologies and ensuring compatibility with state-of-the-art VR devices becomes a consideration to stay at the forefront of the virtual tourism experience. Therefore, periodic assessments and updates to the system may be necessary to capitalize on emerging technologies and deliver an up-to-date and cutting-edge virtual exploration platform.

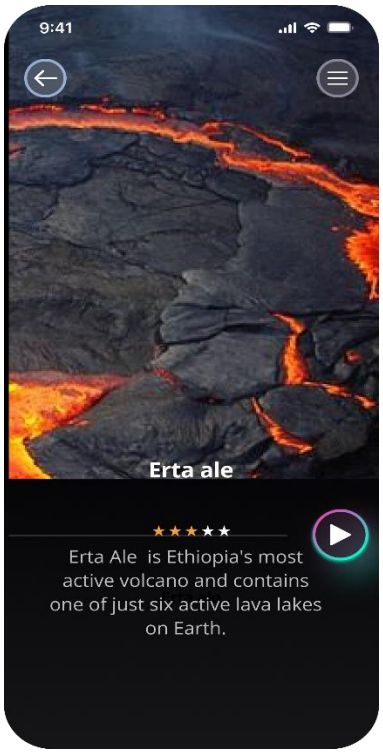
In essence, recognizing and embracing the potential for requirement changes is integral to ensuring the longevity, relevance, and competitiveness of the "Exploring Ethiopia: A Virtual Reality Tour." By staying attuned to shifts in design aesthetics, user expectations, and technological innovations in VR hardware, the project can proactively respond to these changes, providing users with an immersive, high-quality, and continually evolving virtual tourism experience.

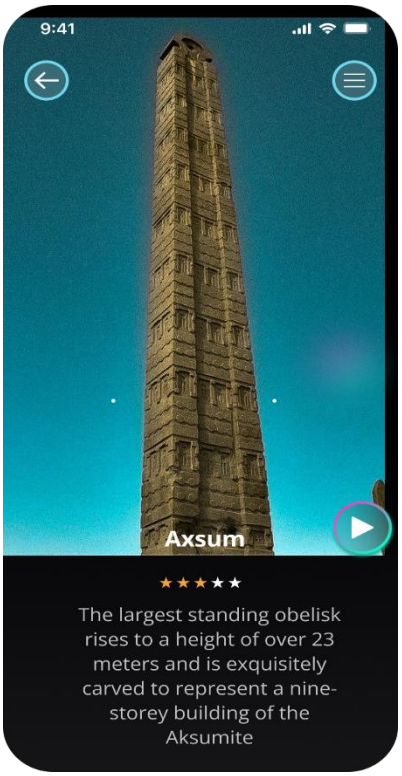
2.2.9 User Interface Prototyping






9:41
sof humer
Sof Omar Cave features a spectacular limestone karst landscape with its underground river, irregular lime stone sinks, cave passages and caverns..


9:41
Erta ale
Erta Ale is Ethiopia's most active volcano and contains one of just six active lava lakes on Earth.


9:41
Axsum
The largest standing obelisk rises to a height of over 23 meters and is exquisitely carved to represent a nine-storey building of the Aksumite

Chapter Three Design

3.1 Purpose and Design Goals

3.1.1 Purpose

The design phase of "Exploring Ethiopia: A Virtual Reality Tour" serves to provide a structured plan for the implementation of the application, ensuring that the envisioned virtual tourism experience aligns with the objectives set forth by the Ethiopian Ministry of Culture and Tourism. This design phase bridges the gap between conceptualization and development, delineating the structure, components, and interactions that will bring the virtual reality tour to life.

3.1.2 Goals

- Performance
  - The design prioritizes performance to deliver a seamless and immersive virtual tour. By optimizing the rendering of 3D environments, minimizing latency, and ensuring efficient data retrieval, the goal is to provide users with a captivating and responsive exploration of Ethiopian tourism sites.
- Dependability
  - Design decisions focus on creating a dependable system. This involves building in redundancies, error-handling mechanisms, and robust data storage to ensure consistent and reliable operation. Dependability is crucial to maintain user trust and satisfaction.
- End User Experience:
  - The primary focus is on enhancing the end user experience. Design choices aim to create an intuitive user interface, allowing users to seamlessly navigate virtual environments. Attention to detail in user interactions, such as virtual object manipulation and feedback mechanisms, contributes to an engaging and user-friendly application.
- Environmental and Cultural Sensitivity:
  - The design incorporates features to ensure environmental and cultural sensitivity. Through accurate representation of Ethiopian tourism sites, the

application aims to foster appreciation while minimizing any negative impact on the environment or cultural heritage.

- Integration with Emerging Technologies
    - Anticipating the rapid evolution of virtual reality technologies, the design facilitates seamless integration with emerging advancements. This goal ensures that the application remains at the forefront of technological capabilities, providing users with state-of-the-art experiences.
- Security
    - The security aspect of the "Exploring Ethiopia: A Virtual Reality Tour" application is integral to ensuring data privacy and maintaining the overall integrity of the system. While the application does not include user authentication, the design incorporates robust measures to protect user data during transmission. Utilizing secure data transmission protocols and encryption methodologies, the system safeguards sensitive information against potential threats. Adherence to best security practices is paramount to fortify the application against unauthorized access and data breaches, ensuring a secure and trustworthy virtual tourism experience for users. The design actively addresses the need for data privacy, even in the absence of traditional authentication components, to uphold the confidentiality and reliability of user interactions within the application.

3.2 Current Software Architecture

The current architecture of the system is three-tier architectural style.

- Separating the presentation layer allows for a clear distinction between the user interface and the underlying application logic and data storage. It enables a responsive and intuitive user experience for both tourists and administrators.
- Centralizing application logic in a dedicated tier promotes modularity, re-usability, and maintainability. It ensures that business logic and core functionalities are separate from the presentation layer.
- Isolating data storage in its own tier ensures that data management is independent of both the user interface and application logic. It promotes data consistency, security, and facilitates scalability.

3.3 Proposed Software Architecture

3.3.1 Subsystem Decomposition

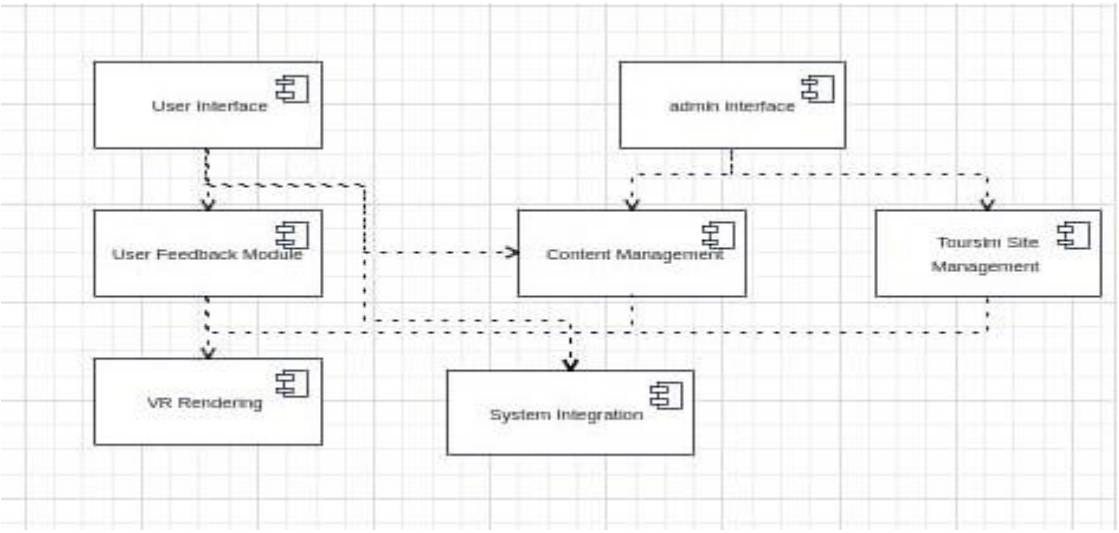


Figure 13 Subsystem decomposition

3.3.2 Component Diagram

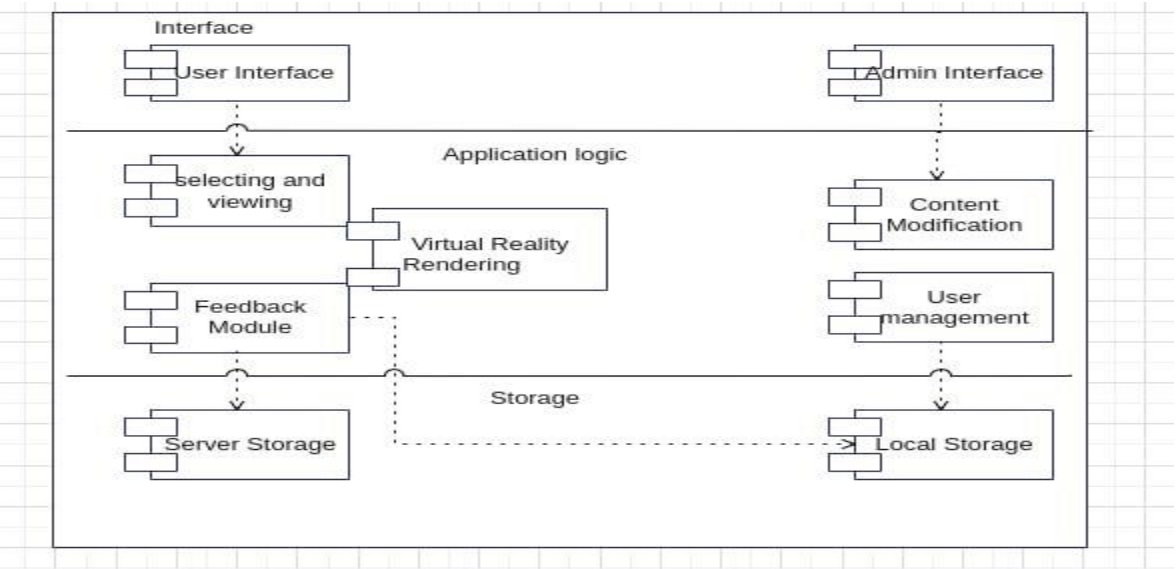


Figure 14 component diagram

3.3.3 Deployment Diagram

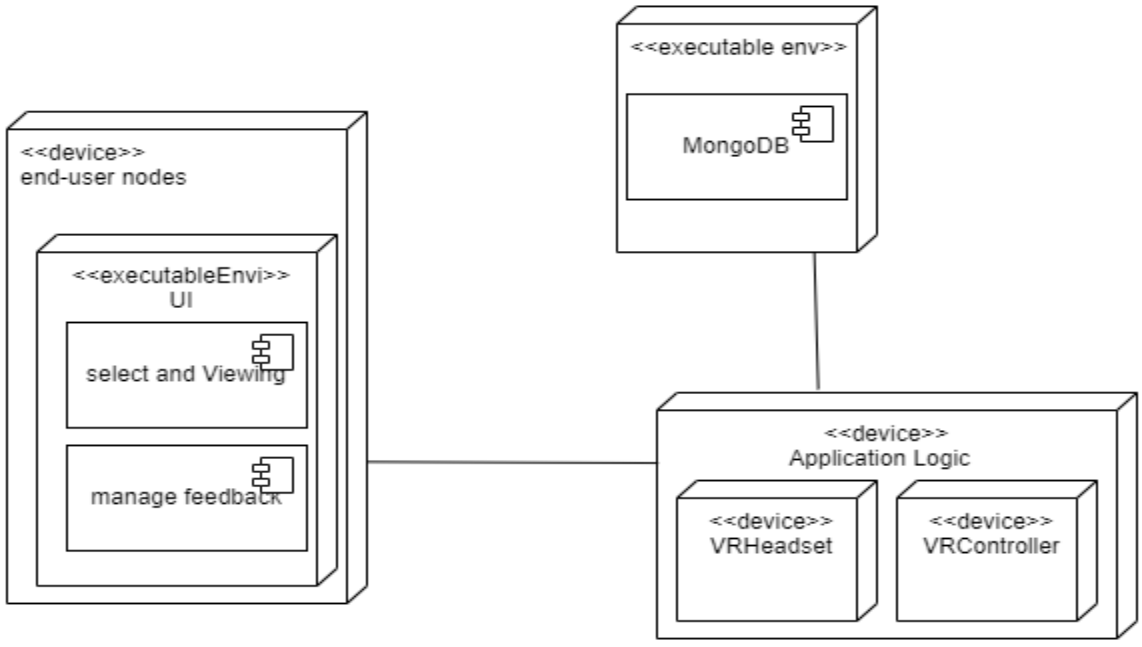


Figure 15 deployment diagram

3.3.4 Access Control and Security

- **User Roles**
  - Tourists: Regular users exploring virtual tourism sites.
  - Administrators: Users with elevated privileges for content management and system administration.
- **Access Control Matrix**

Table 1: access Control

Functionality / Data	Tourists	Administrators
Access VR Experience	Yes	Yes
Switch Tourism Sites	Yes	Yes
Provide Feedback	Yes	Yes
View Tourism Site	Yes	Yes
Select Tourism Site	Yes	Yes
View Manipulation	Yes	Yes
Manage Tourism Site Content	No	Yes
Manage User Feedback	No	Yes

- **Details of Access Controls**

Tourists

- Tourists have read-only access to VR experiences, tourism site information, and user feedback.
- They can interact with the VR application, provide feedback, and navigate between tourism sites.

Administrators

- Administrators have additional privileges for content management and system administration.
- They can manage tourism site content, modify VR experiences, and oversee user feedback.

- Administrators have the authority to make changes to the system's configuration and settings.

- **Security Measures**

Authentication

- Implement a robust authentication system to verify the identity of users and administrators before granting access.

Authorization

- Enforce role-based access control (RBAC) to ensure that users and administrators only have access to functionalities and data relevant to their roles.

Data Encryption

- Implement encryption mechanisms to secure sensitive data, especially during data transmission between components.

Audit Trails

- Maintain audit trails to log user activities, helping in monitoring and identifying any unauthorized access or suspicious activities.

Secure Communication

- Use secure communication protocols (e.g., HTTPS) to protect data exchanged between clients and servers.
- Regular Security Audits:
- Conduct regular security audits to identify and address potential vulnerabilities in the system.
- Error Handling:
- Implement proper error handling mechanisms to avoid leaking sensitive information in case of errors or exceptions.