ZOOVRVENTURE: A VIRTUAL REALITY FEATURING REALISTIC ZOO ENVIRONMENT WITH COMMON AND EXOTIC ANIMALS

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BACHELOR OF INFORMATION TECHNOLOGY (INFORMATICS MEDIA) WITH HONOURS UNIVERSITI SULTAN ZAINAL ABIDIN
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THIS THESIS IS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF BACHELOR OF INFORMATION TECHNOLOGY (INFORMATICS MEDIA)

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DECLARATION

I hereby declare that the report is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Sultan Zainal Abidin or other institutions.

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CONFIRMATION

This project Zoovrventure: A Virtual Reality Featuring Realistic Zoo Environment With Common And Exotic Animals application was prepared and submitted by Mohamad Rafiq Bin Roznan (Matric Number. 079181) and has been found satisfactory in terms of scope, quality, and presentation as partial fulfillment of the requirement for the Bachelor of Information Technology (Informatics Media) with honors in University Sultan Zainal Abidin.

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ABSTRACT

Animals, including both common and exotic species, have long fascinated humans due to their diverse behaviors, habitats, and unique characteristics. However, the lack of opportunities to observe live animals has limited people's understanding of these species. To address this issue, a virtual reality application named “ZooVRventure” is proposed, focusing on educating users about common and exotic animals in a fun, informational, and interactive way featuring a realistic zoo environment. This application will feature a user-friendly interface and utilize 3D models and environments, along with multimedia content such as audio, video, and animations, to provide an engaging and immersive learning experience that will help users retain information through visual and auditory elements. ZooVRventure is a mobile-based application operating on Android, which users can experience through VR head-mounted displays (HMDs) such as Google Cardboard. Following the ADDIE model, the project progresses through five phases: Analysis to identify user needs, Design to plan features, Development to build 3D models and integrate multimedia, Implementation to deploy the app, and Evaluation to refine its effectiveness. This project aims to enhance understanding and appreciation of common and exotic animals by offering an accessible and interactive platform for users to explore their characteristics, habitats, and fun facts.

ABSTRAK

Haiwan, termasuk spesies biasa dan eksotik, sentiasa memukau manusia kerana kepelbagaian tingkah laku, habitat, dan ciri unik mereka. Namun, kekurangan peluang untuk melihat haiwan secara langsung telah mengehadkan pemahaman manusia terhadap spesies ini. Untuk mengatasi isu ini, aplikasi realiti maya bernama "ZooVRventure" diperkenalkan dengan fokus untuk mendidik pengguna tentang haiwan biasa dan eksotik secara menyeronokkan, informatif, dan interaktif dalam persekitaran zoo yang realistik. Aplikasi ini menampilkan antara muka mesra pengguna serta menggunakan model 3D dan persekitaran maya, bersama kandungan multimedia seperti audio, video, dan animasi bagi memberikan pengalaman pembelajaran yang menarik dan mendalam, membantu pengguna mengingati maklumat melalui elemen visual dan auditori. ZooVRventure ialah aplikasi mudah alih yang beroperasi pada sistem Android dan boleh dinikmati melalui paparan kepala VR (HMD) seperti Google Cardboard. Mengikut model ADDIE, projek ini melalui lima fasa: Analisis untuk mengenal pasti keperluan pengguna, Reka Bentuk untuk merancang ciri-ciri aplikasi, Pembangunan untuk membina model 3D dan mengintegrasikan multimedia, Pelaksanaan untuk melancarkan aplikasi, dan Penilaian bagi menambah baik keberkesanannya. Projek ini bertujuan untuk meningkatkan pemahaman dan penghargaan terhadap haiwan biasa serta eksotik dengan menawarkan platform interaktif dan mudah diakses bagi meneroka ciri-ciri, habitat, dan fakta menarik mengenai haiwan.

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LIST OF ABBREVIATIONS

VR	Virtual Reality
HMD	Head-Mounted Display
AR	Augmented Reality
IoT	Internet of Things
AI	Artificial Intelligence
UI	User Interface
FAQ	Frequently Asked Questions
ADDIE	Analysis, Design, Development, Implementation, Evaluation

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CHAPTER 1

INTRODUCTION

Virtual Reality (VR) is a groundbreaking technology that immerses users in simulated digital environments, transporting them to entirely new realms or enhancing their real world experiences (Zotos et al., 2021). Wearing a VR headset lets individuals explore, interact and engage with these computer-generated worlds, offering boundless opportunities for entertainment, education, training and innovation.

In today's world, the coexistence of humans and animals presents a unique opportunity to foster understanding and appreciation of the natural world. Animals, both common and exotic, possess fascinating characteristics, behaviors, and adaptations that make them unique. However, limited access to live animals often restricts people's ability to learn about them in depth. In addition, many children who live in villages or rural areas do not get the opportunity to explore the atmosphere of the zoo. This is because most Zoos in the country are located in urban areas. Therefore, implementing VR education methods in schools, institutions, and for general audiences is an excellent way to make the learning process about these animals more engaging, interactive, and informational indirectly making them experience realistic zoo environment. By creating immersive virtual experiences, such as ZooVRventure, individuals can explore and learn about the behaviors, habitats, and diets of common and exotic animals in a fun and memorable way, enhancing their connection to the natural world.

1.1 Project Background

ZooVRventure is a mobile-based application designed to educate users about common and exotic animals through Virtual Reality (VR) technology while creating an immersive and realistic zoo environment. This project addresses the limited opportunities for individuals, especially children, to observe and learn about live animals, which often restricts their understanding of common and exotic species. By focusing on common animals that are widely recognized and exotic animals with unique traits native to specific regions, the application provides a balanced approach to learning by helping users connect with common species while sparking curiosity and interest in exotic ones. This combination ensures a comprehensive and engaging educational experience. By incorporating three-dimensional (3D) models, animations, and interactive elements, ZooVRventure allows users to explore and learn about the characteristics, habitats, and behaviors of a wide range of animals in an engaging and memorable way. The application utilizes a combination of multimedia elements, including audio, video, graphics, text, and animation, to deliver educational content effectively. Users can interact with 3D objects within the virtual environment, making the learning experience more dynamic and enjoyable. This innovative approach aims to foster a deeper understanding of the natural world by introducing different animals from common and exotic ones and inspire curiosity through the seamless integration of technology and education.

1.2 Problem Statement

In today's world, the coexistence of humans and animals presents a unique opportunity for deeper understanding and appreciation of wildlife. Animals, both common and exotic, play essential roles in ecosystems, but limited opportunities to observe them often create a knowledge gap. Traditional methods of learning about these animals, such as textbooks, images, or lectures, can be detached from real-world experiences, making it difficult for individuals to fully grasp the characteristics, behaviors, and habitats of various species. This lack of engagement and awareness not only limits people's understanding of wildlife but also hinders their ability to connect with and appreciate the diversity of animals in the natural world.

The problem at hand is that zoos are unevenly distributed, primarily located in urban areas, which makes it difficult for children in rural or remote regions to visit and experience wildlife firsthand (Yang et al., 2023). Additionally, physical limitations, ethical concerns, and restricted access to diverse species hinder the ability to provide comprehensive learning experiences (Lugosi & Lee, 2021). Moreover, physical zoo visits are often constrained by high costs, safety concerns, and limited engagement, which can detract from the overall educational value (Pradnyana et al., 2017). These challenges emphasize the need for alternative, accessible methods of learning about animals that can bridge the gap left by traditional zoo visits.

The "ZooVRventure" project aims to address these challenges by leveraging virtual reality technology to create an immersive educational solution that enhances knowledge of common and exotic animals while fostering a deeper appreciation for

wildlife. This project seeks to provide a transformative learning experience that bridges the virtual and real worlds, revolutionizing the way we engage with and understand animals, ultimately leading to a greater connection with nature and more informed interactions with diverse species.

1.3 Objectives

There are three objectives for this project as follows:

- To design Virtual Reality (VR) application that focus on learning about common and exotic animal species and their habitats.
- To develop an immersive VR environment that replicates realistic zoo settings, allowing users to engage with 3D representations of common and exotic animals while exploring their characteristics.
- To test the functionality of the mobile based virtual reality environment for virtual exploration and interaction.

1.4 Scope

The scopes of this project are described as the following:

1.4.1 Target Scope

The target user for this virtual reality application is children age from 7 to 12 and educational institutions such as schools, universities and colleges.

1.4.2 Content Scope

The content scope of this project are described as below:

i. 3D Model of Zoo: The interior of the zoo will be arranged nice and accurate like a real life animal zoo using real zoo like “Zoo Negara” as a reference and will be divided into two sections.

ii. 3D Model of Animals: The model consists of 20 common and exotic animals with realistic texture and characteristics. Ten of each will be placed in their related environment.

iii. Information: Users will discover information about both common and exotic animals, focusing on their characteristics, habitats, and fun facts. Plus, there will be an additional video for each animal.

iv. Environment: There are two types of animals which is common and exotic animals and they will be divided into different section. Each of the environments will represent the habitats of the animal according to real life zoo environments.

1.4.3 Device Scope

All mobile devices with Android operating system and able to use VR Box or VR Technology.

1.5 Limitation of Work

ZooVRventure application is limited by these aspects :

i. This application is only mobile-based.

ii. Need a compatible smartphone.

iii. Require VR headset for immersive experience.

1.6 Expected Result

In the end, this project is expected to develop a comprehensive VR application that enhances learning about common and exotic animals through immersive interactions with 3D models, aiding users in understanding their characteristics, behaviors, and habitats. Additionally, it aims to provide an engaging experience that makes users feel as though they are exploring a real zoo environment. Furthermore, the application seeks to spark curiosity and foster a deeper appreciation for the diversity of wildlife while addressing the limitations of traditional learning methods. Lastly, a user-friendly and interactive environment will be a key feature, ensuring accessibility and an enjoyable experience for all users.

1.7 Gantt Chart

A Gantt chart is a visual representation of a project schedule that uses horizontal bars to show the duration of tasks or activities over time, providing a clear timeline of the project's plan and progress.

Table 1.1: Gantt Chart

TASK / ACTIVITIES	WEEK													
	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
Final Year Project 1 Briefing														
Researching for suitable Project Title														
Title discussion and confirmation with supervisor														
FYP Title and Topic submission														
Proposal Writing – Chapter 1 and 2														
Researching for slide presentation														
Workshop: FYP Mendeley														
Proposal defend presentation														
Proposal correction and Chapter 3 writing														
Discussion and Correction of proposal														
Proof of concept (POC)														
Drafting report of proposal														
Draft report submission to supervisor														
Preparation, Final Presentation and Evaluation														
Final presentation and Final report submission														
Supervisor Evaluation														

1.8 Summary of the Chapter

In conclusion, this chapter outlined the main points of the proposed project, covering the problem statements, objectives, scopes, limitations, expected results and the Gantt Chart for timeline activities. From the gathered research, it is clear that we need to improve learning methods by using virtual reality (VR) technology. This will help make the study of both common and exotic animals more engaging and accessible, especially for those who have difficulty visiting real zoos. By creating a realistic zoo experience, VR technology aims to provide a fresh way to enhance teaching and learning, incorporating interactive multimedia and immersive settings.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter focuses on the Literature Review (LR), which includes studies from existing articles and applications. Reliable articles are obtained from renowned platforms such as SpringerLink, Google Scholar and ScienceDirect, while applications are sourced from Play Store, Google Play Store, and Steam. These are platforms offering tried information, which can be used in a way to inspire new ideas that will help in noting areas for improvement in the project in regard to similar topics.

By looking through more existing articles or applications, developers can come up with remarkable differences and make conclusions before finalizing their project vision. In other words, this chapter encourages developers to create an innovation based on the skills and knowledge of others for the sake of technologies that should be fun and useful for users, hence making the learning process fun for everybody.

2.2 Virtual Reality

Virtual Virtual Reality (VR) has evolved significantly since its inception, with its roots tracing back to early innovations such as the Sensorama. These foundational developments paved the way for modern VR systems, which have gained significant traction in recent years (Hamad & Jia, 2022). VR technology enables users to engage with immersive, three-dimensional environments that replicate real-world settings or create entirely new ones. This interaction is made possible through head-mounted displays (HMDs), motion sensors, and controllers that track user movements and respond in real time (Gonçalves & Boas, 2014). VR systems are classified into two primary categories: immersive and non-immersive. Immersive systems, such as those employing HMDs, fully engage users by isolating them from external stimuli, creating a sense of presence within the virtual environment. Non-immersive systems, like desktop simulations, provide a less enveloping experience but still allow users to interact with virtual environments (Zahida et al., 2021).

The unique ability of VR to replicate real-world experiences or design entirely virtual scenarios has made it a versatile tool across various domains. It enhances user interaction by incorporating high-definition graphics, spatial audio, and precise motion tracking to provide a seamless and engaging experience. As a result, VR is revolutionizing industries such as education, healthcare, entertainment, and training, transforming traditional methods of learning and interaction into innovative, experiential formats (Hamad & Jia, 2022). With its capacity to transport users to virtual realms and offer unparalleled interactive experiences, VR continues to push the boundaries of technological advancement. Its rapid development highlights its potential to redefine how individuals engage with digital content, making it a transformative force in the modern era (Gonçalves & Boas, 2014).

2.3 Virtual Reality Devices and Platform

Virtual reality (VR) devices can be categorized into several types based on their hardware and the level of immersion they provide. Here's a summary of three prominent types: Head-Mounted Displays (HMDs), Desktop-Based Virtual Reality, and Mobile Virtual Reality.

2.3.1 Head-Mounted Display (HMD)

A head-mounted display (HMD) is a wearable device that delivers an immersive virtual experience by displaying images directly in front of the user's eyes. Typically, HMDs feature two small screens (one for each eye) that render stereoscopic graphics, creating a 3D effect. Many models also include built-in audio systems and sensors for tracking head movements, enabling users to look around the virtual environment naturally. With high levels of immersion, real-time head tracking, and spatial audio, HMDs are widely used in gaming, training simulations (such as medical and military training), virtual tourism, and educational applications where immersive experiences enhance learning outcomes.

Figure 2.1: Head-Mounted Display (HMD)

2.3.2 Desktop-Based Virtual Reality

Desktop-based VR utilizes standard desktop computers to generate and interact with virtual environments displayed on a monitor. Users navigate these environments through input devices such as a mouse or keyboard, eliminating the need for specialized VR equipment. While it provides a less immersive experience compared to HMDs, users remain aware of their physical surroundings and can still interact with 3D graphics on the screen. Desktop-based VR is commonly employed in educational settings, technical training, and casual gaming. Its cost-effectiveness and ease of implementation make it an accessible option for various applications.

Figure 2.2: Desktop-Based Virtual Reality

2.3.3 Mobile Virtual Reality

Mobile VR leverages smartphones or tablets to deliver virtual reality experiences through dedicated headsets designed to hold the mobile device. These lightweight and portable headsets allow users to explore VR environments by moving their heads, with the smartphone screen displaying the content. Although interaction is generally more limited compared to HMDs, mobile VR offers moderate immersion and accessibility. It is particularly popular in gaming and entertainment, as well as in educational tools that utilize mobile technology for ease of use. Its affordability and convenience make mobile VR an ideal entry point for users new to virtual reality.

Figure 2.3: Mobile Virtual Reality

Table 2.1: Virtual Reality Devices Comparison

Feature	Head-Mounted Displays (HMDs)	Desktop-Based Virtual Reality	Mobile Virtual Reality
Immersion Level	High immersion with stereoscopic 3D visuals	Moderate immersion, displayed on a monitor	Moderate immersion using mobile screens
Hardware Requirements	Requires HMD, often with motion controllers	Requires a powerful desktop computer	Requires a smartphone and compatible headset
User Interaction	Head tracking, hand controllers, spatial audio	Mouse/keyboard input	Head movement and limited touch controls
Portability	Less portable; typically tethered or standalone	Not portable; fixed setup	Highly portable; easy to transport
Cost	Expensive	Affordable	Affordable
Applications	Gaming, training simulations, virtual tourism	Education, technical training, casual gaming	Gaming, entertainment, educational tools
Examples	Oculus Quest 2, HTC Vive Pro 2	Oculus Rift S, Valve Index	Samsung Gear VR,

2.4 Types of Virtual Reality

Virtual reality (VR) encompasses a range of technologies that simulate immersive environments. There are primarily three main types of VR, each with distinct characteristics and applications:

2.4.1 Fully Immersive Virtual Reality

Fully immersive VR provides the most realistic and engaging experience by completely surrounding users in a digital environment. This type of VR typically requires specialized equipment such as head-mounted displays (HMDs), headphones, and motion tracking devices. Users are isolated from their physical surroundings, enabling them to interact with the virtual world through sight, sound, and sometimes touch. Commonly used in gaming, entertainment, and advanced training simulations such as medical training for surgeries, fully immersive VR offers a profound sense of presence and interaction within the virtual space.

Figure 2.4: Fully Immersive Virtual Reality

2.4.2 Semi-Immersive Virtual Reality

Semi-immersive VR blends real and virtual elements, allowing users to interact with both physical and digital environments. This is often achieved through advanced displays or projection systems that create a partially immersive experience. Users maintain some awareness of their real-world surroundings while engaging with the virtual environment. Frequently used in educational settings and training simulations such as flight simulators, semi-immersive VR enhances learning experiences by providing interactive lessons without the need for full detachment from reality.

Figure 2.5: Semi-Immersive Virtual Reality

2.4.3 Non-Immersive Virtual Reality

Non-immersive VR provides a computer-generated environment that users can interact with using standard input devices like keyboards or game controllers. Unlike immersive VR, this type does not isolate users from their physical surroundings, offering minimal sensory engagement. Non-immersive VR is often utilized in applications such as video games on personal computers or consoles and is commonly seen as an entry-level experience into virtual environments.

Figure 2.6: Non-Immersive Virtual Reality

2.5 Analysis on Related Existing Article

A thorough review was carried out to collect important information and aid in the project's development. Reliable academic databases like Scopus and Google Scholar were used for this purpose. These platforms were selected because they have a wide range of scholarly articles and research papers.

2.5.1 Analyzing Augmented Reality (AR) And Virtual Reality (VR) Recent Development In Education

The article discusses the trends and applications of AR and VR technologies, focusing on how they have revolutionized different industries. It highlights some of the recent technological innovations in AR and VR that would enhance experiences: better hardware, better graphics rendering, and improvements in artificial intelligence. It then goes further to analyze the usage of these technologies in healthcare for surgical simulations and therapy, education for immersive learning experiences, entertainment by gaming and virtual events, and business for virtual meetings and product demonstrations. Additionally, it investigates some of the challenges that AR and VR face: high development costs, hardware limitations, and user experience/accessibility issues. It highlights that AR and VR will increase in integration with other emergent technologies such as 5G, IoT, and AI, promising even more revolutionary ways of interaction with both digital and physical worlds. Additionally, it gives the outline that there is a need to surmount some barriers that will influence the full realization of AR and VR technologies: technical complexity, content creation, and ethical considerations. Overall, the paper positions AR and VR as instrumental in defining the future of human-computer interaction, transforming various sectors through immersive, efficient, and innovative solutions.

2.5.2 The Benefits Of Virtual Reality In Education

The article explores the benefits of integrating Virtual Reality (VR) technology into education, particularly through a qualitative study comparing a VR application for astronomy learning with its mobile counterpart. Conducted by Mustafa Hussein and Carl Nätterdal from the University of Gothenburg, the research addresses the evolution of VR from being an expensive and inaccessible technology to a more affordable and widely available tool, especially with the advent of devices like Google Cardboard and Samsung Gear VR. The study involved interviews with 20 students and 5 educators who evaluated the Xolius application, designed to teach users about the solar system by visualizing planets in an immersive environment. Findings indicated that VR significantly enhances learning in subjects requiring interactivity and immersion, promoting active engagement and concentration compared to traditional mobile applications. Participants reported that the VR experience allowed for a better understanding of spatial relationships and scale, making learning more enjoyable and effective. However, some users experienced discomfort, such as motion sickness, highlighting the need for careful design and implementation of VR in educational contexts. The authors conclude that while VR offers unique advantages in education, further research is necessary to fully understand its long-term impact and to develop best practices for its integration into various learning environments.

2.5.3 Exploring The Needs And Ways To Use Virtual Reality To Understand Animals' Perceptions

The article explores the potential of virtual reality (VR) as a tool to deepen understanding of animal perceptions and behaviors. It identifies a growing need to enhance the human-animal connection and improve educational and conservation outcomes by leveraging immersive technologies. VR is presented as a medium capable

of simulating realistic animal habitats and enabling users to perceive the world through animals' sensory experiences, such as their unique visual, auditory, and tactile inputs. The study emphasizes the importance of designing VR experiences informed by accurate biological and ecological data to ensure scientific validity and authenticity. Furthermore, it discusses various applications of VR, including educational platforms for children and adults, research tools for studying animal behavior, and conservation campaigns to evoke empathy and inspire action. Challenges such as the technological complexity of replicating animal senses, the ethical considerations of simulating living beings, and the need for interdisciplinary collaboration among technologists, biologists, and educators are also highlighted. Ultimately, the article advocates for VR as a transformative tool to bridge the gap between humans and animals, fostering empathy, understanding, and proactive engagement in conservation efforts.

2.5.4 A Case Study Exploring The Use Of Virtual Reality In The Zoo Context

The study examines the use of Virtual Reality (VR) technology in zoo settings as an educational and engagement tool. By integrating VR, zoos can enhance visitors' experiences, allowing them to explore virtual environments that replicate or extend animal habitats, overcoming limitations such as restricted animal visibility or seasonal changes. The study focuses on the effectiveness of VR in engaging zoo visitors, particularly children, by enabling immersive interactions that foster learning about wildlife conservation and ecology. It highlights how VR facilitates a deeper connection with animals by offering unique perspectives, such as viewing animals in their natural habitats or understanding their behaviors up close without physical boundaries. Furthermore, the research explores the balance between entertainment and education, emphasizing the importance of carefully designed VR content that aligns with

conservation goals. The case study evaluates user feedback, technical challenges, and the potential of VR to complement traditional zoo exhibits, underscoring its role as a transformative tool for enhancing wildlife education and conservation awareness.

2.5.5 Smart Learning of Animals Using Virtual Reality Zoo

The article explores the innovative use of virtual reality (VR) technology to revolutionize animal education for primary school students. It highlights the development and testing of a VR zoo application that immerses users in lifelike virtual environments where they can explore animal behaviors, habitats, and other characteristics using devices like Google Cardboard. The study emphasizes how VR enhances learning engagement by combining visual, auditory, and interactive elements, allowing students to deepen their understanding of biodiversity and conservation. A key component includes a quiz feature, which enables children to test their knowledge interactively within the VR setting, further solidifying the learning experience. Feedback from 20 participants aged 6 to 10 revealed overwhelmingly positive responses, citing increased interest, ease of navigation, and memorable interactions. The paper concludes by acknowledging VR's potential for broader educational applications, including the incorporation of extinct and endangered species, underwater exploration, and space learning in future iterations. This approach underscores VR's transformative role in making learning experiential, effective, and accessible.

2.5.6 Pengembangan Virtual Reality Pengenalan Binatang Buas Untuk Anak Usia Dini

The article details the development of a virtual reality (VR) application designed to introduce preschool children to wild animals in an engaging and educational manner. Developed using the ADDIE model, this Android-based app features fourteen 3D

animal models complete with animations, sounds, and habitat simulations that can be experienced in both 3D and VR modes. The application provides interactive content, including audio narrations about the animals' characteristics and diets, enhancing learning while addressing safety and logistical challenges of exposing children to wild animals directly. The VR experience allows children to feel immersed in realistic virtual environments, fostering greater engagement and comprehension. User tests conducted at TK Negeri Pembina Singaraja revealed overwhelmingly positive feedback, with an average satisfaction score of 88.50%, highlighting the app's effectiveness in teaching children about wild animals, their movements, sounds, and habitats in a user-friendly manner.

2.5.7 Design Of Zoo 3D Roaming System Based On Unity3D Virtual Reality Technology

The article outlines the development of a virtual zoo experience using Unity3D, 3DMax, and C#. Aimed at addressing limitations in traditional zoos, the system enables immersive interaction with animals through a virtual platform, overcoming spatial, logistical, and behavioral constraints. It features dynamic animal models, environmental simulations, and human-computer interaction to create an engaging and educational experience. Users can explore the zoo, interact with animals, and even encounter extinct species through virtual reality, enhancing learning and entertainment. The system integrates various technologies, including animation and sensor-based navigation, providing realistic scenarios such as feeding animals or navigating their habitats. Designed for deployment on Android platforms, the project demonstrates significant usability, stability, and potential to increase accessibility to zoological education, offering benefits to both users and zoo management by blending education, conservation, and digital innovation.

2.5.8 Design of Virtual Reality Zoos Through Internet of Things (IoT) for Student Learning about Wild Animals

The article discusses the development of a Virtual Reality (VR) zoo integrated with the Internet of Things (IoT) as an educational tool aimed at enhancing the learning experience of elementary school students regarding wild animals. It highlights the limitations of traditional zoo visits, where animals are often not visible or interactive due to safety concerns, and the minimal information provided on-site. The proposed VR zoo allows students to engage with 3D animated representations of wild animals through an Android-based application embedded in YouTube, making it accessible and interactive. The research employs the Multimedia Development Life Cycle (MDLC) model, which includes stages such as concept development, design, material collection, assembly, testing, and distribution. The application was tested on various Android devices, demonstrating compatibility from versions 5.1.1 to 11. The results indicate that the VR zoo effectively provides a safe and engaging way for students to learn about animal diversity, enhancing their understanding through visual and auditory stimuli. The study concludes that this innovative approach not only makes learning more efficient compared to traditional methods but also encourages further research into the impact of VR on educational outcomes. Future recommendations include analyzing the effectiveness of this VR application in improving students' comprehension of the material taught.

2.5.9 Virtual Reality In The Zoo: A Qualitative Evaluation Of A Stereoscopic Virtual Reality Video Encounter With Little Penguins (Eudyptula Minor)

The article presents a qualitative evaluation of a stereoscopic virtual reality (VR) video experience featuring little penguins (Eudyptula minor) at a zoo, exploring how digital

technologies can enhance human-animal encounters in zoological settings. Conducted by researchers from various institutions, the study utilized a 'research-through-design' methodology to create a 5-minute VR video that combines footage of penguin feeding and behind-the-scenes animal care, narrated by a zookeeper. The evaluation involved semi-structured interviews with 67 participants, including zoo visitors, teachers, and offsite viewers, to assess their experiences and attitudes towards the VR installation. Findings revealed that visitors generally had positive attitudes towards the VR experience, appreciating its ability to provide unique, immersive content that complemented live animal viewing rather than replacing it. Key themes emerged from the analysis, including cognitive and emotional immersion, social presence, and the participatory nature of the experience, which fostered a deeper understanding of animal care and conservation issues. Participants reported feeling a strong sense of presence, as if they were physically close to the animals and the zookeeper, which enhanced their emotional engagement and connection to the conservation message. The study concluded that VR video could serve as a valuable addition to traditional zoo experiences, offering practical benefits such as accessibility and the ability to engage visitors in conservation education, while also highlighting the need for further research into the implications of using such technologies in zoos.

2.5.10 Digitizing Wildlife: The Case Of Reptiles 3D Virtual Museum

The article details the design and development of a 3D virtual museum focused on reptiles, aimed at enhancing public education about wildlife that is often difficult to observe in their natural habitats. The project, led by a team of researchers from various institutions, involves the high-resolution reconstruction of reptile meshes, the creation of rigged digital counterparts, and the acquisition of their movements through advanced

technologies such as optical motion capture systems, accelerometers, and RGB-vision cameras. The museum not only showcases animated 3D models of reptiles but also includes comprehensive metadata documentation that covers various aspects of the species, including behavior, ecology, and conservation status. The virtual museum is designed to be publicly accessible, allowing users to interactively explore the reptiles' behaviors and movements in a gamified learning environment. A user study conducted to evaluate the museum's effectiveness confirmed its ease of use, realism, and educational value, demonstrating that the 3D representations significantly enhance understanding compared to traditional static images or videos. The article emphasizes the importance of such digital tools in bridging the gap between humans and nature, particularly in an era where urbanization and environmental degradation threaten wildlife. Additionally, the work lays the groundwork for future applications in wildlife monitoring, conservation efforts, and educational tools aimed at engaging younger generations with the natural world.

2.5.11 Summarization Table of Literature Review

Table 2.2: Overall Analysis of Existing Article

No	Year	Author	Title	Objective	Result	Conclusion
1.	2023	Al-Ansi, Abdullah M. Jaboob, Mohammed Garad, Askar Al-Ansi, Ahmed	Analyzing augmented reality (AR) and virtual reality (VR) recent development in education	The study aimed to evaluate the effectiveness of a Virtual Reality (VR) application for astronomy education compared to a traditional mobile application, focusing on user engagement, understanding of spatial relationships, and overall learning experience among students and educators.	Participants reported that the VR application significantly enhanced their understanding of the solar system, promoting active engagement and concentration, although some experienced discomfort such as motion sickness.	The research concluded that VR technology offers unique educational advantages, particularly in interactive subjects, but emphasizes the need for further studies to explore its long-term impact and establish best practices for effective integration into educational settings.

No.	Year	Author	Title	Objective	Result	Conclusion
2.	2015	Hussein, Mustafa Nätterdal, Carl Steghöfer, Jan-Philipp	The Benefits of Virtual Reality in Education	The study aimed to assess the benefits of Virtual Reality (VR) in education by comparing a VR application for astronomy learning with a traditional mobile application, focusing on user engagement, immersion, and educational effectiveness among students and educators.	Participants found the VR application to significantly enhance learning through immersive experiences, improved understanding of spatial relationships, and increased engagement, although some reported issues like motion sickness.	The findings suggest that VR can greatly enrich educational experiences, particularly in interactive subjects, but further research is needed to understand its long-term effects and to develop effective integration strategies in educational environments.

No.	Year	Author	Title	Objective	Result	Conclusion
3.	2020	Kasuga, Haruka Ohashi, Machiko Yamamot, Masataka Konishi, Yusuke Kitamura, Haruna Ikeda, Yuichiro Murai, Takashi	Exploring the needs and ways to use virtual reality to understand animals' perceptions	The study aimed to explore the needs and methods for utilizing head-mounted display virtual reality (HMD-VR) to enhance understanding of animal vision, assessing its educational efficacy in workshops and exhibitions.	Participants reported varied interests in animal vision based on demographics, with HMD-VR effectively facilitating engagement and comprehension of animal perception differences, although some experienced discomfort.	HMD-VR can significantly improve awareness of animal vision and welfare, but tailored instruction and content are essential for different audience demographics, necessitating further research on its educational impact.

No.	Year	Author	Title	Objective	Result	Conclusion
4.	2021	Lugosi, Zsuzsa Lee, Phyllis C.	A case study exploring the use of virtual reality in the zoo context	The study aimed to evaluate the potential of Virtual Reality (VR) as an educational tool in zoos, specifically assessing visitor engagement and learning outcomes when comparing a VR experience with a traditional video presentation about African wild dogs.	Participants in the VR condition reported higher enjoyment and engagement levels compared to the video group, although knowledge retention was mixed, with some struggling to recall specific information.	The findings suggest that VR can enhance visitor experiences at zoos, providing immersive educational opportunities, but further refinement is needed to improve information retention and ensure effective learning outcomes.

No.	Year	Author	Title	Objective	Result	Conclusion
5.	2024	S, Parvathavarthini M, Pyingkodi M, Dhaneesh	Smart Learning of Animals Using Virtual Reality Zoo	The article aimed to investigate the effectiveness of Virtual Reality (VR) as an educational tool in zoos, focusing on how it influences visitor engagement and learning outcomes compared to traditional video presentations.	The research discovered that visitors using the VR experience reported significantly higher levels of enjoyment and engagement than those watching the video, although knowledge retention varied, with some participants having difficulty recalling specific details.	The article concludes that while VR has the potential to enhance educational experiences in zoos, further improvements are necessary to optimize information retention and ensure effective learning outcomes for visitors.

No.	Year	Author	Title	Objective	Result	Conclusion
6.	2017	Pradnyana, Made Ardwi Arthana, Ketut Resika Sastrawan, Gusti Bagus Hari	Pengembangan virtual reality pengenalan binatang buas untuk anak usia dini	The article aimed to explore the impact of Virtual Reality (VR) technology on enhancing educational experiences in zoos, specifically assessing visitor engagement and knowledge retention compared to traditional video presentations.	The research discovered that visitors who experienced the VR presentation reported greater enjoyment and engagement levels than those who viewed the video, although knowledge retention was inconsistent among participants.	The article concludes that VR can significantly enrich educational experiences in zoos, but further refinement is needed to improve knowledge retention and ensure effective learning outcomes for all visitors.

No.	Year	Author	Title	Objective	Result	Conclusion
7.	2023	Yang, Yunchao Lu, Zhengheng Xu, Yan	Design of Zoo 3D roaming system based on Unity3D virtual reality technology	The article aimed to evaluate the effectiveness of a Virtual Reality (VR) application in enhancing educational experiences about animal behavior and conservation in zoos, comparing its impact on visitor engagement and learning outcomes to traditional methods.	The research discovered that participants using the VR application reported higher levels of engagement and enjoyment, although knowledge retention varied, with some users struggling to recall specific information presented.	The article concludes that while VR has the potential to enhance educational experiences in zoos, further development is necessary to improve information retention and ensure that learning outcomes are effectively achieved for all visitors.

No.	Year	Author	Title	Objective	Result	Conclusion
8.	2023	Sukmawati, Fatma Santosa, Eka Budhi Rejekiningsih, Triana	Design of Virtual Reality Zoos Through Internet of Things (IoT) for Student Learning about Wild Animals	The article aimed to investigate the effectiveness of a Virtual Reality (VR) zoo application as an educational tool for elementary school students, focusing on its ability to enhance understanding of wild animals compared to traditional learning methods.	The research discovered that students using the VR application demonstrated increased engagement and interest in learning about animals, with many expressing a better understanding of animal behaviors and habitats.	The article concludes that the VR zoo application significantly enhances educational experiences for students, providing an innovative approach to learning about wildlife, but further studies are needed to assess long-term retention of knowledge.

No.	Year	Author	Title	Objective	Result	Conclusion
9.	2020	Carter, Marcus Webber, Sarah Rawson, Simon Smith, Wally Purdam, Joe Mcleod, Emily M	Virtual Reality in the Zoo: A Qualitative Evaluation of a Stereoscopic Virtual Reality Video Encounter with Little Penguins (Eudyptula minor)	The article aimed to evaluate the potential of Virtual Reality (VR) technology in enhancing visitor experiences and educational outcomes in zoos, specifically through a qualitative assessment of a VR installation featuring little penguins.	The research discovered that visitors reported high levels of engagement and enjoyment with the VR experience, appreciating its immersive qualities, although some expressed concerns about motion sickness and the need for live animal interactions.	The article concludes that VR can significantly enrich educational experiences in zoos, offering unique opportunities for engagement and learning, but emphasizes the need for careful design to address potential discomfort and ensure effective educational outcomes.

No.	Year	Author	Title	Objective	Result	Conclusion
10.	2021	Zotos, Savvas Lemonari, Marilena Konstantinou, Michael Yiannakidis, Anastasios Pappas, Georgios Kyriakou, Panayiotis Vogiatzakis, Ioannis N Aristidou, Andreas	Digitizing Wildlife: The case of reptiles 3D virtual museum	The article aimed to assess the effectiveness of a 3D virtual museum focused on reptiles in enhancing public education about wildlife, particularly species that are difficult to observe in their natural habitats.	The research discovered that users found the virtual museum engaging and informative, reporting improved understanding of reptile behaviors and conservation issues, while also noting the ease of use and accessibility of the platform.	The article concludes that the 3D virtual museum serves as a valuable educational tool, effectively bridging the gap between humans and wildlife, but suggests further enhancements to optimize user experience and expand the range of species represented.

2.6 Analysis of Existing Applications

To make sure this project develops successfully, Thorough research into current applications that use virtual reality (VR) technology are conducted. These apps gave an important additional information about the features and contents that we can use or enhance for our project. Here's a summary of some key VR applications that are related to our work:

2.6.1 Zoo World VR

Figure 2.7: Zoo World VR Interface

Figure 2.7 shows an interface for Zoo World VR which is a virtual reality for windows pc and can be downloaded from steam is a game that allows players to explore various natural habitats and interact with wildlife. Developed by Intentio Education, the game emphasizes environmental-themed quests and educational content. Tablw 2.3 shows a deep analysis about Zoo World VR.

Table 2.3: Pros and Cons of Zoo World VR

Advantages	Disadvantages
• Offers immersive exploration of diverse ecosystems. • Provides information about different animal species and their habitats.	• As an early access game, it currently offers a limited number of animals and quests. • Some users report issues with gameplay mechanics and overall polish.

2.6.2 Ocean Rift

Figure 2.8: Ocean Rift Interface

Figure 2.8 shows an interface in Ocean Rift, it is a virtual reality aquatic safari park published by Picselica Ltd from steam windows that allows users to explore underwater environments populated with diverse marine life, including dolphins, sharks, and turtles. Table 2.4 shows deep analysis about Ocean Rift.

Table 2.4: Pros and Cons of Ocean Rift

Advantages	Disadvantages
• Features detailed and vibrant underwater environments. • Includes a wide range of sea creatures for users to discover.	• Interaction with marine life is somewhat restricted, focusing more on exploration. • Some users may experience discomfort due to underwater movement dynamics.

2.6.3 Nature Treks

Figure 2.9: Nature Treks Interface

Figure 2.9 shows an interface for Nature Treks VR from steam windows published by Greener Games offers immersive experiences in various natural environments, allowing users to explore and relax in virtual settings like forests, beaches, and meadows. Table 2.5 shows a deep analysis about the Nature Treks.

Table 2.5: Pros and Cons of Nature Treks

Advantages	Disadvantages
• Provides soothing music and serene landscapes for relaxation. • Offers multiple biomes to explore, each with unique aesthetics.	• Focuses primarily on exploration with minimal interactive elements. • Some users may find the experiences lacking in variety over time.

2.6.4 VR ZOO Safari Park Animal Game

Figure 2.10: VR ZOO Safari Park Animal Game Interface

Figure 2.10 shows an In-Game Interface within VR ZOO Safari Park Animal Game, it is a mobile VR application from Google Play Store published by VR Thrills that simulates a safari park experience, allowing users to observe and learn about various wild animals in a virtual setting. Table 2.6 below shows a deep analysis about VR ZOO Safari Park Animal Game.

Table 2.6: Pros and Cons of VR ZOO Safari Park Animal Game

Advantages	Disadvantages
• Available on mobile devices, making it widely accessible. • Provides information about different animal species.	• Visual quality may be lower compared to PC-based VR experiences. • Primarily focuses on observation with minimal interactive features.

2.6.5 VR Virtual Zoo 3D

Figure 2.11: VR Virtual Zoo 3D Interface

Figure 2.11 shows an In-Game screenshots within VR Virtual Zoo 3D, it is a mobile VR application from Google Play Store published by Sculfa VR that offers a virtual zoo experience, enabling users to explore 3D environments and encounter various animal species. Table 2.7 below shows a deep analysis regarding VR Virtual Zoo 3D.

Table 2.7: Pros and Cons of VR Virtual Zoo 3D

Advantages	Disadvantages
• Designed for ease of use on mobile platforms. • Features a variety of animals for users to learn about.	• May not offer the high-fidelity visuals found in more advanced VR applications. • Lacks advanced interactive elements and may have limited replay value.

2.6.6 Comparison between Reviewed Applications

Based on table 2.4, it can be concluded that most of the applications have audio, animation and information for multimedia content. These elements will be mainly implemented to the project.

Table 2.8: Multimedia Element Comparison

Features	Applications				
	Zoo World VR (Steam)	Ocean Rift (Steam)	Nature Treks VR (Steam)	VR ZOO Safari Park Animal Game (Google Play Store)	VR Virtual Zoo 3D (Google Play Store)
Image	✔	✔	✔	✔	✔
Audio	✔	✔	✔	✔	✔
Information	✔	✔	✔	X	X
Interactive	✔	✔	✔	✔	✔
3D Animation	✔	✔	✔	✔	✔
Internet Connection	X	X	X	✔	✔

2.7 Technique

A technique or method in VR is mainly an planned way of achieving certain goals or results in a virtual environment. It can include methods of interaction, such as gaze-based interaction, hand tracking, gesture recognition, and so on. The techniques also include those to make the visuals and sounds really immersive. The mixture of these methods might be applied by VR developers in order to make the experience within virtual worlds exciting. Gaze-based interaction, applied in this work, corresponds to all the requirements necessary from it.

2.7.1 Gaze - Based Interaction

Gaze-based interaction in virtual reality refers to a user interface mechanism that allows a user to interact with digital elements within the virtual environment by simply moving their eyes or the direction of their head. It utilizes the natural act of looking at an object to trigger an action; hence, it is intuitive and hands-free. This is very useful in those VR environments where using traditional input devices, such as controllers or keyboards, is impracticable or simply not workable. By focusing on an object or user interface element alone, users can select, activate, or manipulate items by simply paying attention to it, thereby enhancing accessibility and user experience.

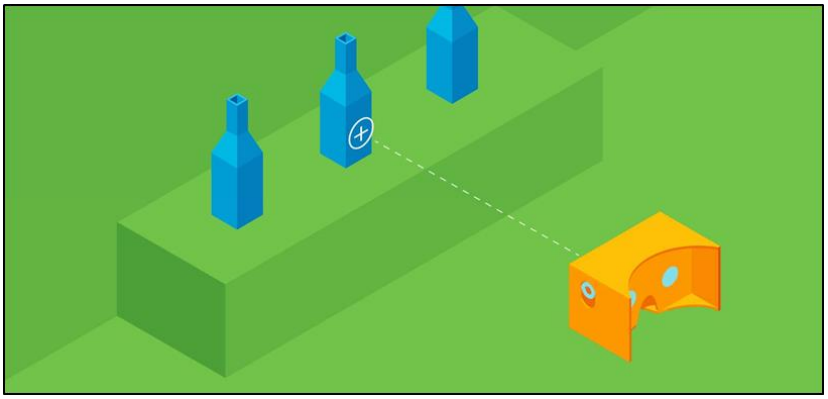

Figure 2.12: Gaze Based Interaction

Gaze-based interaction works on the basis of sensors, cameras, or gyroscopes to track the direction of gaze or head movement. In VR systems with eye-tracking technology, infrared sensors detect and follow the movement of the user's eyes to determine exactly what the user is looking at. In systems that don't have advanced eye tracking, head movement detection is done through gyroscopes or accelerometers in the VR headset. The VR software uses this gaze data to identify what object or interface element was being looked at. Typically, there will be a visual indication, such as a reticle or pointer, on the object being focused on. After a user keeps looking at a target for some time-a "dwell time"-the system interprets that as a selection or activation and thus performs the required interaction without the user having to use any physical input devices.

2.8 Summary of the Chapter

This chapter has discussed the literature review, providing a comprehensive overview of existing research on the integration of virtual reality in educational tools and applications. By analyzing various studies, theories, and methodologies employed by researchers, common themes, trends, and gaps in the literature were identified and critically evaluated. Additionally, comparisons of existing VR applications and analysis of related studies have informed ideas for the development of ZooVRventure. This literature review contributes to a deeper understanding of how VR can enhance wildlife education, offering valuable insights to guide the project’s design and suggesting implications for its implementation and potential future improvements.

CHAPTER 3

METHODODLOGY

3.1 Introduction

Effective planning is essential for the successful development of any project or application, and a well-defined methodology provides a structured framework to guide the process. This methodology outlines the procedures for data gathering and evaluation, clarifies the nature of the problem, justifies the chosen approach, and details the exploration process. By improving understanding of how the methodology is applied, it becomes easier to interpret research findings. Thorough preparatory work is crucial to ensure that the final product functions as intended, and in this project, the ADDIE model will be employed due to its simplicity, organization, and comprehensibility. Utilizing a structured approach like ADDIE enables project teams to optimize processes, mitigate potential issues, and enhance overall quality and success.

3.2 ADDIE model

The ADDIE Model will be the methodology followed in the development of this ZooVRventure application project because of its systematic process in instructional design. This model contains five iterative phases: Analysis, Design, Development, Implementation, and Evaluation, which ensure thorough planning and execution of learning materials and experiences. With the ADDIE model, learning outcomes are matched with the project's goals to ensure that instruction is effective and relevant. It emphasizes evaluation as a continuous process of reassessment and reformation of instructional practices based on feedback and data that will enhance educational effectiveness. ADDIE model significantly improves student learning outcomes at the university level, as demonstrated in a study where students taught using this model outperformed those in traditional settings (Zahida et al., 2021). Furthermore, the model's flexibility allows it to be adapted across diverse educational contexts and subjects, making it a valuable resource for developers aiming to create interactive and immersive learning experiences (Zahida et al., 2021). Figure 3.1 below shows Process of ADDIE Model.

Figure 3.1: ADDIE Model Process

3.3 Methodology phase

The ADDIE model consists of five phases, which will be explained below:

3.3.1 Analysis Phase

In the analysis phase of ZooVRventure, research is done on various related articles for the identification of the problem and objectives but only 10 selected articles are reviewed in detail. This is quite a vital step toward understanding the needs, goals, and constraints of the educational context and its stakeholders. Additionally, five existing wildlife or VR-based applications are analyzed for insights into the current practice and features. This phase identifies the target audience, characteristics, and specific learning objectives that will be achieved; these need to be compatible with the project outcome and goals (Zahida et al., 2021). In this regard, a literature review and analysis of applications may reveal the requirements needed for the project, both in terms of software and hardware. The successive phases of the ADDIE model will be correctly steered to fall in line with the purpose of the project by laying the ground.

3.3.2 Design Phase

In the design phase, a clear plan for the instructional materials is made. This includes outlining the structure, choosing suitable methods, planning activities, and arranging content to match the learning goals (Zahida et al., 2021). During this phase, instructional designers use the insights gained from the analysis phase to create a structured plan for the ZooVRventure application. This includes designing the app's flow using a navigation map, developing the interface layout, crafting button designs, and creating a storyboard to visualize the user experience. The project structure and content are carefully planned to align with the objectives, ensuring an engaging and interactive

learning environment. Prototypes, mock-ups, and other visual elements are developed to refine the application before moving to the next stage.

3.3.2.1 Navigation Map

This is the navigation map for the ZooVRventure app. It shows how users move through the app, starting from when they open it, going through the different content, and finally exiting the app.

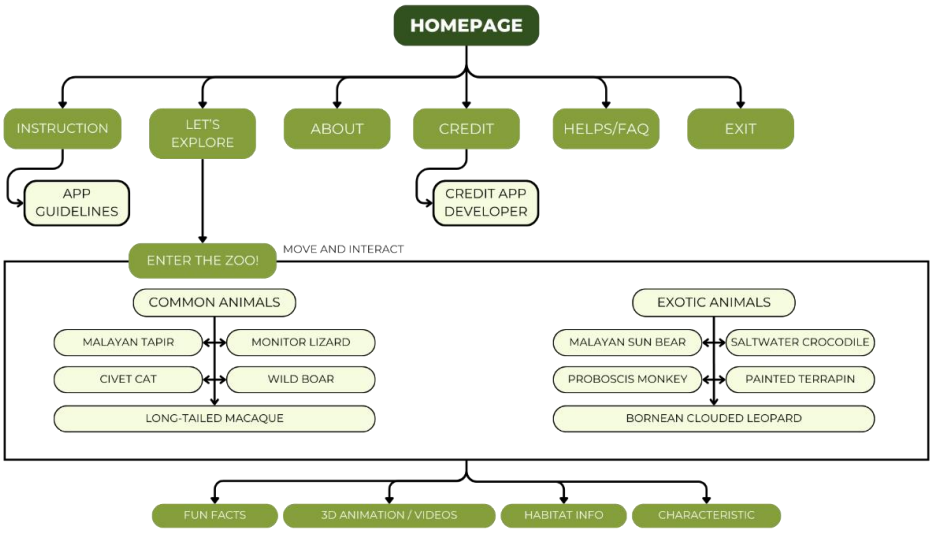

Figure 3.2: Navigation Map

3.3.2.2 Content of the Application

The material includes a 3D setting and a model within the zoo. Once the user presses the start button, the content will appear, placing the user right inside the zoo entrance where the starting point is located.

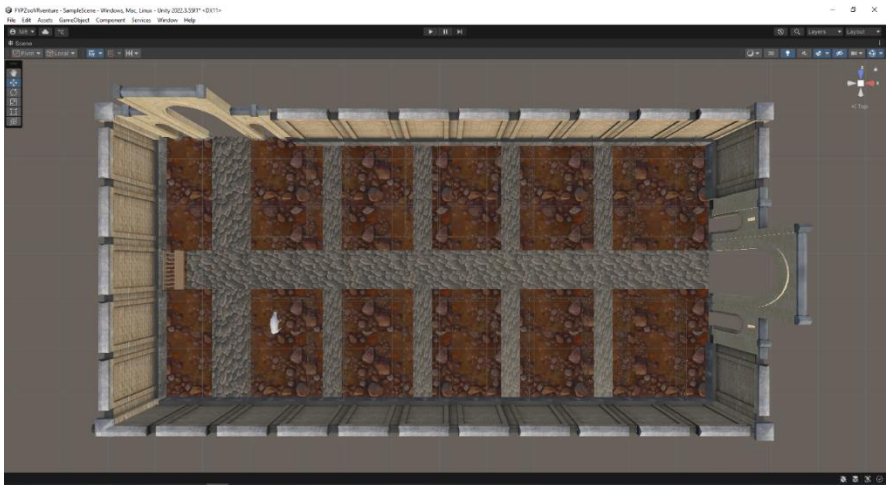

Figure 3.3: ZooVRventure Map

3.3.2.3 Logo Design

The ZooVRventure logo was designed in Adobe Photoshop using modern typography techniques to reflect current logo design trends. It features three versions: a main green logo symbolizing nature and wildlife, and two black-and-white options for versatile use.

Figure 3.4: Logo In development

3.3.2.4 Storyboards

Storyboards serve as a visual blueprint for designing and structuring the ZooVRventure application, enabling effective planning and organization of scenes, interactions, and narratives. They provide a clear depiction of the user journey and illustrate the complete look of the application once fully developed. The storyboard for ZooVRventure includes key pages such as the main menu, instruction page, "Let's Explore" page, exit page, about page, credit page, and help/FAQ page, ensuring a seamless and intuitive user experience. The storyboard for ZooVRventure is as shown below:

1) Main Menu

When the user opens the application, it shows the main menu showing 5 optional buttons which are “Let’s Explore” button, Instruction button, About button, Credit button and Open Door icon represent Exit button.

Figure 3.5: Main Menu Interface

2) Instruction

The instruction button provides users with step-by-step instructions on how to use the application effectively. The second page of the instructions explains how users can navigate through the VR environment seamlessly.

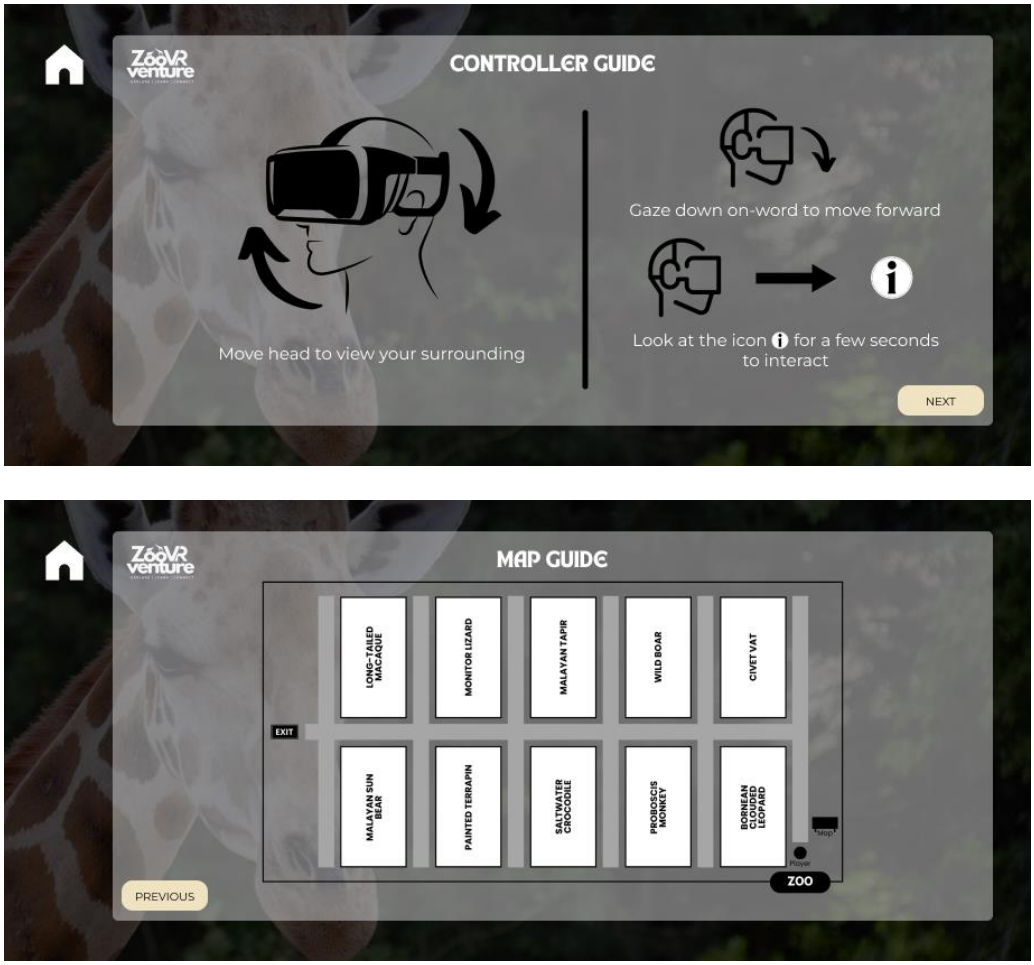

Figure 3,6: Instruction Interface

3) Credit

Users can view the details of the developer and supervisor, and this page also highlights the primary software used in the application's development.

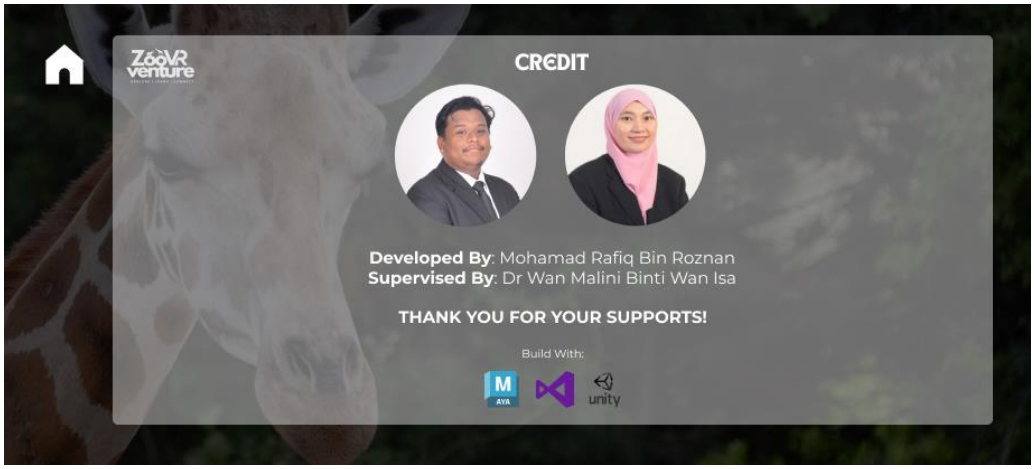

Figure 3.7: Credit Interface

4) Exit

Application will ask users confirmation whether they want to exit the application or not. If the user clicks on "No" it will send the user back to the main menu but if the user click on "Yes" user will quit the game and the game will be shutdown.

Figure 3.8: Exit Interface

5) About

This page gives an overview of ZooVRventure, explaining its purpose and features as an immersive VR experience that educates users about common and exotic animals through interactive 3D environments.

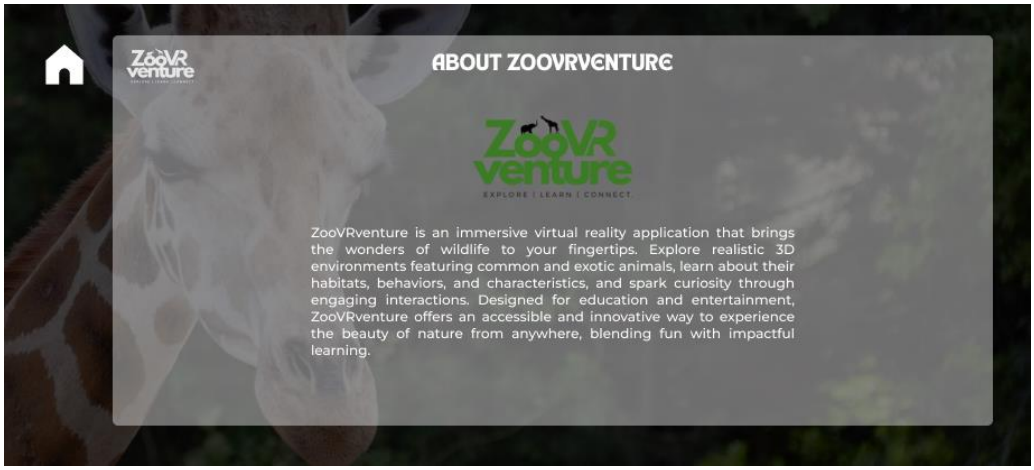

Figure 3.9: About Interface

6) Helps/FAQ

The "Helps/FAQ" page provides quick answers to common questions, including device compatibility, offline access, and suitability for children, ensuring informed user experience.

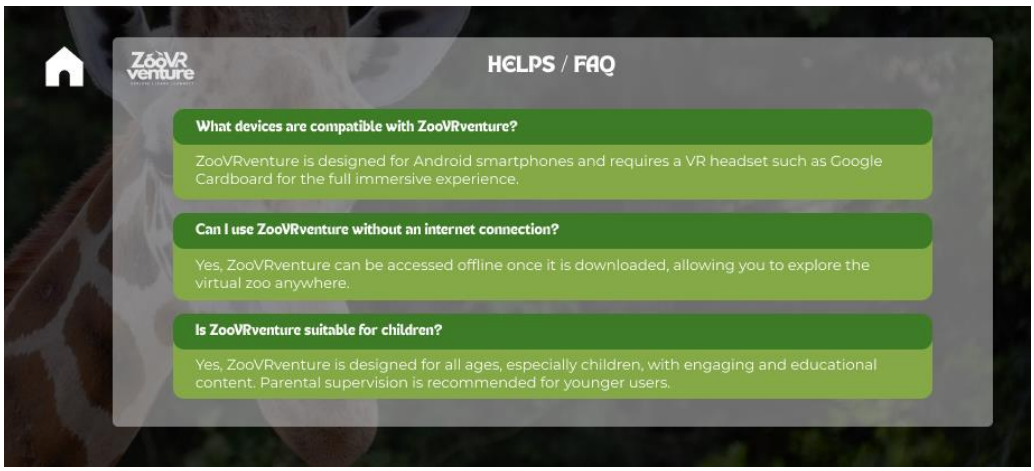

Figure 3.10: Helps/FAQ Interface

7) Let’s Explore

The "Let's Explore" page invites users to start their ZooVRventure journey while providing a safety warning about potential VR discomfort before entering the immersive Zoo environment using the “Enter the Zoo” button.

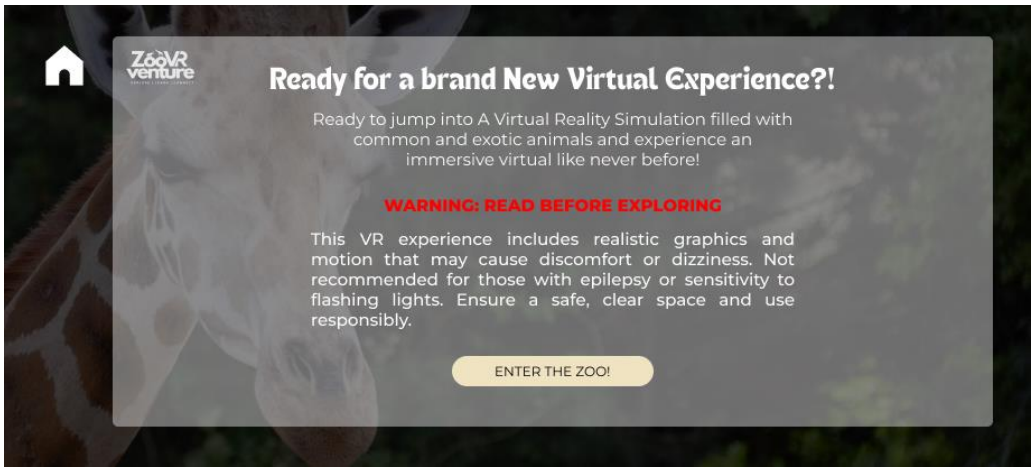

Figure 3.11: Let’s Explore Interface

8) Enter The Zoo (Entrance)

When users enter the ZooVRventure virtual environment for the first time, they will begin their journey at the zoo's entrance, serving as the main starting point for their VR experience

Figure 3.12: Entrance of Enter The Zoo Interface

9) Enter The Zoo (Path)

The paths users will navigate in the ZooVRventure environment are carefully designed to follow the layout depicted in the map provided on the "Instruction" page.

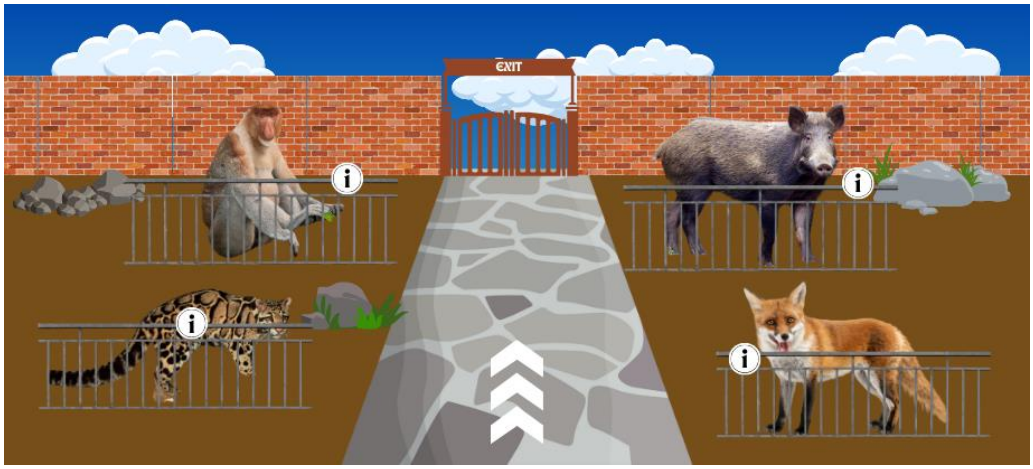

Figure 3.13: Path of Enter The Zoo Interface

10) Enter The Zoo (Animals View)

As users explore the ZooVRventure environment, an "i" icon representing information will appear when they stop at a specific animal. By gazing at the icon for a moment, a popup will display details about the animal's characteristics, habitat, and fun facts. Additionally, users can gaze at the play video button to watch a video about that particular animal.

Figure 3.14: Animal's View of Enter The Zoo Interface

11) Enter The Zoo (Exit)

To exit the ZooVRventure virtual environment, users must pass through the exit gate located at the end of the map, which will automatically redirect them to the main menu page.

Figure 3.15: Exit of Enter The Zoo Interface

3.3.2.5 Framework

The framework for ZooVRventure comprises the user, a head-mounted display, the ZooVRventure application, its content, and the software used for its development. First, the user wears the VR headset, which connects to the ZooVRventure application. The application then retrieves content from the development software and displays it on the VR headset. Finally, the headset delivers an immersive virtual zoo experience to the user.

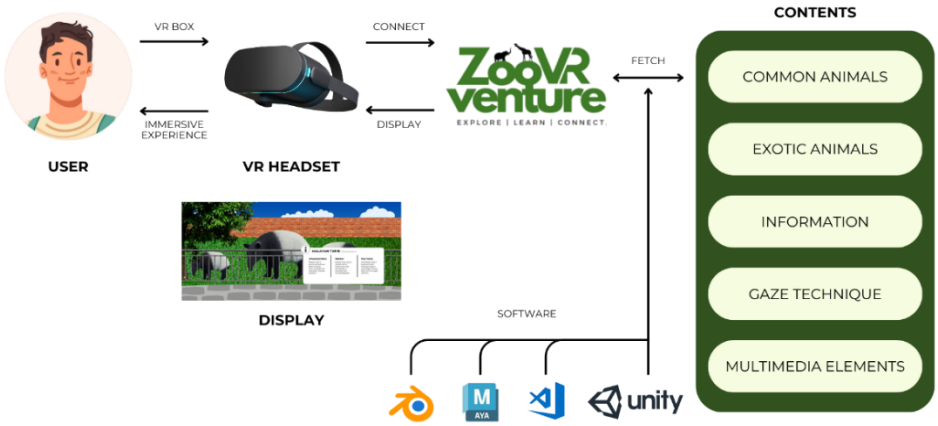

Figure 3.16: Framework Process

3.3.3 Development Phase

The development phase focuses on creating and assembling all instructional materials, integrating multimedia elements, and finalizing content through iterative testing and refinement to ensure quality and usability (Zahida et al., 2021). Storyboarding and prototyping in the development phase are two useful and crucial materials in developing ZooVRventure application. It entails ideas that will surely capture the target users' interests. In line with the established developed concept and storyline, it is focused on developing and implementing 3D models and features of the said software using Autodesk Maya and Blender for element button and 3D model creation. All assets and models then will be put together in the VR environment using Unity software.

3.3.4 Implementation Phase

This phase involves delivering the instructional content to the target audience, setting up the required tools or platforms, and providing any necessary training to ensure smooth and effective execution (Zahida et al., 2021). The ZooVRventure project transitions from planning and development to actual deployment for user engagement. This involves integrating the VR application into the learning environment, such as educational platforms or virtual animal museum. The Head-Mounted Unit (VR headset) will be utilized to deliver an immersive experience to users. During this phase, developers will monitor user interactions, engagement, and feedback, addressing any technical issues or challenges in real-time to ensure a smooth and effective implementation process.

3.3.5 Evaluation Phase

The evaluation phase assesses the overall effectiveness of the instructional design by collecting feedback, measuring outcomes, and identifying areas for improvement to enhance future iterations of the project (Zahida et al., 2021). The developers test the effectiveness of the project and the learning experience provided. This involves testing the functionality of the application to ensure it meets the intended objectives and identifying areas for improvement. Methods such as user testing and performance evaluations are used to assess the application's strengths, weaknesses, and any discrepancies between expected and actual outcomes. Based on the results, necessary adjustments and refinements are made to enhance overall performance and user experience. Through systematic assessment of design and content, developers ensure continuous refinement of ZooVRventure for optimization in a series of iterations to come, thus offering an improved immersive learning experience.

3.4 Hardware and Software Requirement

For ZooVRventure, hardware and software requirements define the essential components and specifications necessary to run the VR application seamlessly. Hardware requirements include a powerful processor, sufficient RAM, ample storage, robust graphics capabilities, and VR-compatible input/output devices to deliver a smooth and immersive experience. On the software side, the application relies on a compatible operating system, necessary libraries, drivers, and development tools such as Unity, Blender, and Autodesk Maya for creating and running the VR environment. Ensuring compatibility between hardware and software is crucial to optimize performance and provide users with an engaging, glitch-free virtual reality experience.

3.4.1 Hardware Requirement

Hardware plays a critical role in ensuring the success of this research project, with each component serving a specific purpose essential to its development. Below is the list of hardware selected to support the creation of this project.

Hardware	Function	Specification
 Laptop: Nitro 5 AN515-43-R5W3 Gaming Laptop	Used for research, documentation, coding, modelling and application development related to the project.	AMD Ryzen 7 3750H processor (2.30GHz), NVIDIA GeForce GTX 1650 GPU (4GB), 16GB DDR4 RAM, a 512GB SSD, a 1TB HDD, and runs on Windows 11 for optimal performance and compatibility.
 Phone: Samsung Galaxy A23	To run and test the application.	Android 12 with One UI 4.1, powered by the Qualcomm Snapdragon 680 4G chipset. Its octa-core CPU comprises four cores at 2.4 GHz and four at 1.9 GHz,

		complemented by an Adreno 610 GPU for graphics processing.
 Head Mounted VR: VR Shinecon	To provide an immersive experience for users.	This product is a lightweight plastic VR headset weighing 620g, designed for mobile phones with screen sizes between 4.7 to 6.7 inches. It supports video input from mobile devices and media formats such as MP3, RMVB, AVI, WMA, and WAV, with a resolution range of 720-1280P. The screen size inside the headset is 300 inches for an immersive experience.

Table 3.1: List of Hardware Used

3.4.2 Software Requirement

Choosing the right software for this project is equally important, as it depends heavily on the project's unique requirements. The software utilized in the development process is listed below.

Software	Function
Autodesk Maya	Create 3D model assets with UV textures, creation, and simulation tools.
Blender	Create a 3D animals model with UV textures, creation, rigging, animations, and simulation tools.
Unity	Used for developing 3D environments and deploying 3D models, multimedia content and its model.
Figma	Figma is used for developing the user interface (UI) of VR applications.

 Adobe Photoshop	To create logos and enhance the quality of images including the development of 3D model realistic textures.
 Canva	To find example templates for presentation to use in the project.
 Microsoft Visual Studio Code	Used for code editing and compiling to create certain functions and features.

Table 3.2: List of Software Used

3.5 Summary of the Chapter

This chapter describes the steps taken to successfully execute ZooVRventure project, including how a framework must have been chosen if the application should have been completed on time. It is for example normally useful to use the ADDIE method as it fits with how such projects are structured progress wise, determination wise, and what tools and approaches need to be used to deliver on the objectives. Finally, this chapter mention the basic hardware and software that its necessary to support the project, as the provided information might guide other projects that have the same nature.

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