Digital Sanctuaries for Environmental Awareness using AR/VR Technology

Gajanan Gambhire[1], Neharika Sharma[2], Nikhil Kelkar[3], Nayana Majeti[4], Vedant Nikam[5], Nikhil Kumar[6], Jairaj Nawgare[7]
[1234567]*Department of Engineering Sciences and Humanities (DESH)*
Vishwakarma Institute of Technology Pune, Maharashtra, India

Abstract*— This project discusses and explores how augmented reality (AR) and virtual reality (VR) technologies can be used to create an interactive and immersive virtual zoo that promotes environmental awareness and animal conservation. Using Blender, a snowy environment resembling arctic life was created, including 3D models of penguins and snow bears. These animations, controlled through a native behavior tree, allow users to interact with the animals and observe their movements. Integration with Unity enhances the user experience by using the phone's gyroscope for precise camera adjustments. The Boids simulation algorithm simulates the real behavior of fish, enhancing the interaction and educational value of the virtual zoo. This application aims to provide a flexible and accessible way for users to learn about biodiversity, the dynamics of animal migration, and the importance of conservation. Immersive experiences showcasing the behavior and existence of unique and diverse species, including those at risk of extinction, can inspire conservation action and offer opportunities for scientific research on animal behavior and ecology.

***Index Terms*— AR, biodiversity, conservation, environmental awareness, VR, wildlife**

I. INTRODUCTION

In today's fast changing and challenging times where the need for such innovative methods to promote wildlife conservation and biodiversity is immense given rapidly growing technology & environmental problems. Inspiration Our Project, “Digital Sanctuaries for Environmental Awareness using AR/VR Technology” is motivated by the call to action! Using augmented reality (AR) and virtual reality technology we aspire to design interactive exhibits that are not only entertaining but also educational; bringing awareness about our natural world and the biodiversity found on Earth.

With wildlife populations having been continuously shrinking and species going endangered or extinct at an alarming rate, this suggests that greater proactiveness from conservation education is needed. Conducted on the site of traditional zoos and by wildlife parks. The fact that animal populations are diminishing, depleting quickly to endangerment or extinction should urge for other actions of intervention in conservation education. This is where traditional zoos and wildlife parks come into play, as they offer a place that the public too can go to see animals from all over. These institutions, however, can only be accessed by so many people and they can only showcase some species. Our virtual zoo tackles these shortcomings with a powerful and engaging, anywhere access system, which makes room to reveal in-depth the marvels of wildlife inside living rooms or classrooms.

Apart from virtual zoos, AR and VR technologies have great potential for transforming education in different areas. For example, students of mechanical engineering can use these technologies to virtually attend workshops and witness the operation of machines in an immersive setting that enhances their practical skills and understanding. Equally, medical students may take advantage of classes where they dissect virtually; this allows them to explore human anatomy at deep levels without having to use real specimens which are limited by physicality and ethical considerations. These instances show how powerful AR as well as VR can be in creating learning experiences that are immersive and practical thus greatly improving education outcomes.

In taking on our project we aim to instill a passion for animals in the minds of young children and teens, so that they grow up into people who care about wildlife alike. That being said, the scope of institutions can be limited in terms of accessibility or diversity among species.

Looking at it, a zoo can have only a limited number of physical exhibits, but our virtual zoo is an application, where you can experience immersive and engaging content no matter where you are in the world,

experiencing the wildlife directly through user's mobile phones, laptops or tablets.

In our initiative, we aim to inculcate a love for animals from an early age and in the youth and nudge them toward being nature conservationists. The second, being some of our animated exhibits, might be a beautiful arctic habitat that enables users to view behavior and interact with animals in a virtual 3D world.

By simulating animal movements and ecosystems, we want to educate people that all parts of our ecosystem are important and that it is delicate too. Also, this virtual zoo we have created can be used as a very valuable educational tool where some animals which may not be seen in normal zoos have been put on display.

It does not only increase public awareness but also provides scientific research with information about animal behavior and ecology. We aim at inspiring future generations to protect the irreplaceable variety of life on earth by creating a love for wildlife and nature closer home.

II. PROBLEM STATEMENT

Wildlife populations are declining at an alarming rate, necessitating proactive conservation education. Traditional zoos and wildlife parks can only showcase a limited number of species and are accessible to a limited audience. Our virtual zoo addresses these limitations by providing an engaging, accessible system that reveals the marvels of wildlife.

III. LITERATURE REVIEW

Previous studies have demonstrated the potential of immersive technologies, such as augmented reality (AR) and virtual reality (VR), in enhancing educational and emergency response experiences. For instance, Isong et al. (2016) developed a mobile-based medical emergency ambulance scheduling system that integrated location-based services and Google Maps for real-time tracking and route optimization, using a cloud-based server for efficient data storage and access. This approach highlights the importance of real-time, interactive systems, a concept that aligns with our project's use of AR/VR for creating dynamic and responsive virtual environments for education. Similarly, Gunasundari et al. (2016) utilized Android Studio to develop an ambulance service application, emphasizing the role of user-friendly mobile interfaces, which parallels our project's focus on accessibility and user interaction through mobile devices.

Rathore et al. (2022) proposed a sustainable EMS model for developing countries, which seeks to improve the efficiency of emergency medical services, ensuring timely critical care—a goal that resonates with our project's objective to use immersive technologies to engage users in conservation efforts effectively. Additionally, Sharma and Brandler (2014) examined the fragmented nature of EMS in India, advocating for a standardized approach, which echoes our project's aim to standardize educational content delivery through a virtual platform that provides consistent, high-quality learning experiences irrespective of physical location. Basyir and Nasir (2018) utilized the Haversine formula on an Android platform to accurately determine the nearest emergency service office, demonstrating the integration of precise computational models to enhance service delivery, similar to how our project uses algorithms like Boids to simulate animal behavior realistically.

Lastly, Andrew (2019) reported a significant increase in ambulance demand in Melbourne, highlighting the necessity for scalable solutions—an insight that informs our project's scalable AR/VR platform, designed to reach a broad audience for conservation education. Collectively, these studies provide a coherent backdrop that underlines the effectiveness of AR/VR and mobile technologies in creating engaging, real-time, and educational environments, which directly supports the goals of our project to foster environmental awareness and conservation through interactive virtual experiences.

IV. METHODOLOGY

The methodology for this project involves creating AR/VR environments to educate users about wildlife and promote conservation. Key phases include literature review, 3D modeling, and animation using Blender and Unity, and the integration of behavior trees and the Boids algorithm to simulate animal behavior. The Google Cardboard SDK was used for stereoscopic rendering, enhancing the VR experience by providing a sense of depth perception

A. THEORY

The methodology for this project involves several detailed phases. First, the project aims to develop AR/VR environments to educate users about wildlife and promote conservation, focusing on an Arctic

habitat with penguins and an underwater biome with various fish species. The initial phase involves a literature review to understand current AR/VR applications in education and wildlife conservation, animal behavior modeling, and the educational benefits of immersive technologies. We collected data from scientific literature, documentaries on the habitats of the selected animals, as well as environmental data on the biomes' climate, terrain, and aquatic features.

Next, the conceptual design phase includes creating and designing landscapes for the biomes. This is followed by 3D modeling and animation using software like Blender and Unity to create detailed models and realistic animal behaviors. In blender we developed the Penguin and fish model and gave animation to it and to give it realistic touch we use the texture paint feature of blender and for movement of animals we add bones to mesh and gave animation according to their behavior. Also developed the snowy environment for the penguin and aquatic(underwater) environment for the fishes. We implemented a basic behavior Tree with sequences, selectors GoTos, and LookTos, and managed to to integrate animation control to enable users to interact with the penguins and observe their movements. Some screenshots of 3d model are attached below: -

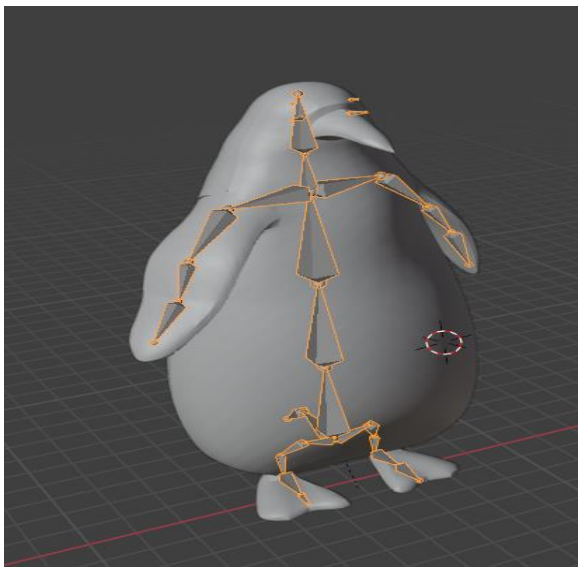

Figure 1 Penguin 3d mesh in blender

We established a connection from Unity to a phone, utilizing the phone's gyroscope values to orient the camera correctly in the coordinate space. For simulating the schooling behavior of fish, we integrated a Boids algorithm. This algorithm models the collective movement patterns of fish, enhancing the realism of underwater scenes and providing users with insights into natural fish dynamics. The Boids simulation not only enhances the realism of animal movements within the virtual zoo but also makes the experience more interactive and engaging for users. For stereoscopic rendering, we integrated the Google Cardboard SDK, allowing us to provide a VR experience that supports fisheye distortion and correct rendering for both eyes. Stereoscopic rendering involves generating two slightly offset images for the left and right eyes, simulating the natural way humans perceive depth. To create the illusion of depth, we rendered two images from slightly different viewpoints that match the positions of human eyes. This small offset, known as binocular disparity, is crucial for depth perception. In Unity, we set up two virtual cameras, spaced approximately 6.4 cm (64 mm) apart, which is the average interpupillary distance. These cameras render the scene from slightly different perspectives, one for the left eye and one for the right eye. To correct the optical distortion introduced by VR headset lenses, we applied fisheye distortion to the images. This ensures that the final images appear correctly when viewed through the VR headset. The lenses in Google Cardboard, magnifies the screen and create a wide field of view but also introduce barrel distortion, making the image appear stretched and curved at the edges. To counteract this, we apply an inverse distortion (fisheye distortion) to the images before displaying them on the screen.

Figure 2 Stereoscopic view

By observing this behavior, users can gain insights into the natural dynamics of fish movements, making the virtual zoo a more educational and captivating experience.

V. RESULTS AND DISCUSSION

After creating 3D models of the animals and their habitats, we developed a virtual environment that closely mirrors the realism of the natural world. Below are some screenshots of our model/app, showcasing the immersive and detailed virtual sanctuary we have crafted. These visuals highlight the design and functionality that make the virtual experience both engaging and educational for users.

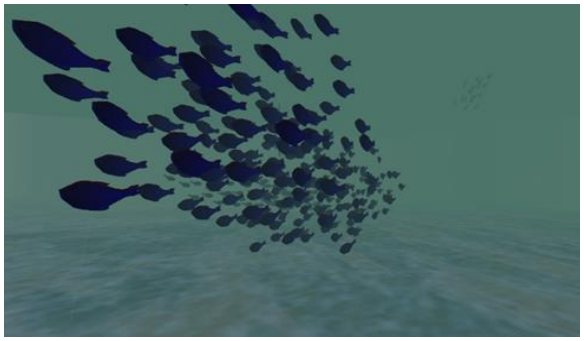

Figure 3 Underwater view of fishes

This feedback is important in gaining insight into how our project can pull in the interests of the younger generation and sustain a greater interest in wildlife and conservation.

Children's Response:

Children responded with great excitement and engagement when interacting with the virtual environments. The overall immersion captured their interest, improving learning dramatically about different species and their habitats. The ability to interact with the animals and observe their behaviours in this kind of environment created for them an educative and memorable time.

Adults' Perception:

The immersive educational experience provided by the virtual sanctuaries was a main point of appeal for the adults. They felt that, in comparison to traditional methods, the level of learning gained from the technology was much better. In addition, AR and VR would make any educational content easily accessible and interesting for the users, especially on topics of environmental awareness and conservation.

Educational Benefit:

Both children and adults demonstrated an increased ability to recall information on the species and their conservation status. The realistic simulations and interactive components allow the users to remember the detailed information of animal behaviors, habitats, and the importance of biodiversity. In other words, it implies that the level of awareness from immersive AR/VR experience improves the learning outcome in environmental issues.

Technological Insights:

The introduction of both AR and VR technologies, such as the use of the Boids simulation for fish behavioral patterns and the mobile's gyroscope, allowing for camera adjustments, contributed vastly to the realism and interactivity of the virtual environments. The stereoscopic rendering using Google Cardboard SDK essentially provided this highly immersive VR experience to give users the ability to visualize depth and interact with the environment in a very natural manner.

User Experience:

Overall, respondents considered the virtual sanctuary to be a very engaging and educational tool. The rich user experience from detailed 3D models and realistic animations entertained and educated. Being able to view the different biomes and species interactively gave a better understanding of the natural world, instilling the importance of conservation.

In summary, the project of AR/VR technology, development, and integration with the virtual sanctuary, have shown enormous potential for the purpose of environmental awareness and education. The positive feedback that has come from these users has proven that the potentials of immersive technologies in making learning experiences engaging and vivid have an important influence on the development of appreciation for wildlife and nature conservation. This project is really the beginning of what could develop into a suite of next-generation education tools harnessing the power of AR and VR to inspire and educate more effectively.

VI. FUTURE SCOPE

The Future scope for augmented reality (AR) and virtual reality (VR) technologies especially in education systems is immense and bright. In future, we may want to make these programs more interactive and lifelike by using advanced artificial intelligence (AI) and machine learning (ML) which can imitate detailed and sophisticated animal behaviors as well as their communication systems. Not just limited to simulation of virtual zoos, this type of e-learning content shall cover various subjects – for example, history, geography or even science thus providing Children with complete knowledge of what they are studying about.

Moreover, different disciplines should be brought together so that engineering students do dissections through their medical virtual reality laboratories among other things. At such a time when the costs of AR/VR gadgets have dropped significantly they may even help us extend education services towards remote areas. It would also be possible to have multiple people using one system simultaneously thereby fostering teamwork skills among learners particularly those involved in joint international projects.

Live updates can make learning dynamic and relevant, while gamification can engage and motivate. Continuous research and development driven by academic and industry partnerships should be the driving force for technological advancements and practices. Increasing the virtual content to various ecosystems and endangered species allows the user to be informed of global issues to the environment and inspires them to take action in support of this cause. Finally, conducting longitudinal studies on the impact of AR/VR-based education will be able to add value in fine-tuning these technologies to maximize learning and, therefore, set the stage for a revolutionary change in the way we learn and relate to the world.

VII. CONCLUSION

Our project "Digital Sanctuary of Environmental Awareness Using AR/VR Technology" demonstrates a huge capacity for how AR and VR technology can rework education and promote stewardship over our environment. These want not be dry, educational ideas however are given meaning in the context of real, interactive, and immersive studies that take users through fun and reachable gaining knowledge of approximately the natural world and ecosystems. The effects of the venture in reconstructing Arctic habitats and growing animal conduct display the effectiveness of such technology in improving learning and engagement. These technologies have applicability nicely beyond virtual zoos. Traditional getting to know stories can be exchanged across disciplines in realistic, hands-on schooling in fields which include engineering and medication. In addition, they bridge training gaps by means of presenting amazing gaining knowledge in far flung and underserved regions. In the future, because the technology holds to expand, capabilities could be in addition enriched, making instructional reports a great deal more practical, interactive, and fun. Expanding schools would help teach young people to love all the creatures and plants living on this planet. So, if we bring AR/VR into schools, students will not only be studying but they will also get a better understanding and appreciation of the environment where they live. it has a potential of completely changing how we research interact with our surroundings thereby creating more knowledge and concern for many.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

REFERENCES

[1] A. Srisuphab, P. Silapachote, N. Sirilert Worakul, and Y. Utara, “Integrated ZooEduGuide with multimedia and AR from the largest living classrooms to wildlife conservation awareness.”

[2] R. L. White, K. Eberstein, and D. M. Scott, “Birds in the playground: Evaluating the effectiveness of an urban environmental education project in enhancing school children’s awareness, knowledge, and attitudes towards local wildlife.”

[3] D. Pimentel, “Saving Species in a Snap: On the Feasibility and Efficacy of Augmented Reality-based Wildlife Interactions for Biodiversity Conservation,” University of Oregon.

[4] M. Morgan, “Predicting effectiveness of wildlife education programs: A study of students' attitudes and knowledge toward snakes,” University of Missouri.

[5] M. Morgan, “A Theoretical Basis for Evaluating Wildlife-Related Education Programs,” University of Missouri.

[6] D. Pimentel, “The Peril and Potential of XR-based Interactions with Wildlife.”

[7] T. Ahmed and M. J. Hossain, “VR Chiriyakhana: A Virtual Zoo Using Google Cardboard,” Leading University and Norwegian University of Life Sciences (NMBU).

[8] Z. Lugosi and P. C. Lee, “A Case Study Exploring the Use of Virtual Reality in the Zoo Context,” King's College London and University of Stirling.

[9] V. V. Osadchyi, N. V. Valko, and L. V. Kuzmich, “Using augmented reality technologies for STEM education organization.”

[10] L. Phipps, V. Alvarez, S. de Freitas, and K. Wong, “Conserv-AR: A Virtual and Augmented Reality Mobile Game to Enhance

Students' Awareness of Wildlife Conservation in Western Australia," University of Oviedo and Coventry University.

[11] L. Phipps, V. Alvarez, S. de Freitas, and K. Wong, "Conserv-AR: A Virtual and Augmented Reality Mobile Game to Enhance Students' Awareness of Wildlife Conservation in Western Australia," University of Oviedo and Coventry University.

[12] D. R. Rini, A. M. Wulandari, and R. T. Wulandari, "Virtual Zoo: Learning Media Based on Augmented Reality for Early Childhood," State University of Malang.

[13] H. Naik, R. Bastien, and I. Couzin, "Animals in Virtual Environments," Technische Universität München and Max Planck Institute of Animal Behavior.

[14] W. Tarng and H.-H. Liou, "The Development of an Internet Virtual Zoo," National Hsinchu University of Education.