VR Diver- Coral Nursery

VR | Unity

Contents

VR Diver- Coral Nursery

VR | Unity

Summary

As a player, you'll take on the task of identifying, measuring, and planting corals from a coral nursery to hidden sites in the reef.

The experience seamlessly integrates technical elements of diving into the game mechanics, creating a truly immersive experience. For example, the time to complete the task is displayed on your virtual dive computer and represented as the no-decompression time. Similarly, the experience offers a unique locomotion mechanic in which the player waves his arms to swim, mimicking the feeling of describing a finning movement with your wrists or arms.

Overall, this VR experience offers an engaging and exciting way to learn about coral reef conservation while also enjoying the thrills of diving in a virtual world.

Figure 1. Shots of the coral nursery installation at Takata Dive and Research Center in Mahahual, Mexico.
Photo credit: Takata Dive and Research Center

Stakeholder	Sector	Contribution	Mode	Technology
Final term project- VR/AR certificate, Lethbridge college	Educational	Experience design Programming 3d modeling & texturing	Single player	VR-Quest2 Unity C# Blender/ Substance Painter

VR Diver- Coral Nursery

VR | Unity

Features

The VR experience features five main components.

1. Hand finning locomotion game mechanic

In the virtual world, players can move in any direction by pointing the controls and rotating their wrists or forearms up and down in a cyclic motion, mimicking the natural motion of arms when demonstrating how to kick with fins.

Scuba diving propulsion is generated solely by the legs, allowing the hands to be free for manipulating objects. However, in the game, hands are used for swimming and manipulating objects, so players must activate the swim mode by pressing and holding the trigger button on the desired control before attempting to move. Using the entire forearm generates greater propulsion, while moving only the wrists creates a lighter movement similar to that of a leg or ankle movement. Similarly, swimming with both hands increases speed.

Figure 2. To activate the swimming mode, hold the trigger button and move your hand(s) up and down, pointing at the desired direction of movement.

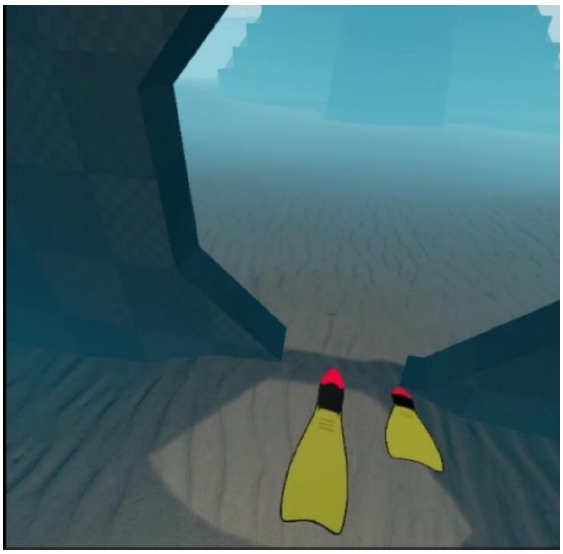


Figure 3 shows a pair of fins, indicating that the player is in swim mode. This is a screen capture from another version of the experience.

These intuitive and adaptable locomotion mechanics make the virtual experience feel more authentic for scuba diving enthusiasts. Plus, players will experience arm fatigue if they overuse arm movements, just as they would in real life. Therefore, it's best to kick once and glide.

Figure 3. A diver is effortlessly swimming using only their legs. Photo credit: Takata Dive and Research Center

VR Diver- Coral Nursery

VR | Unity

Hand finning locomotion pseudo code

```
while swim mode is active:
        if movement is valid:
                get controller's current and previous frame positions
                calculate displacement between current and previous frame positions
                get controller's facing direction from previosu frame
                calculate distance proportional to displacement in the facing direction
                add the calculated distance to the player's position
        else:
                do nothing

    # "Movement is valid" check
        get controller's current and previous frame orientations
        calculate pitch angle between current and previous frame orientations

        if pitch angle is greater than a threshold:
                set movement as valid
        else:
                set movement as invalid
```

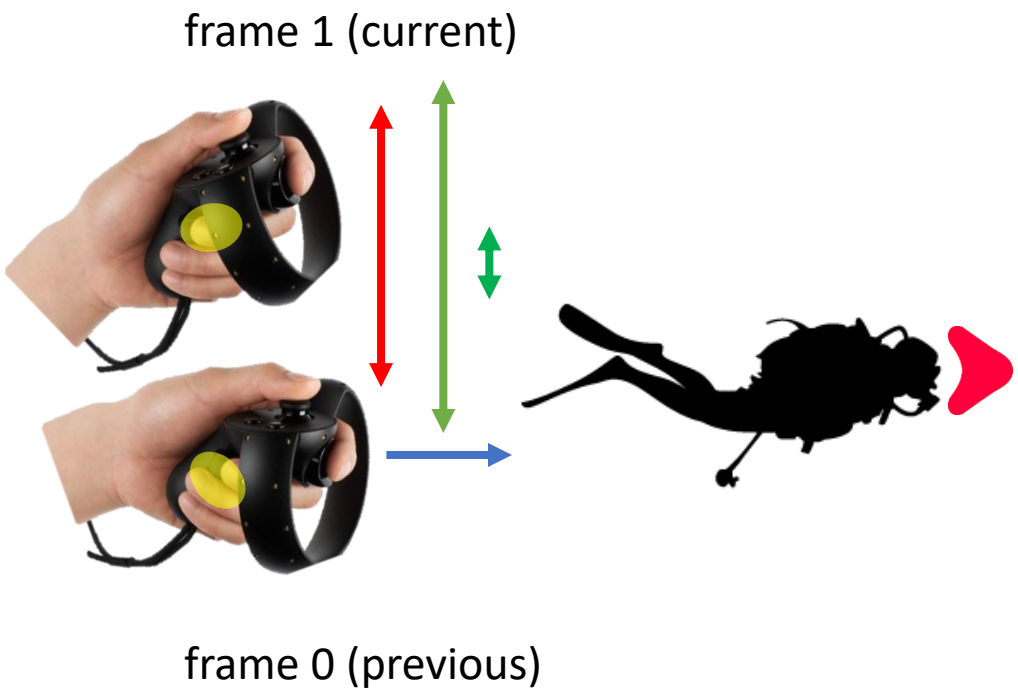


Figure 4. Visual representation of the hand finning locomotion pseudo code.

2. Interactice wrist dive computer

The game includes an interactive wrist dive computer that allows players to access crucial information about their dive. With the ability to point and click on the grey buttons located at the borders of the computer, players can quickly swap the information displayed on the screen. For example, they can change the measurement units from feet to meters, or navigate between the dive information screen and the date-time screen.

Figure 5. Unity-rendered Suunto wrist dive computer displays dive information screen, including the largest bold number indicating no decompression time.

One of the most critical pieces of information displayed on the computer is the "no decompression time," a technical term commonly used in real-life diving. This term refers to the maximum amount of time a diver can spend at a particular depth before needing to undergo decompression stops to prevent decompression sickness. However, in the game, the "no decompression time" refers to the time left for the player to achieve the mission objective. As the time remaining approaches its limit, an alarm will begin to beep at an increasing rate, adding a sense of urgency and realism to the virtual dive experience.

Figure 6. Player interacting with the buttons of the dive computer.

Overall, this feature enhances the gameplay by providing players with a more immersive and challenging experience, while also introducing them to real-life diving concepts.

VR Diver- Coral Nursery

VR | Unity

3. Measuring corals

The player can approach the corals hanging from the nursery tower with the ruler close enough to trigger a chime or raspy sound, which indicates if the coral is ready for planting or not. Only corals of the right size should be grabbed. Otherwise, when attempting to plant them in a coral spot, they will be rejected.

Photo credit: Takata Dive and Research Center

4. Coral planting spots

Coral planting spots are volumes scattered across the game map that can only be planted with corals of the correct species and size. They are represented as glowing white ghosts of specific coral species.

When a coral planting spot enters in contact with a coral of the wrong species or size, it will reject the coral by changing its color to red and emitting a raspy sound. However, if the correct coral does, the planting spot will accept it by changing to green, emitting a victory chime sound, and triggering a timer that counts up as long as the coral is held by the player inside the planting spot. Once the timer completes, the held coral takes the position of the ghost coral and replaces it, indicating a successful planting.

Figure 7. A coral planting spot located in the game map displaying the ghost image of an elkhorn coral. These planting spots can only be filled with corals of the correct species and size.

Figure 8. Planting spots emit sounds and display colors to indicate acceptance or rejection of the coral species and size, and a timer counts up until a successful planting is achieved. (left) a coral spot rejecting the incoming coral shown in red color, (center) coral spot accepting the incoming coral shown in green color, and (right) a successfully planted coral replacing the ghost coral.

VR Diver- Coral Nursery

VR | Unity

Abstracting the coral planting action

Planting corals underwater, as I experienced it, is a laborious task. It involves creating holes in the hard rock surface using chisels and hammers, and then using an epoxy clay to secure the coral fragment to the surface. All of this must be done while maintaining a steady buoyant position to prevent damage to the surrounding living reef. To add to the challenge, the water's resistance significantly reduces the momentum of a striking hammer. And don't forget to regularly monitor your air supply since it can deplete faster than expected.

Photo credit: Takata Dive and Research Center

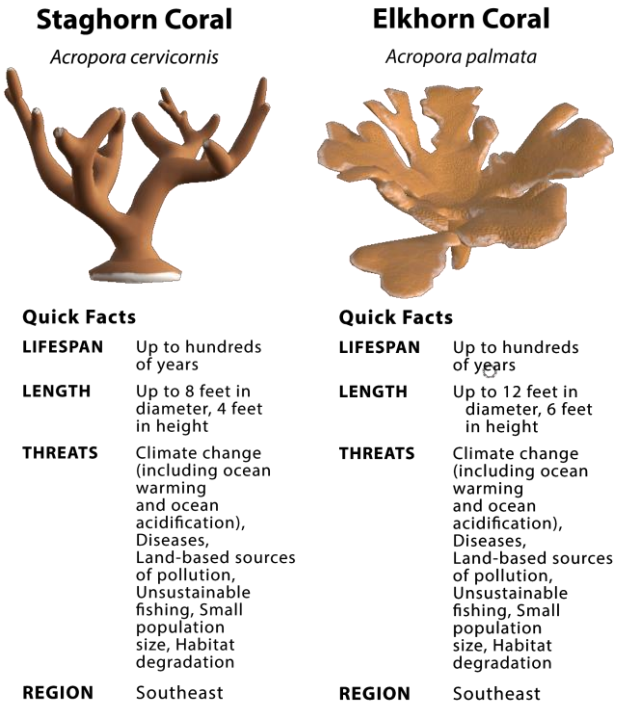
One design challenge was to convey that coral planting is a time-consuming activity without the need to create assets and interactions for each sub-step. To solve this, a game mechanic was developed where the player must hold a coral in a designated "planting spot" for a specified duration before the planting action is completed. A timer counts up as long as the coral is held within the planting zone, and the player can track the progress of the action through a circle at the base of the ghost coral, which fills gradually as the conditions are met. Additionally, the player receives audio feedback in the form of a cracking sound. If the coral leaves the planting spot, the timer pauses and the sound stops. Once the action time is complete, the coral takes the place of the ghost coral, a victory chiming sound plays, and the task slate updates, indicating that the action is finished.

Figure 9 shows a planting spot with a base semi-full, indicating an unfinished planting action.

VR Diver- Coral Nursery

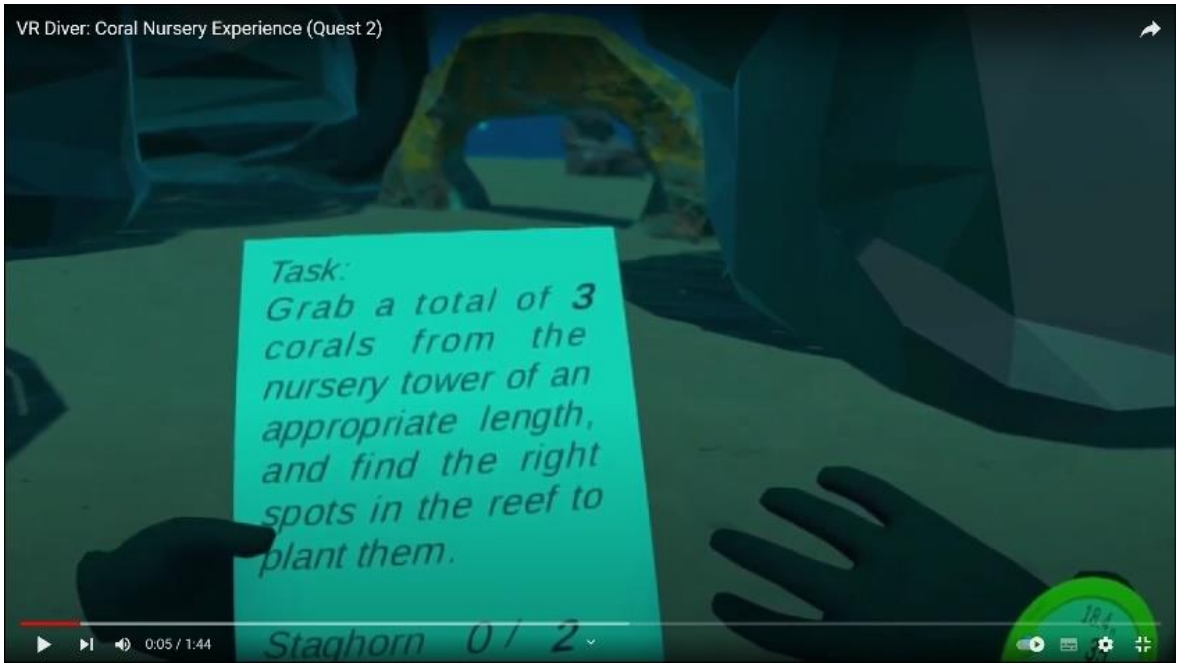
VR | Unity

5. Diving slates



The player has access to useful information that will help them achieve the game's mission and learn about the marine life in the reef through a collection of diving slates. For example, one of the slates shows the number of corals to plant and updates this information as the player progressively achieves their goals. Another slate helps them identify the different coral species found throughout the reef, and a third slate instructs them about how to swim and use and read the dive computer.

To hide or show the slates, the player can press a button on the left motion controller. Similarly, they can switch between different slates by using the left joystick.



VR Diver- Coral Nursery

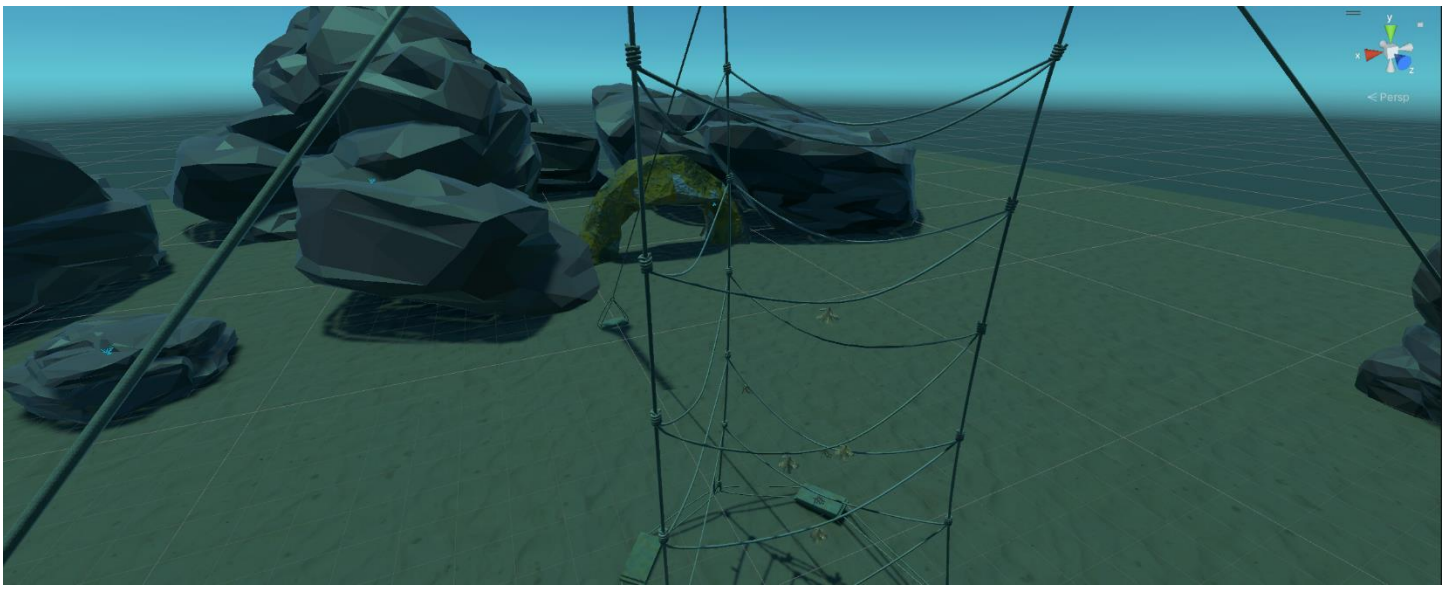
VR | Unity

Conclusion

Overall, creating the VR Diver-Coral Nursery experience was a challenging yet enjoyable and inspiring learning process. As the designer with expertise in scuba diving, programmer and artist of the experience, I faced the challenge of aligning my vision with my skills, while also navigating hardware and time constraints.

During this first VR project, I had the opportunity to apply and enhance my understanding of different programming concepts and 3D math operations. For instance, I recall using C# interfaces for the buttons and screens of the wrist dive computer, vector math operations for the hand finning locomotion mechanic, and Unity coroutines and events in multiple cases. I also learned the importance of planning for sound design early in the development process, as it can be a significant amount of work and challenging to synchronize sounds with game events.

However, there is still ample room for improvement in many areas. Level design and lighting are skills that require more of my attention. Additionally, optimization is crucial, as it is easy to get carried away with adding features to the game and then realize that the frame rate is too low. I also need to work on improving the locomotion mechanic to make it feel smoother, as well as adding specific feedback behaviors when the controller is in swim mode. For example, I plan to stick the virtual hands that are in swim mode to a position in front of the avatar, describing a relaxed position, or briefly showing the fins sprite before fading them out.



VR Diver- Coral Nursery

VR | Unity