

MR Coral Sea Evolved

Mixed Reality Aquarium with Physical MR Displays

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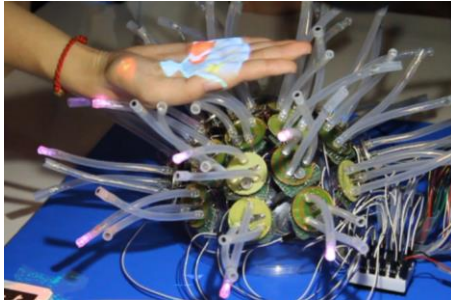


Figure 1: Experience of MR Coral Sea system

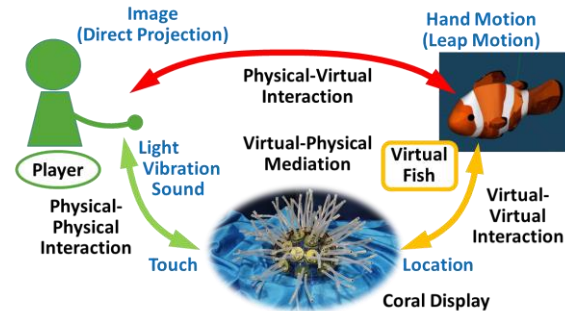


Figure 2: Interaction in MR Coral Sea system

1. Introduction

The MR Coral Sea is a mixed reality tiny aquarium. The intent of the system is to play with little virtual fish. A player can interact with the virtual fish via Coral Display, an interactive device with multisensory physical feedback. When a player presents his or her hand above the device, fish bait appears on the palm, and the virtual fish come to eat it. The device provides the user with a feeling of spatial existence through illumination and vibration.

The previous version was exhibited at SIGGRAPH ASIA 2014 Emerging Technologies. The latest version has progressed substantially concerning MR experience by using an improved Coral Display with sensors and a projection-based display.

A player and the audience can enjoy the MR experience by watching the physical space, including both the Coral Display and an image that is projected onto the player's hand. Furthermore, the player can feel pseudo-haptic sensations of the virtual fish using the Coral Display. Figure 1 shows the virtual fish and fish bait being projected onto the hand above the Coral Display.

2. Our Approach and Implementation

The MR Coral Sea is a part of our MR Entertainment Project. In the project, we propose a *physical MR display* that can mediate physical experiences synchronized to the virtual world to enhance the enjoyment of the MR experiences for all participants including both players and the audience surrounding the field. The physical MR display augments the real field through physical feedback from the virtual space in synergy with the basic MR visual experiences.

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SIGGRAPH 2015 Posters, August 09 – 13, 2015, Los Angeles, CA.
ACM 978-1-4503-3632-1/15/08.
<http://dx.doi.org/10.1145/2787626.2792619>

The Coral Display for MR Coral Sea system has been developed as a case study of a physical MR display. Figure 2 shows that the Coral Display mediates the interaction between the physical and virtual spaces in the system in response to both the virtual fish and player's hand. The Coral Display shows the virtual fish near the tentacles by illumination, and tactile feeling and kinetic movement by vibration. It looks like a sea anemone rather than a coral, but the structure is similar to this latter. It is a colony of coral polyps. The Coral Display comprises 24 individual coral polyp modules, each of which has three tentacles with sensors and actuators. Three LEDs and a disc vibration motor are on the body of the coral polyp module. Translucent silicon rubber tubes of the tentacles lead light from the LED and glow softly. The tubes also convey vibration from the motor.

Each of the three tentacles has different functions, as follows:

- 1) A touch sensor tentacle has an optical proximity sensor in the tip. When it detects the user's hand contact, both the vibration motor and the LEDs on the body of the module are activated. This safely simulates a pseudo-stinging feeling to the hand through vibration.
- 2) An LED lamp tentacle indicates that it is near the fish using colored light from a multicolor LED. It is driven by an infrared signal from a base unit.
- 3) A vibration tentacle also reacts to virtual fish, presenting haptic sensations, motion, and sound through vibration.

3. Conclusion and Future Work

Display elements of the Coral Display are currently sparse but it shows possibility of a multisensory spatial display in synergy with the MR experience. We intend to improve the device with different volumetric interactive display by miniaturizing the display elements with sensors, and increasing density of the elements on the display. And, we will try to find applications of soft robots with MR feature for real-to-virtual and/or real-to-real communication by applying the flexible physical MR display.

Acknowledgments

This work was supported by JSPS (Japan Society for the Promotion of Science) KAKENHI Grant Number 24500159 and 24220004.