

Mingle with An Amoeba

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Abstract

Amoebas are microorganisms ranging in length from 25 to 400 μ m and are not large enough for humans to touch. Also, since they are not visible in everyday life, it isn't easy to get involved with amoebas. In this project, we create an opportunity to have simulated contact with amoebas in a virtual environment. By touching the transparent slime as if it were an amoeba, you can experience transforming the amoeba with your own hands, seeing the amoeba's reaction to being touched, and perceiving Pseudo Haptics information via visual vibrations from the amoeba.

CCS Concepts

• **Human-centered computing** \rightarrow Empirical studies in interaction design;

1. Introduction

We created this work with the intention of bringing tangible objects to life through the expression of virtual space. This project aims to present the sensation of playing with a deformable virtual creature: the amoeba and to provide a strange experience of feeling a sense of life from a dense object to users. For this purpose, we utilize emotional expressions and visual vibrations on a physical slime, which is not a living thing. To enhance emotional expressions, we change the amoeba's eyes and body-color when the user touches the slime. We also provided visual vibration feedback using [LCK*00]Pseudo Haptics. By vibrating the user's hand model in the VR space, the user can feel the pseudo-sensation of the amoeba shaking on the hand, allowing the user to enjoy interaction with the amoeba.



Figure 1: Overall View of the Work

2. System Configuration

The system configuration is shown in Figure 2. We use an MR headset, [Var]Varjo XR-3, and a desktop PC. The headset outputs an image of the amoeba and performs hand tracking and eye tracking. The eye tracking function allows the amoeba's eyes to make eye contact with the user's eyes when looking at a part of the amoeba's body. On the desktop PC, CG processing is performed on the hand model and the amoeba in the VR space. It creates a pseudo-sensation by visual vibration feedback to the user to make an experience as if a live amoeba were actually on the hand.

3. Interaction Design and Implementation

3.1. Drawing An Amoeba

As visual representation of the amoeba, We prepare spheres in the VR space and created metaballs by filling pixels between spheres when the distance between each sphere was less than a certain distance. The amoeba's body is composed of many metaballs made in this way. The ray-marching method is used to create the metaballs, and the LogSumExp function is used as the distance function to achieve smooth interpolation between spheres.

3.2. Pseudo-Haptics

While the slime is placed on the user's hands as a physical representation of the amoeba, pseudo-vibration feedback is provided using the Pseudo-Haptics principle. By shaking hand models in VR in small increments while touching the amoeba's body, the user can feel the amoeba's biological vibrations transmitted to the hands, even though the user's hands are not shaking. If the hand models tremble, the amoeba cannot correctly be placed on the hand model. Therefore, only the appearance of the hand models trembles.

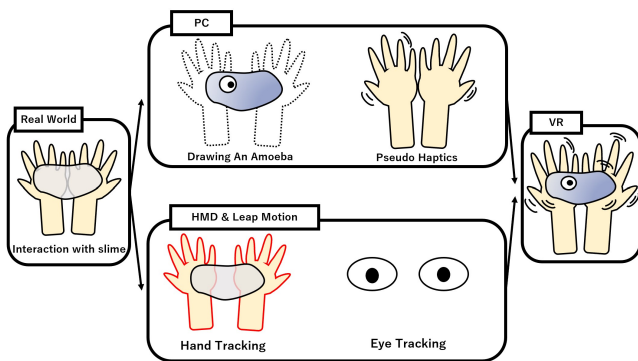


Figure 2: System Configuration

3.3. Hand Tracking

The hand position is obtained by using LeapMotion and Varjo XR-3. The Varjo XR-3 has a built-in hand-tracking camera, which enables highly accurate hand tracking by simply taking a picture of the hand. However, there was a problem the slime hid the hand and prevented hand tracking if we used only one camera. Due to this, we will use multiple Leap Motion cameras in the arrangement shown in Figure3 to enable hand tracking while touching the slime. In addition, Mesh collider is used for the hand models to make them behave closer to reality.

3.4. Eye Expression

The amoeba in this work has eyes instead of a nucleus, increasing as the amoeba's body divides. The eyes are substituted for the nucleus, so the number of eyes increases during cell division. Cell division occurs only when the hand models are in contact with the amoeba's body. And eyes are generated regularly from the contact points between the hand model and the amoeba. The sensation of increasing eyes on the hand reinforces the feeling that the user is interacting with the organism.

3.5. Eye Contact

The HMD "Varjo XR-3" has an eye-tracking function, and we used it to make the amoeba and the user's eyes meet. When the user's

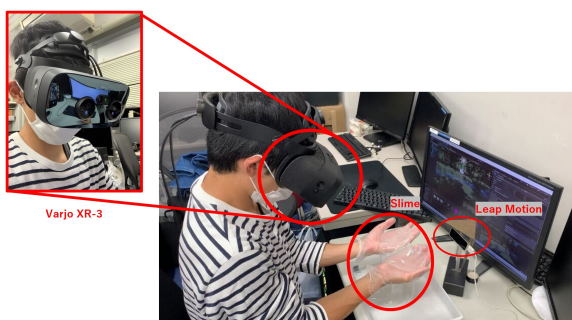


Figure 3: The Way to Detect Hands



Figure 4: Amoeba's Body and Eye Reaction

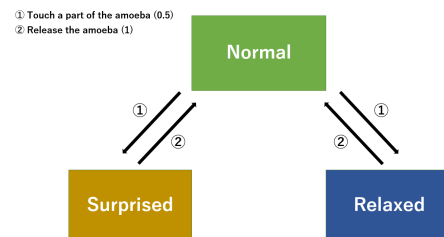


Figure 5: Amoeba's state transition diagram. () means transition probability

gaze overlaps with a part of the amoeba's body, the amoeba turns all of its eyes to the starting point of the ray from the user's eyes. Eye contact with the amoeba gives the user the sensation of communicating with it.

3.6. Amoeba's Reaction

The amoeba responds, as shown in Figure4 to touch by relaxing or being startled. When relaxed, the amoeba squints its eyes, and its body color turns blue; when startled, it rolls its eyeball, and its body color turns yellow. Emotional transitions are stochastic, with a 50% chance each of relief and surprise. If the hand model is not in contact with any of the spheres that make up the amoeba's body, it returns to its normal state. The state transition diagram is shown in Figure5. This good visual responsiveness, coupled with the tactile experience with the slime, reinforces the sense that the user is interacting with the amoeba as a living organism rather than a slime.

4. Conclusions

In this presentation, we showed that by combining the unique feel of slime using Pseudo-Haptics and visual pseudo-sensory presentation, it is possible to perceive non-living objects as if they were alive. The amoeba is not only deformed by the user's hand but also provides emotional feedback, which allow users to perceive the amoeba's animality.

References

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[Var] VARJO: Varjo xr-3. <https://varjo.jp/varjo-xr-3/>. 1