



# XRAYHEAD GARDEN

小鷹研理<sup>1)</sup>, 中山愛唯<sup>2)</sup>

Kenri KODAKA, Ai NAKAYAMA

1) 名古屋市立大学 芸術工学研究科 (〒 464-0083 愛知県千種区北千種 2-1-10, kenrikodaka@gmail.com)

2) 名古屋市立大学 芸術工学部 (上同, ai.nkym.72@icloud.com)

**概要:** 我々の研究グループは、これまでに、ハーフミラーによって仕切られた二つの空間の光量を調整することによって、身体の一部が透過し、その中に任意のオブジェクトを定位可能な視触覚錯覚システムを発表してきた (XRAYSCOPE、XRAYHEAD)。本発表では、既存の頭部の透視・透触錯覚装置を拡張し、頭蓋骨を開頭し、実験者の手によって内部をまさぐられる感覚、および頭内にモノが放置された感覚を与える XRAYHEAD GARDEN の展示を行う。

**キーワード:** XRAY 錯覚, 透触視錯覚, ラバーハンド錯覚, フルボディ錯覚

## 1. Background

Recent psychological research has demonstrated that multi-sensory correlation can create the illusion of possessing transparent body parts[1]. Based on this concept, we have previously introduced illusion devices that make one's hand or head appear transparent, creating the sensation that an experimenter is directly touching the bones inside. These devices share the common feature of utilizing the properties of a half-mirror. Specifically, by adjusting the lighting conditions in the two spaces separated by the half-mirror, a distinct optical situation where both transparency and reflection are combined is designed. As a result, the body part (hand or head) on one side of the half-mirror visually becomes semi-transparent, while a solid object (such as a pen or skeleton model) placed on the opposite side appears to actually exist within the semi-transparent body part.

In 2020, we presented XRAYSCOPE at the Best Illusion of the Year Contest 2020, introducing an illusion that makes the hand appear translucent[3]. The open laboratory experiment showed that 115 out of 141 participants stated the illusion of owning the translucent hand was strong or very strong. Subsequently, we introduced XRAYHEAD, an experience that provides a visuo-tactile sensation for the semi-transparent head. In a public experiment, 77 out of 101 participants reported a strong or very strong sensation of actually having their own skull touched. This system was also showcased at SIGGRAPH Asia 2022[2], where it received the Best Extended Reality Contents Award. Thus, our technology reliably created the illusion of seeing and touching the interior skeleton of one's translucent body.



**図 1: Series of XRAY Work (Left:Xrayscope, Right:Xrayhead)**

## 2. XRAYHEAD GARDEN

XRAYHEAD Garden extends the concept of XRAYHEAD, expanding the penetration area from the surface of the skull to its interior. In this section, we will first briefly explain the setup of XRAYHEAD, followed by a detailed description of the new design introduced in XRAYHEAD Garden.

### 2.1 Setup of the XRAYHEAD Garden

XRAYHEAD Garden extends the concept of XRAYHEAD, expanding the penetration area from the surface of the skull to its interior. In this section, we will first briefly explain the setup of XRAYHEAD, followed by a detailed description of the new design introduced in XRAYHEAD Garden.

### 2.2 XRAYHEAD

The participant's head and the skull model face each other through a half-mirror. The half-mirror functions as a simple mirror reflecting the participant's face as long as the hidden skull model does not shine. Once the experimenter holds the palm of their hand against the skull model in the hidden space, the face viewed in the mir-

ror begins to fade into translucence and the illuminated skull model is replaced with the participant's face from the participant's view. This is because the light intensity of the embedded LED in the skull model is designed to illuminate based on the motion of the participant's hand, using a Leap Motion controller embedded on the top of the skull model. The physical touch to the skull model is given by the experimenter in sync with a direct touch to the participant's head with the other hand. In addition, the auditory stimulus (generated by Max/Msp) is given to the participant through a speaker where the sound is modulated in sync with the degree of the mirror's translucence, contributing to enhancing an illusory tactile sensation to the participant's own bone.

### 2.3 XRAYHEAD Garden

The skull model was newly designed to physically open and close along the forehead line. Additionally, by embedding green artificial grass made of plastic into the hollow areas, the half mirror creates a visual effect that makes it look like grass is growing out of one's head. In this state, by having the experimenter simultaneously touch the artificial grass and the participant's hair, the tactile sensations of the hair and the grass are linked, enhancing the realism of the visuotactile illusion.



図 2: XRAYHEAD Garden

When touching the inside of the skull model, the experimenter holds an Otamamin, a product by Maywa Denki, in their hand. The Otamamin is a compact sound speaker with a built-in light sensor that can change its tone like a theremin according to the amount of surrounding light. Since an LED is embedded in the center of the skull, bringing the Otamamin closer to the inside of the skull sharply increases the sound frequency. This mechanism allows the participant to perceive the depth of the experimenter's hand's intrusion into their head as an auditory experience. Furthermore, by pressing the participant's head down and leaving the Otamamin inside the skull before closing it, the participant vividly experiences the illusion that a sound-emitting object is actually left in-

side their head.

### 3. Laboratory Experiment

This technology was tested in a laboratory experiment. After each three to five-minute trial with XRAYHEAD Garden, we asked each participant to rate the strength of two types of illusory experiences: "It felt like there were hands or objects inside my head" (illusory inside-the-skull intrusion) and "It felt like something was left inside my head" (illusory sense of something left inside the head), using a seven-point Likert scale (from -3 to +3). The result was that 18 out of 21 participants (86%) agreed with both illusory sensations positively (rated +1 or more), with 15 or 16 participants rating +2 or more for each statement. Additionally, when participants were asked to indicate how far the hands or objects felt like they were inside their head, with the top of their head being 0 and the position of their nose being 10, the average rating was 4.76, which is significantly larger than the 2.40 rating for the condition without tactile and auditory stimulations. Overall, the technology was found to consistently create the illusion that something is penetrating one's head.

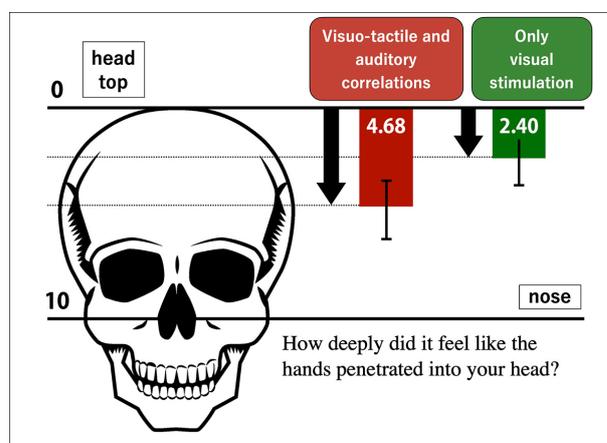


図 3: Evaluation of XRAYHEAD Garden

#### 参考文献

- [1] Arvid Guterstam, Giovanni Gentile, and H. Henrik Ehrsson. 2013. The invisible hand illusion: Multisensory integration leads to the embodiment of a discrete volume of empty space. *Journal of Cognitive Neuroscience* 25, 7 (2013), 1078–1099.
- [2] Kento Imai, Haruka Kayano, and Kenri Kodaka. 2022. XRAYHEAD. *Proceedings - SIGGRAPHAsia2022XR,SA2022*. <https://doi.org/10.1145/3550472.3558411>
- [3] Kento Imai and Kenri Kodaka. 2020. XRAYSCOPE. *Best Illusion of the Year Contest 2020*

(2020). <http://illusionoftheyear.com/cat/top-10-finalists/2020/>