RemoconHanger: Making Head Rotation in Remote Person using the Hanger Reflex

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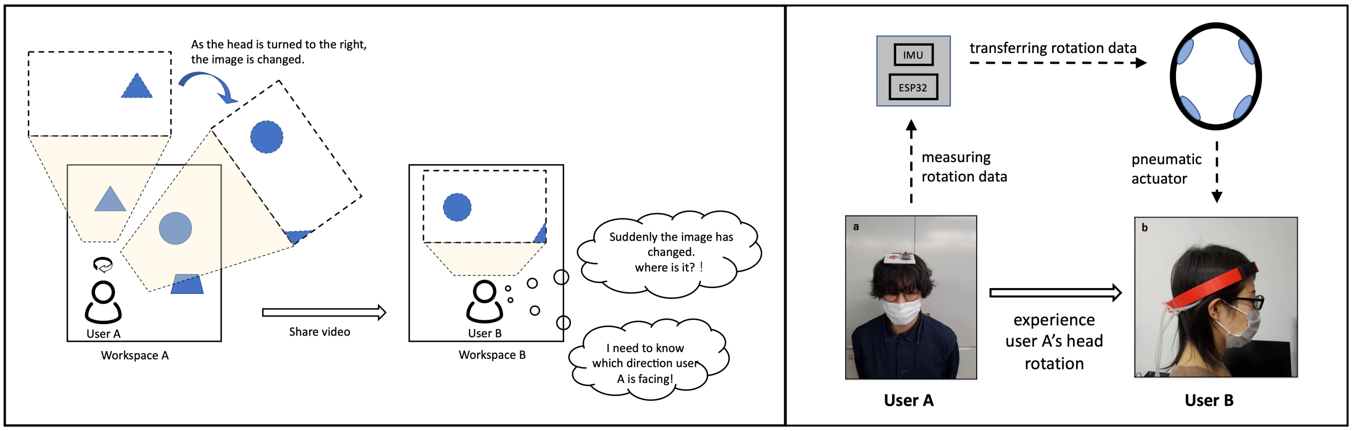

Figure 1: The figure on the left shows the difficulties encountered in remote collaboration, so we propose to use the figure on the right to let user B experience the head rotation of user A to better understand the spatial position of user A at that moment.

ABSTRACT

For remote collaboration, it is essential to intuitively grasp the situation and spatial location. However, the difficulty in grasping information about the remote user's orientation can hinder remote communication. For example, if a remote user turns his or her head to the right to operate a device on the right, and this sensation cannot be shared, the image sent by the remote user suddenly appears to flow laterally, and it will lose the positional relationship like Figure 1 (left). Therefore, we propose a device using the "hanger reflex" to experience the sensation of head rotation intuitively. The "hanger reflex" is a phenomenon in which the head turns unconsciously when a wire hanger is placed on the head. It has been verified that the sensation of turning is produced by the distribution of pressure exerted by a device worn on the head. This research aims to construct a mechanism to verify its effectiveness for telecommunication that can unconsciously experience the remote user's rotation sensation using the hanger reflex phenomenon. An inertial measurement unit(IMU) grasps the remote user's rotation information like Figure 1 (right).

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CCS CONCEPTS

• **Human-centered computing** → **Collaborative and social computing devices**.

KEYWORDS

Remote Collaboration, Hanger Reflex, Synchronous Rotation, Positional Relationship

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1 INTRODUCTION

In the past, there have been methods to share the line of sight of remote users with voice, text, images, and vibration for collaborative work in remote areas. Specifically, the direction is indicated by auditory, visual, and tactile means. For example, auditory means speaking to the other person or following the sound of an announcer, and visual means being shown the destination by an arrow in a train station. In addition, there have been previous studies on tactile directional guidance by remote users using devices controlled by vibration motors, such as the HapticPointer[4]. However, these methods have some limitations regarding visual, auditory, and tactile sensations, which may cause misunderstandings. Therefore, we propose a method to supplement the established methods in which the directing person or object and the directed person are considered weak. Interaction using the above methods has been done. However, communication through physical movements is also an essential part of it, and if remote users and each other can communicate through physical movements, remote communication can be improved. In addition, by enhancing the interaction of body movements, we can promote sharing other people's body movements and use them to express subtle emotions remotely.

In this paper, we propose a device for unconsciously experiencing the head rotation sensation of a remote user by using the hanger reflex phenomenon. Compared to conventional methods, this research uses an angular rate sensor to acquire and communicate the remote user's rotation information. Using the hanger reflex phenomenon, the wearer of the hanger reflex device can unconsciously experience the remote user's rotation sensation. It is thought to improve directional guidance when walking and real-time communication when immersed in virtual reality (VR) space. It is also expected to improve the quality of life for the elderly and disabled people by improving communication in remote directions.

As a result of our experiments, we confirmed that we could feel the left-right rotation of the remote user in the yaw axis using the hanger reflex phenomenon.

2 RELATED WORK

2.1 Remote Communication

Brave has created a system called inTouch to apply haptic feedback technology to communicate with remote users [1]. The system has rotatable rollers on both sides of the remote, and the rotation of the rollers conveys little emotions to the remote user, thereby enriching real-time communication. Nishida et al. have also reported on a pairing wearable device that can transmit kinetic sensations between two people [6]. The user can sense muscle contraction and joint stiffness in both directions and experience a sense of movement based on electrical muscle stimulation (EMS).

2.2 Head Rotation Induction

There are many existing studies on galvanic vestibular stimulation (GVS) as a method for unconsciously experiencing rotation sensation. Electrodes are placed behind both ears to stimulate the vestibular organs, inducing a virtual sensation of directionality and head movement. Compared to GVS, the hanger reflex device does not require any electrical stimulation and can realize yaw axis rotation by changing the pressure received on the head. Sato et al. developed a device that can control head rotation using the hanger reflex phenomenon[7], and this study reported that a linear actuator was used to apply pressure to the temporal head to reproduce head rotation like a wire hanger. Then, they also reported a study that reproduced head rotation using pneumatic actuator [2] and rubber band traction [5].

This research will be implemented using a pneumatic actuator, considering the possibility of communication with remote locations and the comfort of wearing the device.

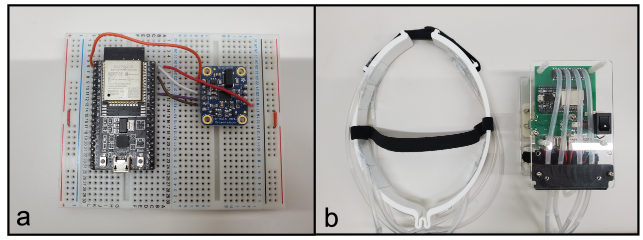

Figure 2: the photogragh of device

3 IMPLEMENTATION

In order to empathize with the rotation sensation of the remote user, we implement a system that measures the rotation information of the remote user and transmits it to the hanger reflex device worn by the local user via wireless communication. As shown in Figure 2 , the device is implemented in two main parts: the rotation measurement side and the hanger reflex side.

3.1 Rotation Measurement

The rotation measurement side uses a 9-axis inertial sensor (Adafruit BNO055 Absolute Orientation Sensor, BOSCH) to measure the rotation angle in the yaw axis (Figure 2(a)). It is controlled by a microcontroller (ESP32-DevKitC, Espressif Systems (Shanghai) Pte. Ltd.)

3.2 Hanger Reflex Device

We have assembled a hanger reflex device controlled by pneumatic actuator. Each pneumatic actuator is driven by a vacuum pump (ZR370-01PM 4.5V, ZhiRongHuaGuan) and a solenoid valve (Fa0520E 4.5V, ZhiRongHuaGuan), and a barometric pressure sensor (MIS2503-015G, MetrodyneMicrosystem) is used to measure the air pressure inside the actuator. The air pressure sensor (MIS2503-015G, MetrodyneMicrosystem) measures the air pressure inside the pneumatic actuator (air bag palced on the frame). These are controlled by a microcontroller (ESP32-DevKitC, Espressif Systems (Shanghai) Pte. Ltd.) (Figure 2(b)).

4 APPLICATION AND EVALUATION

To evaluate the performance of the proposed device, we did a pilot experiment that one user was assigned to wear the rotation measurement device (Indicator) and the other one was assigned to wear the hanger reflection device (Controlled people).In the experiment, we confirmed that indictee would ratate his head in the same direction as indicator's like Figure 3.

5 FUTURE

We will try to increase the force point of the head and adjust the air pressure's strength to increase the rotation pattern. Also, only the indicator transmits rotation data to the controlled people. As a result, the controlled people do not respond to the indicator, so the indicator does not get feedback. In the future, we will construct a mechanism in which both users wear the hanger reflex device to verify two-way communication. Two users can act as both the indicator and the controlled people.

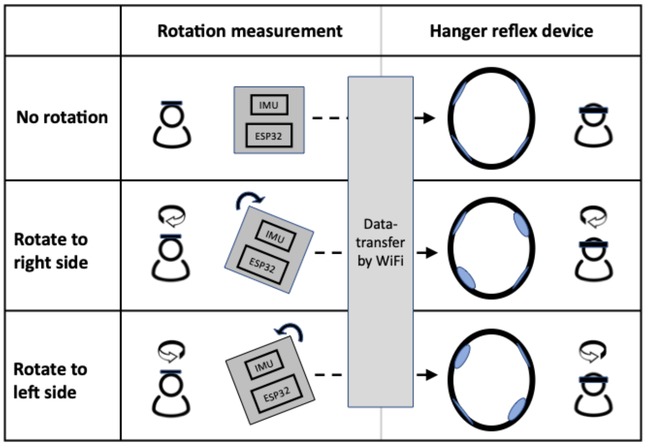

Figure 3: The user on the rotation measurement side wears a device with an IMU on the head; the user on the hanger reflection side wears a hanger reflex device on the head.

In addition, when both users are wearing IMU, the response time of head rotation can be recorded using the sensors during experiments.

Furthermore, to improve the sense of immersion in VR space, there are previous studies of head-mounted displays (HMDs) with built-in motion illusion induction functions using GVS or hanger reflexes [3]. Since the future of multi-person collaboration via cross-reality (XR) is near, we would like to consider applying the communication with remote users in this study to a broader area via HMDs.

6 CONCLUSION

In this paper, to improve remote communication, we use a hanger reflex device to transmit the head rotation sensation to others and confirm that the remote user can experience the head rotation sensation. According to the results, the interaction between remote users can be enhanced by the rotation of the head.

ACKNOWLEDGMENTS

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