Application of Hanger Reflex to wrist and waist

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ABSTRACT

When a wire hanger is placed sideways on the head, and the temporal region is sandwiched by the hanger, the head rotates unexpectedly. This phenomenon has been named the "Hanger Reflex". Although it is a simple method for producing pseudo-force sensation, the use of the wire hanger in this way has up until now been limited in posistion to the head. Here we report a new finding that when a wrist or waist is equipped with a device of a larger circumferance the arm or the body rotates involuntarily. This fact suggests that the Hanger Reflex principle might be applicable to parts of the body other than the head, leading to the possible compact whole-body force display. This paper documents the development and testing of the devices and, suggesting stable presentation of the rotational force.

Keywords: Hanger-Reflex, pseudo force.

Index Terms: H.5.2 [Information Interface and Presentation (e.g., HCI)]: User Interfaces— Haptic I/O

1 INTRODUCTION

Conventional force feedback systems require a large space and high cost actuators. To cope with this problem, attempts to present pseudo-forces using illusions have been intensely studied, such as those via skin sensation and visual stimulation [1][2].

The Hanger Reflex is one such illusory force perception [3] (Figure 1). It is a phenomenon wherein the head rotates involuntarily when a wire hanger is wrapped around its temporal region. Sato et al. measured pressure distribution when the Hanger Reflex occurs, and discovered that the pressure on the side of the forehead or on the contralateral side of the forehead plays a major role [4]. Because the Hanger Reflex can present force using a simple nonelectrical mechanical device, it is considered to be suitable for the treatment of cervical dystonia, which is a disease related to neck posture [5].

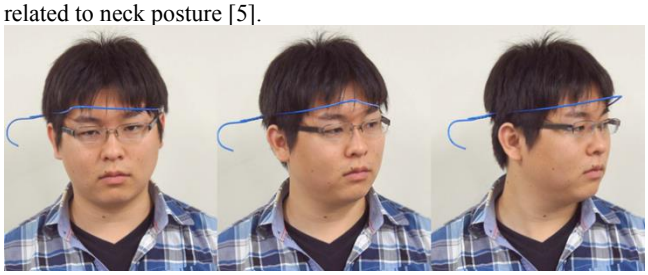

Figure 1 Hanger Reflex

Hanger Reflex is a phenomenon that occurs only at the neck. If this phenomenon occurs at other parts of the body, it could be applied to larger fields such as rehabilitation and whole-body haptic display.

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Here we report a new phenomenon: that the waist and wrist rotate in some cases when they are sandwiched by large clothespins. The Hanger Reflex and the rotation of waist or wrist by large clothespins share the common situation where "involuntary rotation is induced by compressing two opposed points".

In this paper, we report details of this phenomenon, discuss its mechanism and show the results of a user test.

2 HANGER REFLEX DEVICES

Conventional Hanger Reflex devices for the head are made of a medical plastic cast shaped by winding it around the circumference of the user's head. Thus the cast copies the user's head shape, and it is possible to efficiently apply compressional force to the head by slightly rotating the cast (Figure 2). Compared with a real hanger made of wire, the pain caused by this pressure is diminished. In this research, we took the same strategy, copied the shape of the waist and arm with a medical cast, and induced involuntary movements by slightly rotating the cast.

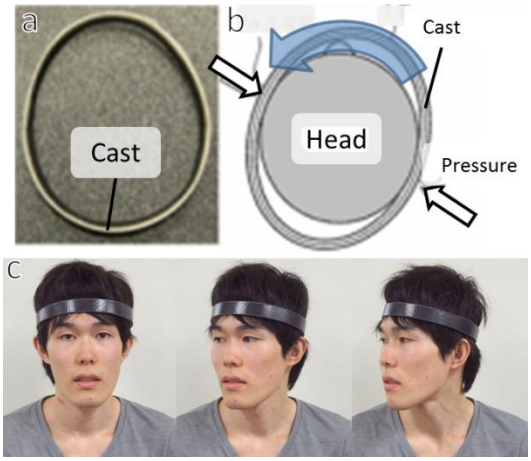

Figure 2 (a) Plastic cast for hanger reflex on the head, (b) structure of the cast, (c) Hanger Reflex using the cast

2.1 Cast for rotating wrist

Figure 3 shows the plastic cast developed for rotating the wrist and the wrist equipped with the cast. We installed a urethane layer on the inner side of the cast to prevent excessive pressure concentration that may cause pain. The cross-section of the cast was elliptically shaped to fit to the wrist, and was designed to apply compressional force to the wrist by slightly rotating the cast (Figure 4).

Figure 3 Hanger Reflex device for wrist

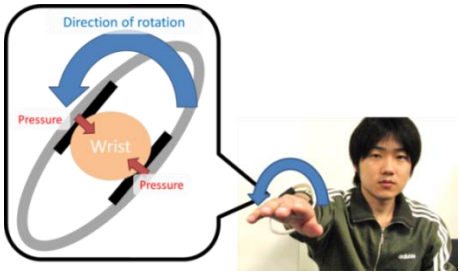

Figure 4 Structure of cast for rotating wrist

2.2 Cast for rotating waist

Figure 5 shows the plastic cast developed for rotating the trunk and the trunk equipped with the cast. We installed a urethane layer on the inner side of the cast to prevent pain. The cross section of the cast was elliptically shaped to fit to the trunk, and was designed to apply compressional force to the trunk by slightly rotating the cast (Figure 6).

Figure 5 Hanger Reflex device for waist

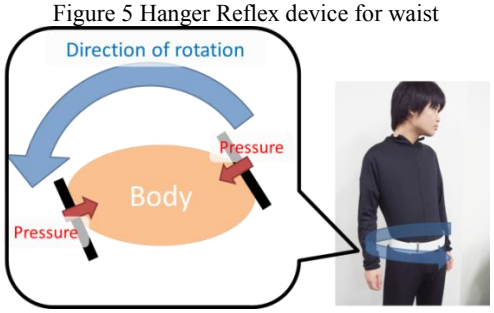

Figure 6 Structure of cast for rotating waist

3 User test

We recruited ten participants to test the cast on their wrists, and two participants to test the cast on their trunks. The cast for the trunk was specifically designed for each participant.

The user test revealed that nine out of ten participants reported a strong rotational force. All of them rotated their arms in the direction of the illusory force by themselves, but they insisted that the force was applied externally. Both participants who wore the cast on their trunks felt rotational force and commented, “I felt a force that rotated my trunk”, and “I felt a force as if I had become a squeezed mop”. From these observations, we suggest that proper pressure distribution on the wrist and trunk could indeed present illusory rotational force.

In addition, participants in both cases reported that by changing the angle of the device, the direction of perceived rotational force changed. This feature is also observed in the Hanger Reflex for the head, suggesting that our new illusions might be similar kinds of phenomena to the conventional Hanger Reflex.

4 Conclusion and future work

In this paper, we applied pressure on the trunk and wrist using a medical cast to induce involuntary rotational movement. The user test revealed that stable presentation of illusory rotational force was possible, accompanied with involuntary rotational movement. The phenomena are quite similar to the Hanger Reflex, a phenomenon accompanied with head rotation.

Our future work includes investigation of the cause of the phenomenon, including the relationship between the compressed points of the trunk and wrist, and the amount of rotation and force, to the direction of rotation. We will also explore similar phenomena for other parts of the body to enable their possible inclusion in whole-body haptic interfaces.

5 Demonstration

In our demo, attendees are equipped with a cast for their wrist, and experience the Hanger Reflex at their wrist. First, we select and provide a cast that fits the attendee from several sizes of pre-prepared casts. The attendee decides which direction to rotate, and rotates the cast a small amount, following our instructions. The attendee then feels the rotational force caused by the Hanger Reflex (Figure 7). A brief video of the demo is available on our web page (URL: http://kaji-lab.jp/ja/index.php?takuto_IEEEVR2014_demo).

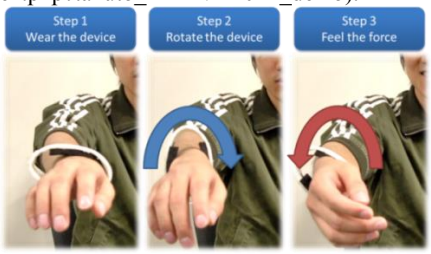

Figure 7 The flow of the demo

6 Our Laboratory

Our laboratory has been located at The University of Electro-communications, Tokyo, Japan since 2007. Our research areas are haptic perception, virtual reality, and human interface. One of the main topics in our laboratory is tactile stimulation inducing motion. The Hanger Reflex is a good example of the phenomena we are researching. The Hanger Reflex induces involuntary head rotation when one’s temporal region is sandwiched by a hanger. This phenomenon is caused by the pressure from the hanger, as it is tactile stimulations. Thus, we are researching these illusionary phenomena to develop our understanding in the areas of haptic perception, virtual reality, and human interfaces.

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