Reconsideration of Ouija Board Motion in Terms of Haptics Illusions (II)
-Development of a 1-DoF Linear Rail Device-

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Abstract. The Ouija board is a game associated with involuntary motion called ideomotor action. Our goal is to clarify the conditions under which Ouija board motion occurs, comparing visual, force, and vibrotactile cues. In this paper, we demonstrated a newly developed 1-degree of freedom (DoF) Linear Rail Device, which we used to study these ideomotor actions with less friction and inertia.

Keywords: Ideomotor action, Pseudo haptics, 1-DoF Linear Rail Device Ouija Board

1 Introduction

The Ouija board is a game that can be played by multiple players, using a flat board marked with letters and numbers, and a planchette, which is a small heart-shaped piece. The players place their fingers on the planchette, ask questions, and the piece moves to point at various letters or numbers in response. Several variations can be found worldwide, such as *Kokkuri-san* in Japan (**Fig. 1**). The movement of the game piece is considered to be a type of ideomotor action, which is a psychological phenomenon wherein a person makes movements unconsciously [1].

Typically, the Ouija board involves multiple players, and the movement might result from the "cooperation" of all players. However, no single person thinks that they are responsible, and assume that they are moved by others (including possible spiritual beings). Hence, this phenomenon can be considered as a type of haptic illusion, which induces users' motion.

In our previous study [2], we showed that visual, force, and vibration cues play roles in this phenomenon. However, the friction and inertia of the device hindered the clear perception of the illusion. In this paper, we demonstrate our new 1-degree of freedom

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(DoF) device for the study of this phenomenon, which has much smaller friction and inertia.

Fig. 1. Ouija board (*Kokkuri-san*): a type of ideomotor action

2 Related Work

Several studies have shown that tactile cues can produce illusory force. Amemiya et al. [3] and Rekimoto [4] realized tractive force presentation with a simple device that uses asymmetric vibration. Skin traction has also been reported [5] [6] [7] [8] to be felt as an external force.

While these haptic illusions do not explicitly accompany motion, in ideomotor actions, users assume that the motion is being produced by others. The hanger reflex is similar to this latter situation [9] [10] [11]. The typical hanger reflex is an involuntary rotational movement caused by deformation of the skin at particular locations on the head, and users typically comment that their head is being rotated by an external force. The potential cause of this phenomenon is assumed to be shear deformation of the skin [12], which contributes to force sensations [13] [14] [15].

In our previous study [2], we hypothesized that there are two necessary conditions for ideomotor actions.

(1) A mechanism to generate an illusory force; and

(2) A context that can be interpreted as allowing for the existence of others.

In the case of the Ouija board, this context is achieved explicitly by the existence of the other players, or by a belief in a spiritual being.

In our previous study, we used a fingertip-type haptic device that can create the perception of pulling on the users' fingers. We showed that visual, force, and vibration cues play roles in this phenomenon. However, the device requires improvement to produce a clearer perception of the illusory force. The friction and inertia of the device need to be lowered, and vibration at an arbitrary frequency might enhance the illusion.

3 1-DoF Linear Rail Device

We developed a device that achieves the two conditions (**Fig. 2**). The device comprises two DC motors (MAXON Inc., 4.5 W, RE16) that pull strings connected to a round planchette that users place their fingers on. The motors can present traction force and vibrotactile stimulation, which are controlled by a microcontroller (mbed NXP LPC1768, ARM Holdings). One motor encoder is used to measure finger position, and a linear rail (LS877, THK CO., LTD.) was used to reduce friction and confine the movement to one dimension.

A visual display is placed on top of the haptic device to present visual information that synchronizes with finger motion (**Fig. 3**). We presume that vibration and visual stimuli can present illusory force, and an occasional actual force can make users believe that they are really being pulled.

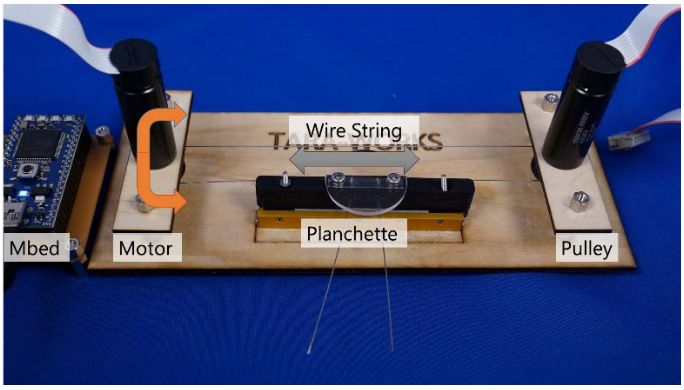

Fig. 2. 1-DoF linear rail device

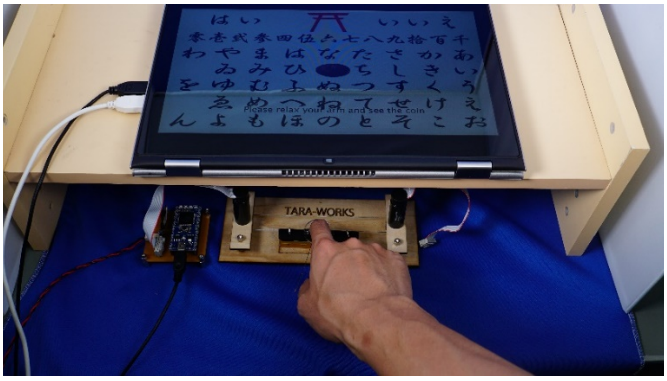

Fig. 3. System setup

4 Hardware Evaluation

We conducted a hardware evaluation to determine the frequency characteristics of the device. We measured amplitude and acceleration amplitude with a 10, 20, 40, 80, 160, 320, 640 Hz sinusoidal wave. To see the open-loop characteristics, we did not apply any feedback. The duration of the PWM (Pulse Width Modulation) signal to the motor was changed depending on the sinusoidal wave.

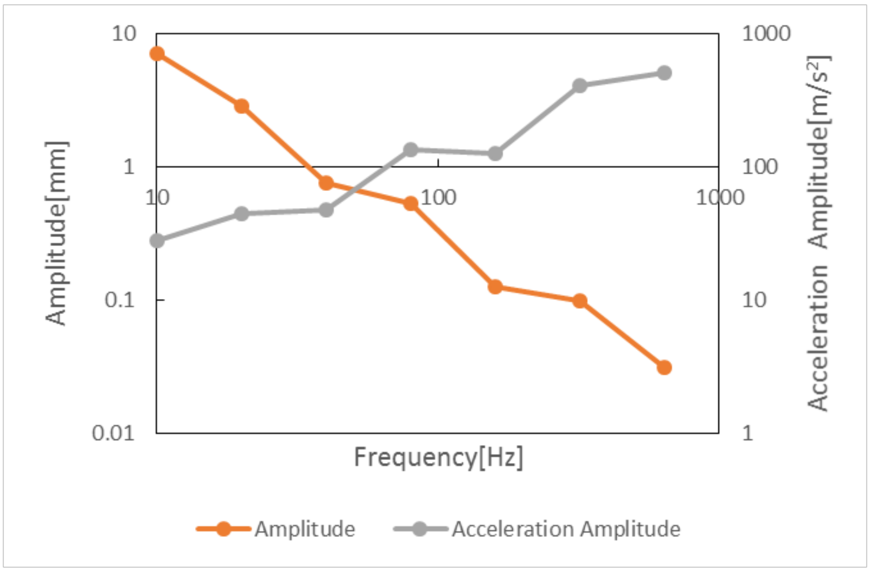

Fig. 4. Frequency characteristics of the device

Fig. 4 shows the amplitude and acceleration of the recorded data. The acceleration was calculated by multiplying the amplitude with the square of the angular frequency. We observed that the amplitude of the vibration was slightly below 1 mm at 40 Hz, and around 0.1 mm at 160 Hz and 320 Hz, which are well above the detection threshold of the human hand [16]. As the purpose of presenting vibration in our study was to present tiny cues for finger movement, we can conclude that the system demonstrates sufficient performance.

5 Demonstration

In this demonstration, we use the 1-DoF Linear Rail Device to let participants experience ideomotor action with the Ouija board. The participants place their right index fingers on the planchette, manipulate the planchette freely, and see how the image of the coin moves in synchronization with their fingers.

Next, they are asked to relax their arms and simply look at the coin on the display (**Fig. 3**). The device presents visual and haptic cues, and uses a novel pseudo-haptic illusion to induce the ideomotor action.

6 Conclusion

In this paper, we developed a new 1-DoF Linear Rail Device that can present force and vibration with low friction and inertia. We presume that vibration and visual stimuli can present illusory force, and an occasional actual force can make users believe that they are really being pulled, and induce unconscious movement in the user.

Acknowledgment

This work was supported by JSPS KAKENHI Grant Number JP15H05923 (Grant-in-Aid for Scientific Research on Innovative Areas, "Innovative SHITSUKSAN Science and Technology").

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