Interaction Support for Virtual Studio by Vibration Feedback

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***Abstract*—Virtual studios, that synthesize video-camera images with CG objects of studio sets and props, are commonly used in professional program production. Actors in a virtual studio cannot directly see the CG objects and instead interact with them with the help of synthesized video displayed on a monitor. However, acting becomes unnatural if their gaze goes toward the monitor. As an alternative to this method, vibration feedback can be used as a means for actors to perceive the positions of the CG objects without having to look at the synthesized video and without affecting the shooting and sound pickup. In this method, a small vibration device is attached to the actor's body that can communicate the distance to the CG objects by the intensity and pattern of its vibrations. A system to verify this method was developed, and the experimental evaluation using it confirmed that vibration feedback is very useful for interactions with studio sets.**

Keywords—program production, virtual studio, interaction, vibration, video synthesis, motion capture, studio set, props

I. Introduction

Virtual studios, that synthesize video-camera images with CG objects of studio sets and props, are commonly used in professional program production. Since the actors cannot directly see the CG objects in the studio, they have to imagine the position of the CG objects with the help of synthesized video displayed on a monitor placed within their field of view. However, it is difficult for actors to look at the monitor while acting. Because their acting becomes unnatural if their gaze goes toward the monitor. Here, we studied vibration feedback as a way of informing the position of the CG objects without the actor having to look at synthesized video and without affecting the shooting and sound pickup. In this method, a small vibration device is attached to the actor's body that can communicate the distance to the CG objects by the intensity and pattern of its vibrations.

II. Experiments and Results

We developed a system to verify the method and evaluated it. Fig. 1 shows the configuration of the system used in the experiments. The PC shoots the actor by using a Kinect and generates synthesized video with a CG object in real time. It also detects the 3D position of the actor's hands by using the Kinect and calculates the distance to the CG object. It transmits control signals to the vibration controller worn by the actor through WiFi and vibrates the vibration motors, which are attached to his/her wrists with adhesive tape, in accordance with the distance to the CG object. Fig. 2 shows the six patterns of vibration used in the experiment. The vibration intensity increases as the hand approaches the surface of the object. The solid line parts indicate continuous vibration, while the dotted line parts indicate modulated vibration that turns on/off at short intervals. This modulation pattern, as well as a multi-step intensity pattern, was chosen to inform change on the basis of the results of preliminary experiments. Table I shows the cases of the experiment which are intended to simulate interactions with a studio set and props. We asked eight subjects to experience all cases and had them evaluate how well they could detect the surface of the CG object and the distance from the surface of the CG object on a four-level scale. An experimenter also observed whether the subject's hand had penetrated the CG object in the synthesized video. The experiment was conducted under conditions in which the subject could not see the synthesized video after s/he had perceived the approximate position of the CG object. Although detailed data on the experiment cannot be shown due to the limited number of pages, pattern C obtained the best score and pattern E obtained the second-best score. The starting point of the vibration should be more than about 50 cm from the surface of the object. It is necessary to change the vibration pattern dramatically just before the hand reaches the surface. Cases 3 and 4 obtained worse scores than cases 1 and 2. These results indicate that, although further tuning of the vibration patterns is necessary, vibration feedback is very useful for interactions with studio sets, except for close interactions like handling props.

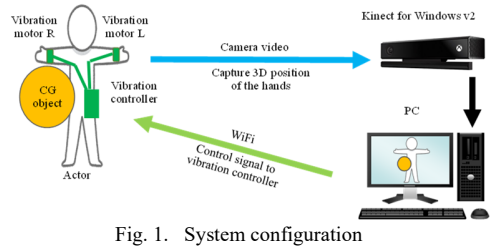

Fig. 1. System configuration

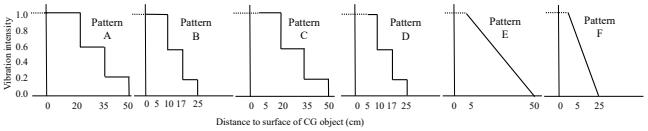

Fig. 2. Vibration pattern

TABLE I. Cases of Interaction with CG Objects

Case 1	Keep a hand close to a stationary vertical plane that simulates a wall without touching it
Case 2	Keep a hand close to a stationary sphere that simulates an object with a non-flat surface without touching it
Case 3	Move a hand to the left or right following an moving object but not touching it
Case 4	Lift a box-shaped object that simulates a small prop with both hands and move it