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Prototype to Control a Mid-air CG Character Using Motion Capture Data of a Plush Toy

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Abstract

We propose an integrated operation system that combines puppet motion capture and human body movements to easily control various movements of a mid-air CG character. The proposed method addresses the problems in controlling CG characters via the body movements of a human operator and puppet. This method can also be used to control spatial movements and multiple parts of a character simultaneously. In addition, our method enables an operator to easily move the character in the depth direction, which is a key characteristic of a mid-air image.

CCS Concepts

• ***Human-centered computing*** → ***Displays and imagers;***

1. Introduction

Puppets and CG characters are used in various settings such as theme parks and TV programs, and play a role in expressing emotions in art and media through behavior such as body movements and facial expressions. The operation of a character's motion attractively is important in entertainment and communication.

The methods for interactively controlling the movements of puppets and CG characters use human motion capture as well as a puppet's body as an interface. Capturing the movements of a human operator's body allows the movements to be directly reflected in the character. Nonetheless, this approach requires a large space for spatial movement, and performing large spatial movements is difficult. Using a puppet's body [NNSH11] enables an operator to control a character's movements via the puppet, but the number of body parts that can be easily and simultaneously controlled via this method is limited.

In this study, we propose and demonstrate an integrated operation system that combines puppet motion capture and human body movements as a system to control a CG character displayed as a mid-air image. Specifically, simultaneous operation of both arms and neck movements and free spatial movement is performed by combining the operation of the puppet's palm and body positions with the operator's own neck movement; we attempted to achieve a high degree of freedom of body movement.

2. Operation of a Mid-air CG Character

In the proposed approach, the movements of the neck, arms, and legs of a character are controlled in the manner of a puppet show, and each motion is generated using a different method.

Arm movements are an important element representing various situations, such as a figure waving their hands or covering their eyes. Most arm movements follow the position of the palm, and operating the position of the puppet's palms enables arm movements with a high degree of freedom. Therefore, the position of the puppet's palms must be monitored in the system.

Neck movement is an essential element in emotional expression. Because operating the puppet's head with the operator's hand while simultaneously operating the puppet's arms would be difficult, the character's neck movement is controlled via the operator's own neck movement, as noted above.

Because the mid-air image can move in the depth direction, activities involving leg movement such as walking are necessary to accompany spatial movement. Based on the idea that the movement of the lower body is relatively automatic while the movement of the upper body is more conscious, we determined that simply playing back the leg movement associated with spatial movement sufficed.

3. System Overview

Fig1 shows the overall configuration of the system. The movements measured by the motion capture device are mapped to the character's motion, and an optical device displays a mid-air CG character.

3.1. Motion Capture System

The position of the puppet's palms and body position, which is 3D coordinates including depth, are obtained using optical motion capture. For the operation of both arms, retroreflective markers are

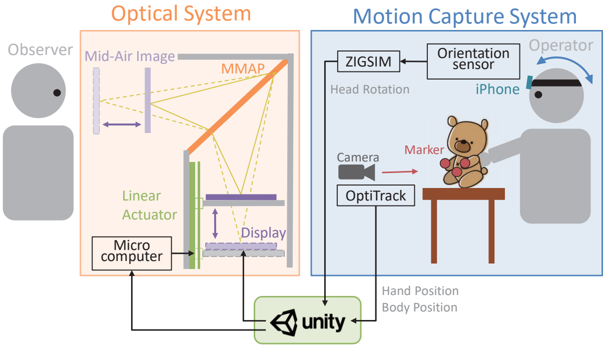

Figure 1: *System Flow*

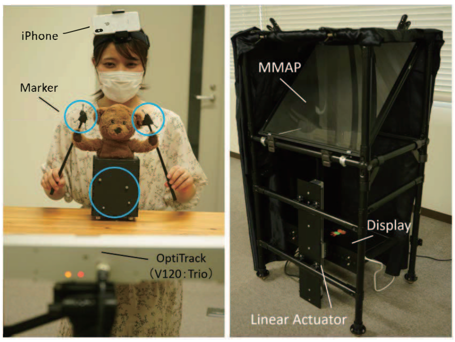

Figure 2: *Implementation*

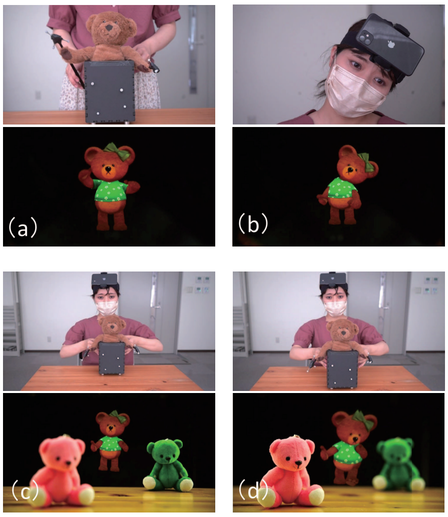

Figure 3: *(a) arm's motion (b) neck's motion (c)(d) depth movement*

fixed to the puppet's palms, as shown in Fig2. The operator uses sticks, similar to those in traditional puppetry, to control the puppet's palms.

The operator wears an orientation sensor on their head, whose movement controls the character's head. A sensor built into an iPhone is used as the orientation sensor.

3.2. Generation of CG Character's Motion

The arm movements of the character are generated by inverse kinematics (IK), which control the displayed arm motion based on the position and orientation data of the palms as measured by a motion capture system.

The leg movements associated with the spatial movement are generated by playing a pre-generated walking motion when the character moves back and forth or left and right at the sufficient movement speed and distance. The displayed walking motion speed varies with the motion speed of the puppet.

The neck movements of the character are generated by synchronizing the data on the orientation of the operator's head from the iPhone's sensor. In addition, to make the character's neck move naturally, their waist bends slightly with the neck movement.

3.3. Optical System

The optical system shown in Fig1 illustrates the optical design used to display the mid-air CG character. For the optical system used to display a mid-air image that can move in the depth direction, we adopt the method of MARIO [KTY*14]. The optical system consists of a display, a micromirror array plate (MMAP), a light shield, a linear actuator, and a microcomputer. The MMAP is an optical element used for a mid-air image. It is installed in combination with light sources and can display a mid-air image in real space. The microcomputer is used to control the linear actuator. The display, which is fixed to a linear actuator, is moved vertically up and down to move the mid-air image in the depth direction. The character's vertical and horizontal movements are generated by moving the character's two-dimensional position on the display.

4. Examples of Character's Motion

Fig3 shows the movements of the mid-air CG character that can be controlled using the proposed system. The user can easily control the attractive movements, such as exaggeratedly waving arms fast.

5. Conclusion

In this study, we demonstrated an integrated operation system that combines puppet motion capture and human body movements to control the movements of a mid-air CG character displayed in real space. We confirmed that the proposed method was able to represent various body movements of a mid-air CG character.

Acknowledgement

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