Editing Camera Work with Virtual Camera and 3D Printed Figures

Shuntaro Kono
Kyushu Institute of Technology

Kunio Yamamoto
Kyushu Institute of Technology

Masaki Oshita
Kyushu Institute of Technology

Abstract

In creating computer animations, it is difficult to edit camera work, the is, the movements of the camera in the scene during an animation. In this paper, we propose an intuitive method for creating a scene and camera work. The idea of this research is to represent a scaled-down version of an actual scene by placing 3D printed figures. The user of our system can create a scene and camera work by placing 3D printed figures and manipulating a virtual camera. Each 3D printed figure represents a short motion of a character. By placing them on a platform, the user can edit a scene configuration and simple animation of characters. Then, the user can edit a camera work by manipulating a virtual camera while playing back the animation and watching the camera view on the screen. We have implemented the proposed system using web cameras and AR markers. As a result of the experiment, we were able to create a simple scene and camera work using our system.

Keywords: computer animation, camera work, augmented reality

1. Introduction

To create a CG image, it is necessary to create a camera work. However, in the general method of creating a camera work, it is necessary to repeatedly set the position and orientation of the camera and the person at a certain time. The setting of the position and orientation is difficult because the amount of movement and rotation must be determined for each axis, which is not intuitive to operate. Therefore, there is a need for a technology that can easily create camera work.

Disney's method using a virtual camera[**?**] has the problems of not being able to position people in real space and requiring a large space such as a studio. Onosaka et al.'s method for creating camerawork using AR technology[**?**] has the problems of not being able to confirm the scene in real space and not being able to change the position and orientation of people. As problems to be solved, there is a need for a method that can reproduce and confirm scenes in real space, and can change the position and orientation of people in a small space.

The purpose of this research is to develop a system that allows users to create and edit camerawork intuitively and easily. The idea of this research is to represent a scaled-down version of an actual scene by placing 3D printed figures. The user of our system can create a scene and camera work by placing 3D printed figures and manipulating a virtual camera. Each 3D printed figure represents a short motion of a character. By placing them on a platform, the user can edit a scene configuration and simple animation of characters. Then, the user can edit a camera work by manipulating a virtual camera while playing back the animation and watching the camera view on the screen. We have implemented the proposed system using web cameras and AR markers.

As a result of the experiment, we were able to create a simple scene and camera work using our system.

Since it is possible to check how the person is reflected in the camera on the monitor display, it is possible to create the camerawork while adjusting the reflection of the person.

2. Proposed Methods

In this section, we describe 3D printed figure, user interface, and implementation of our method.

2.1. 3D printed figure

Our system uses 3D printed figures to represent short motions of characters. The user of our system can edit an animation by placing them on the platform.

Figure **??** shows example of 3D printed figures. The geometrical model of each 3D printed figure is created based on a human body model, a short motion and a key time that is specified by the user. The key time is chosen so that the pose at the key time represent the motion. For example, the orange figure in Figure **??** represents a punching motion, while the gray figure represents a staggering motion.

A physical 3D figures are printed from the geometrical model what is generated by a human body model and the pose of the motion at the key time.

Figure 1: 3D printed fiugre

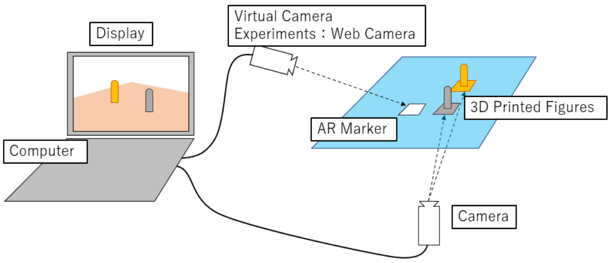

Figure 2: Overview of the system

2.2. User interface

Figure**??** shows the overview of our system. Before using the system, a number of short motions and the corresponding 3D figures that are used for creating animations are prepared in advance.

The user places a 3D printed figure on the platform. An animation is generated based on the motions that the 3D printed figures represent. When multiple 3D printed figures are placed, these motions are played sequentially in the order that the figures are placed. The timings of motions are adjusted so that the interval of key pose between adjacent motions becomes a fixed interval (0.5 sec. in our experiment). The key pose during motion is set by the user in advance. Even though the user may want to adjust the timings more precisely, our system simply plays motions sequentially. The user of our system can still make various simple animations by placing several 3D figures in arbitrary order. This simplification makes our interface intuitive.

After an animation is created, the user can edit the movement of the camera, by moving the virtual camera over the platform. Based on the position and orientation of the virtual camera, the current view is displayed on the display. The user can manipulate the web camera while playing back the animation and viewing the display in a similar way that the user can shoot a scene by using a real camera. The movement of the virtual camera is recorded along with the animation and can be used to generate a video. The user can repeat manipulating the virtual camera and viewing the created video until the user can obtain a satisfactory camera work.

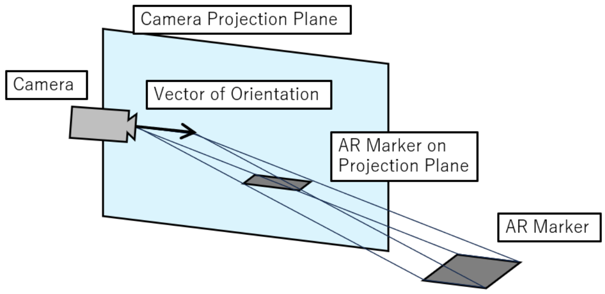

Figure 3: Calculate marker orientation

2.3. Implementation using AR markers

Our system needs to detect the positions and orientations of 3D figures and virtual camera. We used AR markers for implementing our system. For detecting the position and orientation of 3D figures, we place AR markers on the bottom of figures and use a transplant platform as shown in Figure **??** so that the position and orientation of AR markers can be detected by the camera placed under the platform. For detecting the positions and orientation of the virtual camera, we placed several AR markers on the platform so that at least one AR marker is captured by the virtual camera.

The method for determining the position and orientation of the AR marker with respect to the camera, based on the state of the AR marker as it appears on the camera, follows [**?**]. From the internal parameters of the camera, the positional relationship between the camera position and the AR marker reflected on the camera's projection plane is determined. Furthermore, since the edges of the AR markers in 3D space and the edges of the AR markers reflected on the projection plane are in the same plane as the camera, the intersection of the two planes can be obtained by finding this plane for each parallel edge of the AR marker **??**. Since the intersection is parallel to the edge of the AR marker, and since the two orthogonal edges of the AR marker are parallel, they can be out-producted to obtain three vectors representing the orientation of the AR marker. The translation component of the AR marker is determined based on the positions of the four corner vertices of the AR marker The translation component of the AR marker is calculated based on the positions of the four corner vertices of the AR marker in the camera's projected plane. The inverse of the transformation matrix representing the position and orientation of the AR marker with respect to the camera is the transformation matrix representing the position and orientation of the camera with respect to the AR marker.

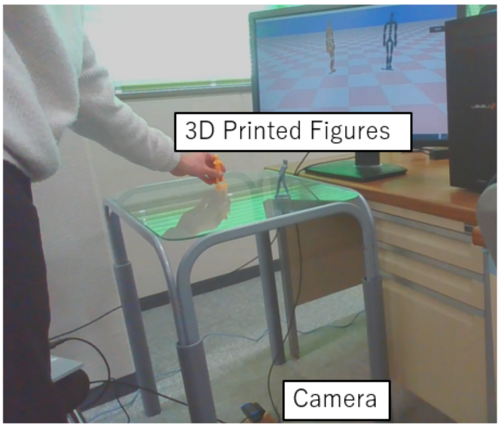

Figure 4: Placement of the figure

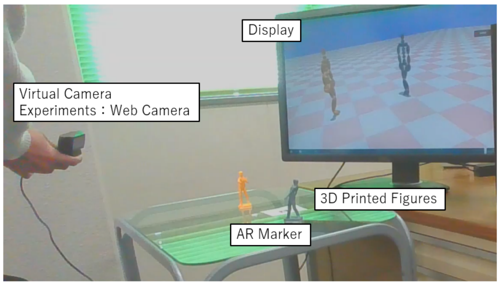

Figure 5: Operation results during camera work recording

3. Experiments

We set up a scene assuming a situation in which camera work is to be created, and confirmed that the system can be used to position people and create camera work.

3.1. Operation confirmation

In order to confirm that it is possible to create a camerawork in accordance with the movements of a person in a scene, we created a camerawork in which the camera follows the movements of the person using the system. Here, we tested the operation of the system assuming the creation of a camerawork in the following scene. Two people appear, and the first person makes a walking motion and then a crouching motion. The second person then makes a walking motion in the opposite direction of the first person from near where the first person was crouching, and the scene ends. During this time, the camera follows the movements of the two persons in turn in a single shot.

3.2. Operation result of figures placement

Confirm that the system can be used to position people in the scene. Figure **??** shows an image of a 3D printed figure being manipulated to place people in a scene. The user holds the 3D printed figure in his/her hand and places it on the table. At this time, the user can position the figures in the scene while viewing the positioning of the figures in the real space and the positioning of the figures in the virtual space on the display.

3.3. Operation result of editing camera work

Figure **??** shows the result of the system operation. It shows the state in which the virtual camera is moved and the camera work is recorded.

Figure **??** shows a series of rendered images of camera work created by the system. First, the gray figure walks to the left side of the screen (1, 2) and then crouches (3). The camera work was created to follow this movement. Next, the yellow figure starts walking to the right side of the screen (4). At this time, the subject of the camera switches from the gray figure to the yellow figure (5), and then the camera work was created to follow the walking of the yellow figure (6). From the figure, it can be seen that the camerawork was created such that the camera captures the moment when the gray person crouches down, and then changes the subject to the yellow person.

3.4. Operation result of a multiple-person arrangement

Figure **??** shows a series of rendered images of arrangement multiple-person by the system. When there are two or more figures in a scene, each motion is played using the method described in **??**. The yellow 3D printed figure was placed first, followed by the gray 3D printed figure (1). Since the time interval was 0.5 seconds and the key time for both 3D printed figures was the highest hand, the yellow figure raised its hand first (2) and the gray figure raised its hand 0.5 seconds later (3) when the motion was replayed. In this way, the user can adjust the order in which the motions of multiple persons are played back.

4. Discussion

In this paper, we developed a system that uses a virtual camera and a 3D printed figure to position people in a scene and create camera work. By using this system, we were able to position people in a scene and create camera work while observing their positions in real space and on a display. In particular, it is possible to create a camerawork that matches the movements of people in a scene where multiple people are moving.

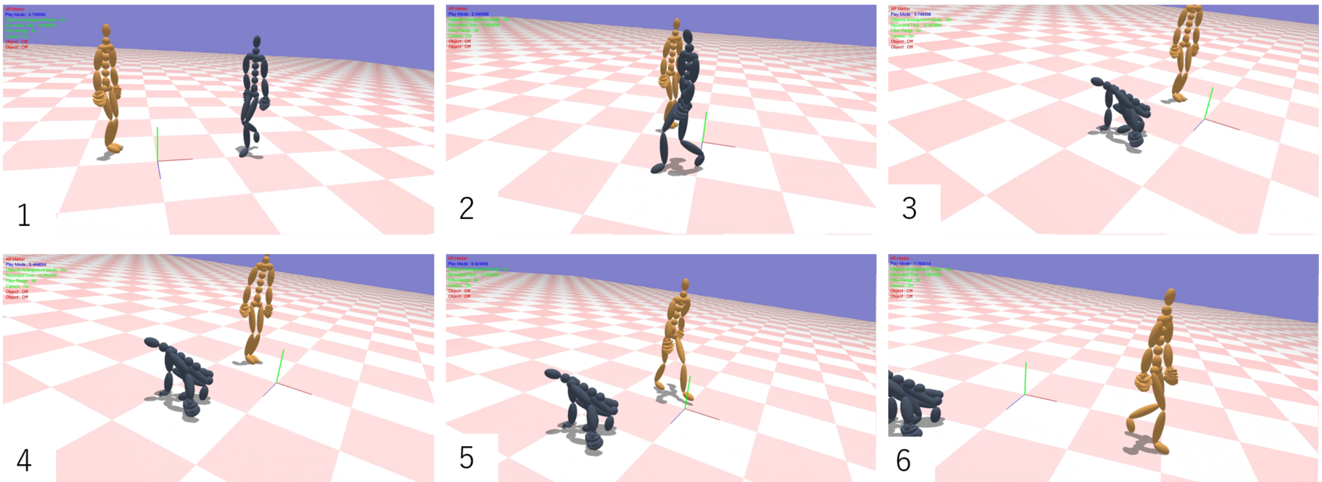

Figure 6: Created camera work

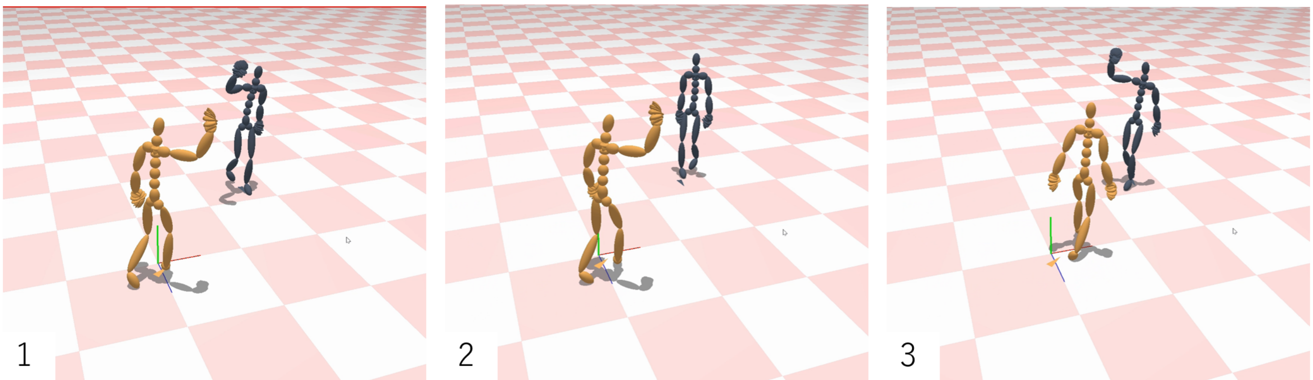

Figure 7: Arrangement multiple-person

However, it is not possible to create a camerawork in which the AR markers do not enter the camera's angle of view. If a marker can no longer be detected, the position and orientation of the marker in the previous frame is used as the position and orientation of the marker in the current frame. The position and orientation of the marker are filtered, and the position and orientation of the previous few frames are smoothed by a smoothing filter to obtain the position and orientation of the marker in the current frame. The result is a smooth operation based on past information, even when the marker is no longer detectable. By increasing the number of markers used to calculate the camera's position and orientation, and by placing the markers in various positions and orientations, it is estimated that it is more likely that more than one marker will appear on the camera for a longer time and that the position and orientation can be calculated with good accuracy. Experiments on this will be the subject of future work.

[1] Disney Studio Official: "Like a VR game? Amazing Way to Shoot!", https://www.youtube.com/watch?v=CGbTiQ_1-6M, YouTube (2019).

[2] A. Onosaka, Y. Shindo: "Development of Camera Work Production System for CG Animation Using AR Technology ," Forum on Information Technology 10th. Third Volume, p. 408 (2011).

[3] H. Kato, M. Billinghurst: "Marker Tracking and HMD Calibration for a Video-based Augmented Reality Conferencing System ," Proceedings 2nd IEEE and ACM International Workshop on Augmented Reality (IWAR'99) (1999).