Motion Synthesis with Motion Splicing

Yusuke Takebayashi, Koji Nishio and Ken-ichi Kobori
Osaka Institue of Technology, Osaka, Japan
takebayasi@ggl.is.oit.ac.jp,{nishio, kobori}@is.oit.ac.jp

Abstract

In recent years, the reuse of motion capture data has become widespread. For example, many methods to generate new motion by synthesizing plural existing motions has been suggested. We can generate a composite motion such as “Walk while waving a hand” by using these methods. However, these methods often lose the feature of original data when they generate a new motion. Then, these methods generate an unnatural motion.
In this paper, we propose a motion synthesizing method with motion splicing. We generate a new motion from the existing motion based on relation of master and servant in a composite motion. Our method generates a spliced motion by splicing a human part. We splice five parts that is the lower body, arms, the torso and the head. Our method generates plural spliced motions, and generates a new motion by synthesizing those motions. In this way, our method can generate a new motion without losing the feature of original data.
Some experiment results show that our method generate a new motion from the existing motion.
Keywords: *Motion capture, Motion Synthesis, Motion Splicing.*

1. INTRODUCTION

In recent years, the reuse of motion capture data has become widespread. Motion capture data of short motion is on the market. However, the motion that a user needs may not be included in the existing motion capture data. The existing motion capture data have a limit to reuse. Therefore, many methods to generate a new motion synthesizing plural existing motions has been suggested. We can generate a composite motion such as “Walk while waving a hand” by using these methods. However, these methods tend to generate a new motion by blending plural motions on arbitrary parameters. Therefore, these methods often lose the feature of original data when they generate a new motion. Then, these methods generate an unnatural motion.
Therefore, the method to generate a new motion by splicing the motion of the upper body and that of the lower body has been suggested[1]. This method can generate a new motion without losing the feature of original data. However, splicing the motion of the upper body and that of the lower body is possible under a condition that the motion of the lower body of two motions must be similar.
In this paper, we propose a motion synthesizing method with motion splicing. Our method generates a spliced motion by splicing a human part based on relation of master and servant. Our method generates a new motion by synthesizing spliced motions. In addition, our method achieves flexible motion synthesis by splicing a human part.

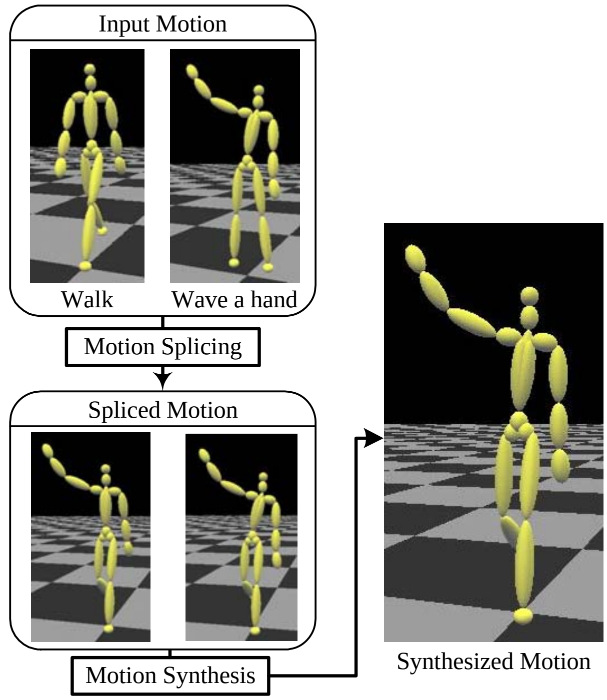


Figure 1: A flow of proposal method.

2. GENERATION OF THE MOTION

Our method generates a new motion from the existing motion by using motion splicing and motion synthesis.
First, we explain relation of master and servant in a composite motion. When the human being performs plural motions at the same time, there is a dominant motion among plural motions. It is assumed that the human being performs “Walk while waving a hand”. When the master motion is “Walk”, the human being performs “Walk while waving a hand” by moving only the right arm. On the other hand, when the master motion is “Wave a hand”, the human being performs “Walk while waving a hand” by moving the upper body greatly. Our method generates a motion by setting the master motion and the servant motion.
We show a flow of proposal method in the Figure 1. The flow of proposal method is as follows.

(1) One of input motions is set as the master motion. We generate a spliced motion by splicing the master motion “Walk” and the part of other input motion.
(2) We set “Wave a hand” as the master motion and generate another spliced motion.
(3) We generate a synthesized motion by synthesizing two spliced motions.

2.1 Motion splicing

Our method generates a spliced motion by splicing the part of the master motion and the part of other input motion. We splice five parts that is the lower body, arms, the torso and the head. In this paper, we define motion capture data $\mathbf{M}(t)$ in Equation (1).

$$\mathbf{M}(t) = \{\mathbf{p}(t), \mathbf{q}_1(t), \cdots, \mathbf{q}_N(t)\} \quad (1)$$

$\mathbf{p}(t)$ is the position of the root joint. $\mathbf{q}(t)$ is the rotate quaternion of the each joint. N is the total number of joints.
At first, our method generates the motion $\mathbf{M}_C(t)$ by splicing the master motion $\mathbf{M}_{Im}(t)$ and the part of the servant motion $\mathbf{M}_{Is}(t)$ in Equation (2).

$$\mathbf{M}_C(t) = \left\{\mathbf{p}^{Im}(t), \mathbf{q}_1^{Im}(t), \cdots, \mathbf{q}_i^{Is}(t), \cdots, \mathbf{q}_{i+n-1}^{Is}(t), \cdots, \mathbf{q}_N^{Im}(t)\right\} \quad (2)$$

i is the number of the root of the part to be spliced. n is the total number of joints of the part to be spliced.
However, there is a possibility that the motion $\mathbf{M}_C(t)$ becomes an unnatural motion when the part of the master motion is replaced with the part of the servant motion directly. The reason is because the movement of each joint depends on another joint when the human being acts. Therefore, we recalculate the rotate quaternion of the root joint of the part to be spliced and generate the motion $\mathbf{M}_S(t)$ in Equation (3).

$$\mathbf{M}_S(t) = \left\{ \mathbf{p}^{Im}(t), \mathbf{q}_1^{Im}(t), \cdots, \mathbf{q}_i^{S}(t), \mathbf{q}_{i+1}^{Is}(t), \cdots, \mathbf{q}_{i+n-1}^{Is}(t), \cdots, \mathbf{q}_N^{Im}(t) \right\} \quad (3)$$

We calculate the rotate quaternion $\mathbf{q}_i^S(t)$ of the root joint of the part to be spliced. At first, in order to keep the feature of the original motion, we calculate a feature of motion of the part from the motion $\mathbf{M}_{Is}(t)$ in Equation (4).

$$\mathbf{F}_j(t) = \mathbf{P}_j^{Is}(t) - \frac{1}{m}\sum_k^{\mathbf{B}} \mathbf{P}_k^{Is}(t) \qquad \left(j \in \{ i, \cdots, i+n-1 \} \right) \quad (4)$$

$\mathbf{B}$ is a set of the joint number of the chest. m is the total number of the chest. Our method defines a relative position from the chest to each part as the feature of motion of the part. The reason is because the chest moves a little when the human being acts. Secondly, when the master motion is spliced the part of the servant motion, we calculate the target position $\mathbf{P}_j^S(t)$ in Equation (5).

$$\mathbf{P}_j^S(t) = \mathbf{F}_j(t) + \frac{1}{m}\sum_k^{\mathbf{B}} \mathbf{P}_k^{Im}(t) \qquad \left(j \in \{ i, \cdots, i+n-1 \} \right) \quad (5)$$

Finally, we calculate the rotate quaternion that minimizes the sum of squared distances between the target position $\mathbf{P}_j^S(t)$ and the position of the part of the motion $\mathbf{M}_C(t)$ using the method of Horn[2]. And, we calculate $\mathbf{q}_i^S(t)$ by multiplying the minimum rotate quaternion by $\mathbf{q}_i^{Is}(t)$.

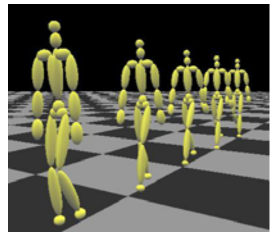
2.2 Motion synthesizing

Our method synthesizes two spliced motions by using linear interpolation. Because the motion capture data is constructed the position of the root joint and the rotate quaternion of the each joint, we can't apply linear interpolation to all data. Therefore, we calculate only the position of the root joint of the synthesize motion by using linear interpolation. On the other hand, the rotate quaternion of the each joint of the synthesized motion is calculated by using spherical linear interpolation. As a result, our method generates the synthesized motion $\mathbf{M}_O(t)$ in Equation (6).

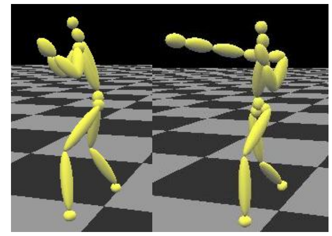
$$\mathbf{M}_O(t) = \left\{ \mathbf{p}^O(t), \mathbf{q}_1^O(t), \cdots, \mathbf{q}_N^O(t) \right\} \quad (6)$$

3. EXPERIMENT

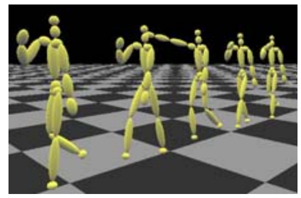
We had experimented to verify our method. We generated a new motion by synthesizing two spliced motions. A parameter of linear interpolation and spherical linear interpolation is set to 0.5 in the experiment.
We generate a new motion by using "Walk" and "Punch" in the experiment. Figure 2 shows the experiment result. Figure 2-(a) shows "Walk" and "Punch" that is input motions. Figure 2-(b) shows generated spliced motion when the master motion is "Walk", the servant motion is "Punch". In addition, Figure 2-(c) shows generated spliced motion when the master motion is "Punch", the servant motion is "Walk". Finally, Figure 2-(d) shows generated synthesized motion by synthesizing two spliced motions.
Our method can generate the spliced motion without losing the feature of the master motion. In addition, our method can generate realistic motion by synthesizing these spliced motions.



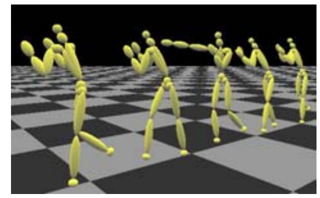
(a) Walk.



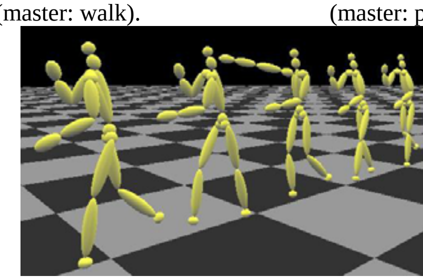
(b) Punch.



(c) Spliced motion (master: walk).



(d) Spliced motion (master: punch).



(e) Synthesized motion.

Figure 2: The experiment result.

4. CONCLUSION

In this paper, we have proposed the motion synthesizing method with motion splicing. Our idea is that two motion data are spliced based on relation of master and servant in a composite motion. Our method has generated a new motion by synthesizing two spliced motions. We have verified that our method could have generated a new motion that maintained the feature on each motion. In addition, we have verified that our method could have generated realistic motion by synthesizing two spliced motion.
In the future, we will generate a motion like the movement of the human being by synchronizing input motions. In addition, we will generate a motion like the movement of the human being by control of the speed of motion.

5. REFERENCES

[1] Rachel Heck, Lucas Kovar, Michael Gleicher, "Splicing Upper-Body Actions with Locomotion," EUROGRAPHICS 2006, No.3, Vol.5, pp.459-466, 2006

[2] Berthold K. P. Horn, "Closed-form solution of absolute orientation using unit quaternions," Journal of the Optical Society of America A, Vol.4, pp.629-642,1987.

About the author

Yusuke Takebayashi is a Ph.D. student at Osaka Institute of Technology, Graduate School of Information Science and Technology. His contact email is takebayasi@ggl.is.oit.ac.jp.
Koji Nishio is an associate professor at Osaka Institute of Technology, Department of Media Science. His contact email is nishio@.is.oit.ac.jp.
Ken-ichi Kobori is a professor at Osaka Institute of Technology, Department of Media Science. His contact email is kobori@.is.oit.ac.jp.