Imposing Constraints on Fragmented Body Motion for Synthesis

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1 Introduction

The generation of realistic motion of human figures for computer games and animation has been under active research in recent years. Since the nature of human motion is complex, motion capture is commonly used to obtain high-quality motion. Although capturing motions directly from human can acquire life-like motion, these motions cannot be easily reused. In order to maximize usage of captured motions, existing approaches attempt to reuse by combining motions of specific parts of the body [Ikemoto and Forsyth 2004] or by splicing actions with locomotion [Heck et al. 2006] to create new motions. While these approaches explore conditions for combining specific body parts to generate full body motions, we lack a generalized representation for animators to specify the conditions under which motions from which body parts can be synthesized to produce convincing full body motions. With a generalized representation, it is possible for animators to use a motion library of body parts to synthesize a wide variety of motions.

In this paper, we extend the notion of motion graph in which space-time constraints can be imposed for specifying conditions under which motions from specific body parts can be combined for synthesizing full body motion. To increase the flexibility in synthesis, acceptable tolerances on the constraints can be specified to allow a range of deviations between body part motions. Indeed, this new representation generalizes motion graph and can be used for generation of motions under interactive control.

2 Exposition

The configuration of a human figure is composed of a translational root and a set of rotational joint angles. The highly related joints, which tend to perform actions together, are assembled to form a body part. Every joint in the human figure is essentially assigned to one of the body parts and once only. Since we have deconstructed the human figure into different body parts, full body motion is not used directly. Instead, motions of each body part are obtained by extracting motions of the corresponding body part from full body motions. The extracted motions are then stored in the corresponding body part and the transitions between them are generated according to the similarity of the motions [Kovar et al. 2002].

Synthesizing the body part motions is a challenging task as they are highly correlated. While motion graph of each body part is created independently of other body parts, the synthesized motion does not usually look realistic. To tackle this problem, we realize two categories of nodes: transition node and constraint node for the motion graph annotated in each body part. Transition node is a stationary pose that seamlessly connects ingoing or outgoing transitions from or to other transition nodes, respectively. These transitions embed the motion clips which are extracted from full body motions, denoted as edges. The other step is to identify the constraint node at the critical frames in the motion clips. This node is responsible for ensuring the specified constraints are satisfied before synthesizing with other body part motions (see Figure 1). The common constraints exist among body parts are space-time constraints. As body part motions are extracted from different full body motions in which orientation is unlikely to be the same, the space constraint ensures all the body part motions are in the same direction. Time constraint describes a frame of a body part motion has to be synchronized with a frame of other body part motion. Satisfying these constraints guarantee the synthesized motion match spatially and temporally. The constraint nodes are prioritized so that all body part motions are required to align with the highest priority constraint node. In order to increase the flexibility of synthesizing motions, we allow a range of allowable tolerances on the constraints. These tolerances describe the acceptable space-time deviations when the body part motions are synthesized. For example, a body part motion A is not necessary to explicitly synchronize with body part motion B if the acceptable tolerances between A and B allows such deviations.

Figure 1: This diagram shows a graphical representation of combining 4 body part motions under the constraints. The motion transition (black arrow) between two stationary poses (square boxes) exists if they are seamlessly connected, which represents a motion clip. The ith constraint Ci in red arrows on a constraint node (red dot) needs to be satisfied with other constraint node before motion synthesis.

3 Discussion

Our motion representation is particularly useful for animators to identify the potential combinations of body part motions so that large collection of believable motions can be generated for interactive applications. As the human figure is deconstructed into several parts, each body part motion provides a variety of choices to be synthesized with each other when the constraints are satisfied. The flexibility of motion synthesis is also increased by introducing the allowable tolerances when synthesizing the body part motions. Motion planning can also be facilitated by selecting a path from a wide diversity of motion graphs of different body parts between two specified poses.

References


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