Automatic Splicing for Hand and Body Animations

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1 Introduction

We propose a solution to a new problem in animation research: how to use human motion capture data to create character motion with detailed hand gesticulation without the need for the simultaneous capture of hands and the full body. Occlusion and a difference in scale make it difficult to capture both the detail of the hand movement and unrestricted full body motion at the same time. With our method, the two can be captured separately and spliced together seamlessly with little or no user input required (see Figure 1). In addition, we provide an easy method for supplying user input for situations where an animator wants to control the timing of the integrated animation.

To accomplish our goal, we propose a novel distance metric based on research on human gesticulation that is applied along with dynamic time warping (DTW) to align motions with significant timing and amplitude differences (for details on DTW see [Keogh and Ratanamahatana 2005]). Such differences arise when the motions are performed at different speeds or with amplitude variations, for example, a performer extending her arm further in one performance over another. Our use of DTW for such a task is novel because, although DTW has been introduced to the graphics community previously for temporal alignment, the extreme amplitude differences seen between performances in our case have not been addressed in previous work.

2 Matching algorithm

Distance metric. Research on human gestures shows that the hand movement can be segmented into distinct phases using objective measures [Kita et al. 1998]. Specifically, *phase boundaries in hand movement are marked by an abrupt change of direction with a discontinuity in velocity profile before and after the direction change.* Exploiting these criteria, our comparison function assesses the signs of the first and second derivatives of motion trajectories over time in order to detect phase boundaries and match corresponding phases in the two motions. The change in signs of derivatives reveals the changes in direction and velocity discontinuities between the phases that Kita and colleagues describe. We compare signs of derivatives rather than derivative values because, for motions with significant amplitude differences, the function based on derivative values produces non-uniform matching within phases, where many frames of one motion are aligned to a single frame of the other (see Figure 2).

To match our source motions, we first apply DTW with the distance function computed from four motion-capture marker positions (two on the wrist, one on the hand, and one on the forearm) to grossly align phases of the motions. Next, to refine the frame correspondences within the motion phases, we apply DTW again, this time on the aligned motions with a comparison function which minimizes the angle differences between the palms of the hand in each frame. Here, we use a narrow DTW band to preserve phase correspondences while allowing adjustments to frame alignment within phases.

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Figure 1: Combining hand and body motion.

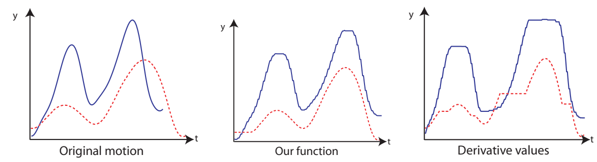

Figure 2: Comparison of distance functions.

User Input. Although our method is fully automatic, user's input can be beneficial for achieving special effects or enforcing specific constraints. Our novel method for incorporating user-defined constraints is a modification to the original DTW algorithm in which the user specifies either explicit frames or frame boundaries for timing matches and the modified algorithm directly adjusts the DTW search band to meet these specifications. With this extension, a user can control the alignment process either exacly or within a chosen tolerance. Therefore, our method allows a user to easily choose from a continuous spectrum of control options: from fully automatic matching with no user input to partial control, where the user suggests matching regions, to complete control, with the user listing specific pairs of frames to be matched.

3 Results and Conclusions

Our simple but effective technique for aligning hand and full body motion exploits characteristics of human gestures in order to properly align motions with large amplitude differences that were captured separately, and at different resolutions. Ours is the first solution to a relevant and time-consuming process in production animation and should lead to other, more sophisticated methods as well as open up investigation in other areas where motion alignment of separately generated motions is required. We have tested our technique on motions with complex gesticulation and obtained correctly synchronized, natural-looking motions. In the accompanying animations, we show an array of examples where hand motion is automatically layered over full body motion capture data. We compare these results to human performance. We also include an example which displays the results derived from user-controlled alignment.

References

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