Enhancing Procedural Animations with Motion Capture Data (a156)

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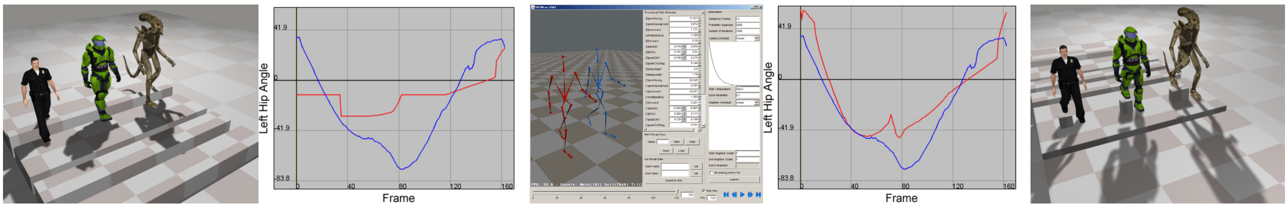

(a) (b) (c) (d) (e)

Figure 1: (a) procedure-generated animations for different characters, (b) arbitrary procedural parameters may result in unnatural motions (red), (c) automatic optimization process by comparing the procedural motions (red) with capture motions (blue), (d) enhanced motion (red) generated by the optimized parameter set, (e) resulting natural and flexible motions generated by animation procedures

1 Introduction

In the approach of procedural animation, knowledge-based algorithmic procedures are designed to generate specific types of animations automatically according to a set of motion-specific parameters (such as step length), character model, and the given environment [Bruderlin & Calvert, 1996]. The main advantage of this approach is that the generated motions can be made adaptive to the character model (without retargeting) as well as the environment. However, in addition to the effort of designing the underlying procedures, it has the drawback of requiring time-consuming parameter tuning to generate natural-looking motions. On the other hand, animations created with motion capture (MoCap) data look more natural but can be made flexible only up to certain degree [Witkin & Popovic, 1995]. In this work, we attempt to take advantage of both approaches and enhance procedural animations by formulating an optimization problem on searching for an optimal set of procedural parameters that make the generated animation resemble the target captured motion.

2 System Design and Experimental Results

In this work, we have used a system called IMHAP developed in our previous work for experimenting procedural animation of human characters [Liang et al, 2007]. We have used the walking motion as an example to illustrate the flexibility of procedural animation and how the generated animations can be enhanced by the optimization process. A snapshot of the animations generated by our walking procedure for characters with different kinematics models on an uneven terrain is shown in Figure 1(a).

In the design of the animation procedure, the walking motion is defined by three keyframes and the interpolation procedure for each phase between two keyframes. These keyframes are defined according to motion-specific parameters such as step length, step height, forward leaning angle, etc. The interpolation procedures are defined according to timing parameters such as the proportion of each phase and the parameters defining the trajectory curve and the timing curve in each phase. In the current design of the walking motion, a total of fourteen parameters are used to govern the generation of the motion. Using an arbitrary set of parameters may result in motions that are far from the ideal natural-looking motion (blue curve in Figure 1(b)), and tuning the parameters to generate more realistic motions is a time-consuming challenging task.

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We propose to tune the parameters in the animation procedure by comparing the generated motion with MoCap data (Figure 1(c)). It is formulated as an optimization problem with fourteen independent variables mentioned above. The objective function for the optimization is defined as

$$f(A)=\sum_{i=1}^{n} d(P_A[i], M[i]), \tag{1}$$

where A is a given set of procedural parameters, $P_A[i]$ and $M[i]$ are the ith frame in the animations generated by the procedure and the MoCap data, respectively, and d is a distance function computing the weighted sum of the discrepancies on the corresponding joint locations between the two motions.

We have used the simulated annealing (SA) algorithm to search for an optimal set of parameters minimizing the objective function defined in eq. (1). The efficiency of the SA algorithm and the quality of the found optimal solution depend on several experimental settings such as initial configuration, start temperature, probability suppress, and cooling schedule. Extensive experiments have been conducted to understand the nature of the underlying optimization problem and how to choose these experimental settings appropriately. An example of the found solution on the hip angle is shown as the red curve in Figure 1(d) (cf. Figure 1(b)). Different styles of walking motions from a motion capture library have been used to search for the procedural parameters that can result in these styles. A rendered example of the enhanced walking motions for characters of different sizes is shown in Figure 1(e).

3 Conclusion

Using MoCap data to optimize procedural animation is an effective way to take advantage of both approaches. It is also a good start point for us to study how to improve the animation procedures if there exists any discrepancy between the optimal solution and MoCap data.

References

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