Complex Character Animation That Combines Kinematic and Dynamic Control

Ari Shapiro*
University of California, Los Angeles

Petros Faloutsos†
University of California, Los Angeles

1 Motivation

We implement a framework for developing interactive characters by combining kinematic animation with physical simulation. The combination of animation techniques allows the characters to exploit the advantages of each technique. For example, characters can perform natural-looking kinematic gaits and react dynamically to unexpected situations.

Kinematic techniques such as those based on motion capture data can create very natural-looking animation. However, motion capture based techniques are not suitable for modeling the complex interactions between dynamically interacting characters. Physical simulation, on the other hand, is well suited for such tasks. Our work develops kinematic and dynamic controllers for interactive character animation, leveraging the advantages of both classes of techniques.

2 Kinematic and Dynamic Control

We build upon our previous work on dynamic controller composition [Faloutsos et al. 2001]. Within our framework, controllers are now black boxes that can encapsulate any kind of animation technique. For example, they can be based on the direct application of motion capture, elaborate motion graph structures [Kovar et al. 2002; Li et al. 2002] or dynamic controllers [Hodgins et al. 1995; Faloutsos et al. 2001].

Our system can switch between kinematic animation and physical simulation for any number of characters in the environment and determines which effects will be placed on which characters. For example, it may be desirable to fully animate one character hitting another by motion captured data and only simulate the impact of the force of the hit on the second character. In other instances, all characters can be dynamically simulated [Faloutsos et al. 2001]. The characters can react to unexpected circumstances through the use of dynamic controllers which are automatically activated based on the state of the character and the environment. For example, a character falling down will automatically put its hands down to cushion the impact. Our system properly matches the positions and the velocities for the degrees of freedom of the characters when it switches between kinematic animation and dynamic simulation.

Our characters can react autonomously to changes in their environment and to user interaction as well as follow user instructions. The power of combining kinematic and dynamic control is demonstrated by the image sequence in Figure 1.

Our system is capable of integrating current and future kinematic and dynamic techniques since it imposes no restrictions on the structure of individual controllers. We are currently working on incorporating the motion graph technique [Kovar et al. 2002] as an individual controller into our system.

*ashapiro@cs.ucla.edu
†pfal@cs.ucla.edu

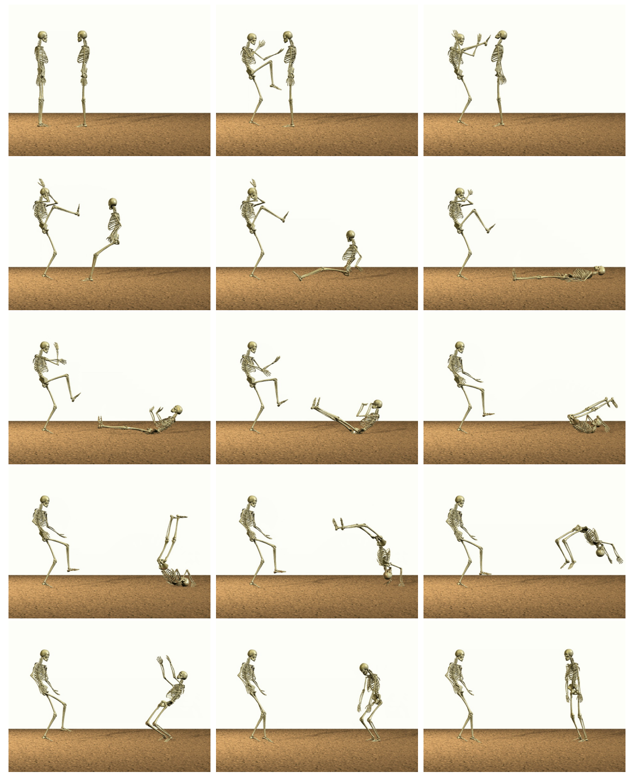

Figure 1: Kinematically animated kick and dynamically simulated reaction and interaction. The motion of the character on the right is dynamically simulated. Images are in raster order.

References

FALOUTSOS, P., VAN DE PANNE, M., AND TERZOPOULOS, D. 2001. Composable controllers for physics-based character animation. In *Proceedings of ACM SIGGRAPH 2001*, Computer Graphics Proceedings, Annual Conference Series, 251–260.

HODGINS, J. K., WOOTEN, W. L., BROGAN, D. C., AND O'BRIEN, J. F. 1995. Animating human athletics. In *Proceedings of SIGGRAPH 95*, Computer Graphics Proceedings, Annual Conference Series, 71–78.

KOVAR, L., GLEICHER, M., AND PIGHIN, F. 2002. Motion graphs. *ACM Transactions on Graphics 21*, 3 (July), 473–482.

LI, Y., WANG, T., AND SHUM, H.-Y. 2002. Motion texture: A two-level statistical model for character motion synthesis. *ACM Transactions on Graphics 21*, 3 (July), 465–472.