Interactive and Reactive Dynamic Control

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Abstract

We provide an interface for controlling humanoid characters under physical simulation. This interface permits a user to control the character at a variety of different semantic levels. The character can be instructed at a high level, such as by issuing a walk command, or at a low level, such as by specifying poses with interactive keyframe selection. In addition, the character can perform autonomously in that it possesses a variety of reactive skills that can be performed when needed. Our work brings together interactive control with reactive control under physical simulation as a major step towards a larger system for an intelligent, controllable and interactive character.

Keywords: character animation, physical simulation, dynamic control

1 Exposition

Developing plausible motion for animated characters is difficult. There are a variety of different techniques that are used to control interactive characters. However, no one technique allows you perform a complete range of motions under any environment with interaction. We combine reactive control [Faloutsos et al. 2001] with interactive control [Laszlo et al. 2000] under physical simulation in order to accommodate a wide range of behavior. The character understands basic reactive and protective behavior. Through user-selected keyframed controllers, the character is able to perform custom tasks that can be adapted to any situation.

A user may instruct the character to perform specific tasks by selecting a keyframe that indicates the desired pose of the character. We use proportional-derivative (PD) controllers to drive the character from their current position to the desired position. The keyframe may also contain information about the gains used as input to the PD controller. The keyframed poses can be used in sequence to achieve a walk cycle, throw punches or kicks, hop, lean backwards, pick up objects and so forth.

Simple pose-based control is not enough to guarantee that the dynamic character will achieve the desired position. Our character also adjusts the poses by applying heuristics in order to better achieve its goals of movement, balance and interaction. For example, a pose indicating a punch will be adjusted automatically to raise or lower the arms to better contact the objects around them. A walking pose will automatically trigger a synchronizing of the character's arms in order to achieve better balance.

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The character's reactive skills permit the animated character to recover from various undesirable positions and situations, such as being prone or supine on the ground, or under attack from another character. The user can explicitly activate the reactive behavior at any time. This is done, for example, if the character is falling and the user wants the character to gracefully handle the fall. The reactive behaviors will activate a series of controllers that will attempt to reorient the character into a safe state, such as standing or resting. In addition, the user can allow the reactive controller to run passively in the background, allowing it to usurp control from the user automatically.

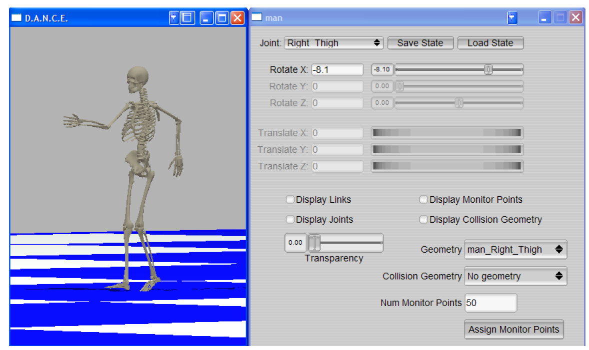

Figure 1: Generating a controller via keyframed pose..

Our characters exist in R^3 and have 18 degrees of freedom (DOF). For the purposes of balance and better control, we have constrained the root joint to one rotational axis, which allows our characters to have static balance. Changes in orientation of the root axis can be made through simple kinematic "hops", which allow the character to reorient themselves and move in 3D.

Thus, our interactive character has three layers of control: 1) a keyframed pose control, 2) a set of heuristics used to achieve better poses under dynamics, and 3) a layer of reactive control that can be activated during physical interaction or imbalanced states.

Motion capture synthesis, keyframing, dynamic control and hybrid techniques must be combined in order to generate high-level, autonomous and interactive behavior that is effective under a wide range of circumstances. We present this application as a first step towards combining a number of these disparate techniques in order to achieve the goal of an intelligent, controllable character.

References

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