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Adaptive Motion Synthesis based on Symetry of Lie Group

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Abstract

In this paper, we propose an new approach for synthesis physics based character motion. This approach produces energy efficient motion while involves very little computational cost. We propose that motion is made up of many motion primitive, motion adaption is achieved through a kind of group action on the motion primitive. Some properties of motion primitive are kept during motion adaptation. This idea can be modelled with Lie Group and its Symetry Property. Via our method, the original variational programming method are simplified as an element searching problem on the Lie Group Manifold. Thus computational cost are greatly reduced.

Categories and Subject Descriptors (according to ACM CCS): I.3.7 [Three-Dimensional Graphics and Realism]: Animation

1. Introduction

Human beings are very sensitive to motions. From the variety in motion details, humans can infer the changes in mental states, health conditions or even the surrounding environment. This makes Character Motion Synthesis (CMS) a challenging task. In industry, high quality motions are still majorly generated by animators' manual work. Because of the complicate structures of characters, a large number of joints need animator to tweak and setting key frames. To make things worse, it is very difficult to reuse these motion data. When the environment or the character changed, the animators have to manually design new motions.

In the past two decades, lots of work has been published to achieve the target of generating realistic character motions. Many researchers are trying to generate lifelike motions automatically by simulating the dynamics of body, environment and the neural control system. However since each virtual character is full of redundant degree of freedom, it not only increases the computational load, but also makes the solution nondeterministic.

In Biology, researchers found out some important features for the motions of living creatures:

ADAPTIVE

Natural motions are adaptive to the changes in the environment or body conditions. For example, a human being can easily adjust its walking motion according to different terrains.

AGILE

The reaction of human and most animals are very fast. Even in a very complicated changing environment, human can change their motions in real time. However from the biology research, the simple functionality and slow processing speed of human neural system make it almost impossible to solve complex motion control problem in a real time.

ENERGY EFFICIENT

According to Darwin's Theory of Evolution, a natural motion should be energy efficient. Live creatures spent far less energy than we expected. An example is that the energy consumed by human walking is only 10% of that for a robot of the same scale.

Current Researches have not anwsered above questions feasibly.The above three important features are very difficult to achieve by current CMS methods.

MOTION PERCEPTION

Perhaps the one of the most important we neglected in in CMS research is **motion perception**. For compute animation applictation, animations don't have to be physically corrected as long as audience don't notice. An interesting question is how can a human find the artifacts in motion instinct, when there is no time for computing the physics reality. An alternative idea is motion perception is based on some key charactersitics of motion. These key features are kept unchanged during motion adatpiton, and are called motion signature.

Contribution

In our research, based on the new theory in neural control research, we developed an noval motion control and computation framework. The biological idea is neural system don't have to synthesis motion from group up. Motion is made up of many motion primitives, neural control system modifies the basic motion primitive to form new motion. During motion adaption, some key properties of motion primitives are kept unchanged. For mathematical point of view, such invariable characteristics are called motion invariety, the adaption action that keep motion invariebility form a manifold of Lie Group. Complicate Motion Synthesis Problem are simplified as search an element from the corresponding lie group manifold. This greatly reduced the computational load and result adaptive and believable motion.

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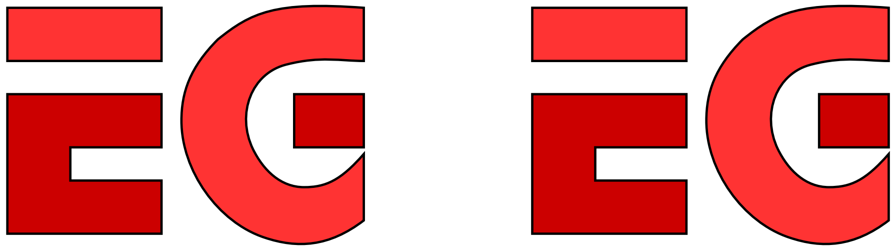

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