Abstract

Generating natural-looking motion for virtual characters is a challenging research topic.

It becomes even harder when adapting synthesized motion to interact with the environment. Current methods are tedious to use, computationally expensive and fail to capture natural looking features.

These difficulties seem to suggest that artificial control techniques are inferior to their natural counterparts.

Recent advances in biology research point to a new motor control principle: utilizing the natural dynamics.

The interaction of body and environment forms some patterns, which work as primary elements for the motion repertoire: Motion Primitives.

These elements serve as templates, tweaked by the neural system to satisfy environmental constraints or motion purposes.

Complex motions are synthesized by connecting motion primitives together, just like connecting alphabets to form sentences.

Based on such ideas, this thesis proposes a new dynamic motion synthesis method.

A key contribution is the insight into dynamic reason behind motion primitives: template motions are stable and energy efficient.

When synthesizing motions from templates, valuable properties like stability and efficiency should be perfectly preserved.

The mathematical formalization of this idea is the Motor Invariant Theory and the preserved properties are motor invariant

In the process of conceptualization, new mathematical tools are introduced to the research topic. The Invariant Theory, especially mathematical concepts of equivalence and symmetry, plays a crucial role.

Motion adaptation is mathematically modelled as topological conjugacy: a transformation which maintains the topology and results in an analogous system.

The Neural Oscillator and Symmetry Preserving Transformations are proposed for their computational efficiency.

Even without reference motion data, this approach produces natural looking motion in real-time. Also the new motor invariant theory might shed light on the long time perception problem in biological research.