White Paper

Dynamic Motion Synthesis

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2 Introduction

Dynamic Motion Synthesis is a completely new approach to 3D character animation. Unlike conventional animation techniques, such as keyframing or motion capture, Dynamic Motion Synthesis uses the processing power of the CPU to create the character's movements in real-time. This is achieved by fully simulating the 3D character, specifically its motor control system and physical body.

Dynamic Motion Synthesis has two fundamental benefits over conventional techniques: 1) it dramatically reduces animation asset production time and costs; 2) it produces fully interactive 3D characters.

This short white paper outlines the concept of Dynamic Motion Synthesis. It argues that Dynamic Motion Synthesis is the only approach capable of economically meeting the animation asset requirements of both an increasingly demanding vfx industry and the next generation of electronic entertainment platforms. Moreover, it is the only approach capable of creating truly interactive characters and gameplay.

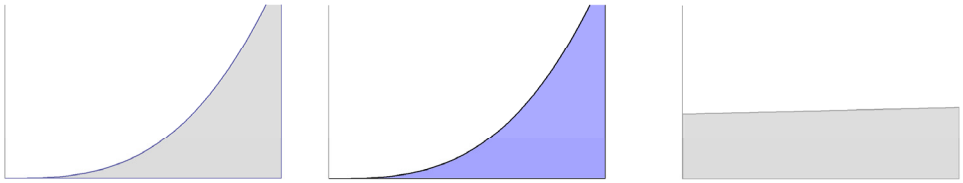
3 Conventional Animation – The Issues

3.1 Conventional Asset Generation Does Not Scale Up

Currently, most 3D animation assets are either produced manually via keyframing or through motion capture.

Both techniques produce canned animation of sufficient quality, but both are also proving costly and time intensive, requiring game studios and visual effects houses to spend significant resources on 3D animation.

Recent history suggests that the exponentially increasing capabilities of new hardware (both console and PC) also gives rise to exponentially increasing volumes of assets. Therefore, as the three graphs below show, when it comes to developing titles for next-generation hardware it will not be possible to cost-effectively meet the explosion of asset requirement with current animation techniques.



1) Processing power 2) Asset requirements 3) Animation productivity

3.2 Current Animation Assets Are Static

Currently, most 3D animation is canned. It is produced manually and then played back in essentially fixed form. As a consequence, current animation assets are not fully interactive; thus putting major limitations on realism, believability and gameplay. For example, despite the availability of high-quality motion capture data, it is not possible to create believable and coherent American football tackles as the infinite number of possible character interactions cannot be predicted or produced beforehand.

4 Animation Assets Should Be Generated By the CPU

The solution to the asset problem outlined above is to decouple the asset generation curve (graph 2) from manual constraints (graph 3), and to couple it with the continuing advances in computing power per dollar (graph 1). This means that, for upcoming asset requirements to be met, **the CPU must generate the assets**. In other words, the very cause for the increased asset requirements should be used to meet them.

Secondly, if animation assets are synthesised by a sufficiently fast CPU, they need not be static but can be dynamic and adaptive. This means that **animations can be fully interactive and adapt to user input and a changing or unpredictable environment**.

5 Dynamic Motion Synthesis

Dynamic Motion Synthesis is the process of using the CPU to generate animation assets.

With this approach, **3D characters essentially animate themselves** and produce movements that are **unique every time**.

The use of the term *Synthesis* implies that the underlying motion processes is fully understood and replicated in simulation. Dynamic Motion Synthesis does this by accurately simulating the 3D character's **motor nervous system** and **physical body**. When a character moves, rather than using a rudimentary technology such as inverse kinematics, Dynamic Motion Synthesis simulates the actual nervous impulses that move the muscle fibres that in turn move the

skeleton. The result is extremely realistic animation produced orders of magnitude quicker than using conventional techniques.

Dynamic Motion Synthesis is R&D intensive because it relies heavily on Artificial Intelligence (AI) techniques related to those used in robotics. In addition, because the resultant animations are designed to look life-like, biology-based or biology-inspired controller approaches are employed. These result in a wide-ranging library of Adaptive Behaviours that the animator can chose from; Stagger, Jump, Tackle, Arms Protect Head, Catch etc.

Fig. An Adaptive Behaviour: The character actively staggers backwards in response to a force.

6 The Animator as Director

With Dynamic Motion Synthesis, animators remain in control of the animation process.

However, unlike keyframing, the animator need not create the animation manually. Instead, they instruct the 3D character to perform a sequence of **behaviours**. And, unlike motion capture, the animator does not hand over the asset production process, but remains in charge throughout.

This creative freedom is married with further technology developed by NaturalMotion, such as **Active Posing**, which allows animators to set end poses that the character will try and achieve using its own muscle power. This allows continuity between animation sequences to be easily maintained, and provides an additional layer of control over Adaptive Behaviours.

7 Real-time Performance

On current generation PCs, dynamically simulated characters run in real-time, or faster. This means that canned animation assets can be synthesized on-the-fly, or, we emphasise again, can be produced orders of magnitude faster than with conventional animation techniques.

In practice, the performance bottleneck of Dynamic Motion Synthesis is the physical simulation of the body. The AI routines (once developed) take up only a fraction of the total CPU cycles.

8 Summary

1. Current animation techniques do not scale up to increasing next-generation asset requirements.
2. Current animation assets are canned and not truly interactive, thus causing major limitations on realism, believability and gameplay.
3. The solution is to dynamically synthesise animations using the hardware's CPU.
4. Dynamic Motion Synthesis creates 3D animation in real-time, by using a combination of artificial intelligence and physical simulation.
5. Dynamic Motion Synthesis essentially uses the increasing computing power to meet the increased asset demand.
6. Characters created with Dynamic Motion Synthesis are truly interactive; animations are adaptive, variable and unique.
7. Animators are central to the asset generation process with Dynamic Motion Synthesis. They instruct the 3D character, rather than manually animating it.
8. Dynamic Motion Synthesis runs in real-time on current specification PCs.