Bond: USD-Integrated Hybrid CPU, GPU Deformation System

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Figure 1: a) *Bond* rig in Maya viewport; b) *Bond* corresponding geometry deformation graph;

ABSTRACT

We introduce *Bond*, a proprietary deformation system able to load geometry data directly from Pixar™ Universal Scene Description (USD) and to compute complex deformation chains on the GPU using NVIDIA® CUDA®. *Bond* also integrates tightly with Autodesk Maya®. This system follows on from our work to integrate USD into our animation pipeline [Baillet et al. 2018].

Bond has been used to deform all characters and props on the *Peter Rabbit 2* movie's 1300 shots to achieve high frame rate during playback and rig interaction.

CCS CONCEPTS

• **Computing methodologies** → **Computer graphics**.

KEYWORDS

animation deformation USD maya

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1 INTRODUCTION

Bond was designed to meet two main goals: to improve rig load times and to increase the execution speed of complex deformations.

Firstly, to decrease rig load times we leveraged our new animation pipeline built on top of USD and the USD binary *Crate* file format.

Secondly, in 2016 we had established via a set of prototypes that the fastest way of computing the deformation of production-sized meshes was to use GPUs and the CUDA programming language.

We started developing *Bond* by simply using USD as our "Rig Bindings" serialization system on the first *Peter Rabbit* production: we created a set of tools to import and export Maya skin weights and blend shapes to and from USD files. This gave us highly valuable production data that we could use to further test *Bond*.

The full *Bond* deformation system was used in production on the *Peter Rabbit 2: The Runaway* sequel in 2018.

2 RELATED WORK

We evaluated Pixar's *usdSkel* schemas very early on, but *usdSkel*'s requirements about being optimized for on-device deformation or crowd characters were too restrictive for our creative needs. *Bond* instead uses custom USD schemas to store arbitrarily complex bindings data in an efficient and lossless way. We would be excited to share our findings and our USD rig bindings schemas.

3 ARCHITECTURE

The *Bond* core engine is written in *C++14* and is exposed via a simple *C* API. We typically use it embedded in Maya, but it can also run standalone. It has a plugin system to provide node implementations for both CPU and GPU modes. The memory is fully managed by the Bond Chain on both CPU and GPU.

We chose to create linear chains of Bond nodes, where each node is evaluated in order. Bond processes buffers, which have a type and a string ID, and tracks which buffers are requested by the client and which nodes can provide them (e.g. Maya viewport requires point positions, triangles, normals, and possibly more buffers for complex shading).

*Also with Frontier Developments.

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