Introducing a Modular Concept for Exchanging Character Animation Approaches

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Abstract

Nowadays, motion synthesis and character animation systems are used in different domains ranging from gaming to medicine and production industries. In recent years, there has been a vast progress in terms of realistic character animation. In this context, motion-capture based animation systems are frequently used to generate natural motions. Other approaches use physics based simulation, statistical models or machine learning methods to generate realistic motions. These approaches are however tightly coupled with the development environment, thus inducing high porting efforts if being incorporated into different platforms. Currently, no standard exists which allows to exchange complex character animation approaches. A comprehensive simulation of complex scenarios utilizing these heterogeneous approaches is therefore not possible, yet. In a different domain than motion, the Functional Mock-up Interface standard has already solved this problem. Initially being tailored to industrial needs, the standards allows to exchange dynamic simulation approaches such as solvers for mechatronic components. We present a novel concept, extending this standard to couple arbitrary character animation approaches using a common interface.

CCS Concepts

•***Computing methodologies*** → *Collision detection; Simulation types and techniques; Animation;*

1. Introduction

Motion synthesis is an important aspect of many sectors in nowadays life, ranging from gaming to automotive industry. In recent years, there has been a vast progress in terms of character animation techniques, ultimately increasing naturalness and realism. The predominant proportion of the utilized approaches rely on motion capture data and use motion blending techniques. Apart from this, there are approaches which are based on artificial intelligence [LZX*17], physics simulation [TLC*10] or statistical concepts [MC12]. While motion blending techniques are widely spread and provided by most target environments, the latter approaches are commonly tailored to specific platforms and use-cases. To incorporate these systems into novel platforms, high porting efforts are usually the consequence. Standardized components, embedding heterogeneous approaches would significantly reduce these porting efforts, while providing additional benefits such as the comprehensive simulation of complex human motions. However, for exchanging context dependent character animation algorithms, there is no solution available, yet. In a different domain than character animation, the Functional Mock-up Interface (FMI) [BOA*11] has already solved this problem by encapsulating various simulation approaches using a common interface. We present a novel concept, extending this standard, to incorporate arbitrary character animation approaches by so called Motion Model Units. Overall, the novel approach targets to enable the simulation of complex tasks by means of co-simulation of these distinct units.

2. Concept for Exchanging Character Animation Approaches

Based on the FMI approach, a novel concept for exchanging dynamic character animation systems is introduced. With the FMI standard, complex systems like industrial machines can be simulated using specialized approaches such as solvers of pneumatic cylinders or kinematic models. The respective sub-simulations are embedded within standardized Functional Mock-up Units (FMUs),

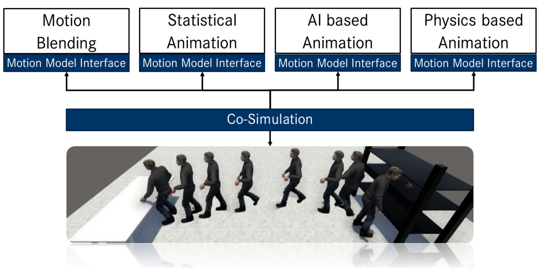

Figure 1: *Principle of the novel approach, which couples heterogeneous character animation approaches by a standardized interface.*

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being represented by compiled C-Code and a XML description file [BOA*11]. Several of these co-simulations are sequenced by a master (co-simulator). This component communicates with the FMUs at discrete points in time and merges the computed results of all heterogeneous approaches into a common simulation. Transferring this concept to the domain of character animation, we present so called Motion Model Interfaces (MMIs) and their implementations called Motion Model Units (MMUs) which allow to incorporate diverse character animation approaches into a common framework. Figure 1 shows the main idea of the novel approach.

2.1. Motion Model Units

The proposed MMUs are an essential part of the novel concept. These units contain the actual animation approach and a do-step routine which is executed in each update step of the simulation. Inside this routine, a motion is computed using the internal solvers, which can be realized with diverse character animation techniques. Initially, the context of the motion must be set (e.g. grab object1 with left hand). Therefore languages such as the behavior markup language [KKM*06] can be utilized. After each do-step routine, the results are provided as output and are further incorporated by the co-simulator. For exchanging this static poses, widely spread formats like bvh or fbx can be used. Moreover, to reduce implementation efforts, the MMUs can use additional services like path planning, collision resolving and scene informations through defined interfaces. Additionally, each MMU contains a skeleton representation to allow the retargeting on a global reference avatar, as well as a priority value for the co-simulation.

2.2. Co-Simulation

Having distinct MMUs comprising specific approaches, the separately generated motions must be merged to obtain natural motions. Therefore a co-simulator is required, which orchestrates the execution of the MMUs according to their priority. In this context, the component merges and overlaps the motions, while considering the constraints of the avatar and MMUs. This orchestration can be realized by hierarchical motion controllers like introduced in [FXS12]. For merging heterogeneous skeletons, a retargeting to a global reference skeleton is applied for each MMU. To process multiple MMUs simultaneously, concepts such as blending masks can be applied. Moreover, since two consecutive MMUs might start/end with a completely different pose (e.g. MMU1 ends with t-Pose, MMU2 starts with idle pose), the transition between the respective units must be explicitly modeled. Therefore motion blending (e.g. inverse blending), statistical or AI-approaches can be utilized.

2.3. Benefits of MMU approach

If utilizing a common exchange format for character animation approaches, there are various benefits. Diverse motion synthesis systems can be easily incorporated into existing environments, thus reducing porting efforts significantly. In this context, specialized or proprietary solutions can be combined in a common co-simulation to allow a comprehensive simulation, without relying on the actual source code. For instance, approaches being specialized on the simulation of motions within less constrained environments could be combined with systems being focused on planning within highly collision-afflicted settings. Whereas, the first systems produce natural motions in a short time, they oftentimes fail to handle highly constrained environments. The latter systems might need significantly more time, however are able to produce collision-free motions. By combining these approaches, the benefits of both systems could be supplemented. Furthermore, these heterogeneous systems can be additionally benchmarked in a common target environment without additional implementations efforts, thus allowing to comprehensively evaluate recent character animation approaches.

The MMU approach allows to generate complex motions by a hierarchical decomposition of atomic MMUs. As an example, the task "pick up object A" can be subdivided into the motions "walk to object A", "reach object A", "grasp object A", "retrieve object A". Therefore various use-case specific motions can be generated by the combination of atomic MMUs, which can be provided by vendors. Moreover, already available implementations of MMUs can be instantly reused for the realization of novel motions.

3. Conclusion & Outlook

The applicability of the novel concept has been validated using an exemplary implementation in the Unity3D environment, combining a statistical motion synthesis approach inspired by [MC12] with Smartbody [Sma18] and a path planning tool. By linearly interpolating the transitions between the different units, the system is able to produce natural motions, while amplifying the benefits of the individual approaches. In future publications, the overall performance will be further analyzed in detail, while additional abilities and principles of the planned MMU standard will be discussed.

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