

Make Way for the Robot Animators!

Bringing Professional Animators and AI Programmers Together in the Quest for the Illusion of Life in Robotic Characters

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Abstract

We are looking at new ways of building algorithms for synthesizing and rendering animation in social robots that can keep them as interactive as necessary, while still following on principles and practices used by professional animators. We will be studying the animation process side by side with professional animators in order to understand how these algorithms and tools can be used by animators to achieve animation capable of correctly adapting to the environment and the artificial intelligence that controls the robot.

Robotic characters are becoming widespread as useful tools in assistive, entertainment, tutoring and manufacturing applications. This is leading to the need of having better animation built into these robotic systems. Traditional character animation relies on having animators design animations which are then faithfully played back on the character.

Now we pose the question: how can we have the animation process integrated with the artificial intelligence agent (AI) that drives the robot? We want the animation to be adaptable to both the agent's internal state and its external environment, while keeping the quality of the animation in line with what an animator expects. The main question here is not just whether or not the users will like the robot or find it believable; instead, we want to have animators collaborating with the programmers in a way that the robot's animation during interaction is satisfying to the actual animators.

Motivation and Goals

Animating an interactive robot is quite different from animating a virtual character. The biggest differences we point out from our experience are the fact that the robot shares the same physical space that humans do, and as such, follow on the same laws of physics. While animating a robot, animators must take into account gravity, inertia, and the actual torques that the robot's motors can achieve. Because they are physical and can interact with users through various types of interfaces and sensors, robots also seem to lead to a much higher expectation from the users, and appeal more to some interactive non-verbal behaviours like gazing, rapport or proxemics than a virtual character would.

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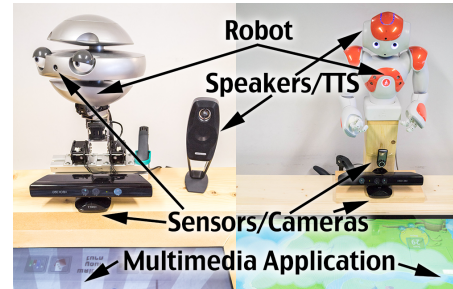


Figure 1: Two example scenarios featuring a touch-based multimedia application, sensors, and different robots.

On this issue of breaking out the traditional animation process into one that can be integrated with an AI, we highlight two different types of animation:

Pre-designed character animation is when artists design an animation for a specific character topology using professional animation software, such that the animation can then be played back in a character with that same topology;

Procedural character animation is when a software algorithm is able to synthesize the character's animation in real-time, by having some higher-level control software tweaking the parameters of the algorithm.

The purpose of our work is to merge both approaches by:

1. Finding out how to build character animation algorithms that can be tweaked by the AI that controls the character during interaction with users and the external physical world;
2. Having these algorithms make use of or blend with pre-designed animation;
3. Bringing animation artists into the process of achieving the previous points.

Our belief is that robot animation should be supported by principles and practices of professional character animation.

Related Work

The influential works by Bates (Bates 1994) and Reilly (Reilly 1996) were some of the first to seek inspiration from the arts, in particular from the well known "The Illusion

of Life”, which describes over 60 years of experience in creating characters at the Walt Disney Animation Studios (Thomas and Johnston 1995). More recently, van Breemen also pointed *user-interface robots to have the same problem of early day’s animations: they miss the illusion of life*’ (Breemen 2004). He defined robot animation as *‘the process of computing how the robot should act such that it is believable and interactive’*. When pioneering 3D character animation for Pixar Animation Studios, Lasseter argued that the traditional principles of animation have a similar meaning across different animation medium (Lasseter 1987).

Several authors have since then looked into developing frameworks for expressive behaviour in interactive characters. However, most have approached the synthesis of animation in specific modalities like gesturing, and animation of humanoid characters (Cassell and Bickmore 2001; Badler et al. 2002; Thiebaut et al. 2008). Many authors follow the SAIBA/BML framework (Kopp, Krenn, and Marsella 2006), which is currently very popular in the Intelligent Virtual Agents (IVA) community, but again, authors have used it mainly oriented at characters or robots that are humanoids (Niewiadomski et al. 2011; Heloir and Kipp 2009).

In previous work we have shown an EMYS robot continuously interacting with both users and the environment in order to provide a more lifelike experience (Ribeiro, Vala, and Paiva 2012; Pereira, Prada, and Paiva 2012). Our latest work on IVAs demonstrates the use of Thalamus to develop component-based agents that separate and reuse high-level intention generation modules and behaviour planning modules in different applications and embodiments, based in the SAIBA and BML standards (Ribeiro et al. 2014a). In particular, we have been developing the Skene module which provides high-level semi-automated gazing and expressive behaviour based on utterances annotated with expressive instructions (Ribeiro et al. 2014b).

In the field of robot animation, Van Breemen’s work was one of the first to automate one of Disney’s principles of animation (Slow-In/Slow-Out) (Breemen 2004). Other authors, including ourselves, have also attempted to understand how the principles of animation can be used in robot animation (Shusong and Jiefeng 2008; Takayama, Dooley, and Ju 2011; Gielniak and Thomaz 2012; Ribeiro and Paiva 2012). Other fields have already succeeded in creating technological tools for artists to use. The Unreal Development Kit¹ enables artists and game programmers to work side-by-side; tools like Pure Data² give musicians and performers the ability to program their own instruments and performances; even in the field of animation, Houdini³ is used in mainstream movies to generate assets and special effects.

More recently we presented Nutty Tracks, an animation engine that allows to animate any robotic character using the animation tools commonly used by animators (Ribeiro, Paiva, and Dooley 2013). Nutty supports both the design and blending of pre-designed animation with procedural animation by specifying parameters in real-time. It brings anima-

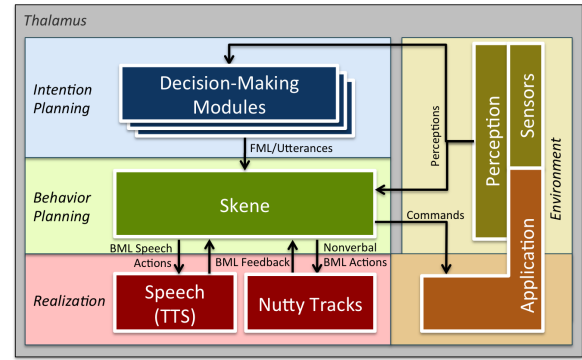


Figure 2: The initial model for expressive robotic characters we are building on. (Ribeiro et al. 2014b)

tion data to a symbolic level, in order for AI systems to be able to control such parameters during an interaction.

Vision

Current generic robot animation and interaction systems require deep mathematical and programming skills, which makes it difficult for artists to collaborate with the programmers. This problem poses to us as the challenge of bringing these two worlds together. The connection will surely lie on designing an animation system that can connect with an AI and learn with the animator’s experience while they define and tweak how such AI generates, selects and blends the robot’s animations.

Our challenge requires some studies involving professional animators in order to understand which are their requirements for using an animation system as we propose. An initial study should hint us on how their creative process works, and what type of tools and techniques they would expect to use in different situations. From there we will be developing algorithms and tools in Nutty Tracks that can meet the animator’s needs and learn from their experience. Next we will develop an interactive scenario with their collaboration, following an iterative design approach (Meerbeek, Saerbeck, and Bartneck 2009) based on tools like Thalamus and Skene (Ribeiro et al. 2014a; 2014b). An initial model of how the different components of such scenario can integrate is illustrated in Figure 2. This model represents the current state of the architecture we are using in different projects to develop and drive robotic IVAs. The Nutty Tracks component however, is still bare of learning mechanisms and proper artist-oriented controllers and algorithms.

The evaluation of our work will both consider how users respond to that scenario with and without the new animation technology, and also how the animators feel about the final result. We expect our work to lead to a new field in robotics, which we call Expressive Robotics. This field will, in turn, lead to new techniques in animation and also new standards and trends in human-robot interaction and robotic systems design.

¹<http://www.unrealengine.com/udk/>

²<http://puredata.info/>

³<http://www.sidefx.com/>

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Acknowledgments

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