Creating Interactive Robotic Characters

through a combination of artificial intelligence and professional animation

Tiago Ribeiro
INESC-ID & Instituto Superior Técnico,
Universidade de Lisboa
Portugal
tiago.ribeiro@gaips.inesc-id.pt

Ana Paiva
INESC-ID & Instituto Superior Técnico,
Universidade de Lisboa
Portugal
ana.paiva@inesc-id.pt

ABSTRACT

We are integrating artificial intelligent agents with generic animation systems in order to provide socially interactive robots with expressive behavior defined by animation artists. Such animators will therefore be able to apply principles of traditional and 3D animation to such robotic systems, and thus allow to achieve the illusion of life in robots. Our work requires studies and interactive scenario development alongside with the artists.

1. INTRODUCTION

As robots shift from the industries into peoples' lives, the concept of having robots interacting socially with humans on a daily basis grows stronger and consolidates as a glimpse of a realistic future. While people are mostly familiar with highly autonomous and expressive robots from science fiction and pop culture, researchers in the human-robot interaction (HRI) field have been struggling to achieve the kind of naturalness that is conveyed in such fiction. In HRI we need robots to interact with humans in real physical environments. The animation must be able to adapt both to how the users are behaving, and also to what is happening in the robot's surrounding physical environment. Our work is based on the belief that a major step in HRI can be achieved by bringing professional animators to work side by side with robotic and artificial intelligence (AI) programmers. Animators have gathered knowledge on creating the illusion of life in animated characters for over a hundred years. Their theories, however, is still mostly applied to traditional and computer-graphics animation, which in turn is designed for a specific character and scene, so that the animation can be played back faithfully on that character.

Our aim is to have the robot animation process integrated with the AI agent that drives the interaction of a robot with users, thus making the animation 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 would expect. The main question here is not just whether or not the users like the robot or find it believable; instead, we want to have animators collaborating with the programmers in a way that the final robot animation during interaction is satisfying to the actual animators.

HRI'15 Extended Abstracts, March 2–5, 2015, Portland, OR, USA.
ACM 978-1-4503-3318-4/15/03.
http://dx.doi.org/10.1145/2701973.2702100

2. RELATED WORK

Several authors have approached the synthesis of animation in specific modalities like gesturing, and animation of humanoid characters (e.g. [15]). Many authors follow the SAIBA/BML framework [8], but this has been used mainly oriented at characters or robots that are humanoids (e.g. [6]). BML specifies only a high-level animation script, which is used to render animations, either by selecting (or composing) then from a pre-existing library, or in more advanced cases, by performing example-based motion synthesis [4]. Pereira, colleagues, and the authors have placed an EMYS robot continuously interacting with users and the environment while playing a touch-based game in order to provide a believable robotic character with social presence [11].

2.1 The Illusion of Life and Robot Animation

Bates [1] was one of the first to seek inspiration from arts to develop interactive agents. He and other authors cite "The Illusion of Life" as the main reference for animation theory, as it describes over 60 years of character and story development at the Walt Disney Animation Studios [16]. 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 [9]. van Breemen pointed *user-interface robots to have the same problem of early day's animations: they miss the illusion of life'* [3]. He defined robot animation as *'the process of computing how the robot should act such that it is believable and interactive'*. More recently, other authors including ourselves have also argued how the principles of animation can be used in robot animation (e.g. [14, 12]).

2.2 Algorithms and Tools for Artists

The Interactive Theatre is one of the first interactive robot animation systems to be developed with a mix of AI and artistic perspective [2]. A robotic anemone was animated in collaboration with animators to portray a lifelike quality of motion while reacting to some external stimuli like the approach of a human hand. The robot was controlled by a behavior-based AI engine in order to dynamically change the appearance of its motion depending on events captured by a vision system. Van Breemen automated Disney's Slow-In/Slow-Out principle of animation into a robot animation system that used the iCat robot [3]. Hoffman created a robot

that automatically responds to music in order to perform beat-synchronized gestures while maintaining eye-contact with users [7]. Gielniak, Thomaz and colleagues have been developing algorithms that can process motion signals in real time in order to add variance, exaggeration and secondary motion to a robotic character's movement (e.g. [5]). Other artistic fields have already succeeded in creating technological tools for artists, such as game design and development (e.g. The Unreal Development Kit[1]), music and performance tools (e.g. Pure Data[2]) and special effects animation (e.g. Houdini[3])). More recently, we developed the Nutty Tracks animation engine that supports both the design and blending of pre-designed animation with procedural body-independent animation by specifying parameters in real-time [13].

3. RESEARCH APPROACH

Previous attempts of bringing animators closer to working with robots have been mostly directed at specific robots. In our case, we are aiming at techniques that can be used across embodiments. Our challenge first requires studies with professional animators in order to understand their requirements for using an animation system as we propose. We expect those studies to inform not just on what algorithms are of most interest for animators, but also how they expect such algorithms to be parametrizable, which factors an AI agent should be aware of in order to control the rendered animation following their artistic standards, and even input on robot form and design. Another question we have is if and how animators expect to be able to use and blend pre-designed animations with procedural and mathematical algorithms. Such motion operators, algorithms and tools will then be implemented generically in *Nutty Tracks*. By integrating them with an AI agent, an interactive scenario will be developed following an iterative design approach [10], with the collaboration of the animators, in a way that the AI controls the character's animation parameters in real-time during an interaction with users. Nutty can also be used to develop controllers needed specifically for robots (e.g., to deal with acceleration and velocity limits).

A final study will use different robotic embodiments to run that same interaction. We will evaluate not only how users respond to the scenario with and without the generic animation system, but also how satisfied the animators feel regarding the final result, and which factors on each embodiment posed as either satisfying or dissatisfying to them.

Our belief is that in either ways, robot animation should be supported by principles and practices of professional character animation in order to achieve a more natural expressiveness, and that it is possible to integrate AI and an animation system in order to do so generically and achieve lifelike animation on interactive robots. In the end, our work should contribute both by with the technology that allows animation algorithms to be used in robot across embodiments, and also with the hint on how animators' creative process works, and what type of tools and techniques they would use in different situations. This will allow the whole community and industry to move forwards towards on achieving the illusion of life on interactive robots by leading 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/`

4. ACKNOWLEDGMENTS

This work was partially supported by the European Commission (EC) and was funded by the EU FP7 ICT-317923 project EMOTE and partially supported by national funds through FCT, under the project PEst-OE/EEI/LA0021/2013.

5. REFERENCES

[1] J. Bates. The Role of Emotion in Believable Agents Joseph Bates. *Emotion*, 1994.

[2] B. C. Breazeal, A. Brooks, J. Gray, M. Hancher, J. Mcbean, D. Stiehl, and J. Strickon. Interactive Theatre. 46(7):76–84, 2003.

[3] A. V. Breemen. Bringing robots to life: Applying principles of animation to robots. *CHI2004*, 2004.

[4] A. W. Feng, Y. Xu, and A. Shapiro. An example-based motion synthesis technique for locomotion and object manipulation. *ACM SIGGRAPH - I3D '12*, page 95, 2012.

[5] M. J. Gielniak, C. K. Liu, and a. L. Thomaz. Generating human-like motion for robots. *The International Journal of Robotics Research*, 32(11):1275–1301, July 2013.

[6] A. Heloir and M. Kipp. EMBR: A realtime animation engine for interactive embodied agents. *2009 3rd International Conference on Affective Computing and Intelligent Interaction and Workshops*, Sept. 2009.

[7] G. Hoffman. Dumb robots, smart phones: A case study of music listening companionship. *RO-MAN'12*, pages 358–363, Sept. 2012.

[8] S. Kopp, B. Krenn, and S. Marsella. Towards a common framework for multimodal generation: The behavior markup language. In *Intelligent Virtual Agents*, pages 205–217, 2006.

[9] J. Lasseter. Principles of Traditional Animation Applied to 3D Computer Animation. *ACM Siggraph Computer Graphics*, 21(4):35–44, 1987.

[10] B. Meerbeek, M. Saerbeck, and C. Bartneck. Iterative design process for robots with personality. In *Symposium on New Frontiers in Human-Robot Interaction*, pages 94–101, Edimburgh, 2009.

[11] A. Pereira, R. Prada, and A. Paiva. Socially present board game opponents. In *ACE'12*, 2012.

[12] T. Ribeiro and A. Paiva. The Illusion of Robotic Life Principles and Practices of Animation for Robots. In *Human-Robot Interaction*, 2012.

[13] T. Ribeiro, A. Paiva, and D. Dooley. Nutty tracks: symbolic animation pipeline for expressive robotics. *ACM SIGGRAPH 2013 Posters*, page 4503, 2013.

[14] L. Takayama, D. Dooley, and W. Ju. Expressing Thought : Improving Robot Readability with Animation Principles. pages 69–76, 2011.

[15] M. Thiebaux, M. Rey, A. N. Marshall, S. Marsella, and M. Kallmann. SmartBody : Behavior Realization for Embodied Conversational Agents. *Information Sciences*, (Aamas):12–16, 2008.

[16] F. Thomas and O. Johnston. *The illusion of life: Disney animation*. Hyperion, 1995.