Synthetic Social Relationships in Animated Virtual Characters

Bill Tomlinson & Bruce Blumberg
Synthetic Characters Group, MIT Media Lab
NE18-5FL, 77 Massachusetts Ave., Cambridge, MA 02139
+1.617.452.5611
{badger | bruce}@media.mit.edu

ABSTRACT

We describe a multi-agent system based on the social behavior of the gray wolf (*Canis lupus*). This system, shown as an interactive installation at SIGGRAPH 2001, allows several participants to direct semi-autonomous wolf pups in a virtual pack. The heart of the system is a simple, biologically-inspired mechanism by which synthetic entities form social relationships with each other. This mechanism enables the virtual wolves to form relationships with each other that are both biologically plausible and engaging to participants in the installation. Systems like the one described in this paper could be of use in a variety of domains, for example, as platforms for simulation, as educational aids, and as entertainment media.

1. INTRODUCTION

Animals provide an excellent example of autonomous interacting entities. In particular, mammalian social behavior enables multiple complex individuals to interact repeatedly over relatively long time scales. Context preservation [Cohen 1999] is the essence of social behavior – behaving differently toward individual social partners. A social relationship is a remembered construct by which an individual keeps track of its interaction history with another individual, and allows that history to affect its current and future interactions with that individual.

The gray wolf (*Canis lupus*) is one species in which individuals form clear, long-term social relationships with one another [Mech 1998]. In an effort to create a group of virtual creatures that can form relationships with one another, the Synthetic Characters Group at the MIT Media Lab, headed by Professor Bruce Blumberg, has created an interactive multi-agent system based on the behavior of packs of gray wolves. In this paper, we present the system and the mechanism by which the virtual wolves form their relationships.

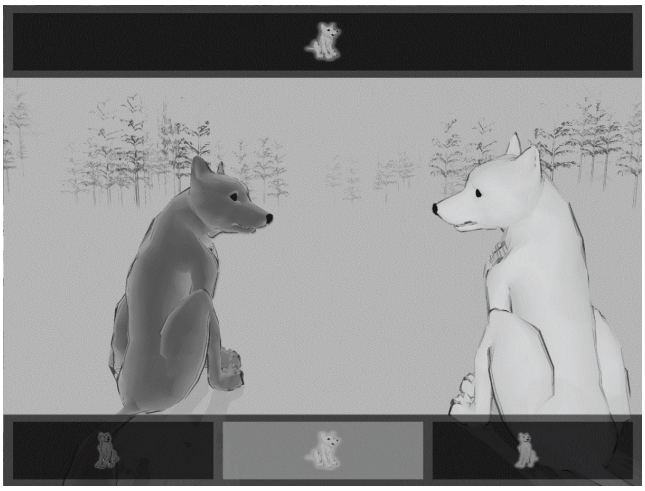

Fig. 1: Two social computational systems exchange a glance.

2. INSTALLATION

An interactive installation featuring the model of social relationship formation presented in this paper was shown in the Emerging Technologies section of SIGGRAPH 2001. In the installation, entitled *AlphaWolf*, three participants help direct the actions of virtual wolf pups in a simulated litter. By howling, growling, whining or barking into a microphone, each participant can tell his pup to howl, dominate, submit or play. The actions that the pup takes affect emotional relationships that the pup forms with its littermates and with the adults of the pack. The pups autonomously maintain these relationships and display them by means of the emotional style in which they take the actions suggested by the participants. The relationships are also displayed to the participant through dynamic buttons at the top and bottom of each screen, which show each of the social partners of that wolf in a dominant or submissive pose that reflects how the participant's pup views that partner.

In addition to the three pups, there are three fully autonomous adults who also inhabit the virtual world. They are similar to the pups in their emotional relationship formation, and use these relationships to decide how to interact with the other members of the pack.

Over the course of the five-minute interaction, each puppy grows up from pup to adult size. By the end of the five-minute interaction, the pups, guided by the users, have worked out their social relationships with the other members of the pack. For a short video describing the *AlphaWolf* installation, please visit:

http://www.media.mit.edu/~badger/alphaWolf/alphaWolf.mov

3. RELATED WORK

Various researchers have studied synthetic social systems from natural models (e.g., [Reynolds 1987]). Hemelrijk [Hemelrijk 1996], for example, did experiments using a similar social relationship mechanism to the one we use in the AlphaWolves. We believe that our 3D animated visualization of the social computational entities makes the project significantly different from her work.

For the *AlphaWolf* project, we used a dimensional approach to emotion (e.g., [Mehrabian 1974]), which maps a range of emotional phenomena onto explicitly dimensioned space. Various researchers have implemented models of emotional learning or memory in non-social domains (e.g., [Velasquez 1998]).

4. MECHANISM

The social relationship mechanism in the virtual wolves is similar to Damasio's Somatic Marker Hypothesis [Damasio 1994]. The essence of the mechanism involves emotion, perception, and learning. Each virtual wolf maintains a simple emotional state that is affected by its interactions with the world. A wolf is able to recognize specific pack mates across multiple encounters. After its first interaction with a certain individual, the wolf forms an "emotional memory" of that social partner. When it again encounters that individual, the emotional memory influences its current emotional state, so that it can "pick up where it left off" with regard to its emotional relationship. At the end of each interaction, the wolf revises its emotional relationship with that social partner. This mechanism allows individual wolves to interact differently with specific social partners, based on the history of interactions between them. As such, we believe that it captures an element of mammalian social behavior in a simple way.

5. CONCLUSION

We have presented a multi-agent system featuring an emotional-memory-based mechanism by which the agents form social relationships with each other. This mechanism incorporates models of emotion, perception, and learning. The system was presented as the *AlphaWolf* installation, shown in the Emerging Technologies section of SIGGRAPH 2001.

The social relationship mechanism is derived from biological studies of animal behavior, simulations of animal behavior and models of emotion. It allows the virtual wolves in *AlphaWolf* to form relationships with each other that resemble the relationships of wild gray wolves.

We believe that the novelty of displaying this social relationship mechanism in a 3D-animated virtual world represents a significant step with regard to the explicability of synthetic social relationships. The interactive experience of *AlphaWolf* proved to be quite engaging for participants, and helped them understand the social relationships of the virtual wolves. We believe that systems like *AlphaWolf* could serve a significant role as platforms for simulation, education and entertainment.

6. ACKNOWLEDGMENTS

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