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Edge of Intention

Submitted to the *Prix Ars Electronica 93*

by the Oz/Animation group:

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This document and the associated videotape describe a realtime, interactive, animated art work entitled "Edge of Intention". Please read this document prior to viewing the videotape.

1 Introduction

Computing and art are becoming increasingly intertwined. Computer animation now greatly influences the film industry, multimedia technologies draw major investments, "interactive digital high definition" television sets containing personal supercomputers seem to be in our future. Beyond these concrete connections, the conceptual implications of robots and other sophisticated machines are increasingly affecting the Arts, while ideas from the Arts and Humanities, such as deconstructionist thinking, gradually infiltrate the theory and practice of computing.

Artificial intelligence (AI) technologies have an essential role to play in this convergence. AI is particularly crucial to future interactive art because works of interactive art must themselves contain artistic knowledge and abilities. They need these to respond in artistically appropriate ways as they interact with the viewer, who is now a participant, without the original artist being present.

A work of interactive art is an emissary of the artist, responsible for details of the interaction that the artist could not precisely anticipate when the work was constructed. This means the artist must strive to create a computing system with a sense of aesthetics, meaning, and the ability to understand and respond to human reactions. The system itself, an emissary, is thus both a work of art and an artist.

It seems to us that in constructing these subtle behaving entities, many traditional technical concerns of artificial intelligence arise. These include how to transfer knowledge into the machine, how to represent that knowledge, and how to process it in ways usually attributed only to humans. The single unusual aspect of this effort is that the domain is the Arts.

The work submitted here, *Edge of Intention*, is an attempt to create an instance of "artificial intelligence based art". In the following, we briefly describe the overall appearance and behavior of the work, interaction with the work, the artistic concept, the technological basis for the work, and present other information requested in the submission form.

2 Appearance and Behavior

This work appears as a realtime, animated, simulated physical world displayed on a computer screen. The world is a 3D space, presented from a fixed point of view. It contains three animated creatures, which interact with each other and with a fourth creature controlled by the user/participant.

Each of the creatures appears as an autonomous, self-controlling, real-time entity. Each seems to perceive its world (including the other creatures), act in response to that world, try to achieve its privately held desires, react emotionally to events that occur, and form simple relationships with other creatures. Each creature has a personality, which is unlike those of the other creatures. The behavior of the creatures is not random, but is also not easily predicted in detail.

We call these creatures "woggles". The particular creatures are named "Bear", "Wolf", and "Shrimp", which are intended to suggest their personalities. These names do not usually appear anywhere in the work when it is publicly displayed.

3 Interaction

The woggles are autonomous. They "live" in their space and interact with each other whether a human is present or not. However, a human participant can enter the world by taking control of a fourth woggle. Using a two button mouse, the user can make the fourth woggle engage in many of the behaviors exhibited by the autonomous woggles.

The primary physical repertoire of the creatures is to jump, slide, change body shape, move the eyes, and change eye shape. In particular, there are two body shape changes that have special social significance.

The first, which we call "hey" or "greeting", is to stretch the body upward for a moment while looking at a particular creature. This may be interpreted as a greeting, as simply acknowledging a creature, or as expressing sympathy. It may also be a request to play "follow the leader", an agreement to play the game, or a request to finish playing the game. Creatures try to determine the intended meaning using context.

The second important shape change is called "in your face". The creature looks at another and puffs up around an axis perpendicular that creature. This makes the first creature look larger in the field of view of the second, and it is generally interpreted as a threatening behavior. Threats are effective in getting the attention of other creatures, but more subtle interaction and relationships are available using "hey".

The fourth woggle, the "user" woggle, is treated by the others exactly as they treat each other. Using simple mouse commands, the user can jump, slide, control the eyes, hey, and threaten. Users who are aggressive will generally provoke fear, anger, sadness, and dislike. Users who are attentive and gentle will generally comfort, please, play with, and make friends with the other woggles.

These emotion words have technical analogs within the minds of the woggles, and thus we are simultaneously speaking technically and subjectively in this characterization. The artistic question, addressed below, is whether the technical capabilities of the woggles clearly convey these subjective internal states, and whether this in turn creates appropriate emotional and intellectual responses in the participants.

The system also includes a sonar system, which allows the creatures some ability to track people walking near the monitor. This information is used by creatures to wake up when sleeping, to look toward people, and to act in ways that might pull a prospective user into using the mouse.

4 Artistic Concept

This work is the result of collaboration between the Oz project and the Graphics & Animation research group at Carnegie Mellon. The goal of Oz is to provide technology that can be used by artists and writers to build dramatic interactive worlds. Such worlds might be expressed as interactive fiction, interactive radio drama, or interactive cinema. The work submitted here might be viewed as a very early predecessor of interactive cinema.

An important element of interactive story-telling worlds, as in traditional drama and narrative, is the presence of rich characters. In interactive media these rich characters must be complete autonomous agents, not just collections of narrative and dialogue. We therefore must strive to build simulated creatures that are believable: the participant must be able to suspend disbelief and treat the agents as living embodiments of the author invented characters.

As this work progresses, and the artistic and technical quality of simulated creatures improves, people interacting with these creatures may begin to feel the bite of philosophical questions that arise in AI research. If AI achieves its grand objectives, the issue of how one judges the presence of thought and feeling in unfamiliar creatures will become a terribly important practical concern.

Our artistic goal in this work is to begin to raise these concerns before they arrive for our society in full force. We have attempted to apply known technology under artistic direction to build suitably confusing creatures, and thus perhaps raise these important issues in personal, emotionally powerful ways. A sign of success for us is when a visitor asks "What happens when you turn them off"?

5 Software technology

The woggle's world is modeled as a height field defined over a rectangle. The height field is painted, to provide a suitable image to the human viewers, but the creatures cannot see the painting. They can see the height field and the position, body configuration, and actions of other creatures. Each autonomous creature is controlled by a personality written in Tok, an architecture for mind that integrates reactivity, goal-directed behavior, and emotion.

Each Tok creature maintains a tree of top level goals and the subgoals they engender. The goals and subgoals are used to organize a collection of reactive mechanisms. There is no complete internal model of the world, but there are small, partial models built through selective sensing processes. Goal success, failure, prospective failure, and judgments that other creatures caused these situations give rise to happiness, sadness, fear, gratitude, and anger in varying degrees. Gratitude and anger affect the longer term relationship of liking or disliking the creature causing the emotion. The emotional state indirectly modulates the creature's choice of goals and reactions.

6 Hardware and space requirements

The system runs on a Silicon Graphics Indigo XS24+Z with an R3000 processor and at least 16MB of main memory. More memory is better, and it is also much better to have an Indigo Elan, with an R4000, if possible. The full piece includes the sonar system, but we would prefer to keep this "one of a kind" collection of hardware at Carnegie Mellon. The sonar is not at all necessary for the system to function well. For the most part it is just looks interesting and pretty.

The work has previously been displayed in conjunction with a written artist's statement, a technical statement, a pictorial system diagram, and a color enlargement of the Woggles in action (a 35mm slide of this image is included with this submission). Thus, there is the need for enough wall space to present these materials.

7 Realization and previous showings

The work was completed in July 1992. It was first shown at the American Association for Artificial Intelligence Arts Exhibition in July 1992 in San Jose, California. Approximately 200 people viewed the work. In January 1993 it was installed for two weeks at the Carnegie Mellon Hewlett Art Gallery, where another 1000 people attended. It opened as part of the permanent exhibition of the Computer Museum in Boston, Massachusetts in February 1993.

8 Oz/Animation group

The members of the joint Oz/Animation group are thirteen faculty, graduate students, and staff at Carnegie Mellon University. They study artificial intelligence, graphics, robotics, speech, drama, writing, and animation.

Below is a brief biography of Joseph Bates, who is the primary contact person for this work. However, if this work receives official recognition, we will be happy to submit biographies of all thirteen participants together with a joint picture. In any case, please be certain to credit the entire Oz/Animation group as creators of this work.

Joseph Bates is a faculty member in the School of Computer Science, and a Fellow of the Studio for Creative Inquiry in the College of Fine Arts, at Carnegie Mellon University. He has been an Assistant Professor in the Department of Computer Science at Cornell University and a Visiting Scientist at the MIT Artificial Intelligence Laboratory. Prior to completing his Ph.D. at Cornell in 1979, he was an early entrant at the Johns Hopkins University, where he received his bachelor's and master's degrees in computer science at age seventeen.

Prof. Bates' primary research interests are in artificial intelligence and interactive media. At Cornell he led an effort to create a knowledge based interactive medium for mathematics (NuPRL). At Carnegie Mellon he directs the Oz project, an interdisciplinary effort to develop computational theories of intelligent/emotional agents, narrative, and drama. Oz is intended to provide the technological foundation for rich, emotionally powerful virtual worlds.

9 Contents of this Submission

With this document we have included a 13 minute NTSC VHS video tape, a 35mm color slide of the Woggles, and an 8.5"x11" color copy of the slide. We have also included two papers, in case the jury wishes to learn more about this work. The first is a position paper on the importance of AI in interactive drama ("Virtual Reality, Art, and Entertainment"). The second is a paper describing the Tok architecture in more detail ("An Architecture for Action, Emotion, and Social Behavior").

We are more experienced with computing and artificial intelligence than with video production.