Zeno: a Cognitive Character

David Hanson, Stuart Baurmann, Thomas Riccio, Richard Margolin, Tim Dockins, Matthew Tavares, Kevin Carpenter

Hanson Robotics, LogicU, the University of Texas at Dallas, the University of Texas at Arlington
1208 W. Executive Drive, Richardson, TX 75081
P.O. Box 830688 Richardson TX 75083-0688
701 S. Nedderman Drive, Arlington, TX 76019
David@HansonRobotics.com, RichardMargolin@gmail.com

Abstract

We hypothesize that well-designed intelligent characters, fusing good artistry with best-of-breed cognitive A.I., can result in greater user engagement. Realizing such designed robot characters, though, requires substantial technical innovation in both software and hardware. To simulate a character with motives and intention, a cognitive framework and authoring tools are needed, as is sensor fusion and enough machine perception, face-tracking and speech recognition to enable the character to appear aware enough to the user to forge a simulated relationship. To test the efficacy of such a Character Interface Device (CID), we developed a prototype in the form of a walking, expressive character prototype named Zeno RoboKind that brings together these systems. To facilitate the CID as a more general, intuitive form of human-machine interface device, and to bridge numerous state-of-the-art A.I. components and other cognitive architectures, we have begun to standardize an open architecture entitled Adaptive Character Engine (ACE).

Characters as an intuitive, entertaining interface

We hypothesize that well-designed intelligent characters, fusing good artistry with best-of-breed cognitive A.I., can result in greater user engagement. Therefore we seek to advance the state of robotics as a medium of character art and test the results with human users. These objectives require substantial technical innovation in both software and hardware. To simulate a character with motives and intention, for example, a cognitive framework and authoring tools are needed, as is sensor fusion and enough machine perception, face-tracking and speech recognition to enable the character to appear aware enough to the user to forge a simulated relationship. We generalize this form of human robot interface as a Character Interface Device (CID, pronounced "kid") , which we define as an intelligent anthropomorphic agent imbued with personality and character and designed to provide a rich, intuitive interface to computing resources. The efficacy of a CID relies on a tight integration of sensory input such as speech-recognition, vision and/or other machine perception and a deep model of its user(s) to interact as a social agent. Possible uses of a CID can be to teach, assist, provide autism therapy, or simply to keep its user company, participating in roles of tutor, assistant, storyteller, therapy device, or friend.

To demonstrate the efficacy of such a Character Interface Device (CID), we have developed a prototype in the form a walking, expressive character prototype named Zeno RoboKind. To make this character intelligently responsive during human interactions—to impart the perception of agency and "being" to a user—we sought to build a software framework for cognitively capable characters. Efforts were made to generalize the practices to define the artform beyond the Zeno character and to provide tools for use of characters as a general, intuitive form of human-machine interface device. To achieve this, we sought to bridge numerous state-of-the-art A.I. components and other cognitive architectures, a practice we have begun to standardize within an open architecture that we title the Adaptive Character Engine (ACE), in collaboration with Brian Scasselatti of Yale. Eventually, we hope such an integrated system will allow such devices to grow more truly intelligent and compassionate, creative, autonomous members of our extended family.

Figure 1. Zeno RoboKind at RoboDevelopment, Dec. 2007. Photos from Aving.net.

Background

Social robots use computer vision, conversational speech and animated gestures to socially engage people. Examples include Kismet and Leonardo of MIT [Breazeal, 2001; Landon, 2003], and the Philip K. Dick Android shown at AAAI in 2005 [Hanson et al, 2005]. Rapid advances in software and hardware performance have increased the prevalence and promise of these robots. Meanwhile, market demand for mechatronic animated characters (such as Furby, Fur-real and Amazing Amanda dolls) has grown explosively in the toy markets, now commanding $8 billion of the $60 billion toy market [Prodigy Research, 2008]. These trends promise to open

Hanson Robotics, developers of low-power, highly expressive conversational robots, including the Einstein of KAIST's walking Albert-Hubo, sought to advance these trends with Zeno in a form that could be manufactured at a low cost ($300 retail price) to expand popular appeal of animated robot characters, get this technology into people's lives, and provide a low-cost platform for software development. In September of 2007, Hanson unveiled Zeno at WIRED's Nextfest, with battery-powered walking, facial expressions, face-tracking and conversational interaction, wirelessly controlled by PC. As Hanson Robotics works to get these to market in 2010, the few prototype Zeno robots remain available for research in the area.

Motivation

The RoboKind research is motivated by our desire to create socially interactive robots with human-inspired personalities that model the cognitive affect of people. With Zeno and his software, we seek to extend the medium of robotics and A.I. into mature character animation media, expanding the creative possibilities of robotics as art.

Objectives

The primary goal of this project is to develop robotics into an intelligent character medium that simulates human interaction, to develop meaningful relationships with people. A second objective is to develop a standardized platform for cognitive A.I. Systems, for interactions with humans, which cognitively model a user's mind, motives and emotions. Another objective is to release compelling products that increase widespread awareness, adoption and demand for friendly A.I.

Achieving these goals requires cognitively modelling user's motives, feelings, and cognitive states, both at present and over time, to build multi-dimensional data representations of a user, which we call "people objects." This form of theory of mind requires advancement in cognitive systems design. To achieve this, we seek to generalize the Hanson Robotics "Character Engine" software framework into an open system that we call the Adaptive Character Engine (ACE), a term coined with Brian Scasselatti of Yale.

Method

Under the premise that good artistic design would improve user engagement, we sought to enable artists to drive the engineering requirements. For a compelling and heartwarming character design, our team included former Disney character designers and sculptors who designed the look of Zeno and the story of his evolution from a toy to a generally intelligent hero robot over the coming years. The face used Hanson Robotics' facial mechanisms and Frubber material made for highly expressive, low-power facial affect. The walking body was co-designed with Tomotaka Takahashi of RoboGarage, known for endearing robots that walk gracefully. The hardware was animated using film animation techniques, and the personality was implemented as "Persona" files in our Character Engine system.

Knowing that today's best A.I. is nowhere near human-level intelligent, we sought to create the *fiction* that the character is intelligent, wherein machine intelligence enhances this illusion. To achieve this, we developed authoring tools to enable artists to design the behavior of the robot. Currently personality authoring is conducted in Drools decision table and xml and csv files for the personality and animation. We are currently developing a web-based personality builder that makes authoring even more intuitive.

Results

We completed three highly functional Zeno prototypes with a mature software system. They receive extremely positive reactions when shown publicly, which indicates that well-developed design increases user engagement, but this remains to be verified in human subject tests.

Future Goals

We seek to develop the ACE system further, with novel algorithms and data structures to represent multiple aspects of a user, including memories of interactions (situational grounding) [Mavrides, 2006], theory of mind, and multiple attentional threads of the robots' current, past and future interactions with a user. We also seek to interface ACE with other frameworks, including OpenCog, SOAR, GOMS and Player-stage.

We seek to further test the Zeno in experiments to verify engagement. We also seek to commercially deploy Zeno as a $300 "super toy" in 2010. We will explore other applications of cognitive characters in education, virtual characters, and health care for autism [Scassellati, 2005] and cognitive stimulation of elderly.

Figure 2. Zeno interacting, reading a story with a child.

Conclusion

We have created functioning Zeno character robots and a draft of a general software framework for cognitively capable characters. The system and robot have proven engaging enough to gain considerable international press attention and numerous requests from consumers wanting their own Zeno. We conclude that intelligent character robots can grow to be a highly influential artform and entertainment medium, which we hope will help accelerate the emergence of true friendly A.I.

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