

# Zeno RoboKind: a Cognitively Capable Character

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## 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. To demonstrate the efficacy of such a "character interface device" (CID), we have developed a prototype in the form of 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). 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.

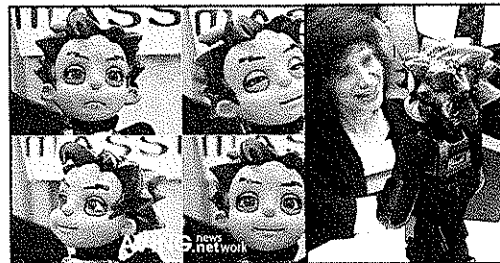


Figure 1. Zeno RoboKind expressing himself at RoboDevelopment, Dec. 2007. Photos from Aving.net.

## 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].

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 which 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.

To achieve 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 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 behaviour of the robot. Currently the authoring is conducted in Drools decision table and xml and csv files for the

personality and animation. We also developed a php GUI that makes the authoring even more intuitive.

### Results

We completed 3 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 further test the Zeno in experiments to verify engagement. 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, Player-stage and others. We also seek to commercially deploy Zeno as a \$300 "supertoy" in 2010. We want to explore other applications of cognitive characters in education, virtual characters, healthcare for autism [Scasselatti, 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 contribute to the emergence of true friendly A.I.

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