Virtual Humans: A New Toolkit for Cognitive Science Research

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Tutorial Objectives

Virtual humans (VHs) are digital anthropomorphic characters that exist within virtual worlds but are designed to perceive, understand and interact with real-world humans. Although typically conceived as practical tools to assist in a range of application (e.g., HCI, training and entertainment), the technology is gaining interest as a methodological tool for studying human cognition. VHs not only simulate the cognitive abilities of people, but also many of the embodied and social aspects of human behavior more traditionally studied in fields outside of cognitive science. By integrating multiple cognitive capabilities (e.g., language, gesture, emotion, and the control problems associated with navigating and interacting with a simulated virtual world) and requiring these processes to support real-time interactions with people, VHs create a unique and challenging environment within which to develop and validate cognitive theories. In this tutorial, we will review recent advances in VH technologies, demonstrate examples of use of VHs in cognitive science research and provide hands on training using our Virtual Human Toolkit (http://vhtoolkit.ict.usc.edu/).

Virtual Humans and Cognitive Science

In helping to define the field of cognitive science, Herb Simon emphasized the importance of "understanding by simulating" (Simon 1969, 17-22). From the perspective of cognitive science, VHs provide the opportunity to understand the mind by simulating the body. Although still limited in their capabilities, VHs combine a rich set of capabilities for exploring how cognitive processes manage interactions with the physical and social world. In this sense, they complement recent interest in robotics as a tool for cognitive science, and address many of the limitations of physical robots.

Embodied Cognition: Embodied theories argue that the brain and body are tightly linked: the configuration and state of one's body profoundly influence cognitive processes and vice versa. For example, posture can impact how easily we are persuaded (Petty, et al. 1983); gestures and language are closely coupled, often grounded in shared metaphors (McNeill 2005); and facial expressions can influence our emotions (Niedenthal, et al., 2010). VH technology is increasingly used to unpack this relationship between mind and body (e.g., Sprague, et al., 2007) and in the tutorial we will review research in this growing area.

Social Cognition: People interact socially through their bodies and VHs allow researchers to systematically examine and model the cognitions underlying social interaction. VHs can act as "virtual confederates" (Blascovich et al., 2002), allowing systematic manipulation of visual appearance, speech type, and contextual graphical environments. This makes VHs a convenient platform to isolate unique sociocultural characteristics and realize them through simulation. Along with enhanced experimental control, ease of manipulations, consistency and controlled measurements, these features make VHs useful and reliable tools for studying social cognitions. In the tutorial, we will review several examples, including how expressions of emotion by VHs can influence decision making in negotiations tasks and social dilemmas (e.g. de Melo et al., 2012; Dehghani et al., 2012); the role of accent in cultural cognition (Dehghani et al., 2012) and the role of rapport and gender in enhancing participants' performance (Karacora et al., 2012).

The Virtual Human Toolkit

The University of Southern California's Institute for Creative Technologies (ICT) is recognized as a leader in the development of VH technology (Gratch et al., 2002) and in applying this research to application domains including "virtual role players" for interpersonal-skills training (e.g., Campbell et al. 2011), informal science education (e.g. Swartout et al., 2010), intelligent tutoring, (e.g. Lane et al., 2011), and as "virtual confederates" to study cognitive and social processes (e.g. de Melo et al., 2012; Dehghani et al., 2012). One goal of the institute is to foster research in VH by making this technology freely available for research purposes through the Virtual Human Toolkit.

The research underlying the toolkit draws heavily on cognitive science research. For example, VH "brains" are inspired by psychological theories of human cognition (e.g. Swartout, Gratch et al., 2006), language (e.g. Traum, 2008) and emotion (Gratch & Marsella, 2005), VH bodies are informed by knowledge of physiological and biomechanical processes (e.g. Honglun, et al. 2007; Thiebaux et al., 2008) and the relation between the VH's brain and body is informed by social psychology research (Lee & Marsella, 2006, Wang et al, 2013). Translating these theories and findings into working software requires the integration of advanced capabilities from a number of domains of computer science research including machine perception, artificial intelligence, cognitive modeling, graphics and animation.

The complexity of creating a VH can appear daunting. Fortunately, considerable research has focused on the de-

velopment of modular, sharable software architectures to facilitate application development. The Virtual Human Toolkit is a general-purpose collection of integrated VH capabilities, including speech recognition, natural language processing, perception, and nonverbal behavior generation & execution. The goal of the Virtual Human Toolkit is to make creating VHs easier and more accessible, and thus expand the realm of VH research as well as other research areas, including cognitive science.

In this tutorial, participants will have the opportunity to get hands-on experience with the Toolkit, with the intent to create a basic virtual confederate. In particular, participants will be able to select a character from a library; place the character in a scene; author a set of lines for the confederate to speak; manipulate its gestures and facial expression; and create a set of experimental stimuli that they can take home.

At the conclusion of the workshop participants should have gained a basic understanding of VHs and their capabilities, of how VHs can be of value in the field of cognitive science in the form of virtual confederates, and of how to utilize several aspects of the Virtual Human Toolkit.

Audience

The likely audience for this tutorial consists of researchers looking to incorporate VHs in their work. This includes researchers in the fields of human computer interaction, education, social cognition, embodied cognition, language and dialogue among others. All participants are encouraged to bring a laptop for installing the Virtual Human Toolkit for hands-on interactions to build a virtual human.

Presenters

The presenters combine over 40 years of experience researching virtual human technologies, developing virtual human applications for health and training, as well as using the technology as a methodological tool in the study of human behavior.

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