Procedia Computer Science

Volume 41, 2014, Pages 204–211

BICA 2014. 5th Annual International Conference on Biologically Inspired Cognitive Architectures

An Architecture for Personality-Based, Nonverbal Behavior in Affective Virtual Humanoid Character

Maryam Saberi[1], Ulysses Bernardet[1] and Steve DiPaola[1]
[1]*Simon Fraser University, Vancouver, CA*
msaberi@sfu.ca, ubernard@sfu.ca, sdipaola@sfu.ca

Abstract

As humans we perceive other humans as individually different based – amongst other things – on a consistent pattern of affect, cognition, and behavior. Here we propose a biologically and psychologically grounded cognitive architecture for the control of nonverbal behavior of a virtual humanoid character during dynamic interactions with human users. Key aspects of the internal states and overt behavior of the virtual character are modulated by high-level personality parameters derived from the scientific literature. The virtual character should behave naturally and consistently while responding dynamically to the environment's feedback. Our architecture strives to yield consistent patterns of behavior though personality traits that have a modulatory influence at different levels of the hierarchy. These factors affect on the one hand high-level components such as 'emotional reactions' and 'coping behavior', and on the other hand low-level parameters such as the 'speed of movements and repetition of gestures. Psychological data models are used as a reference to create a map between personality factors and patterns of behavior. We present a novel hybrid computational model that combines the control of discrete behavior of the virtual character moving through states of the interaction with continuous updates of the emotional state of the virtual character depending on feedback from interactions with the environment. To develop and evaluate the hybrid model, a testing scenario is proposed that is based on a turn-taking interaction between a human participant and a 3D representation of the humanoid character. We believe that our work contributes to individualized, and ultimately more believable humanoid artifacts that can be deploy in a wide range of application scenarios.

Keywords: Cognitive Architecture, Nonverbal behavior, Personality, BIS/BAS, Five Factor Model, Personality traits, Hybrid Model, Hierarchical Approach

1 Introduction

The term "personality" refers to consistent patterns of emotions, thinking and behavior, which make humans unique and distinguishable. During daily human to human interactions, people evaluate the personality of others e.g. to predict their behavior, to understand them, to help or to motivate them. One of the important sources of information people rely on when attributing personality to others is nonverbal behavior such as gestures, body stance, facial expressions, and gaze behavior. For instance,

 Selection and peer-review under responsibility of the Scientific Programme Committee of BICA 2014

doi:10.1016/j.procs.2014.11.104

the speed of body movement or duration of direct gaze affects how people perceive personality of a person (Campbell & Rushton, 1978; Borkenau & Liebler, 1992). Likewise, during human and virtual humanoid character interaction, people attribute personality to virtual characters by using clues from their nonverbal behavior (e.g. McRorie et al., 2012). Yet, in many architectures designed for virtual humanoid characters, nonverbal behavior is generated for communication purposes and decision making processes while ignoring the importance of personality in the generation of behavior. This leads to virtual humanoid characters with behaviors that are not consistent through time and do not follow human behavioral patterns.

Our goal presented in this paper is to develop a biologically and psychologically grounded computational architecture for generating nonverbal behavior to express personality for virtual humanoid characters. The architecture is designed in a way which can generate plausible dynamic behavior for the virtual humanoid character in response to the human user's inputs in real time. Since we are focusing on nonverbal behavior of the virtual character, the interaction is "content-free" meaning there is no speech involved. Our problem domain is narrowed down to the turn-taking strategy-based interaction. In this study, the behavior that represents the personality include torso movements, head and neck movements, gaze, facial expressions, hand movements, body gestures and postures, all of which are visible from above the waist. For each behavior, we consider parameters like frequency and speed (e.g., frequency of blinking or speed of head movement). Gaze parameters such as fixation points and duration of gazing per points are also considered.

2 Computational Background on Expressing Personality through Nonverbal Behavior

Following is a review of related background literature on various computational models for generating the impression of emotion and personality through nonverbal behavior. Kshirsagar and Magnenat-Thalmann (2002) devised a personality model of emotional virtual characters. They used Bayesian Belief Networks and a layered approach for modeling personality, moods and emotions. The focus in this work was only on emotional personality. Alternatively, ALMA (A Layered Model of Affect) (Gebhard, 2005) was designed to provide a personality profile with real-time emotions and moods for virtual humanoid characters. Similarly, the concentration in this study was on modulating the appraisal process, but there was no mapping between nonverbal behavior and personality traits. Poznanski and Thagard (2005) developed a neural network model of personality and personality change. Their focus was on modeling personality changes, with nine behavior mapped to personality via output tags, e.g., "talk" or "avoid help". Similarly, Wen Poh et al. (2007) designed an architecture to control affective story characters with parameters for personality and emotion. They developed a hierarchical fuzzy rule-based system to control the body language of a story character with personality and affect. In this system, story designers specified a story context with personality and emotion values with which to drive the movements of the story characters. Zammitto et al. (2008) proposed a multidimensional hierarchical approach to model a parameterized facial character system, which only focused on facial features to express personality. Read et al. (2010) proposed a neural network model of structure and dynamics of personality based on research about the structure and neurobiology of human personality. Differences in the sensitivities of motivational systems and inhibitory strength were used to model the given personality traits. The model was designed only for high-level portions of behavior such as "Tease and Make Fun of" and "Ask for Date" as well as for situational parameters such as "At Home" or "In Conference Room". McRorie et al.'s work (2012) was part of a European project (SEMAINE) with the aim of developing a system that facilitates human interaction with conversational and Sensitive Artificial Listeners (SAL). Their main focus was the content of the conversation and behavior during the conversation. The study empirically examined how users rate