

Virtual Humans Personified

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ABSTRACT

The focus of the virtual human research has recently shifted from modeling and animation towards imparting personalities to virtual humans. The aim is to create virtual humans that can interact spontaneously using a natural language, emotions and gestures. In this paper we present a system that allows the design of personality for emotional virtual human. We adopt the Five Factor Model (FFM) of personality from psychology studies. To realize the model, we use Bayesian Belief Network. We introduce a layered approach for modeling personality, moods and emotions. In order to demonstrate a virtual human with emotional personality, we explain how the model can be integrated with an appropriate dialogue system.

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Keywords: Virtual humans, Personality modeling, Five Factor Model, Facial animation, Bayesian Belief Network.

1. INTRODUCTION

Personification means attribution of personal qualities and representation of the qualities or ideas in the human form. We focus on emotional personification using facial representation of the virtual human. André *et. al.* [1] have given a detailed description of the work done for three projects focused on personality and emotion modeling for computer generated lifelike characters. They use the “Cognitive Structure of Emotions” model [2] and the Five Factor Model (FFM) of personality [3]. Ball *et. al.* used Bayesian Belief network to model emotion and personality [4]. They discuss two dimensions of the personality, dominance and friendliness. El-Nasr *et. al.* use a fuzzy logic model for simulating emotions in agents [5]. A good overview of various other emotion and personality based systems can be found in [6]. We do not focus on a specific application, but our model could be adapted to several applications in games, entertainment and communication in virtual environments. We implement the Five Factor Model using a Bayesian Belief

network. Further we propose a layered approach to personality modeling (Personality-Moods-Emotions). We explain how the emotion and personality models can be easily linked with a dialogue system resulting into a communication with an emotional autonomous virtual human.

2. LAYERED APPROACH

Personality is the characteristic of a virtual human that distinguishes him from the others. In psychology research, the Five Factor Model (FFM) [3][7] of personality is one of the most recent models proposed so far. The five factors are considered to be the basis or dimensions of the personality space, and are Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness. Since, the model states that these five factors form the basis of the personality space, one should be able to represent any personality as a combination of these factors.

By emotion, we understand a particular momentary state of mind that is reflected visually by way of facial expressions. Thus, conceptually, we refer to the same thing by emotion and expression. We use the emotions defined by the model proposed by Ortony, Clore and Collins [2], commonly known as the OCC model. They categorize 22 various emotion types based on the positive or negative reactions to *events*, *actions*, and *objects*. We use 24 emotions (22 defined by the OCC model with surprise and disgust as additional emotions) that can be associated with the dialogue. Though we do not use the cognitive processing defined by the OCC model, the categorization is useful to link the emotional state with the dialogue system. To reduce the computational complexity, we re-categorize these 24 emotions into 6 expression groups (joy, sadness, anger, fear, surprise, disgust) to represent the emotional states.

Mood is a prolonged state of mind, resulting from a cumulative effect of emotions. The FFM describes the personality, but it is still a high level description. We need to link the personality with displayed emotions that are visible on the virtual face. Hence, we introduce a layer between the personality and the expressions, which, we observe, is nothing but mood. Personality causes deliberative reactions, which in turn causes the mood to change. Mood is defined as a conscious state of mind that directly controls the emotions and hence facial expressions; it is also affected by momentary emotions as a cumulative effect. The expressions can exist for a few seconds or even shorter, whereas mood persists for a larger time frame. The personality, on the highest level, exists and influences expressions as well as moods, on a much broader time scale.

3. SYSTEM OVERVIEW

We demonstrate the personified virtual human using a real time communication system. Figure 1 shows the various components of the system and their interactions.

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A text processing and response generation module processes the input text; in our case it is the chat-robot ALICE [8]. We define the AIML database such that emotional tags are embedded in the responses. Each response can be associated with more than one emotion, each having a probability value associated with it. The chat system can be replaced by a more sophisticated dialogue system that generates such tags depending upon context and cognitive processing. These emotional tags are passed on to the personality model, which is a Bayesian Belief Network (BBN). There is a lot of uncertainty easily observed in human behavior with regards to reactions and expressions. A BBN handles uncertainty powerfully, which is evident in evolution of emotions. Secondly, it gives a structured probabilistic framework to represent and calculate otherwise very complex and rather abstract concepts related to emotions, moods, and personality. Ball *et. al.* [4] previously have reported the use of the BBN for personality and emotion modeling. The main difference in their approach and our approach is that we try to use the FFM of personality to devise a way of combining personalities and also introduce an additional layer of “mood” in the model.

One BBN is defined for each personality type. A user can specify the desired combination of the five or less factors, thus allowing easy definition of personality. The BBN has two parent nodes corresponding to current mood and response mood (from the dialogue). The child node is the actual resulting mood. The conditional probability function (that can be designed by the user) governs how moods change as a function of personality. Thus, the personality model, depending upon the current mood and the input emotional tags, updates the mood. As mood is relatively stable over time, this mood switching is not a frequent task. The probabilities for all possible moods are calculated using the current mood and the prior probability values of the response mood coded in the dialogue database. The mood is represented by a simple probability transition matrix (also designed by the user). We use only three moods, namely good, bad, and neutral. Each has a transition probability matrix that decides the probability of changing from one emotional state to the other.

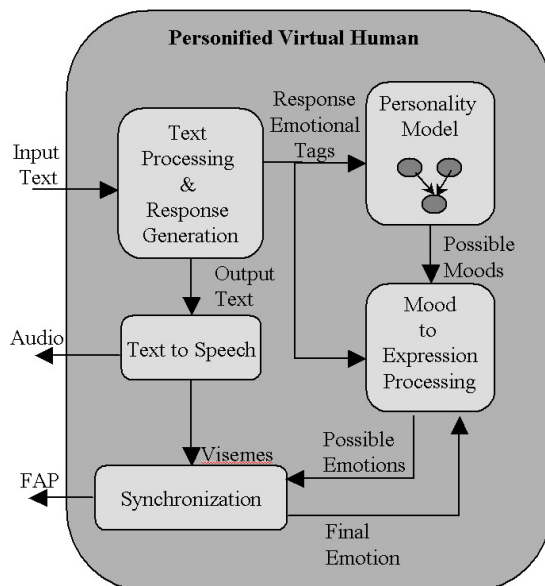


Figure 1. System Overview

The changes in mood and emotional state do not directly and instantly reflect on the facial expressions. The synchronization module analyses previous facial expression displayed and output probabilities of the mood processing. It determines the expression to be rendered with appropriate time envelopes. It also generates lip movements from the visemes generated by the Text to Speech engine. It finally applies blending functions to output the facial animation parameters (FAP) depicting “expressive speech”. A separate facial animation module renders the FAPs in synchrony with the speech sound.

4. CONCLUSION

We have developed a system incorporating a personality model for an emotionally personified virtual human that covers the following important aspects:

- Many concepts are brought together from psychology, artificial intelligence and cognitive science to create a layered model of human personality directly affecting the emotional and expressional behavior.
- A user is able to design personalities for virtual humans as a combination of five basic factors. Further, the user can define moods for the virtual humans and how the moods affect the emotional state and displayed expressions.

It is extremely challenging task to fine-tune the conditional probabilities of the personality Bayesian Belief Networks and mood transition probability matrices. We continue to make improvements by way of tests and experimentation.

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