Agent Personality Traits in Virtual Environments Based on Appraisal Theory Predictions

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Abstract. The current work investigates issues of expressivity and personality traits for Embodied Conversational Agents in environments that allow for dynamic interactions with human users. Such environments are defined and modelled with the use of state of the art game engine technology. We focus on generating simple ECA behaviours, comprised of facial expressions and gestures in a well defined context of non-verbal interaction [2].

1 INTRODUCTION

Research in affective computing and virtual agents has still many challenges to take up. Enthusiastic reactions to the virtues of affective human-machine interactions have often been disproved by more in depth studies. Although it is clear such interactions are richer and allow for stronger human relations, what is not clear is in what situations one should use such types of interactions with computers [17].

In the case of the design of virtual agents, issues of believability and naturalness have to be addressed, along side with user expectations and the reported quality of interaction. To increase believability and life-likeness of an agent, she has to express emotion [3] and exhibit personality in a consistent manner [12], [15]. Several studies have shown the significance of cultural factors, personality and environment setting when designing an agent [10]. These studies have also pointed out the importance of consistency in a virtual character. Traits are regarded as chronic propensities to get into corresponding emotional states and thus are a major source of emotional and behavioural consistency.

In our current work we focus on modelling affective virtual characters so as to depict different behaviours to similar situations depending on their personality traits and current moods. Our work is based on a collapsed version of the OCC model proposed by Ortony in [15]. The structure of the paper is as follows: Section 2 consists of a short literature review explaining the motivation of our current work, section 3 gives an account of the parameters used to manipulate expressivity, section 4 presents our modelling approach, the chosen context in terms of interaction scenarios, the application structure and the technologies adopted. We conclude with section 5 where the necessary next steps are identified in terms of extending and evaluating the model.

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2 PERSONALITY, MOODS AND EMOTIONS

In psychology research the term affect is very broad, and has been used to cover a wide variety of experiences such as emotions, moods, and preferences. In contrast, the term emotion tends to be used to refer to fairly brief but intense experiences although it is also used in a broader sense. Finally mood or state describe low-intensity but more prolonged experiences [7].

It is common in personality and emotion literature to focus on general positive or negative moods and on the broad traits of positive/negative affectivity and extraversion/neuroticism. According to [6] extraversion concerns individual differences in the preference for social interaction and lively activity whereas neuroticism represents individual differences in proneness to unpleasant emotional experience. Traits of affectivity are often defined as stable individual differences in the tendencies to experience positive and negative mood states.

Nervertheless according to a detailed review of research on emotion and cognition by Rusting [18] very few studies in psychology have included measures of traits directly related to mood regulation (e.g. negative mood-regulation expectancies, meta-mood experience). There remain many gaps in the understanding of $Personality$ x $Mood$ interactions. Personality traits represent underlying propensities toward mood states, but do not necessarily always produce them (e.g. an individual high in neuroticism can be in a good mood at least for some of the time).

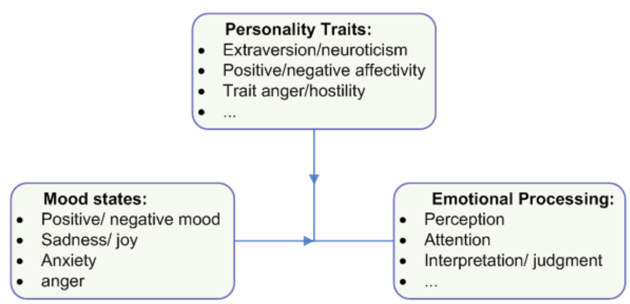

Figure 1. The mediation approach, in which mood-congruency effects depend on individual differences in emotional personality traits

In Rusting's review, it is acknowledged that among various emotional processing theories there is reasonable support for the moderator approach which claims that emotional processing depends interactively on personality and mood state (see figure 1). This gives us motivation to try and model an expressive character based on the prevailing personality traits and take under consideration a broad account for positive and negative mood states. It is stated that the broad dimensions of positive affectivity and extraversion, and negative affectivity and neuroticism, may represent similar underlying tendencies with respect to positive and negative mood experience, and they may therefore involve similar sensitivities to positive and negative emotional cues.

2.1 Emotion models based on appraisal

There exist several theories in psychology for modelling and representing the process of emotion elicitation [9], [16],[20], [19]. These models provide predictions for possible emotional states through the process of cognitive appraisal of stimuli. Various virtual human models have been put forward using these theories as foundations in conjunction with factor models of personality such as the five factor model [14]. To name a few, there is work on presentation strategies by affective virtual humans [1], the virtual human project based on a layered model of affect accounting for both mood and personality traits in a dialogue based agent interaction [8] and the multilayer personality model [11], [5]. The common denominator in this line of research is mutlimodality. Both speech and facial expressions are modelled as well as body gestures.

Our current research aims to initially scale down the problem and thus we currently choose to focus only on non-verbal human-to-agent interactions. We want to give virtual characters expressivity that makes sense in the context it is expressed. The context is provided through chosen scenarios put forward in a following section. Motivation for this approach was given by Ortony's recent simplification of the original OCC model [15].

2.2 A simplified version of the OCC Model of Appraisal

In this approach it is stated that believability is an application-dependent notion, strongly related to context. The simplification collapses the original 22 emotion types down to five distinct positive and five distinct negative reactions by taking under consideration the emotional states that make sense for a virtual character. The idea is to start simple in making the agent able to differentiate his expressions between positive and negative and then progressively develop more elaborate categories. An agent could have an identical positive expression in a situation where she is happy about obtaining a desired object or in a situation where she is happy because she feels proud when she has attained some goal. The expressivity would not change in such a coarse approach, only the context.

The main point of the OCC model is that the appraisal process taking place during an emotion elicitation event is either in terms of events, in terms of an agent's actions or in terms of objects (and attitudes towards them). As a first step to tackle the modelling problem we are only going to focus on events. This simplifies the agent's candidate emotion states to only ones related to events according to OCC such as joy, distress, hope, fear, relief etc.

According to this simplified version of the OCC model each emotion type is assocciated with a variety of possible reactions. It is considered that all emotions share the same set of $response\ tendencies$ and the differentiation lies in the extent each tendency participates in the state. Ortony defines three major types of emotion response tendencies: expressive, information - processing and coping (see figure 2).

In our current work there is yet to be an account of world knowledge representation for the virtual character and no information processing or coping functionality. Thus we are going to focus solely on the expressive reaction tendencies of each emotion state. The expressive reaction states are divided in three subcategories as depicted in figure 2.

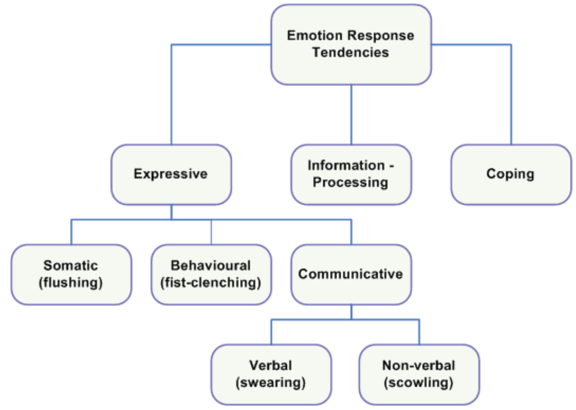

Figure 2. Emotion response-tendencies in the case of anger

A key issue is the mapping of emotional states of the character to behaviours and actions. Here is where personality and repsonse tendencies take over. Personality is the engine of behaviour. One tends to react in a certain way in a situation because she is that kind of person [15]. Thus personality is the key to character and behaviour consistency. The good news is that traits don't live in isolation. On the contrary they are strongly correlated and tend to cluster together. Upon this truth lie the various factor structures of personality.

While trying to keep the level of complexity of our model as low as possible we are going to account only for two personality traits: extraversion and neuroticism. These are only two traits of the five factor model that is comprised of openess, conscientiousness, extraversion, agreeableness and neuroticism [14]. Neuroticism is reported as the tendency to experience negative thoughts and extraversion as willingness to communicate and preference for social situations.

3 EXPRESSIVITY PARAMETERS

3.1 Facial expressions

Our group has previously focused on the animation of facial expressions based on the predictions of K. Scherer's component process model (CPM) theory [20], [13]. Component process model theory studies the emotion elicitation process and provides analytical facial deformation predictions based on the cognitive appraisal of the stimuli presented to the subject. These predictions were mapped to MPEG-4 facial animation parameters and videos of the evolution of the emotion expression were synthesised. This was a stand alone approach and the work produced is currently in the phase of evaluation through a rating tests and further expression synthesis. It is not yet obvious if such predictions can lead to realistic synthesis results and there remain a lot of issues to investigate. Keeping also in mind the fact that neither MPEG-4 facial animation parameters have a mapping in human models in virtual worlds as yet, our current approach caters for rudimentary positive and negative facial expressions with the intent to extend it for the MPEG-4 standard. The benefits of such an extension are several. The standard allows for flexible manipulation of objects and models in synthesised environments and facilitates both re-use and deep parametrisation of the produced animations.

3.2 Body expressivity

Our previous work on gesture expressivity from the frame by frame analysis of naturalistic video sequences [4] has six dimensions of expressivity to offer which we can manipulate in our current work. These dimensions have been designed for communicative behaviours only. Each dimension acts differently for each modality. For an arm gesture, expressivity works at the level of the phases of the gesture: for example the preparation phase, the stroke, the hold as well as on the way two gestures are co-articulated. The six dimensions of expressivity proposed:

- Overall activation
- Spatial extent
- Temporal
- Fluidity
- Power/Energy
- Repetitivity

These parameters were extracted both manually from the annotation of real data video corpus and automatically from the video corpus of acted data using image analysis techniques. They were then used through a copy-synthesis approach in synthesising similar behaviour in virtual humans (see figure 3).

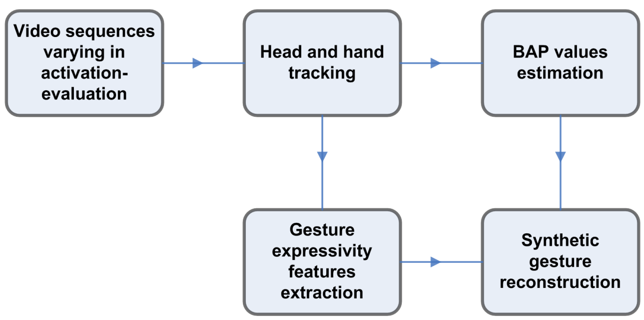

Figure 3. Synthetic Gesture Reconstruction

Overall activation was considered as the quantity of movement during a conversational turn in the video. Spatial extent was modeled by expanding or condensing the entire space taken up by a gesture. The temporal parameter determines the speed of movement for the participating body parts in a gesture and also signifies the duration of movements (e.g. quick versus sustained actions). Fluidity differentiates smooth/graceful from sudden/jerky actions and captures the continuity between movements.

In the synthetic gesture recunstruction phase both extracted expressivity parameters and MPEG-4 body animation parameters (BAPs) were used. There is currently no available mapping of the MPEG-4 standard parameters for a character in a virtual environment at the moment. Therefore in our synthesis approach we only rely in expressivity parameters at this phase.

In order to differentiate the two modelled personalities (extrovert with positive affectivity and neurotic with negative affectivity), we are going use the above expressivity parameters and adjust their intenisity in order to generate behaviours that make sense for the given personality traits and their given moods.

4 APPLICATION

4.1 Overview of modelling approach

At this point we are interested in modelling a virtual character's expressivity through simple interactive scenarios with human users. The idea is to provide a well defined context for non-verbal interaction between a human and an agent. The human user will be given a choice of actions and the agent will react affectively depending on the appraisal of the action by the user. It is not in the scope of the current paper to investigate issues of knowledge representation for the virtual character. Thus we adopt a simplified rule based solution for the agent's action/ event appraisal based on the personality traits attributed to the character. This means that the virtual characters' goals and intentions are defined in the domain of the application, in our case in the interaction scenarios. We use Finite State Machines in order to model each personality.

At this point one state machine is used for the extrovert/positive affectivity case and one for the neurotic/ negative affectivity. Having assumed that the extrovert is more prone to be in a good mood and to react to positive stimuli were as the neurotic personality is more prone to be in a bad mood and to pay more attention to negative stimuli we came up with the scenarios described in the following subsection.

In terms of finite state machine terminology in one $reaction$ the machine maps a current state and an given input to a subsequent state and a specific output (see figure 4. In our case appraisal of stimuli serves as input and positive or negative expressions serve as outputs while state transision is attained between positive mood state and negative mood state as depicted in the state transision diagram. Appraisal of stimuli is modelled taking under consideration the constraints put forward for each personality. Probability functions are used to express a high likelihood for the extrovert personality to stay in a positive mood and react to positive emotions and similarly a low likelihood for the neurotic to move to a positive mood state etc.

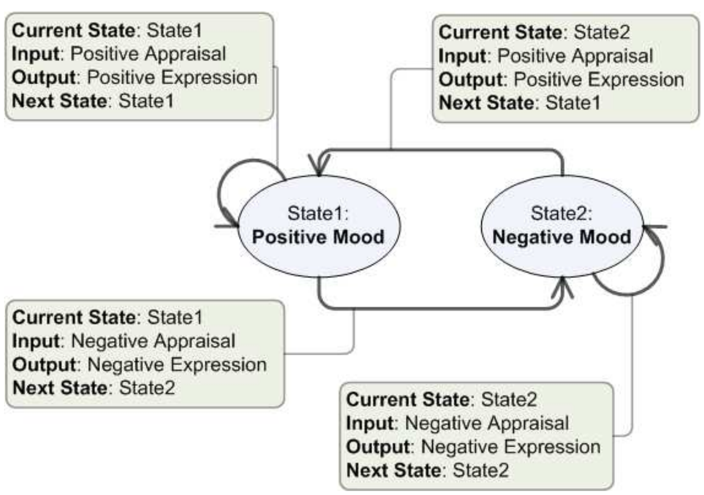

Figure 4. State transition diagram for a character's moods

4.2 Application scenarios

In a neutral virtual environment simulating a valley, the human user, originally situated in visual field of the agent, has a choice of actions to execute. Only one of the two virtual characters is present at a time. The stimuli produced by the user's action is appraised. Each agent will react differently to the user stimuli and consistently to her attributed personality and current mood. We have chosen the same 3D model for both personalities in order to counterbalance effects of appearance (a user could find one model more friendly judging only by her appealing appearance which would lead to confounding results on the perceived expressivity of the agent). The user can manually choose the affective state she depicts as she carries out one of the available actions. The choice is between neutral, happy or angry. In the first scenario the user can approach or move away from the agent $expressing$ one of the three affective states. In the second scenario the user apart from approaching, also has the choice to execute an action such as lighting a fire, planting a flower, throwing a rock etc. The scenarios are purposely chosen to be simple at this stage. The agent's appraisal of the events and consequent reactions/expressions are the fingerprint of her character/ mood state. The neurotic agent is more prone to interpret the approach of a neutral face approaching as negative stimuli and stay in a bad mood. The extrovert will react pleasantly and expressively in a similar case due to her tendency to stay in a good mood and to interpret stimuli in a positive manner.

4.3 Why use a game engine?

As previously mentioned, we are interested in modelling a virtual character's expressivity through simple interactive scenarios with human users. Game engines enable simplified, rapid development of the required interaction premises allowing one to stray from a formal game development approach. Through such an environment a user is given the chance of interacting with a virtual character in a realistic setting where she can move freely and invoke various actions.

4.3.1 Torque

Torque is a game engine by Garage Games. It has been chosen as a platform among various others, mainly because of its flexibility/ease in quick virtual environment deployment, its vibrant developer community and its open source policy. It allows for the implementation of Finite State Machines in order to model the states of a virtual character. In our case we are interested in modelling both mood and emotional states.

Figure 5. Screen shot from the Torque game engine

5 CONCLUSIONS AND FUTURE WORK

As pointed out by Bartneck in his review of the OCC model for embodied characters [2], mapping emotion categories to available expressions should be based on strong theoretical foundations, that might not always be available. When not available the developer of the character is then forced to invent these mappings. Any such arbitrary mappings in our work will be empirically tested in user studies to follow. These studies will aim to measure the effects of expressivity of the virtual character, how they are perceived and how they are rated in terms of believability, naturalness and overall appeal.

Results from this formative evaluation will be used as feedback for further extension of the model. We are interested in expanding the covered emotion categories of the collapsed OCC model as well as accounting for a history function of the visited states allowing for appraisals that evolve over time and $remember$ previous states thus developing an attitude towards events.

Another interesting point worth investigating is the analysis of the human user's affective states during such interactions. It is common practice to use a game environment in order to collect such data and the specific context of interaction can provide vital information regarding the appraisal processes taking place, the temporal evolution of emotional episodes and the possible relationships of human and agent affective states.

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