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A Methodology for Incorporating Personality Modeling in Believable Game Characters

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Figure 1. Sample animated heads showing expressions, talking, and moving, all created from one synergistic system.

ABSTRACT

Strong human personality models exist but are not easy implemented within current gaming systems. The main stumbling block to utilizing classical personality models to drive real time game characters is a hierarchy, standards-based methodology that ties low level 3D movements to semantic gestures, through to emotion and time based personality sequences. Personality is the combination of qualities and traits that makes us unique. Good game character personality models allow for more natural and believable non player character scenarios hence increasing player engagement. In this paper we overview our multidimensional hierarchical approach to modeling known human personality systems into a customizable and parameterized facial character system. We describe well established psychological personality models and detail our XML based facial animation language for scripting such systems.

Categories and Subject Descriptors

J.4 [**Computer Applications**]: Social and Behavioral Sciences – *Psychology*, *Sociology*
H.5.1 [**Information Systems**]: Information Interfaces and Presentation: Multimedia Information Systems: - *Animations*

General Terms

Design, Experimentation, Human Factors.

Keywords

Personality, believable, character, face, video games.

1 INTRODUCTION

Believable characters are a game element that reinforces player engagement [1]. A significant amount of work has been done on implementing emotional models for character architectures. However, emotions are only a part of the mimic complexity of human beings, so personality has been the other aspect incorporated into the character modeling in order to increase their believability. A believable character should move accordingly to the emotional state and personality; however, not much work has been done regarding the intersection between kinetic and personality aspects. The ultimate goal of this work is to provide a framework that enables facial character movement based on a personality module that has a strong theoretical and user study framework.

2 BELIEVABILITY

A believable character is the one that allows suspension of disbelief, the player would perceived it as a lifelike form, a real being [2]. It is not necessary realistic; actually, trying to create a photorealistic human character will suffer the "uncanny valley" effect described by Mori [3] which explains that more realistic details will be a reminder of how far it is from being real and would cause repulsion to the people. Different authors

[1][4] mentioned the different aspects that a believable video game character needs:

- Modeling: references to the shape and audio features.
- Kinetic: indicates how the character moves.
- Cognitive: is the character's knowledge, how it perceives, plans and reacts.
- Emotional: contains the emotional aspect and personality of the character.

These layers should interact among them as different modules that compose the character architecture in order to get a coherent unity. However, most of the work done on these aspects tackles them individually, as a strict hierarchical tree, or combines them as slots of modeling-kinetic, cognitive-emotional. This paper aims to address a multidimensional hierarchy among the aspects of a believable character with special emphasis on the interaction between the kinetic and emotional aspects for high-detailed agents. In sections 4, 5 and 6 is explained the process of modeling human personality into a customizable and parameterized facial character system.

3 RELATED WORK

In the 3D game character modeling and animation world, the used tools are general-purpose software such as Alias Maya, Autodesk 3ds Max and SoftImage XSI. Although the multiple utilities of these software, there is still a lack of dedicated face-centric features to efficiently work with realistic, facial states and actions. In real-time environments, animated characters have limited degrees of freedom, and don't have any face-specific support.

Regarding head models, the work done by Parke [5] can be considered as the first parameterized computerized head model and later improved by other researchers for further flexibility [6][7]. Parameterized models are an efficient method for building and animating heads, they can be grouped into conformation and expression categories respectively. Systems to control these points have been applied, for instance the Facial Action Coding System, (FACS) that was later formalized in MPEG-4 standard with its Face Definition Parameters (FDPs) and Face Animation Parameters (FAPs) [8]

While these systems provide a face-specific manipulation of points, there is "flatness". This means that not all applications need all parameters. A way to optimize the information is by establishing hierarchical grouping of parameters. Certain facial actions, such as 'smile', could be defined by high-level of abstraction. Some authors [9][10] have implemented hierarchical head model that use grouping, regions, and abstract level of actions, in order to provide flexibility with the less possible effort. Our system, as it will explain later in this paper, uses this approach. Other authors have preferred a different approach, such as DeCarlo et al. [11] who use specify rules for head motions and facial actions to animate speaking face agents from a given text, unfortunately not supporting real run-time.

Compelling characters are effective game elements. Well-defined and consistent modules of emotion and personality benefit the character believability. There have been some works that introduce theory based personality in characters. Chittaro and Serra [4] implemented a personality module for agents in their cybertherapy application. Special emphasis was made to obtain a realistic behavior, although there is no further explanation about how they dealt with the 'uncanny valley' effect. The selected personality model was the Five Factor Model (FFM), and each factor was weight with a value between 0 and 100. For further resembling the unpredictable nature of human beings, a probability algorithm is used to influence the personality weighting. The personality module would affect the sensing and decision making of the agent but there is no relationship between the personality traits and the facial actions. André et al. [12] are more interested in 'affect' that was defined as a class of motivational control. Implementing personality was a medium for having a closer control on affect. These authors also selected the FFM for representing the personality of the agent, emphasizing social interactions in the descriptors of the factors. For that reason, the authors decided to implement only two personality traits: extraversion and agreeableness. Three different applications were examined: Virtual Puppet Theatre, Inhabited Market Place, and Presence. Puppet is a learning environment for kids, users would learn that emotions and personality influence behaviors. Market Place is a virtual environment where agents discuss about products from their personality traits perspective. Presence is a kiosk application that pursues a conversational dialogue between agent and user. In these three environments, sensing and decision making were rules influenced by personality. No facial actions were related to personality. Campos et al. [13] developed an organization simulation that supports three different personality models: FFM, Jung, and Millon. The main concept to test was 'autonomy'. Agents' personality influences how to interact among them, and the quality to accomplish the work. Based on information from human resources, tasks are performed better and faster by people with certain personality traits. There is an interfaces for setting the variables of the simulation but there is no visual representation of the avatar. Kshirsagar [14] propose a multi-layer personality model. It includes layers of personality, mood, and emotions on top of each other, upper layer controls the one below, but parameters can be defined for each level. The chosen personality model is the Five Factor Model. This hierarchical structure complicates the control of facial action by personality parameters since they can not be independent from emotions, what is exactly the opposite of what Rousseau and Hayes-Roth [15] suggested.

4 IFACE SYSTEM

4.1 Facial Animation System

iFACE (Interactive Face Animation-Comprehensive Environment) is a facial animation system composed by three different main spaces: Knowledge, Personality, and Mood. There is no hierarchy among them in order to keep them autonomous, in this sense they can be considered as parallel parameters that can interact with each other. There is fourth space called geometry that receives information from the other spaces, and it will render the visual information of the facial actions, this is the kinetic aspect. Knowledge belongs to the above mentioned Cognitive aspect of game characters, where the scripts are processed. The emotional aspect in this system is subdivided into Personality and Mood. The former can affect the later.

4.2 Face Multimedia Object

MPEG-4 standard and its parameters, FDPs and FAPs, are a suitable format for creating multimedia content where different sources are combined. Even more specifically when human faces are the main interesting content, there is a system for better integrating face functionality into an autonomous, controllable object: Face Multimedia Object (FMO) [16]. See figure 2.

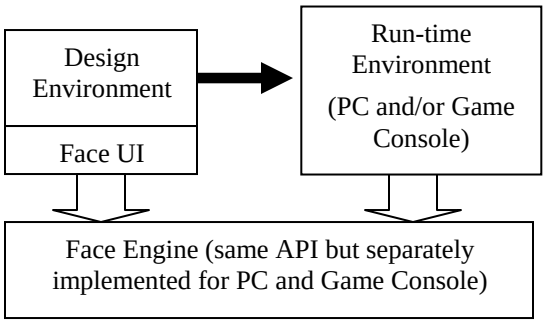

Figure 2. Using Face Multimedia Object

In order to make this notion work, it is necessary to provide freedom for creating and showing a wide range of geometry and behaviors. As explain earlier, layering of abstraction allows to manipulate the required level of detail. Hence, a hierarchical model suits both 3D and 2D geometry by including high-level and low-level functionalities, for instance resizing a region or manipulating a point respectively. However, behaviors heavily depend on the environment, type of interactivity, and particular given characteristics such as personality traits. Real-time run applications are prioritized, for this reason FMO is considered as a "face engine" that can support commands instead of only key-frames. In this way, it is possible to achieve optimization by having less information saved in the design tool, and passed to run-time. This encourages dynamic applications and user-controlled events without the need of pre-design.

4.3 Parameter Spaces

Roussseau and Hayes-Roth [17] developed a social-psychological model for characters, the most important parameters are: Personality Traits (patterns of behaviors, but not grounded in any psychological theory), Moods (emotions), and Attitudes (interpersonal relationships). Acknowledging this model but at the same time improving it, we would like to bring the notion of Parameter Spaces. With this concept, we point to the different parameters involved in a communicative behavior of a face which we do not consider in a hierarchical-dominant order but at a level that can provide information to each other. These four parameters are: Geometry, Knowledge, Personality and Mood. Geometry, is the physical shape of the face, based on this information and by manipulating it, the face is animated. 2D or 3D the geometry is organized into hierarchical regions and sub-regions (see figure 3). Knowledge is where the behavioral rules are processed, it determines how the characters will react to the stimulus. This space uses an XML for identifying scenarios, events, and doing decision-making. Personality is what distinguishes a character from other, it is that combination of traits that makes them unique; even though they can share some qualities, their personality will mark the way they perform, choose, and behave. One of our main goals is to achieve an efficient personality model with parameterized facial actions. The last space is Mood populated by emotions (such as anger) and sensations (for example, fatigue). Extensive work has been done on facial actions of emotions [18]. Emotions can be mapped into a 2D representational model and quantify into facial actions [19][20].

It should be noticed that these parameters are highly aligned with the conditions for creating believable game characters that Vick enumerates [1]. Whereas we distinguish the nuance of personality and emotions, Vick covers both in the emotional aspect, and whereas he distinguishes between modeling and animation, include them in the geometry space.

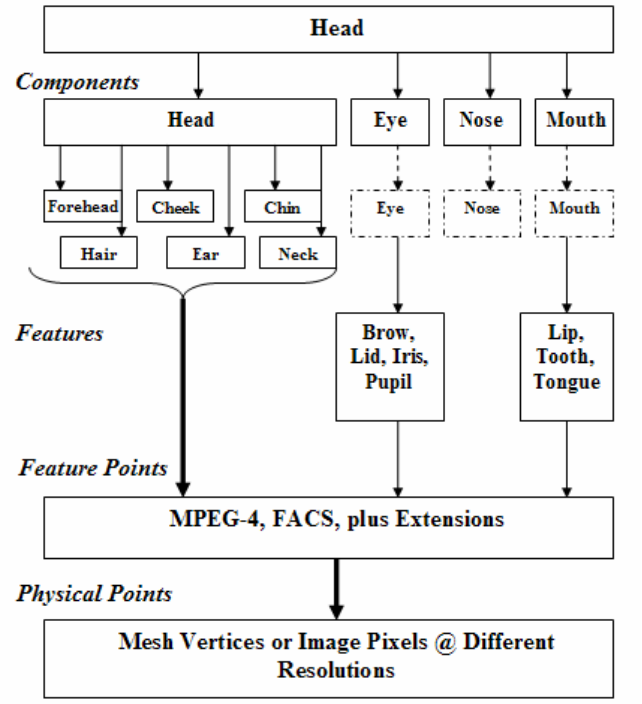

Figure 3. iFACE Geometry Hierarchical Head Model

5 PERSONALITY

5.1 Definition

The origin of the term goes back to the Ancient Greece. Actors used to wear masks and read aloud their scripts from scrolls. For referring to 'mask' the word 'persona' was used, in this way 'character' became a synonym of 'personality'. Nowadays, personality is a psychological abstract concept that can be described by different theories. Nevertheless, all psychologists would agree that personality is the particular combination of traits, qualities, and behaviors that makes a person unique [21]. Implementing personality into characters requires to operationalize the abstract concept. This means to breakdown

personality into measurable variables that show specific observations.

Finding a suitable theory to implement would help to increase consensus of what is meant when referring to characters' personality, and would encourage leaving aside intuitive implementations. Psychodynamic theories like psychoanalysis offer little ground due to high reliance fixation of psychoenergy; somatotype theories, where people is classified by they body build into personality, have low validity but would provide interesting visual cues for modeling characters. Traits theories introduce continuum of a characteristic rather than binary ('have-it-or-not'), like Allport's cardinal, central and secondary traits. Phenomenological theories such as Rogers's are based on self perception and there is no measurement which makes it almost impossible to implement. Factor theories emerged from statistical factor-analytic techniques that prompt certain variables that can be measured by personality inventories, this type of theories also consider factors as a continuum dimension, well-known factor theories are Eysenck's super-traits, Cattell's multifactor theory and the Five Factor Model. This last kind of personality theory would be the most suitable for implementing personality modules for game characters since they offer measurable personality dimensions that can be easy operationalized, keeping the nuances of human nature.

The Five Factor Model (FFM) also known as "The Big Five" has been the preferred factor theory used for believable agents [4][12][22]. Its five traits are: Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism. See table 1.

Table 1. Five Factor Model Traits

Trait	Refers to	If low score
Openness	Imaginative, prefer variety, independent	Down-to-earth, conventional, low aesthetical appreciation
Conscientiousness	Well-organized, careful, reliable, self-discipline	Disorganized, careless, weak-willed
Extraversion	Sociable, affectionate, optimistic	Reserved, sober
Agreeableness	Trusting, helpful	Suspicious, cynical
Neuroticism	Anxiety, experience negative emotions, vulnerable	Secure, calm, self-satisfied

Within the factor theories, and as chosen personality model for the earlier version of iFACE system, there is the Wiggins' model. It presents personality in two dimensions: Affiliation, and Dominance. Wiggins' model can be considered as a simplified version of the FFM by implementing two of its five factors (Extraversion and Agreeableness) and representing them into a circumference map. Such representation, as a blend of two factors, distributes personalities into a plane where they can be identified as points. See Figure 4.

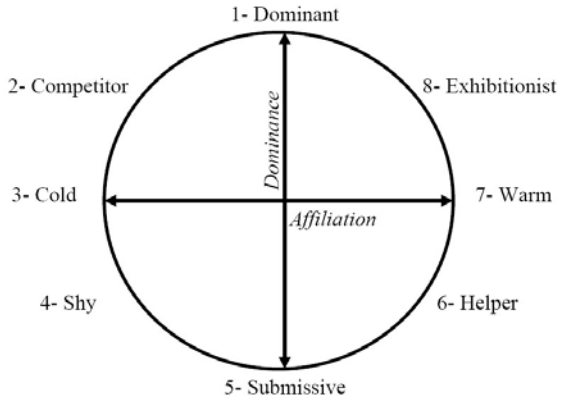

Figure 4. Wiggins' circumplex personality model

5.2 Face Modeling Language

Regardless the different mark-up languages used in multimedia process such as VHML, MMPL, there is a lack of addressing specific means for facial animation. Due to this reason, an XML-based face specific language that is compatible with MPEG-4 was developed. iFACE uses Face Modeling Language (FML) for the face animation. The behavioral aspects are processed by the Knowledge space, given as a script like the following:

```
<fml>
  <model>
    <event name="kbd" />
  </model>
  <story>
    <action>
      <!--parallel actions-->
      <par>
        <hdmv type="yaw" value="80"
            begin="0" end="2000" />
        <play file="Audio1.wav" />
      </par>
      <!--exclusive actions -->
      <!--only one of options will run-->
      <excl ev_name="kbd">
        <talk
ev_value="F1_down">Hello</talk>
        <talk ev_value="F2_down">Bye</talk>
      </excl>
    </action>
  </story>
</fml>
```

5.3 Mood

The Mood space is independent but related to personality. When a script is processed and a new emotion is set, it can overwrite the personality. Moods are represented in one of the facial states show in Figure 5. There are two types of mood: pre-set and custom. The pre-set moods are based on the basic emotions (fear, happiness, anger, surprised, disgust, and sadness). The custom mood is defined by the user, giving the coordinate in the Russell's circumplex model [19]. This mood matrix has two axis Stress and Energy, the user input will be snap to the closer emotion in the matrix.

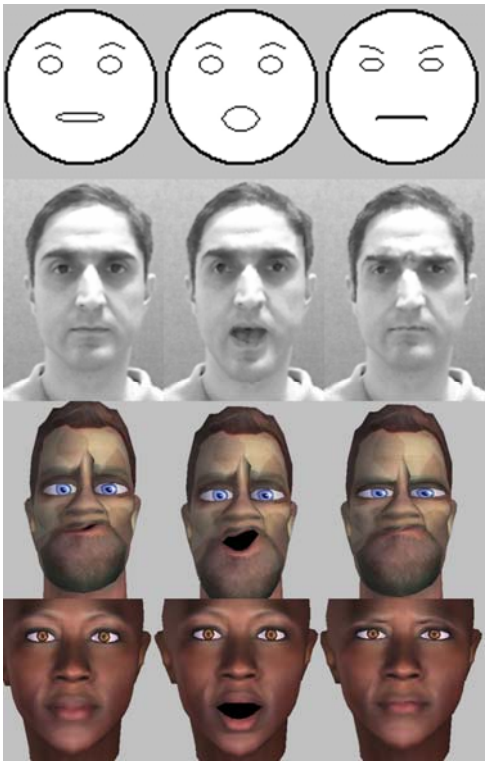

Figure 5: Neutral, Talking, and Frowning facial states (left to right) of four different characters.

5.4 Face Personality

A two dimensions personality model was mapped successfully to facial visual cues for iFACE. Based on Wiggins' model, different personalities are distributed into an orthogonal two parameters graphic, the axes are Dominance and Affiliation (see figure 4). The weight of these parameters activates randomly, periodically or based on speech energy level certain facial actions of the character, for example nodding when emphasizing. A study was run in order to start exploring the relationship between personality and facial gesture. Visual cues were defined as individual or combined MPEG-4 FAPs. Subjects identified consistently particular visual cues to different personalities [7]. It was also detected that emotions can modify the perceived personality mainly along the affiliation parameter. Since the system supports running real time, lip-synchronization is used by Onlive with ETCodec. For a clear analysis, visual cues were classified into Static or Dynamic (see table 2). The visual cues identified by subjects were located into Wiggins' model. Different mappings were created according to the associated emotion and to speed of the action performed as visual cue, for instance if it was slow or fast. Figure 6 shows the mapping for fast actions.

Table 2. Static and Dynamic Visual Cues for Personality

Static Visual Cues	Dynamic Visual Cues
• Standard Emotions o Joy o Sadness o Anger o Fear o Disgust o Surprise o Contempt • Head rest position • Speaking out of a corner of mouth • Gaze (looking into camera) • Gender • Age • General Appearance (round face, full lips, eye separation, nose shape, brow thickness, etc) • Baby face vs. mature • Other attraction-related features	• 3D Head Movements o Frequency o Duration o Direction (yaw, pitch, roll) • Nodding (especially in emphasis for speech) • Laughing • Raising eyebrows • Frowning o Symmetric vs. one-sided o Frequency o Duration • Gaze shift • Blinking o Frequency o Duration • Frequency and duration of expressions listed in Static Visual Cue

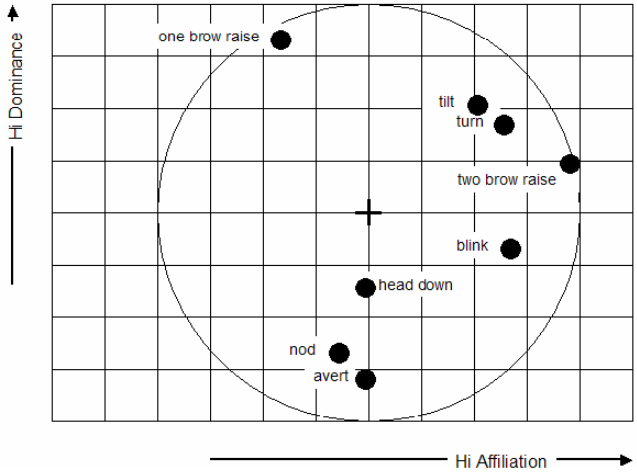

Figure 6. Fast actions of visual cues mapped onto Wiggins' model of personality

Once that the facial actions were classified, the associated perceived visual cues were matched to the dominance and affiliation personality traits subdivided into three values: low, medium, and high (see table 3).

Table 3. Visual Cues and Personality Types

Visual Cue	Perceived Personality Type
Happiness and surprise	high in dominance and affiliation
Anger	High dominance / low affiliation
Sadness and fear	low in dominance
Averted gaze	low affiliation
Moving away	low affiliation
Frequent moving	high dominance
eyebrow raise - 1 sided	high dominance
Tilted head	low dominance and/or high affiliation
Wide-open eyes	high affiliation
Frequent blinking	low affiliation / low dominance

6 ONGOING WORK

Our work aims to provide designers a system that allows them to manipulate parameters rather than deal with hardcore technical details. In this way the character will make facial expressions related to the stipulated personality defined by the designer.

The first personality system for iFACE was based on Wiggins' model, an orthogonal two dimensions personality system. It has been highly prolific and critical information has been collected through research. One of the main reasons for selecting this model was due to considering that less dimension would be easier to visualize for artists. Nevertheless, we want to improve the Personality space parameter of iFACE by operationalizing and implementing the Big Five model. By doing so we would be able to test if an n-dimension model traits would provide a better parameterized option than an orthogonal-bidimensional model. We predict that by implementing this well-known model with more dimensions will improve personality modeling of characters, by allowing further character uniqueness and keeping simple the variables to be manipulated by the designers. This underlies the objective of creating a better user-friendly-interface for character design.

In order to keep the valuable information collected in the studies run so far using iFACE, it necessary to implement the transition by using an intermediate model from Wiggins to Big Five which is the Abridge Big Five dimensional Circumplex (AB5C) [23]. This model provides the framework to compute the data that we have with the new personality module.

The two Wiggins' parameters are based on the Extraversion and Agreeableness parameters of the Five Factor Model [23]. The reason for few parameters, besides simplification, is an answer to a linguistic issue. Personality trait labels can not describe perfectly a close cluster, due to impossible unequivocal interpretations. Hence, a mapping representation opens the adjoining borders of categories based on semantic cohesiveness. Flexibility of interpretation is gain in exchange of precision.

Hofstee's et al. work [23] provides us with the framework for going from the mapped circumplexes to meticulous use of labels. These authors implemented a finer segmentation of primary and secondary loading for each of the five factors. Adjectives for the Five Factors were judged independently by lexicographers who agreed consensus (mislabeling prevention) (see table 4). Out of the ten circumplexes of AB5C, Wiggins' only take one. This parsimonious oversees nuances in the adjectives, consequently in their factor weight. Circumplexes models can only cover a subset of dimensions, for instances to analyze by combining Extraversion and Openness factors. Adding more pairs of factors does not help to manipulate the data for characters' personality modules, since it would be a considerable complication to implement computationally. For this reason, out of the AB5C analysis we do not take circumplex combination of factor but their personality descriptor for each of the five traits.

Table 4. AB5C – Big Five factors and personality descriptors

Factor	Bipolar factor makers
Extraversion	talkative-silent, sociable- unsociable, dominant-submissive, competitive-uncompetitive, boisterous-restrained, courageous-cowardly, explosive-sedate, and adventurous-unadventurous.
Agreeableness	sympathetic-unsympathetic, friendly-unfriendly, agreeable-rough, considerate-inconsiderate, generous-selfish, affectionate-unaffectionate, and tactful-tactless.
Conscientiousness	organized-disorganized, ambitious-unambitious, cautious-reckless, reliable-unreliable, consistent-inconsistent, perfectionist-haphazard, and conventional-unconventional.
Neuroticism	unenvious-jealous, unselfconscious-insecure, unexcitable-excitable, patient-irritable, and unemotional-emotional.
Openness	creative-uncreative, inquisitive-uninquisitive, , deep-shallow, individualistic-dependent, perceptive-unobservant.

As a result we have lexicographic approved adjective for identifying the Big Five personality factors, plus specific visual cues for two of them from our previous findings. After running new studies, we expect to incorporate visual cues for the all the dimension of the Big Five Model, and we would be able to compare if the same visual cues are perceived for the dimensions Extraversion and Agreeableness (dominance and affiliation in Wiggins' terms). See figure 7.

By following this methodology of transitions between models, we keep the lessons learnt from perceived personality visual cues with the Wiggins' model, but improving the nuance of personality by incorporating the dimension of the Big Five, plus meticulous adjectives from rigorous personality factor makers.

Figure 7. Screenshots from iFACE
Visual cues use for personality traits:
Upper left: Head tilt. Upper right: Head Turn.
Bottom left: One eyebrow raised. Bottom right: Head Nod.

7 CONCLUSION

This paper describes iFACE, a facial animation system that is composed by four different spaces: Geometry, Knowledge, Personality, and Mood. There is no hierarchy among them to keep them autonomous from each other. There is a hierarchy for the geometric space for facilitating modeling and animation details, and it allows group functions to be performed more efficiently. iFACE framework is a powerful "face engine" for character-based online services, games, and any other "face-centric" system. A change in the personality space is presented, the intention is to evolve from the already implemented model based on Wiggins' model to a parameterized the Big Five. The information collected by the previous model (perceived personality visual cues) would be incorporated into the new model by using as an intermediate tool the Abridged Big Five Dimensional Circumplex model. We expect to incorporate more precision and distinction of personality traits, and at the same time to provide a tool to the game developer community that would allow manipulating specific facial actions to evoke the desire personality.

8 ACKNOWLEDGMENTS

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