Modeling and Implementation of Emotions in Virtual Humans

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***Abstract*—Emotions in Virtual Humans has generated a lot of research in the field of Human Computer Interaction. We propose a method of modeling and embedding Virtual Humans with emotions. The outcome of this proposal is to create an application that simulates basic humans through a Virtual Human face. Virtual Humans have been given emotions so that we can interact with them more freely and make them trustworthy. We have experimented the proposed work using tools such as Blender and MakeHuman. Standards such as mpeg-4 are also used to model and animate the Virtual Humans.**

Keywords—Virtual Human; modeling; emotion; Blender; MakeHuman; mpeg-4

I. INTRODUCTION

In the field of Human Computer Interaction a lot of research is being done to improve the methods of improving relation between Virtual Humans and People. Exploration in the field of Computer Graphics has led to creation of lifelike appearance of human characters. However these characters would just be life-less models without any emotions. People are inclined to be more comfortable with others who exhibit human like behavior i.e. emotions [1]. This has found many applications as seen in gaming industry, animated movies and even in the field of education where Virtual teachers are dominant [2]. These Virtual Teachers are found to be patient and more effective in teaching children. This model also makes the teacher available as and when required. Another application of Virtual Humans is having Virtual Digital Assistance. This involves interacting with a Virtual assistance that can be used to takes notes and perform other commands.

This area has a lot of scope for further research especially into emotion model as seen with the research done by Paul Ekman group [3]. They have conducted studies on live participants to capture the various aspects of Human emotion. These studies will help us model Virtual Humans better and make them more comfortable to interact with.

This paper is structured as follows: In Section II we present the relevant background on mpeg-4 standards and its implication for our work. In Section III we discuss the animation of Virtual Human face model to show basic emotions. In Section IV we discuss further possible work towards this area of interest.

II. RELATED WORK

A lot of work has carried by the research institutions around the world. Some notable works include that of Hana Boukricha and Ipke Wachsmuth [9], where an empathy model EMMA was created through which expression of empathy can be designed in Virtual Humans. Shi Lin and Lin Zhigang [10] have worked on simulating human emotions according to Basic Emotion Theory and Cognitive Evaluation Theory in Psychology. They used Fuzzy IF-THEN rules to generate emotion factor. The emotion intensity is computed by a nonlinear function restricted by personality, emotion factor and emotion state at the previous moment. Loris Ambrosini et al. describes methods of 3D human modeling using mpeg-4 standards. They also used 3D scanners to take images of human faces to calibrate their results.

III. BACKGROUND AND MODELING

A. MPEG-4 Standard

In the year 2000, mpeg-4 standard was released by Motion Pictures Experts Group as an ISO standard. As far as Virtual human modeling is concerned, MPEG-4 Facial Body Animation Parameter, specified in ISO/IEC 14496-2:2004 Information technology relates to coding of audio-visual objects [4]. MPEG -4 defines these sets of parameters for animation as well as calibration of a human face:

FDP (Facial Definition Parameter): These parameters are used to define the structure and shape of the face. There are 84 feature points that describe the head. Figure 1 illustrates this Feature Points (FP) [5].

FAP (Facial Animation Parameter): These are responsible for movement or animation of the human face. They may be low level point with respect to displacement of a single definition point on the face or high level with respect to reproduction of a facial expression [6].

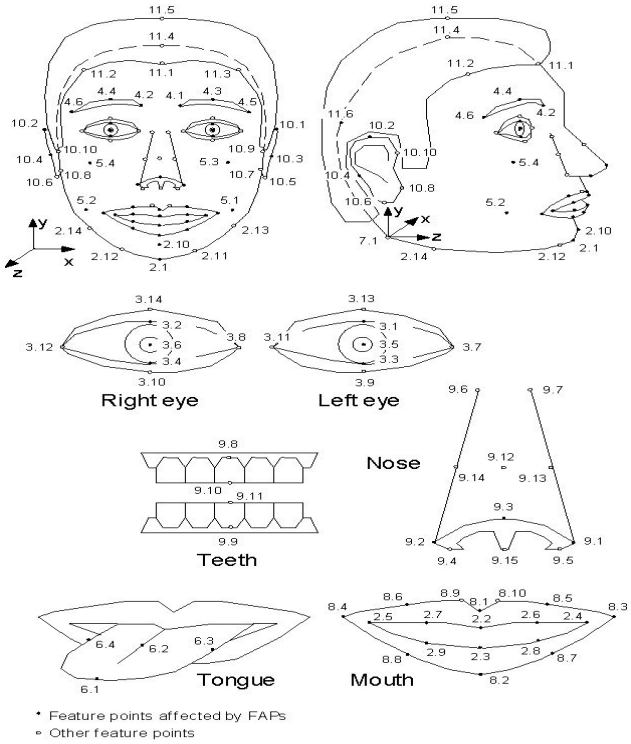

Fig.1. *Feature Points of a human head*

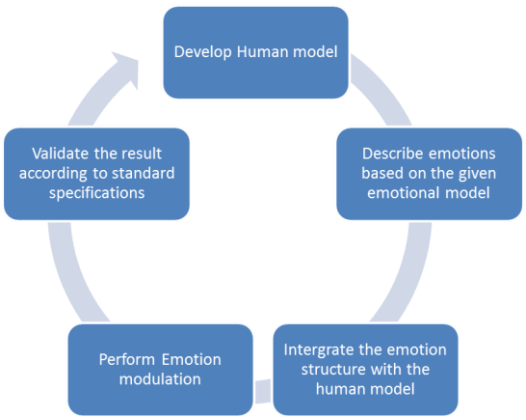

Fig.2. *Lifecycle of adding emotions to the virtual human*

B. Modeling the human face

The Human model was constructed using the open source tool MakeHuman developed by the MakeHuman team [7]. The tool provides various modeling feature on the face such as face shape, size, color, hair etc. MakeHuman is a parametric polygonal Virtual Human Modeler [7]. This allowed us to eliminate the need to create a Virtual Human from scratch. MakeHuman files can be exported to Blender in form of mhx files. The version of MakeHuman used is 1.0 alpha 7.

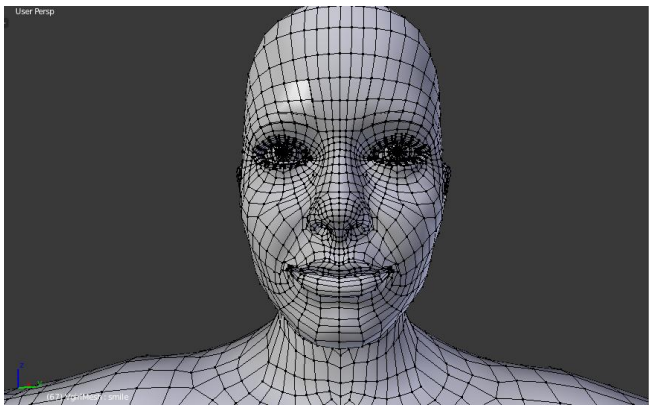

Fig.3. *Mesh model of Human face*

Other tool for Virtual Human modeling includes Xface [8] that employs MPEG-4 standard to create a Human Face.

IV. EMOTION MODELING IN VIRTUAL HUMAN

Once the Human model is imported from MakeHuman, emotions have to be added it. The model once imported is in neutral face i.e. the basic state without emotion to which it must revert to once the emotion is displayed. The specification of the neutral face includes [11]:

- The coordinate system is right-handed;
- Head axes are parallel to the world axes; gaze is in direction of the Z axis;
- All face muscles are relaxed;
- Eyelids are tangent to the iris;
- Pupil diameter is 1/3 of the iris diameter;
- Lips are in contact; the line of the lips is horizontal and at the same height of lip corners;
- The mouth is closed and the upper teeth touch the lower ones;
- The tongue is flat, horizontal with the tips of the tongue touching the boundary between upper and lower teeth;

A. Defining the emotions

There are hundreds of human emotions and to implement them all is a tedious and process intensive task. According to EKMAN all the emotions are classified under 6 basic types: happy, anger, fear, surprise, disgust and sad [3]. We define these emotions in Blender based on the still photographs obtained from a small survey conducted for this purpose.

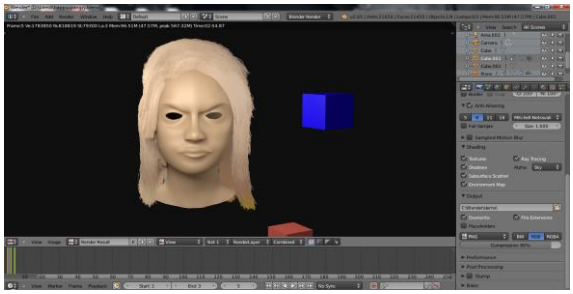

Fig.4. *Angry Base model*

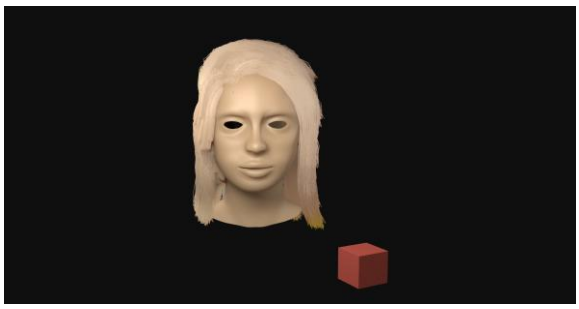

Fig.5. *Neutral base model*

V. PROPOSED WORK

Once the Virtual Humans were given basic emotion, it is required to test the model. The proposed plan of action is to obtain real time data from real humans where emotions is concerned and compare them with the existing model to calibrate and correct it. This data can be collected by means of a survey where each participant is asked to display intensities of a given emotion. By means of regression an average emotion structure can be identified. This procedure can be repeated for a number of participants and a collective average can be calculated and established as the mean model. A database will be created where a large number of emotion models can be accessed through our application and also made available for use in further research. However it is to be noted here that this result may vary due to different factors like geography, economic condition, literacy, political influence, cultural and religious background [12].

Standard databases created after extensive field study such as the one by EKMAN group can also be used to calibrate our model.

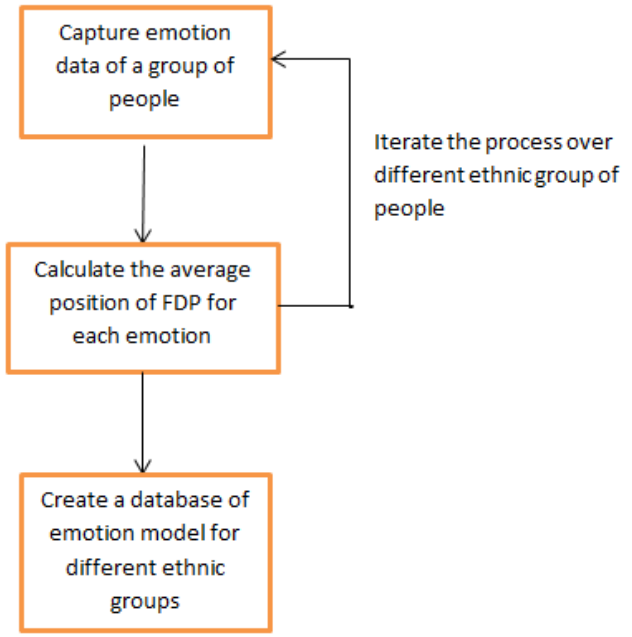

Fig.6. *Flow of proposed work*

Once a database is created we use this emotion model to calibrate the output obtained by manual assignment. This process can be repeated a number of times to achieve a good result.

Fig.7. *Incorporating emotions to human model*

VI. CONCLUSIONS

Due to its immense application in the field of gaming, animation industry and artificial reality, this area is still under intensive research both from the industry as well as research institutes. Our application will be aimed at beginners in this field and will focus on continuous improvements through testing and evaluations.

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