CREATING AND SIMULATING TEMOTIONS ON N ANIMATED CHARACTER

I. C., ENACHE, National University of Science and Technology POLITEHNICA Bucharest, Bucharest, catalina.enache@upb.ro , ROMANIA
S., IURCO, National University of Science and Technology POLITEHNICA Bucharest, Bucharest, simonaiurco@yahoo.com, ROMANIA
S. C., BĂDOIU, Faculty of General Medicine, silviu.badoiu@umfcd.ro, Bucharest, ROMANIA
A., BUJOR, National University of Science and Technology POLITEHNICA Bucharest, Bucharest, andrei.bujor@yahoo.com, ROMANIA
A., BLIDARU, National University of Science and Technology POLITEHNICA Bucharest, Bucharest, alexandrublidaru@yahoo.com, ROMANIA
S. I., DUMITRESCU, Titu Maiorescu University, Bucharest, silviudumius@yahoo.com, ROMANIA

Abstract: *In this paper, we present a comprehensive analysis of the methodology employed in the development of an emotion-driven character model. We outline each step involved in the design and implementation process, from the initial conceptualization and data preparation stages to the selection and integration of specialized software packages and libraries that facilitate model training and real-time emotional simulation. Particular emphasis is placed on the incorporation of Paul Ekman's classification of basic human emotions—happiness, sadness, fear, anger, surprise, and disgust—as the theoretical foundation for the emotional framework. By mapping these emotions to specific facial expressions and behavioral responses, we aim to enhance the character's realism and improve its capacity to engage users in interactive or immersive environments such as virtual reality, gaming, or human-computer interaction scenarios*

Keywords: emotion modeling, character animation, virtual characters, facial expression

1. INTRODUCTION

In recent decades, computer animated character modeling has become a source of content for a variety of applications. For them to take on the public the most difficult task is to make them credible.

In order to create as realistic an animated character as possible, he must display realistic features and behaviors. In other words, for an animated character to look as realistic as possible, the audience expects a high degree of realism in behavior, so non-verbal communication.

Nonverbal communication or body language is an important form of communication, a natural and unconscious language that transmits emotions to a person. In this context, the face plays an important role in the real rendering of a character, because, as in reality, people instinctively focus on the face.

In this study, our goal is to understand what emotions are, how they appear and how we can recognize certain emotions, what graphics and modeling programs we can use to create an animated character, and then to simulate as realistically as possible the expressions that govern a certain emotion. emotion on the character.

I will focus on the steps of creating a model / animated character, presenting the programs and packages used in its creation, and reproducing emotions by the character based on the classification and recognition of emotions studied by Paul Ekman.

2. THE EMOTIONS AND THEIR CLASSIFICATION

According to Professor Andrei Cosmovici [1], emotions are defined as affective states, of short duration, often accompanied by changes of the body, mirroring the individual's attitude towards a situation. They can be triggered by a real or imaginary circumstance.

Emotions can be externalized by mimicking the face, gestures, crying, laughing or by the way they speak. These represent nonverbal communication (also called emotional expression) [1]. The most recognized expression when we talk about recognizing emotion is mimics.

Mimic is the aspect of the moving face in relation to the emotions experienced by a person. It most easily reveals to us the emotions that our interlocutor transmits. The most expressive parts of the face are the eyes (their oscillations, their brightness, their eyeball changes), their eyebrows, cheeks and lips. Mimics can be manipulated (actors can simulate a wide range of emotions) [1].

One of the most popular classifications of emotions is that made by Paul Ekman and presented in the book "Emotion revealed" [2]. He identified six fundamental emotions (happiness, sadness, fear, surprise, anger and disgust). To these emotions he found some characteristics (reactions of the face / mimic) that later became standard in the recognition of emotions.

Table 1. Creating and simulating emotions on an animated character

Emotion	Expression of the face
Happiness	Pushed up cheeks Present of the smile Movement from muscle that orbit the eye
Sadness	Drooping upper eyelids Losing focus in eyes Slight pulling down of the lip corners
Fear	Eyebrows raised and pulled together Raised upper eyelid Tensed lower eyelids Lips slightly stretched
Surprise	Eyebrows raised Eyes widened Mouth open
Disgust	Nose wrinkling Upper lip raised Lower lip down
Anger	Eyebrows down and together Eyes glare Narrowing of the lips

Thus, in simulating the emotion that we will do to the character, we will refer to the characteristics in the table above.

3. STEPS TO CONCEPT AN ANIMATED CHARACTER

Those who working in games or cartoons consider certain steps in designing a character.

3.1. Concept Art

The first phase in creating a character, is that of Concept Art. What works at this stage, it has to realize what role the character (in the game / story) has, the constraints on the demand impose on the character and how he will look, and this they will do it based on a research. For

example: if we want to draw a bear, we will look for pictures of bears to inspire us by size, proportion, etc. Based on this research, is created a "Mood Board" (Table of references) [4]. Based on this, feedback is provided, and the direction is set in the way the character looks. In my situation, the constraints that I will apply to the character are:

1. Style: The styles chosen for my character are "chibi" (little person) and anime.
2. Gender: Character is a girl.

Based on these constraints, the Concept Art of my character was created.

Figure 1. Concept Art character

3.2. Modeling Character Art

The next stage in character design is Modeling Art. In this stage we deal with the 3D modeling of the character. 3D modeling is a computer graphics technique for producing a 3D digital representation of any object or surface [3].

For modeling we use special software to manipulate points in virtual space (called vertices) to form a mesh: a collection of points that form an object. These 3D objects can be automatically generated or created manually by deforming or manipulating such vertices.

The 3D modeling process produces a digital object capable of being fully animated.

For modeling the character, I use Blender 2.81.

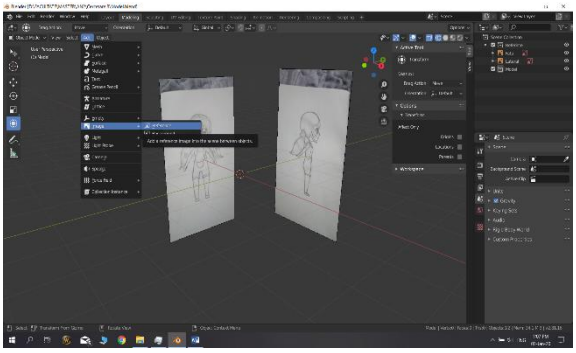

Figure 2. Introducing reference images in Blender

First, we enter the model reference images with Add> Image> Reference. Then we position them according to the direction in which we want to model.

We will start generating a primitive, in our case a circle (**Add> Mesh> Circle**) and modify the circle (by scaling, translation) so that it fits with the model's waist.

We will extrude and modify that modified surface so that it fits with the character's trunk. To make our work easier, we will select the **Mirror** option.

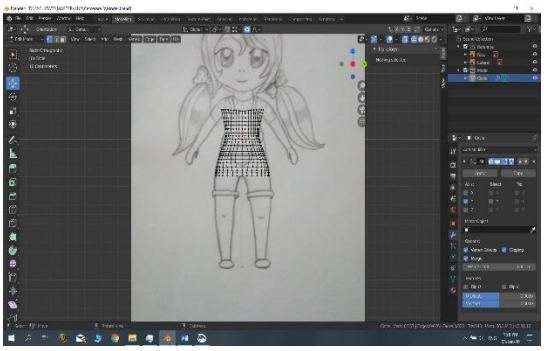

Figure 3. Character body

We insert a cylinder and subdivide it using the **Loop Cut** command. We model it according to the reference images, then with **Merge vertex**, we join the legs with the model's trunk.

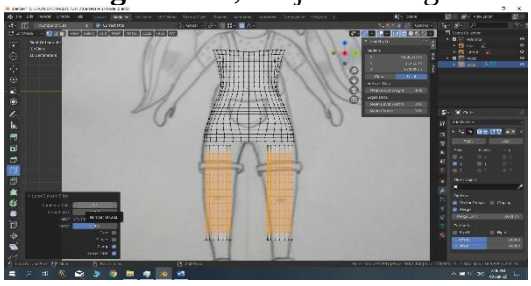

Figure 4. Inserting a cylinder to create the legs

For the soles we do the same, but in this case we will use a sphere. For the arms, we start from a cylinder and model in relation to the reference images.

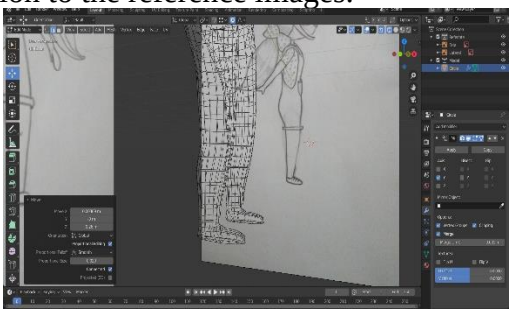

Figure 5. Creating tiptoes

Figure 6. Creating the arms

We create a sphere and unite it with the base of the neck. Join the body head with the Join command. We model the girl according to the reference images.

To create the hand, add a cube and transform it in order to make a finger. From Modifier> Subdivision Surface we set Viewport to 3, and thus created the finger.

Copy the finger with Shift + D (Mesh-Duplicate) and position and transform according to the reference images.

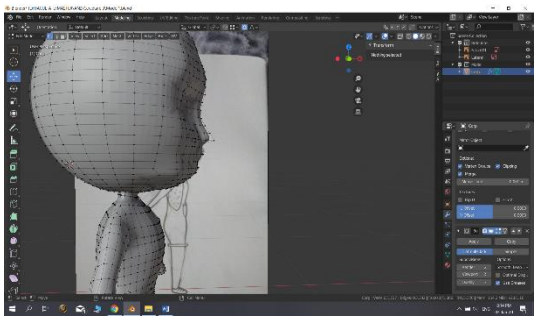

Fig. 7 Creating the head and face

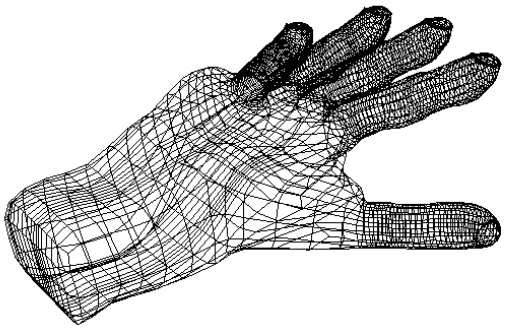

Fig. 8. Creating fingers

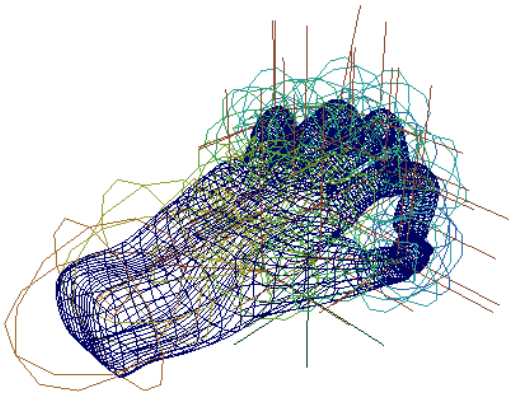

Fig. 9. Hend in pinch position

We join our fingers together using **Vertex> Merge Vertex> At center** to get a surface with which we will shape the palm of the hand. I extruded the surface that joins the fingers, then joined it with the wrist using the **Bridge Edge Loop** command.

I Add lines (with **Loop cut**) and I give a more natural shape of the palm.

Then we wipe the surfaces that are connected to the thumb, and then join it with the palm of the hand (**Merge Vertex**). This is the final result of the hand.

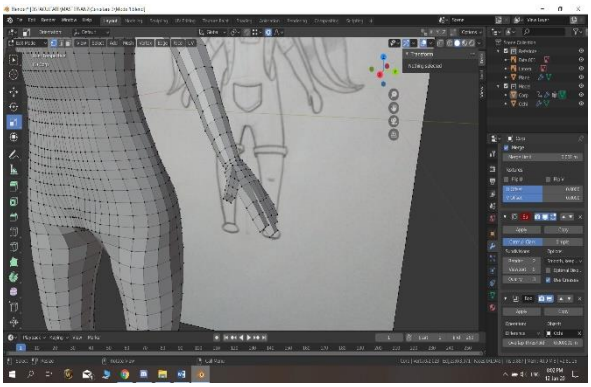

Figure 10. Hand in final form

We create two spheres and insert them into the areas for the eyes (orbits). This is what our final model will look like.

Figure 11. Proxy character (basic)

The resulting character is Low Poly, that is, it consists of fewer polygons, so it will not require the video card.

3.3. Texturing

However, to introduce the character of details, the next step was to create the UV map. The UV map is the unfolded surface of the model. It's like an open cardboard box. On this are textures, color to give the impression of detail, without introducing additional polygons [3].

Figure 12. Introducing texture

To introduce texture and color to the model we use a shader. A shader is a piece of code that dictates how a model's surface looks. The characteristics of the model that we can modify are the color, the transparency and the introduction of textures (material).

In my case, I introduced the texture of the skin and the color of the eyes and eyebrows. Enter the Shading menu. Select he component parts of the character. From this, I select the edges and I press the **Mark Seen** command (with **Right Click**). This command helps us to focus on the area of interest. From **Modifier> Texture Properties**, we introduce skin texture. To color the eyes and eyebrows, enter the menu **Texture Paint**. Select the color and paint the desired area. The result is in this photo.

3.4. Character Rigging

In this stage we deal with a very important aspect in 3D animation: the creation of the skeleton (rigging).

Rigging is a process by which we can animate a character by making him a skeleton [3]. Bones control different parts of the character. If we move a bone the part of the assigned character moves. Creating a skeleton is quite painstakingly, and to animate the character, we often get to have a lot of bones, sometimes even forget to insert bones. To reduce working time and ease of work we will use a package called Auto Rig Pro. This package will automatically put the bones on character depending on what specifications you give them. It will also automatically place the skeleton constraints.

For my character, we will create a skeleton of the body and one of the face. Enter the menu of the Auto Rig Pro package. Select the model and press the **Get Selected Object** button. We position the points according to the given specifications.

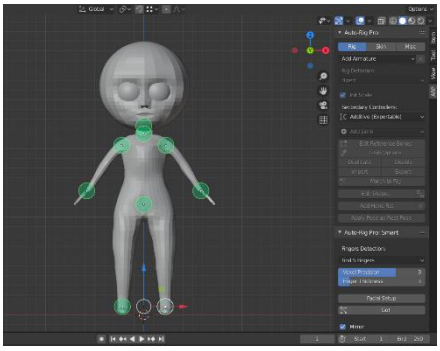

Figure 13. Positioning the key points in creating the skeleton

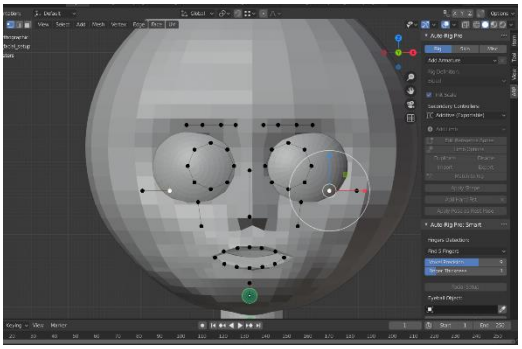

Figure 14. The bones of the face in random position

Once we have arranged them, we press the Go Facial button. The program automatically puts random these bones. We will position them according to the area they will move.

This is how the bones will look after I have arranged them.

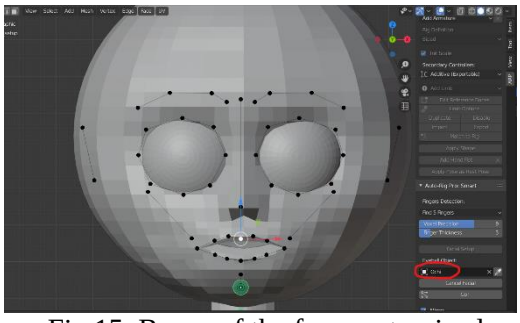

Fig.15. Bones of the face customized to the character

Figure 16. The final shape of the rig

In the **EyeBall Object** field we select the eyes. Press the **Go** button. It will introduce the skeleton to the model. After inserting the skeleton, we will select it with the model and press the **Match to Rig** button. It will assign to each bone an area of interest and create constraints according to the assigned part of the model.

4. SIMULATION OF EMOTION ON ANIMATED CHARACTER

In this chapter we will try to simulate the emotions presented in the first chapter according to the expressions of the face. For this we will use the previously created rig. Below are the results after positioning of the bones.

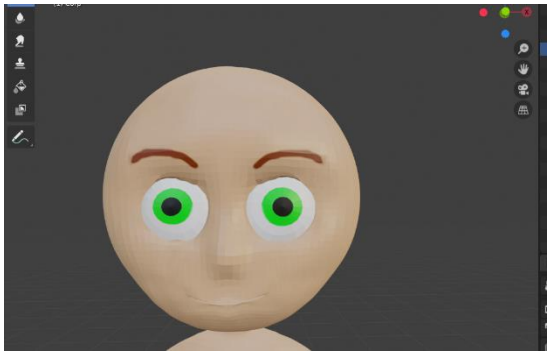

Figure 17. Simulation of happiness

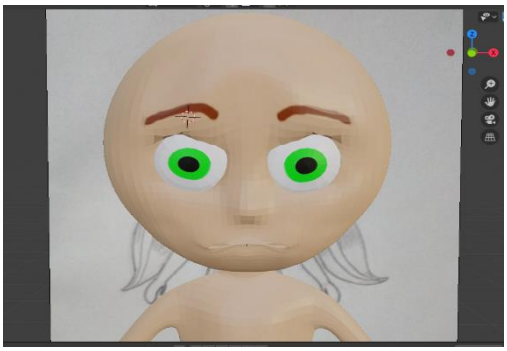

Figure 18. Simulation of sadness

Figure 19. Simulation of fear

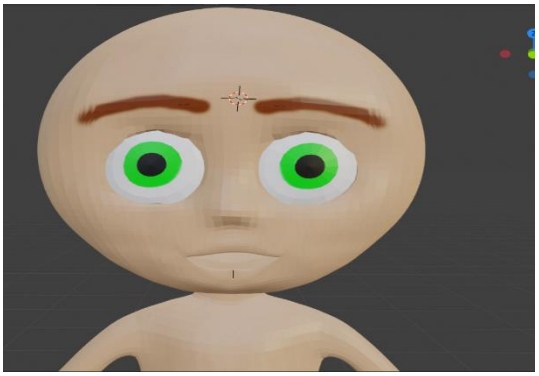

Figure 20. Simulation of surprise

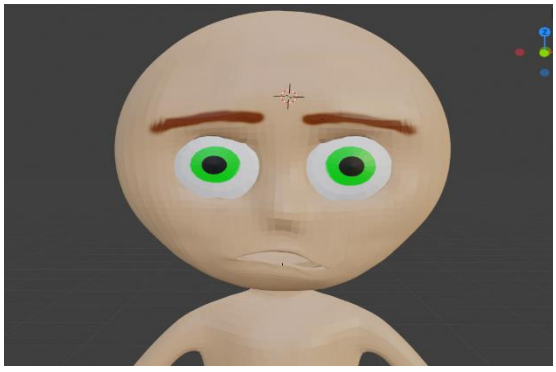

Figure 21. Simulation of disgust

Fig. 22 Simulation of anger

The simulation results do not look good because I did not set the details of the bones and the details of the character (such as hair and clothes) are non-existent, giving the impression of lack of character expression.

5. CONCLUSION

In conclusion, this study underscores the importance of accurately modeling emotional expression in digital characters, with a particular focus on facial mimics.

The initial results of the emotion simulation revealed significant limitations, largely due to the foundational issues in the character's design. Specifically, the improper modeling of the head structure, along with the inadequate definition of the bone system and the lack of fine details in the character's appearance, compromised the intended expressiveness.

These shortcomings highlight the crucial role that anatomical accuracy and model detailing play in achieving realistic and compelling emotional simulations.

The findings from this study serve as a valuable foundation for further exploration in the domain of emotion modeling. They also emphasize the need for a more refined approach in future work, which will address these limitations by focusing on the anatomical reconfiguration of the model, particularly through the application of Weight Painting to enhance bone structure interaction. Moreover, further detailing of the character's appearance, including aspects such as clothing, hair, and facial textures, is essential to ensuring that the character's emotions are conveyed with greater authenticity and depth.

In the future, it will be important to incorporate advanced techniques in both the modeling and simulation phases. The improvement of the character's anatomical design and the inclusion of dynamic textures and movements are expected to significantly enhance the overall emotional expressiveness of the character. This could open up new avenues for research and applications in fields such as virtual reality, video game development, and human-computer interaction, where the accurate representation of emotions is essential for creating engaging and immersive experiences.

6. REFERENCE

[1]. **Andrei Cosmovici**, (1996), *Psihologie generală,* Editura Polirom, ISBN: 973-9248-27-6, Available at: https://www.academia.edu/36489134/Psiho_Generala_Andrei_Cosmovici_pdf_pdf.

[2]. **Paul Ekman** (2011), *Emoții date pe față (Emotion Revealed)*, ISBN: 0-8050-7275-6. Available at: https://zscalarts.files.wordpress.com/2014/01/emotions-revealed-by-paul-ekman1.pdf

[3]. **Yucel, GURSAC**. (2001). *3-D Computer Animation Production Process on Distance Education Programs Through Television Anadolu University OEF* (The Open Educational Faculty) Model. The Turkish Online Journal of Distance Education. 2.

[4]. **Lan, Yuxi**. (2023). *Development and Application of 3D Modeling in Game.* Academic Journal of Science and Technology. 7. 94-97. 10.54097/ajst.v7i2.11949.