Lip and mouth animation as an aid to speech

Jesuliana Nascimento Ulysses - julysses@ic.uff.br
Aura Conci - aconci@ic.uff.br
Instituto de Computação - UFF - Niterói,RJ

SCRIPT

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INTRODUCTION

- The language is the most important process in the human evolution.
- Through the language
  - The man is inserting in society
  - The man translates and transmits his thought
- When a person loses the capacity to communicate, he must find alternatives that propitiate the development of others kind of language
  - Substitution of the audition for other channels: vision, touch and movement
- Those people can develop an oral language or a sign language.

INTRODUCTION

- Some relates alternative communication modes using series of symbols.
  - Symbols Bliss System
  - Pictogram Ideogram Communication System
  - Picture Communication Symbols
  - ImagoAnaVox
- However, they are not related to learning deficient hearing people.
- Deaf people can know how to hear by lips reading.
- They can know how to speech by emitting sounds at the same time that they mimic mouth elements position and movement.

INTRODUCTION

- The **oral language** uses body and facial language of the interlocutor. This is denominated oro-facial or oro-labial, for understanding it identifies the corporal expression, the eyes expression, the facial muscles contractions and the lips movements.
- Due this characteristic of the oral language, facial animation can be used in aid deaf learning systems.
- **VISEMES**: Construction of the visual image of the speech.
  - Disable people can identify and learn the formats of the lips on pronouncing a certain phoneme, aiding in the learning of the language.

FACIAL EXPRESSION ANIMATION

- The **virtual characters** are present in our audiovisual environment and become more and more interactive.
- A virtual characters representing a person is generally use to communicate another person
- The main aspects of human communication are speech and facial expressions.
- The controlled facial animation is a complex task due to the huge complexity of the real structure of the face, which is composed of muscle, bone and skin

FACIAL EXPRESSION ANIMATION

- The facial expression is related with speech mainly by mouth shape.
- The lips and other elements of the face are controlled by the muscle movements.
- Muscles change the face expression combining theirs effect in one area. The possible movements are caused by contraction of some muscles and relax of others.
- There are two types of muscle in the human face: linear and sphincter (Figure 1).
  - A linear muscle becomes thickened and shortened with contractions, and pull the face in a direction.
  - Sphincter muscles are circular band muscles that encircle and close an orifice of the body or one of its hollow organs.

FACIAL EXPRESSION ANIMATION

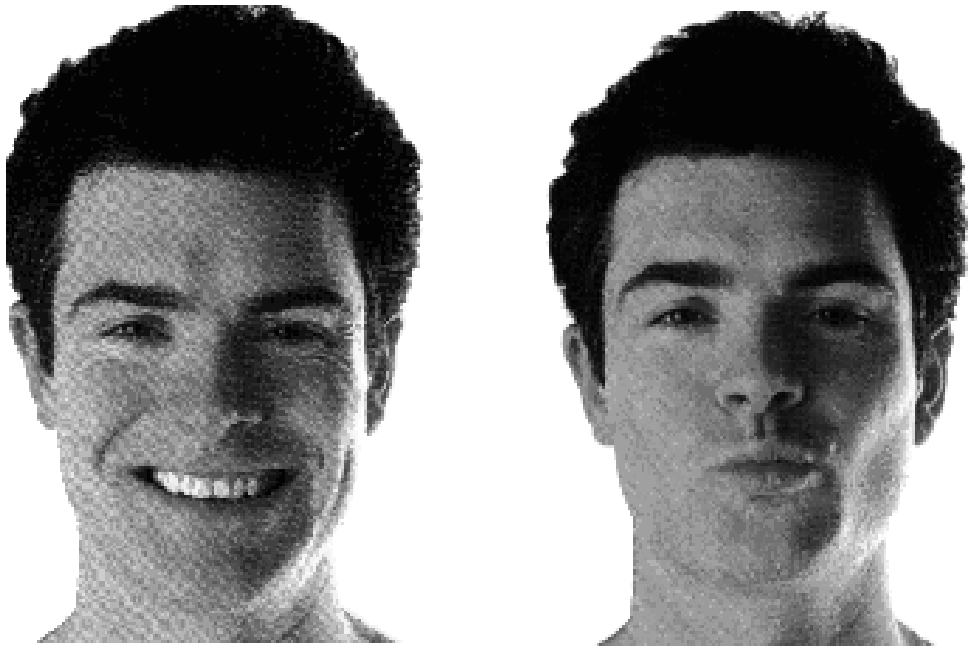


Figure 1: On the left expression, mainly two linear muscle (the Zygomatic Major Left and Right) are stressed. On the right the sphincter Orbicularis is used to close the lips

ABSTRACT MUSCLE-BASED MODEL

- *Abstract muscle-based model*, first reported in 1987 by Waters.
- *Abstract muscle-based model* is based on the human facial anatomy due to the fact it uses abstract muscles to modify the polygon mesh that represent the face (Figure 2).

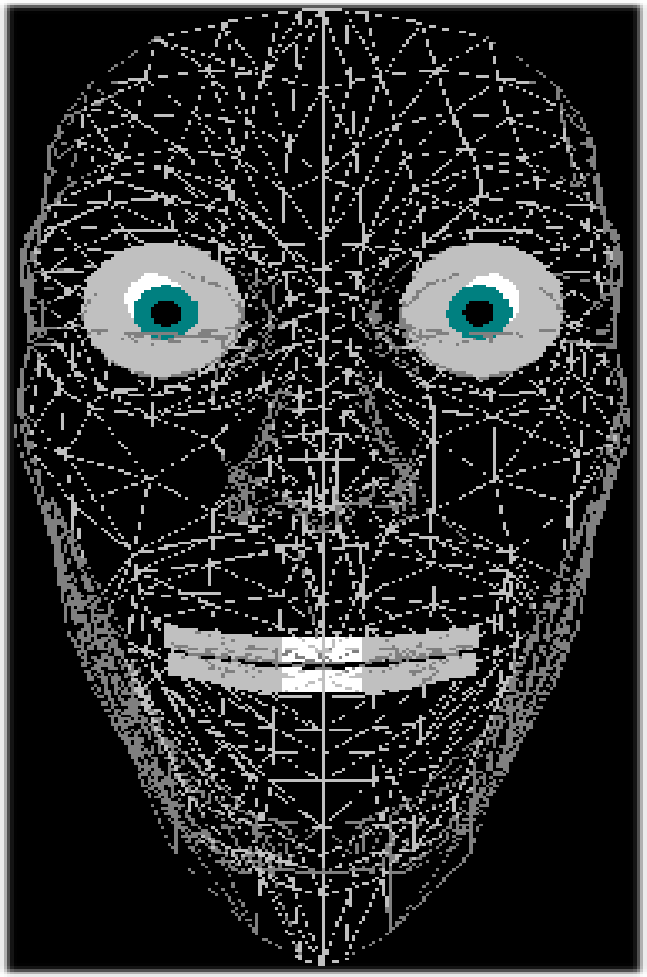


Figure 2: Polygon mesh

ABSTRACT MUSCLE-BASED MODEL

- Two types of abstract muscle are modeled:
  - the linear muscle to pull the mesh
  - the sphincter to squeeze the mesh
- The mouth can be adequately controlled by the two types of muscle behavior (linear and sphicter muscle) .
- The linear muscles can move their influential zone (figure 3) in the direction showed on figure 4
- On the face model this muscles deformed a polygonal mesh which patches after render represent the skin.
- In order to modify the polygon mesh (figure 5) through a muscular control, the algorithm travels the vertex list to find those that are in the influence zone.

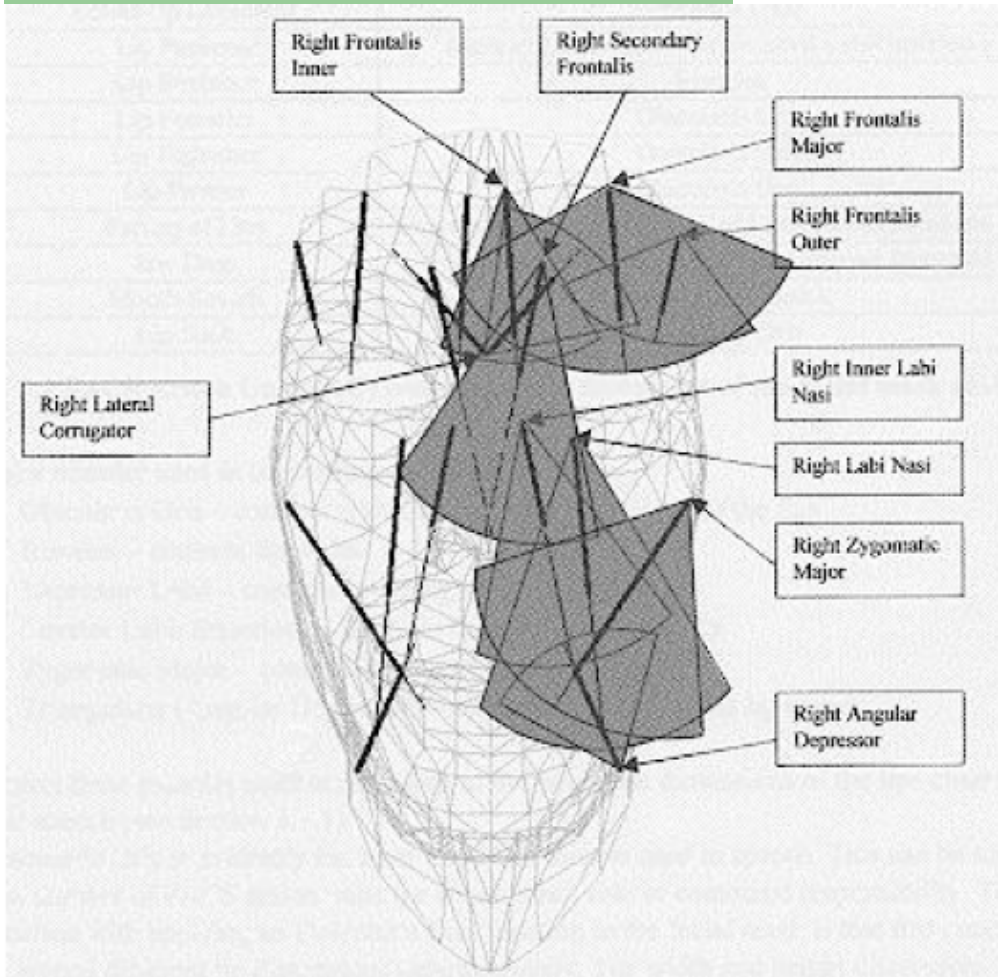


Figure 3: Overlapping muscular in fluencies upon mask facial, as uses in Water's original model

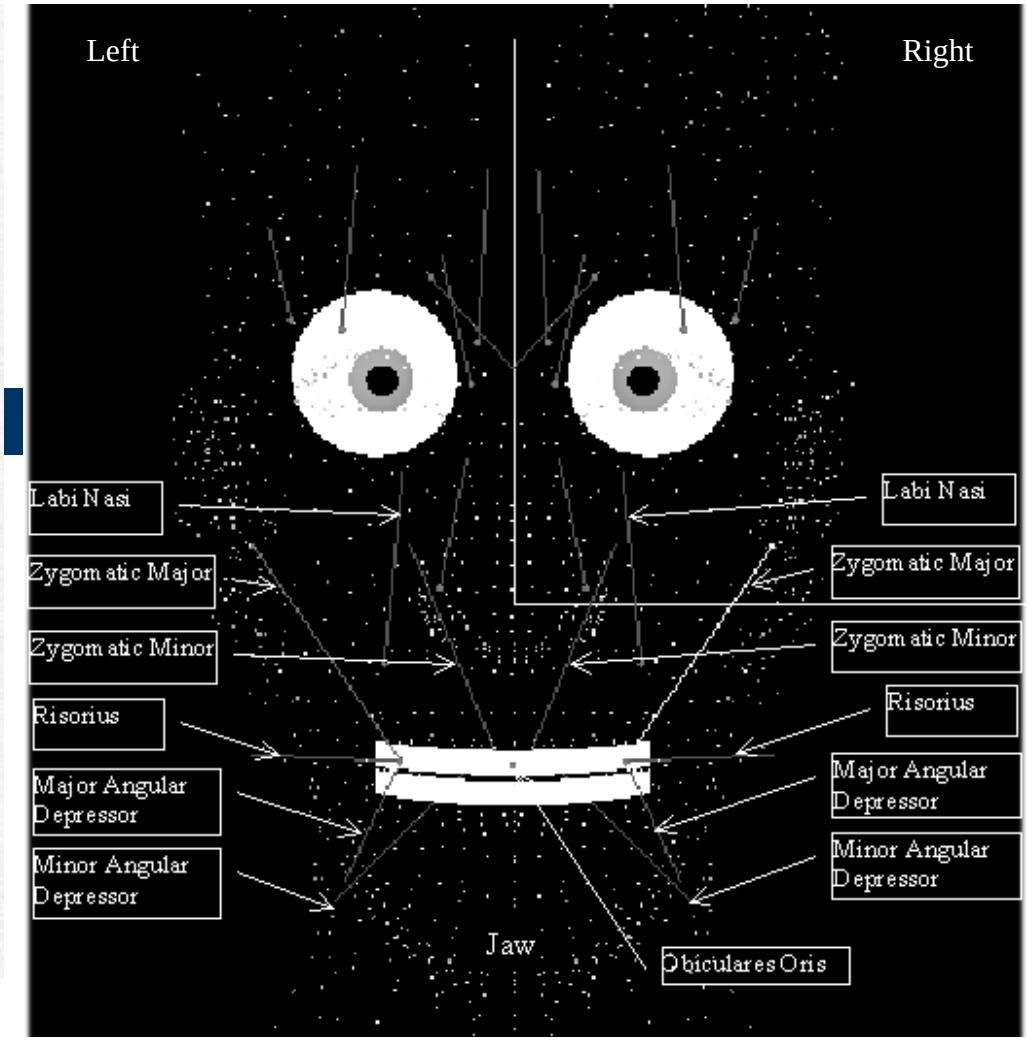


Figure 4: Muscle association and control directions used for phoneme animation

Muscle simulated	Shape Motion
ObicularisOris (sphincter)	increases lip rounding, reduces lip width, increases lip protrusion
Risorius (ledft/right linear)	increases lip width
Depressor Labii (left/right linear) Labii Superioris (left/right linear)	lowers bottom lip Raises upper lip
Zygomatic Major (left/right linear)	Raises the lip corners
Traingularis (left/right linear)	lowers the lip corner
Jaw Rotation	mouth openness

ABSTRACT MUSCLE-BASED MODEL

- In addition to these two types of abstract muscle, a control for the jaw rotation was developed .
- The rotation of the jaw is done by rotating the vertices that compose the jaw in relation to the point of the face (Figure 4)
- Through these few controls, muscles and jaw rotation, the polygon mesh can be deformed and thus produces large range labial expression.
- The **implementation** uses **macros** to create the animation of the mouth.
- These macros control duration of the expression using the influence zone of the muscle movements

METHODOLOGY

- Observation that the position of the mouth over a short period can be correlated with the phonetic sound of the speech over the same time interval.
- We have to develop a proper approach to measure the mouth position during the speech process.
- The parameters controlling the mouth elements position and shape are predicted from an analysis of Portuguese phonemes and the possible control of the facial animation (figure 5).
- All parameters will be measured in a video analysis and image processing software and scaled in accordance with the interlocutor distance of the speaker.
- The mouth measurements are in millimeters

METHODOLOGY

- **JAW** is the jaw position and is measured as the distance between the two (upper and lower) jaws.
- **FLARE** is the height of the maximum vertical aperture between lips.
- **The** EDGE measures the lips joint points, where the upper and lower lips connect.
- **CORNERS** represent the horizontal aperture of the lips during speech.

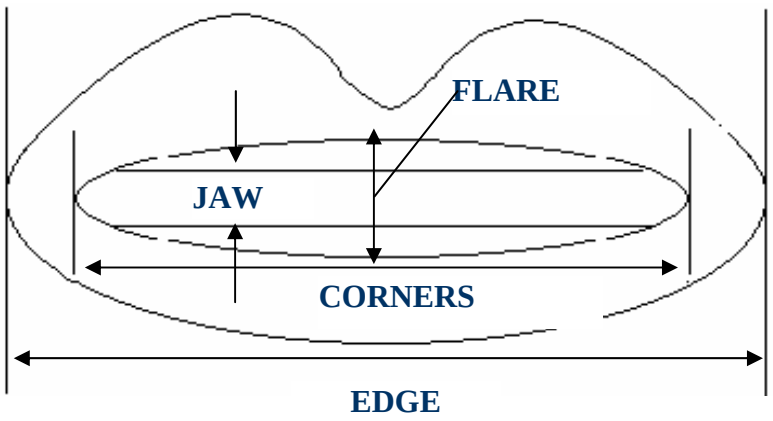


Figure 5: Mouth Parameters

IMPLEMENTATION

- The system was implemented in C++ using OpenGL, in PCs .
- The main objects of the face are:
  - ***Face*** object: *load* a face from files (Create function), *save* a face in files, *contract a muscle* given its name, *open the mouth*, *rotated the jaw* , etc
  - ***FaceIO*** object: object is used to read data from the files and construct a new *FaceStructure* object with this data
  - ***FaceStructure*** object: list of muscles; two *Eyes* object; a *Teeth* object; a *Skin* object and a vector of 3D points

IMPLEMENTATION

– ***Skin*** object: is composed of 6 elements.

(1) A vector of vertices (3D point) used as the position of the face after the loading.

(2) A second vector of vertices representing the facial mask which is displaced by the muscle and drawn.

(3) A vertex index vector to know the vertices composing the polygons to draw.

(4) A vertex index vector representing the vertices contained in the jaw. (5) A vector of *discontinuity*.

(6) Value representing the rotation of the jaw.

IMPLEMENTATION

- ***Expression*** object: is composed of the following elements.

(1) A vector of muscle names used to make the expression.

(2) A vector of muscle contraction corresponding to the name muscle at the same index and indicating the contraction of this muscle.

(3) A value corresponding to the jaw rotation used to make the expression.

(4) And the names of the expression.

- ***ListeExpressions*** object: is a vector of expressions
- Muscle hierarchy:
  - The muscles are represented by an abstract class *Muscle* from which two other class are derived: *LinearMuscle and SphincterMuscle*

MACRO

- *name* is the macro's name
- *time* is the animation time.
- After these parameters all the muscles used in the motion are listed with the corresponding deformation (figure 6)

MACRO}//begin macro

<name> *<time>*

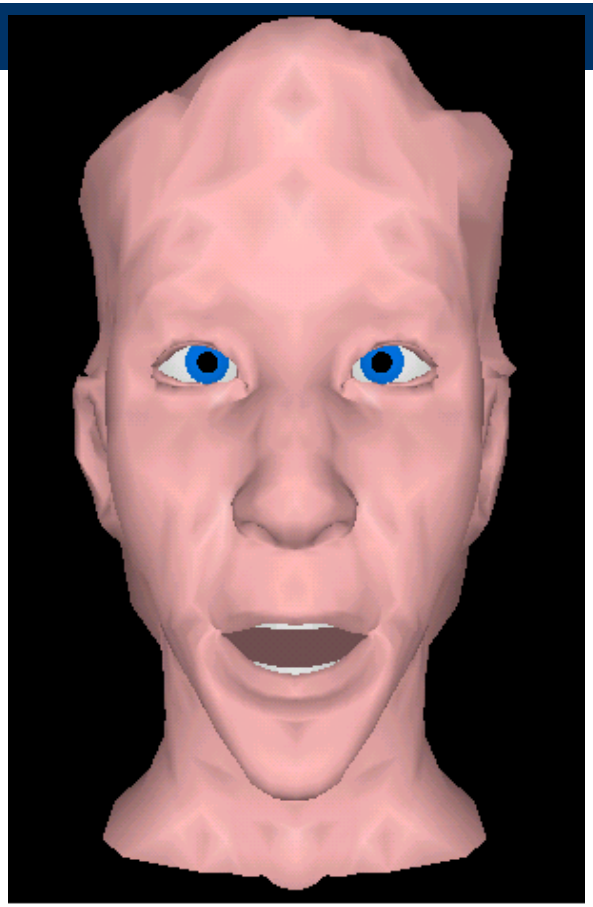
<muscle_name> *<measurement>*

{/MACRO} //end macro

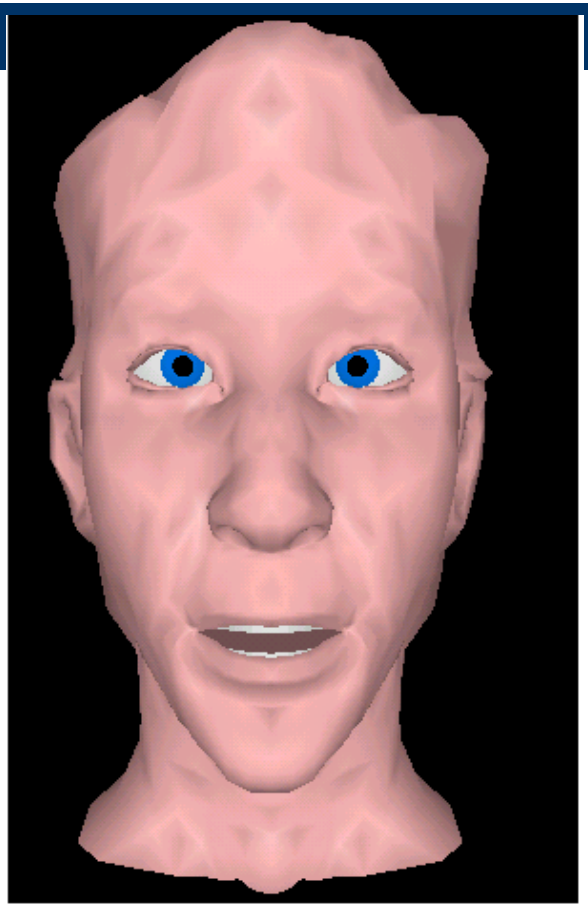
```
{MACRO}
a 10
Jaw 8.7
Left_Major_Angular_Depressor 1.0
Right_Major_Angular_Depressor 1.0
Obicularis_Oris 1.3
Left_Labi_Nasi 0.2
Right_Labi_Nasi 0.2
Left_Minor_Angular_Depressor 0.6
Right_Minor_Angular_Depressor 0.6
Left_Risorius 0.4
Right_Risorius 0.4
Left_Zygomatic_Major 0.3
Right_Zygomatic_Major 0.3
Left_Zygomatic_Minor 0.6
Right_Zygomatic_Minor 0.6
Left_Labi_Nasi 0.2
Right_Labi_Nasi 0.2
{/MACRO}
```

Figure 6: File macro

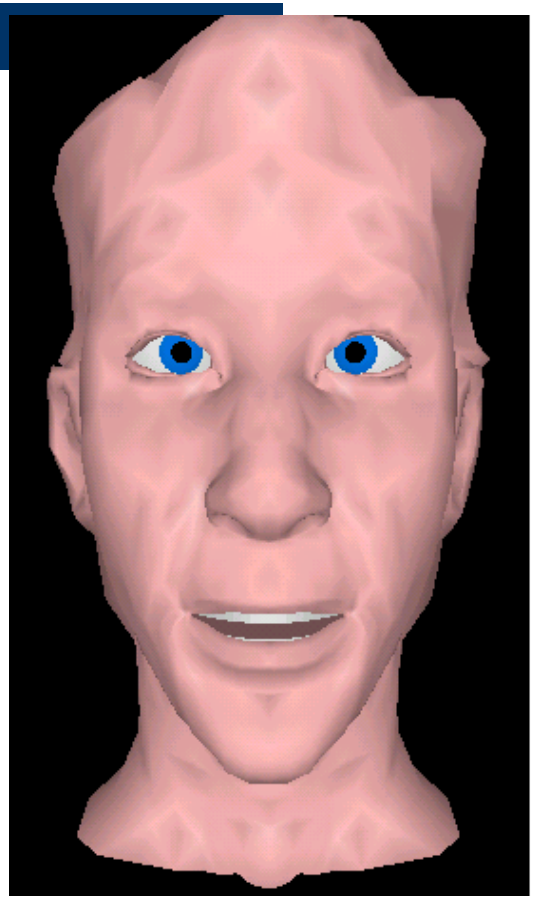
SOME RESULT



Viseme “*A*”

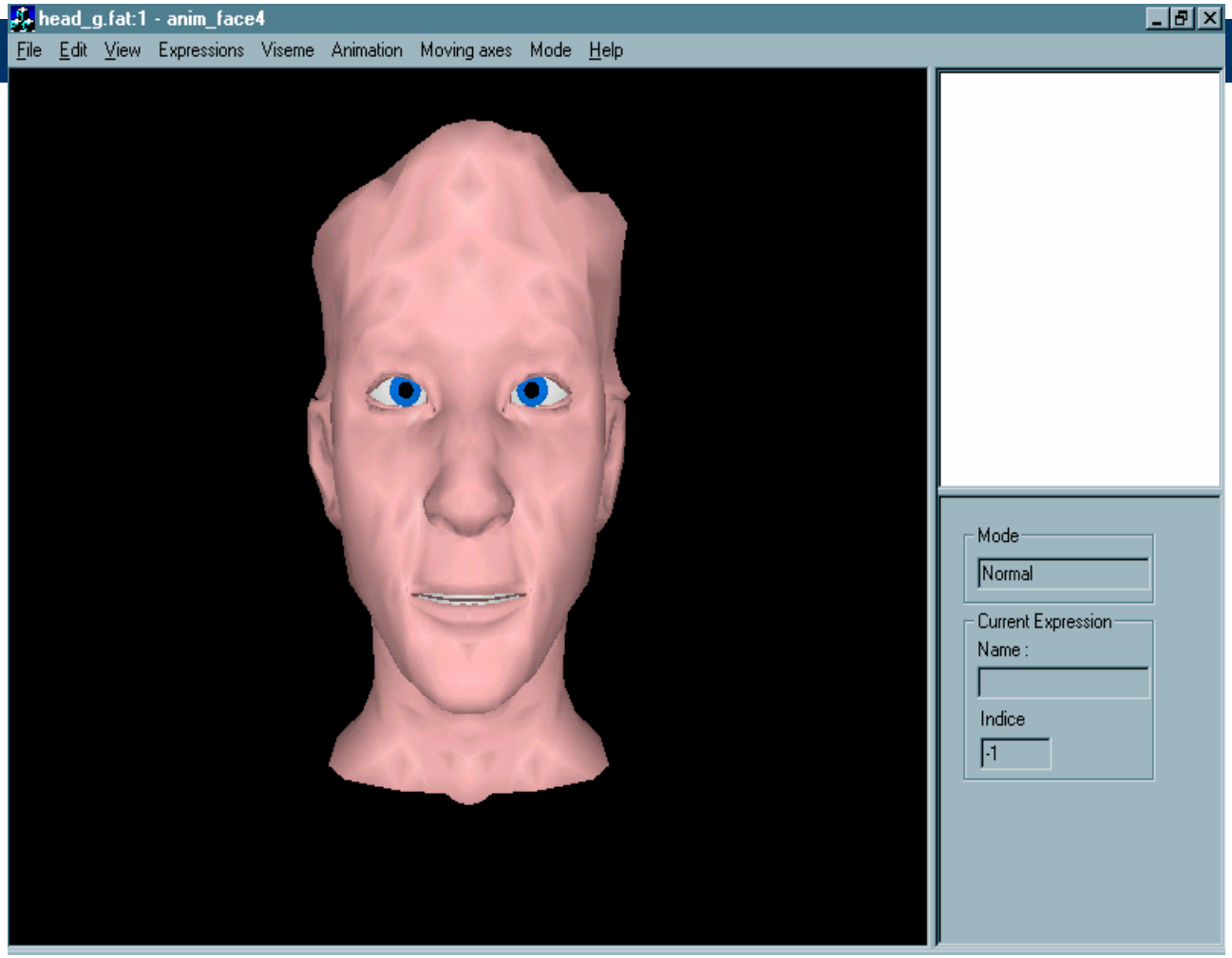


Viseme “*E*”



Viseme “*I*”

PROGRAM'S WINDOW



CONCLUSION

- Although, we are at the initial steps in direction of a complete system to aid special people to speech, we can see that the presented methodology and the facial model used enable the construction of such system.
- Next steps in this direction will be:
  - Systematized of the methodology of measurements proposed in order to turn possible easy map of the four parameters for many other Portuguese phonetic sounds.
  - Composition of a dictionary of macros relating the measures with the muscle.
  - Add improvements on the interface to turn the system adequate to different levels of user (children, adult).

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