A Proposal for the Classification of Virtual Character

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Abstract: This paper proposes a classification of virtual actors based on the movement analysis of their creation medium that we call *matrix sculpture*. The analysis is based on two concepts: the origin, either internal or external, of movement and decision. It leads to define four categories, the *virtual puppet*,the *virtual golem*, the *virtual actor* and the *virtual mask*.

1 INTRODUCTION

Nowadays, it is common to meet "virtual actors", either in movies, video games or digital worlds. Some are referred to as avatars, others as bots, others as digital humans or virtual companions, the terms being used most often according to the context in a empirical way.

Would it not be possible to establish a precise classification that would allow to class and compare these different virtual entities? This article propose a nomenclature based on two concepts: *the origin of movement* and *the origin of the decision*, that provide with an effective grid for analyzing these virtual entities.

2 THE THALMAN CLASSIFICATION

Nadia and Daniel Thalman had established in the article (Thalmann, 1996) a classification of virtual entities based on 4 categories:

- *participants* whose gestures are reproduced "in the same way" that of the real manipulator thanks to a motion capture device,
- *guided actors* whose movements are controlled by an external manipulator thanks to an input device (keyboard, mouse, etc.)
- *autonomous actors* able to interact with their environments through the use of "simulated senses"
- *interactive perceptive actors* able to interact with other actors, real or virtual

We see a strong link between participants, guided actors and the notions of *mocaptor* and *manipulactor* described respectively in (Gagneré et al., 2018a) and (Gagneré et al., 2018b) in a research about theater and avatar. The *mocaptor* controls a virtual puppet in a mimetic way through a capture device , while the *manipulactor* controls the same virtual puppet through other devices.

The boundary between *autonomous actors* and *interactive perceptive actors* seems more blurred. And, if this classification is effective in describing their work, it seems to us that it is not necessarily suitable for more widespread use. For example, in this classification, what differentiates a virtual entity from a video game *Creatures*(Grand and Mindscape, 1996) whose intelligence interacts with the player and learns through a artificial neural network, and a non-player scripted character that we may encounter in an application like *Facade*(Mateas and Stern, 2004)?

3 MATRIX SCULPTURE

In our classification, we assume that all these virtual entities are above all a geometric shape, which we call *matrix sculpture* in order to emphasize that this geometric shape does not express a fixed pose as for a real sculpture, but a shape that can express multiple poses by adding controllers capable of manipulating it(see figure 1).

The *matrix sculpture* must therefore be thought in terms of topology (Raitt and Minter, 2000) with a view to a future deformation. On one hand, the movement controllers receive data from sources that can be

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Figure 1: A matrix sculpture with its animation mechanism.

situated in relation with the sculpture matrix. Either the source has no relation with it and could be considered as external, or the source is partially influenced or totally produced by process dependent of the matrix sculpture. We speak then of internal (or partially internal) sources of movement.

On the other hand, the animated matrix sculpture is placed in a digital world. We can build a modelization of this world and endow the sculpture with an algorithm able to interpret this modelization in order to adapt its movement. We call decision of the movement this process of contextualizing the movement according to an interpretation of a modelization. When the modelization and the interpretation algorithms are fixed and independent of the matrix sculpture, we say that the movement decision is external. When the matrix sculpture can modify either the interpretation algorithm or/and the world modelization, we speak about internal decision. Our classification consequently derives from two fundamental dimensions, source and decision of movement, that we map on two axes as following (see figure 2):

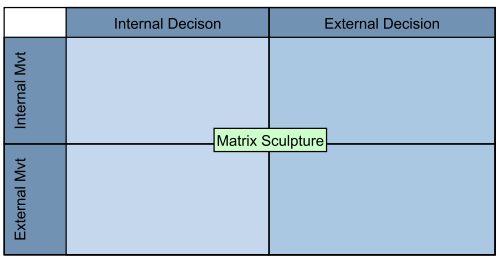

Figure 2: Mapping the matrix sculpture on movement and decision axes.

4 VIRTUAL PUPPET

Adding controllers to the *matrix sculpture* gives capacity of movement to this formal envelope originally based on aesthetic criteria and dynamic possibilities. Controllers need sources of data, that we consider first without any connection with the sculpture matrix. For instance, the manipulative sources may have both human and algorithmic origins, external to the envelop : a synthesized image character animated by keyframe animators, a digital lining controlled by a mocaptor wearing a motion capture suit or a video game player character.

Moreover, the relationship between the matrix sculpture and the world in which it is moving only derives from the movement sources. The sculpture matrix has neither perception of its environment, nor any mean of influencing it. In other words, the contextualization process that we called decision is external to the matrix sculpture. We nevertheless consider that some external decisions are closer to the point of view of the matrix sculpture than others. For instance, the mocaptor who controls a sculpture matrix with his own body through a motion capture suit approaches a better embodiment of it that the manipulactor that controls it with his hands and devices (see figure 3).

Figure 3: A mocaptor and its virtual puppet.

We therefore understand that the embodiment will have a significant impact on the control. We define the *virtual puppet* as a entity that has no decision-making capacity and is manipulated from the outside by another entity (human or algorithmic). There are three ways to handle it:

- *deliberate manipulation*: the manipulator is aware of his manipulative power, he positions himself as

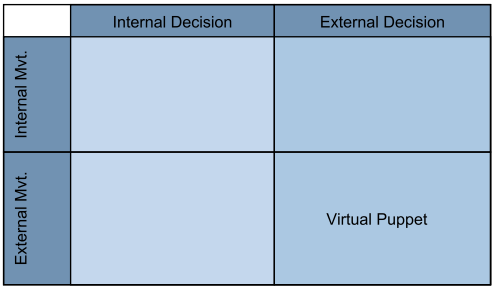

Figure 4: The virtual puppet: decision and movement of external origin.

the user of a tool because he knows that his actions lead to a response from the virtual puppet.

- *unintentional manipulation*: the manipulator does not know that he animates the virtual puppet, and therefore does not have a grid of correspondences between his and its gestures.
- *tamed manipulation*: the manipulator becomes aware of his manipulative power and understands the relationships between his manipulations and the movements of the puppet as he interacts with it

The puppeteer is therefore closely linked to his virtual puppet, which is incapable of movement initiative or decision-making initiative. And the manipulation requires an empathic attention because he has to "put himself in the place of his virtual puppet" (Gagneré et al., 2018).

5 VIRTUAL GOLEM

The virtual puppet needed an external entity as a source of movement and process of decision. The concept of virtual golem is based on a fundamental difference: it can figure out its environment and react in consequence following external orders. This makes it able to produce partially internal sources for its movements inside the environment (see figure 5).

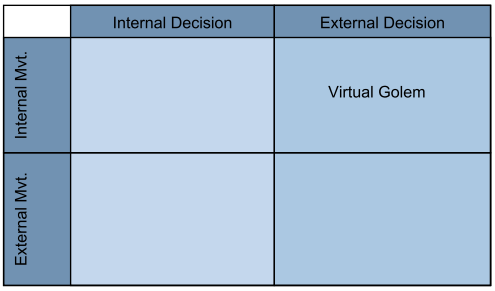

Figure 5: The virtual golem: decision of external origin, movement of internal origin.

The virtual puppet has a system for receiving movement input sources from external manipulators, an output actuation mechanism, and a system for matching inputs and outputs. The architecture of a virtual golem is more complex and consists in :

- A mechanism for listening to an environment modelization
- A mechanism for listening to the manipulator
- A mechanism for interpreting its environment
- An order execution mechanism.
- An actuation mechanism

The virtual golem is equipped with a modelization of its environment and with algorithms able to receive external instructions and produce internal movement answers in relation with the modelization. Even if these internal answers are generally mixed with external sources, it makes the virtual golem able to partially move by itself, that was impossible for a virtual puppet. In any case, the environment modelization and the interpreting and instructing algorithms remain under the external control of the manipulator, depriving it of any decision process. As the mythological figure, the virtual golem only follows orders without free will.

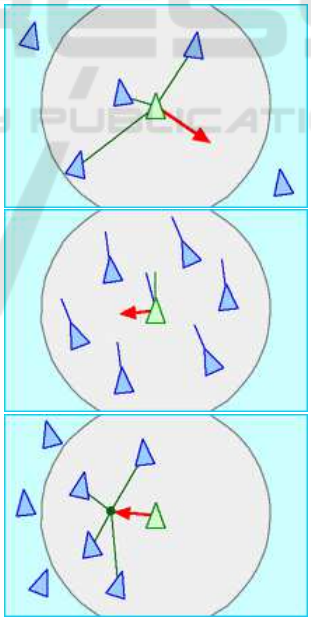

Figure 6: The three rules of cohesion separation and alignment that boids follow(Reynolds, 1987).

Thus we can store video game boxes based on a number of predefined algorithms (path finding, behavior tree), as well as swarm systems. Sometimes, even if the virtual golem only executes more or less complex orders after analyzing its environment, we

observe behavioral phenomenon, as for boids (see 6), due to the multitude of entities (Reynolds, 1987), or, as for chat-bots, due to the multitude of implemented rules in syntax analyses such as AIML (Wallace, 2003) or Eliza (Weizenbaum, 1966). Indeed, even simple virtual golems like the entities of the game of life, create a chaotic system that makes them appear as impredictable complex structures.

6 VIRTUAL ACTOR

The virtual golem obeys orders, obediently without questioning them. It only unrolls an algorithm, processed in an modelized environment, without any possibility to change it neither the environment. An entity able to add its own rules and change the environment modelization would become able to take decisions. We are talking here about learning in the sense of the memorization processes used by animals or humans to develop or modify specific behavioral patterns under the influence of their environment and experience.

We realize that there is indeed a memorization process but that there is also the influence of the environment and the experience. This entity must be able to conduct an experiment, that is to test, evaluate if there is success or failure, and from there draw its own conclusions. True learning requires some form of understanding and assimilation, or even questioning through experimentation, in order to transform a belief into an ontology.

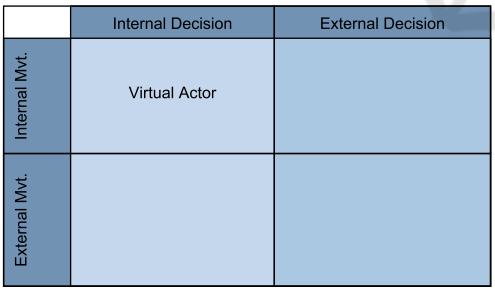

Figure 7: The virtual actor: decision and movement of internal origin.

A *virtual actor* would therefore be an entity able to generate its movement like a virtual golem. But when the latter can't take any decision, the virtual actor can change the algorithms modelizing the environment and giving instructions for movement (see figure 7). Therefore the virtual actor becomes his own arbitrator. He is able to generate his decision that triggers his movement and reciprocally a movement will make him generate a decision in an enacted step. The virtual actor gains in complexity, but also in autonomy. In a certain way, a complete internal decision process endows the matrix sculpture with a free will.

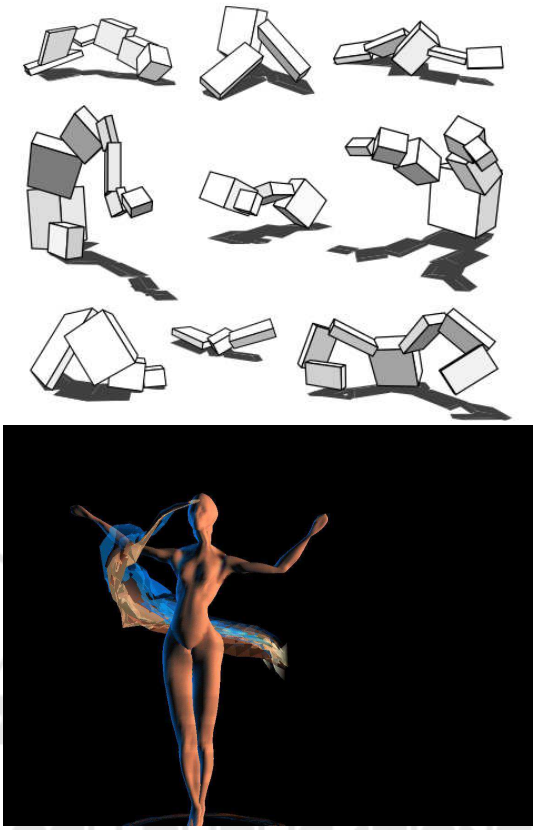

Figure 8: Karl Sims' creatures(Sims, 1994) and Michel Bret's dancer(Thirioux et al., 2009).

Thus Karl Sims' creatures (Sims, 1994), or Michel Bret's characters (Thirioux et al., 2009) or more recent behavioral animation works based on genetic algorithms, or artificial neural networks fall into this category because they develop their own responses and strategies in interaction with their environment.

7 VIRTUAL MASK

A fourth entity capable of decision-making but no movement could be figured out when we study the concept of autonomy by necessity that Jacques Tisseau uses in his description of different forms of autonomy (Tisseau, 2004) :

- *Autonomy in essence* associated with living organisms and animates
- *Autonomy by necessity* which is based on a model that constrains movement, and adapts to changes in the system.

- *Autonomy by ignorance* whose behavior is not predictable and tends to organize by itself towards a goal (teleological behavior).

In autonomy by necessity, the ”model”, external to the entity, manipulates the entity based on the information contained in the model. We propose to call this last category *virtual mask*, noting that in a number of cultures the mask represents a superior entity (god, spirit...) that takes possession of its carrier (see figure 9).

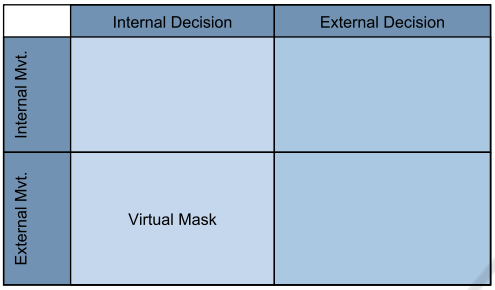

Figure 9: The virtual mask: decision of internal origin, movement of external origin.

The gravity could be considered as a virtual mask controlling a rag-doll, that is a matrix sculpture equipped with actuators organized with external rules. In this case, an untouchable entity manipulates the matrix sculpture as a dynamic motor. The virtual mask could also interact with the three other entities, either virtual actor, virtual puppet or virtual golem. For example, the sims video game is based on the joint use of these two categories, the golem for the different bots encountered, and the masks for intelligent objects that control the different characters.

8 DISCUSSION

This classification made it easier to define the ergonomic, structural and conceptual issues that we encountered in various projects. We point out that we could have entities capable of oscillating between puppet, golem and actor. The Cigale project (see figure 10) (Batras et al., 2016) entails an entity that is:

- a puppet, when controlled by a kinect capture device,
- a golem when it replays pre-recorded animations
- an actor when it generates new populations of movements by genetic algorithm.

Should we consider these three states as different entities or as an entity which plays different characters? Indeed an virtual actor can play the role of a puppet or a golem, but the converse is not true : a puppet cannot play the role of a golem, and a golem cannot play the role of an actor (see figure 11).

Figure 10: Interacting with the Cigale project avatar.

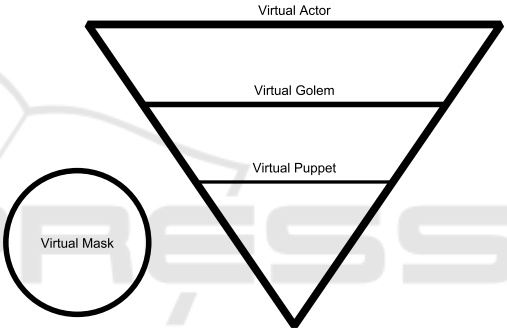

Figure 11: Interweaving virtual puppet, golem and actor.

We have to quote Norbert Wiener(Wiener, 1964) and Marvin Minsky(Minsky, 1988), pioneers of the field who codified forms of learning, which are currently questioned by deep neural network approaches. The notion of virtual actor could be further broken down by taking into account new paradigms leading to a category called ”virtual being”, which we still need to reflect on. This notion would perhaps make it possible to better define virtual entities closer to artificial life.

The notion of a mask is also subject to further investigation. Indeed, if in the case of dynamic systems we are in the presence of a pure algorithmic model, but for example, in the case of genetic algorithms we can say that the mask is the fitness function and the selection method used to choose and construct the new generation.

9 APPLICATION OF THE MODEL

It is now possible for us to differentiate between the entities of *creature*(Grand and Mindscape, 1996) game and *facade* game. *Creatures*'s Norns(see figure 12) are therefore learning entities that evolve as they interact with the environment and the player. These entities are at the origin of both their decision and their movement, so they are virtual actors (Taylor, 1997).

Figure 12: the Norn, characters of the game creatures(Grand and Mindscape, 1996).

On the other hand, the characters of *Facade*(Mateas and Stern, 2004) follow an established program based on behaviour trees and natural language recognition, so they evolve within a precise framework and obey their program, they are therefore generators of their movement, but the decision-making process is the result of orders transcribed in the form of an algorithm by the creators of the game(see figure 13).

Figure 13: The two main character of Facade(Mateas and Stern, 2004).

If we have to analyze the game *the sims*(Wright and Maxis, 2000), we discover a more complex structure. The sims themselves are golems that follow and evolve as part of their program. But the objects themselves act as principals: in fact they are the ones that contain the information of animations and decisions (Forbus and Wright, 2001). in this case we can see

Figure 14: The Sims(Wright and Maxis, 2000).

them as masks, because they have a decision-making mechanism, but must use an external entity to generate the movement (see figure 14).

Figure 15: *Siren* from *Epic Game* (Cowley, 2018).

We can similarly describe the *Siren* digital double of *Epic Game*(Cowley, 2018) (see figure 15) or *Senua* from *Ninja theory* studio (Theory, 2016) as virtual puppets, because the decision and movement come from the actor who animates the virtual character. But we can also identify as a puppet an avatar of the second-life virtual world or the character of the pacman video games.

10 CONCLUSION

The reflection started with two questions:

- is the movement of the virtual entity controlled by itself, or by an external input, human or not?
- does the virtual entity have free will, i.e. take its own decisions, or does it obey to external orders?

The answers lead to a classification of a virtual entities, allowing to describe their nature (see figure 16).

The classification aims to provide both a tool and a basis to define virtual entities. From our experience, it helps to more effectively describe their relationship to their virtual environment, their manipulator and their programming rules.

Movement analysis of the matrix sculpture, a model with control mechanisms and movement capabilities, brings up four categories:

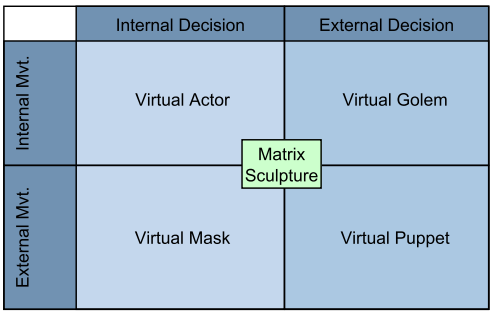

Figure 16: virtual entities classification.

- *Virtual puppet* whose decision to move and the origin of the movement comes from an external entity.
- *Virtual golem* capable of moving by itself but without free will.
- *Virtual actor* who has a freedom of thought and a capacity for movement by its own will.
- *Virtual mask* which is an external entity capable of making decisions, but which manipulates a third person (such as a puppet, golem or other actor).

This classification helps to differentiate an avatar (virtual puppet), a bot (virtual golem), or a creature from artificial life (virtual actor).

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