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Some Perceptual Studies of Animations Based on Physical Models and Shape Coating

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ABSTRACT

In this work, we designed virtual animations by generating motion synthesis by means of physical modeling and synthesized shapes mapped on some produced movements. The novelty is that we associated two complementary kinds of figures: on one hand, the movement, as it is built using physical models, which presents realistic and coherent dynamics, and on the other hand, various non realistic shapes that are mapped on them. With this process, we created paradoxical and questioning animated pictures. Then, through psychocognitive experiments, we are investigating the impact of these unusual animations on the human perception and cognition. This led to a first set of human's behavior observations and some first results on human cognition and perception faced to such new perceptive stimuli. Mainly, our approach is to experiment the creative perceptual posture of human subjects confronted to novel types of artistic animations.

1 GENERAL PRINCIPLE

Except when shapes and motions are created by physical modeling such as finite elements methods, computer animation software solutions usually allow some separation between 3D shapes and motion. Indeed, in most prominent marketed products such as Maya [3], users first design 3D shapes, then add motion to these shapes. Conversely, in motion capture processes, the movement is first produced and it can be applied to various 3D synthetic shapes. In the work presented here, the motion is produced first, but instead of being captured, the motion is generated by physical modeling. Thus, the motion can be both more realistic and various than real captured motions. In order to reach a wide variability in the produced animation, as the motions are rather realistic, we chose to map them onto less realistic and more abstract shapes. The resulting animations are thus artifacts produced by any mapping between a virtual physical-based motion and a set of synthetic shapes or graphics. Therefore, this is a perceptual and cognitive novelty in the sense that such resulting animated sequences may have no reference in the real world. In that case, we can say that the animation produced in this way is truly a multimodal construction where both combined modalities come from different sources. Therefore, proposed pictures are paradoxical. The motion can look like something real, although the shapes and their association with the motion cannot refer to anything real. This new animation building process led us to study their relevance in order to understand perceptual and cognitive consequences. To do so, we achieve perception experiments through qualitative methods, specifically semi-structured interviews and a content analysis approach.

2 MODELING PRINCIPLES

The first element of the virtual animations we achieved is the physical model of motion. The physical model is built on MIMESIS software [1] which is dedicated to motion synthesis with physical models. The model is designed by creating

structural components: masses called MAT and interactions between them represented by physical links called LIA. These links describe linear or non linear elastic and viscous interactions between masses.

The second element that defines the virtual animation is the coating of a motion. Motions are coated either by using MIMESIS shaping basic functionalities or more complex shapes designed with MAYA. Some sequences can exhibit dynamic topological evolutions as described in [2]. The coating process consists in associating a part of the masses of the physical model with geometrical points and in designing shapes from these points. Shapes can be as various as lines, surfaces, elementary volumes, or more complex representations such as garments with tearing.

It is important to keep in mind that there is no isomorphism between shapes and motion, some masses can be hidden and fixed geometrical points can be added in the coating.

3 MODELS DESCRIPTION

The main idea is to coat the motion with different shapes at three different stages: (1) a topological stage allowing the movement to be associated with a single or multiple topological entities; (2) a geometrical stage and (3) the rendering stage. An animation is a combination of all these choices. In order to be neutral when the human subjects were confronted to the animations sequences, each animation was referred by a neutral identifier that has no sense for the subject but that is a help for the experimenter. For example, in the animation sequence labeled with the identifier: P03T01G01R00, P03 represents a specific physical model (here, the third of the set we designed), T01 represents the first topological space, G01 the first geometrical shape and R00 rendering number 00, respectively.

In the following paragraph, we present the 5 physical models of motion coated by different shapes, developed for our research.

3.1 Model I “the suspended balls”

The first physical model, called “suspended balls” is composed of 5 colliding masses suspended with deformable wires. It has been associated with 4 visualizations achieved on Maya (Figure 1).

On the first one (top – left), the topological model consists in 5 separated objects. The geometrical one is composed of wires and spheres. Textures and colors are added to the shapes in order to form the final rendering. The three other visual representations are based on different topological models made with the software called MorphoMap software [2]. On the top - right, a Voronoï meshing is built, based on the masses of the wires and of the suspended balls. On the bottom, using MorphoMap, we introduced topological changes describing tearing: one tearing on the left, several tearings on the right. To sum up, a single movement using suspended masses is visualized as (1) suspended cherries, (2) a double surface joined

by their low side; (3) a double surface with one tearing; (4) a single surface with multiple tearings.

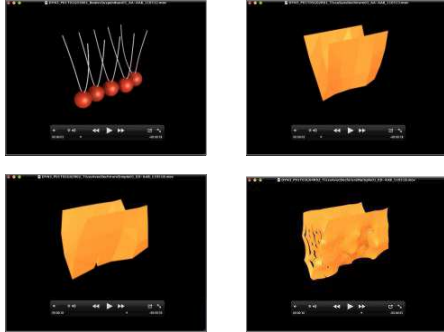


Figure 1: Different visualizations of the "suspended balls" model.

3.2 Model II "the breakable bar"

This model called "bar" is a mass-interaction model of a breakable bar associated with 4 visualizations. The physical model [2] is composed of a set of masses linked by spring-damper interactions, except on the center of the bar on which the interactions are irreversible cohesion interactions [4].

The first and second visualizations (Figure 2, top) are based on the direct coating provided by MIMESIS. All masses are represented by small red spheres. On the left, only visco-elastic interactions are drawn with white lines. Thus, with this visualization, we see a kind of hollow bar breaking in two parts. On the right, interactions modeling the breaking at the middle of the bar are also represented by white lines. Thus, we see a large elastic-like deformation on the middle of the empty bar.

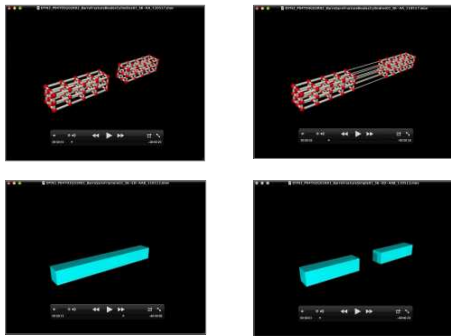


Figure 2: Different visualizations of the "bar" model.

The third and fourth visualizations (Figure 2, bottom) are designed with Maya. They are based on a simple geometrical model of a full bar that does not break on the left but breaks on the right. Masses are not displayed.

3.3 Model III "the two-surfaces"

Model III is called "two-surfaces". The physical model is composed of two independent visco-elastic surfaces. Here, we choose to show only 4 visualizations among the 15 we have designed. On figure 3 top-left, we can see the direct visualization of the two structures. Each mass is associated with one vertex. Physical interactions are represented by lines. There

is no interaction between the two surfaces. In this visualization, the visual topology exactly maps on the physical structure. In the three other visualizations, the coating consists in creating lines linking some masses of one surface and some of the other surface. On the top right of figure 3, three triangles are shown where one vertex is taken from the upper physical surface, and the others are selected from the lower physical surface. The triangles form three "objects" that do not exist in the initial physical model. In addition, two small independent shapes are mapped on the lower physical surface. Following the same idea, on the bottom right and left of the figure 3, we designed wavy lines that join together some masses of the upper surface with some others of the lower surface. The shape is represented by a spline. Each visualization gives a very different view from the initial physical model.

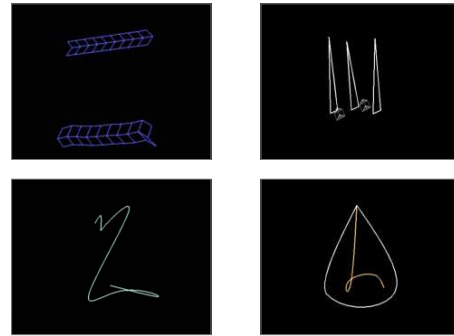


Figure 3: Different visualizations of the "two-surfaces" physical model.

3.4 Model IV "The double pendulum"

This model is called "double pendulum". We designed 10 views from the original one. We present here only 4 of them.

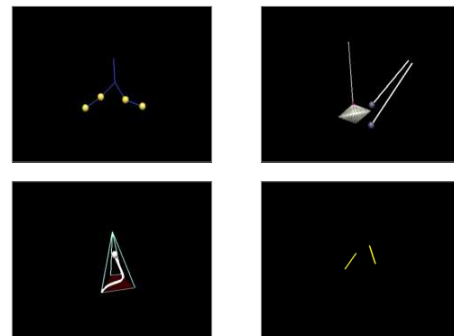


Figure 4: Different visualizations of the "double pendulum" model.

The physical model contains 6 masses. These masses are structured as a double pendulum. The first visualization (top left of figure 4) follows the structure of the physical model. We can see the different points and their links. On the other visualizations, we coated the motion by adding or removing shapes from the initial view. In the visualization on top right of the figure 4, we added two fixed points in order to draw the two lines on the right. Two of the masses are represented by blue spheres. The two others are represented by a superellipsoid. In this visualization, the movement of the double pendulum is mapped on three "objects" with different shapes. These shapes

cannot remind the double pendulum structure. However, since the motion applied to these shapes is the motion of the double pendulum, association seems paradoxical. In the visualization shown in figure 4, bottom left, the movement of the double pendulum is mapped on only one “object”. The coating consists in using 4 masses to draw the red rectangle. Then, the triangles are formed by connecting these masses to another fixed mass. The remaining mass of the motion model is used to represent the small white sphere. The motion of the shapes can remind the pendulum but many deformations result from this new shape configurations. Finally, in bottom right of the figure 4, we represented only two lines each of them linking two masses.

3.5 Model V “the blobby motion”

This model has been called “the blobby motion”. We present here 4 visualizations among 14. The physical model is composed of a kind of deformable surface made of 16 masses linked by visco-elastic interactions. The surface is put in motion by another mass that hits the surface. On the first visualization (top left of figure 5), we can imagine the physical structure of the surface as the masses correspond to the vertices of the grid. Topologically, this visualization is represented by a single topological entity.

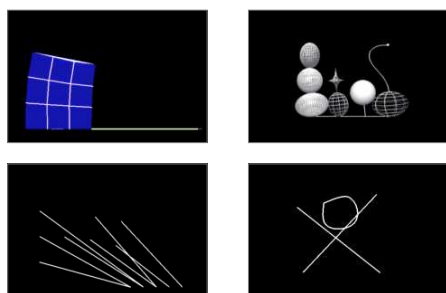


Figure 5: Different visualizations of “Blobs” model.

The top right of figure 5 represents a set of spheres and superellipsoids mapped on the motion model according to a multiple connected components scheme. A group of masses is hidden and another one is represented by spheres or by superellipsoids. The superellipsoids are constructed using pairs of masses. Similarly, the third picture (bottom left) contains multiple disconnected topological entities but the geometrical shapes are by lines instead of spheres and superellipsoids. In the fourth view (bottom right), four masses are joined by two crossed lines and some others are joined to constitute a kind of ring. Many masses are not visible and topology and geometry are completely different from the previous visualizations.

4 PSYCHOCOGNITIVE EXPERIMENTS

The mapping of the same motion on very different coatings can not only lead to different perceptions but also produce perception ambiguities. To determine the impact of these ambiguities on human perception and on the creativity sense, we developed a first set of psychological and cognitive experimentations that we present in the following paragraphs.

4.1 Methods and approaches

The questions about visual perception of virtual animated pictures in paradoxical associations of shape and motion are new research directions. The impact could be important, mainly in the creative aspects attached to this kind of new images.

Consequently, in the context of human studies, among lot of approaches, the domain discussed here is related to “oriented exploratory domain”. Furthermore, the theoretical context is phenomenology-oriented. For these reasons, we selected qualitative research methods, particularly approaches to subjective viewpoints [6]. The choice of a qualitative method leads to choose both a data collection technique and an interpretation method. Therefore, we have based our research on open interviews, as semi-structured interviews and narrative interviews [6]; and have followed the content analysis method [5] that is most used in interviews analysis [8] [6] [7].

4.2 Experimental protocol

The experimental protocol is based on focusing the discourse of the human subject faced to the videos around a few major levels of the discourse, without falling into any restrictive issue: sensation, evocation, imagination and relationship with the images which is part of enaction [9]. The “sensation level” refers to all the sensory descriptions; the “evocation level” to what the picture reminds such as past perceptions and experiences; the “imagination level” to fictional representations. Finally, the “enaction level” is the indication of the embodiment and involvement of the subject faced to the stimuli.

4.3 Interviews

The experiment consists in performing free interviews with individuals. Each person has to watch two or three pairs of the designed videos, each pair containing the same motion. When viewing the videos, subjects have to express their perception about what they see. This expression is stimulated by the interviewer aiming at obtaining the richest discourses material on each expected level. The interview is conducted by the interviewer in a neutral attitude: he/she does not give indication on the scenes; he/she must use only words that were introduced by the subject; he/she have to tolerate silences; he/she may inform that there is no right or wrong answer; he/she may encourage to “think aloud” as when the subject is alone, etc.

4.4 Analysis

Our experiments involved 10 subjects and 29 animations, resulting in 14 hours of interviews. The integral text transcriptions of the audiovisual recordings constitute the main material to be analyzed. The crucial step in this kind of method is the categorization process. For each transcription, several steps need to be achieved: annotations and instantiations, grouping and synthesis and finally extractions of the subject’s exploratory strategy and his - her behavior. Comparison between all these analyzes allowed us to get overall observations.

5 RESULTS

The experimentations analyses led us to interesting observations. The first main observation is that, despite our fears that participants would be annoyed when facing to these strange and often abstract videos, all the participants were unanimously highly interested and stayed more than one hour on the experiment. The second main observation is that all the participants unanimously considered animations as “intriguing”. When they detected some kinds of paradoxes, their curiosity increased strongly. For example, following are quotes from some participants: “*In fact, it raises questions about the kind of material and the kind of reaction, what could this possibly still be*”; “*It makes one wonder since we don’t know in which direction it turns*”.

Following those interrogations, participants set a hypothetic plausible scene and attempted to recognize it by several manners. This observation confirms results presented in [10]. This purpose is rather explicit as: *"I try to recognize what it is ... I ask the question, yes, by curiosity, what it could be?"*

We can classify these interrogations into two main behaviors:

- The reference to the real world by seeking real objects and situations similar to the animation observed.
- The exploration of pictures by abstract reasoning.

The first behavior is the most followed one. Most of participants try to identify the animated pictures according to the objects and phenomena existing in the real world. For example: *"There, for me, he is sitting, because the legs are horizontal, so he lies on a big swing"*.

In the second behavior participants choose to understand the animated pictures in their abstract nature. In other words, they focus on the geometrical shapes and dynamic behavior of the videos. This mode of reasoning is often based on the abstraction of observed phenomena, but some real world references can be used. For example: *"At first, they really are in opposite phases, and then, they seem to synchronize to each other"*.

Subjects are often getting in misunderstanding situations. However, this situation leads subjects to more curiosity and interrogations. Consequently, to overcome this situation of misunderstanding, they seek to enter in an interactive and progressive relationship with the animations.

Paradoxes are either tolerated or not. In the first case, subject appreciates the videos and expresses a feeling of novelty and creativity. For example, they said: *"It is not realistic to put them together but now I like it, I find it interesting, I find it creative"*. In the second case, the person denies and rejects the existence of the objects on the animated pictures. For example, they said: *"it is an illusion". "That means nothing anyway, it does not exist, that is not possible ... although I would like to know what it could correspond to, ... I do not see at all!"*.

Depending on the different feelings, participants try to have a better exploratory strategy in order to achieve their goals. We noted five main orientations:

- 1) Search for more information by repeating the observation.
- 2) Construction of new concepts. For example: *"... a drawing done by hand but that would have an existence like that in three dimensions in the space"; "... paper rubber"*.
- 3) Changing in observation strategies: for example, some participants switched to a different observation mode. They focused on the motion instead of the shape when the shapes were not identifiable.
- 4) Build of imaginary and symbolic configurations especially when the person cannot match the picture to real world objects.
- 5) Continuation of the same exploratory reasoning.

Exploratory behavior shows that all participants were invested in the exploration and understanding of visual scenes despite perceptual difficulties. In addition to the results on the behavior, the experiments also allowed us to obtain results on motion and shape cooperation. The influences of the two modalities have been classified into the four following categories. The first one is the influence of the shape on the motion perception, such as creating illusions of movement from the shapes. The second one is the motion influence on the shape perception. Indeed, sometimes, persons perceive the shape configuration only when the picture is moving. The third category is related to the shape itself. We observed that on one hand, the shape is the main inspiration of evocations; on the other hand, the nature of the shape is the cause of the

observation focus. Finally, the fourth category is related to the motion itself. We noted that the motion inspires more feelings and emotions and it is often used to establish the correspondance with realistic dynamics in the real world.

In conclusion, we can learn from this analysis that:

- The persons do not necessarily distinguish explicitly the respective influences of both modalities on what they perceive. Shape and motion are both involved in the perception mechanism, but with different degrees of focus.
- Indeed, we noticed that the movement further stimulates feelings and emotions.
- And finally, focus on the motion leads the person to notice similarities in motion, then going closer to the fact that motions are identical.

6 CONCLUSION

In this work, we applied a new process to create computer animations. The coating of realistic motions by abstract shapes creates unusual and paradoxical animated pictures. This kind of pictures did not divert people. On the contrary, people explored them with creative perception. Although these first set of observations have to be enlarged and confirmed, they tend to illustrate that we may increase the creativity of animation tools. In terms of creativity, the results of experiments show that this kind of animations, that are not only acceptable but also appreciated, can open new perspectives beyond the sole concept of realism.

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