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The Visual Representation of the Physical Space through Stereoscopic S3D Documentary[1]

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ABSTRACT

In 1987 I began my academic activities as a film researcher and documentary filmmaker. Since 2003 I have been researching the subject of stereoscopic film (S3D [3]), as much from a technological point of view and from the point of view of the audiovisual language. The interest in documentary films led the author to experiment with various techniques of stereoscopic filming, as well as analyze various documentary films in both 2D and S3D. The S3D film technology that uses two synchronized cameras has been competing with technology that uses a single camera with two lenses and two sensors. The heavy weight and large size of the two-camera technology complicates the mobility and agility of the documentary film language. This paper intends to investigate theoretical issues related to the use of these technologies in filming S3D documentaries and its immersive function. The current stage of the two-camera technology implies a setback in the film methods that have been enhanced from the experience of the American Direct Cinema and French Cinémà Vérité, with strong implications on the film language.

Keywords: Film, Cinema, Documentary, Stereoscopy, Stereo 3d.
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[3] The acronym S3D or Stereo 3D, is used to represent the stereoscopic system, thus avoiding confusion with the 3D images produced by computer modeling of three-dimensional environment, which are mostly two-dimensional.

1.0 Introduction

The paper analyzes the relationship between film language and stereoscopic techniques[4] in making documentaries. This line of research has been developed in the Research Laboratory of Image and Sound (lapis digital), Course of Visual Arts at Center of Human Sciences in the Federal University of Mato Grosso do Sul (UFMS), coordinated by this author since 2003[5] (Souza, 2009)[6].

This research is the result of a long study in the documentary field, which was started more than 30 years. This author started its academic activities in the audiovisual area since his Master's degree in Cinema (1983), which conducted research and production of a documentary ("Cubatão Meu Amor" [7] - 1987) in respect of a Brazilian industrial region with strong environmental degradation (Souza, 1989). From this research I developed great interest in the subject of Physical Space representation through the language of cinema.

I gave continuity to the production of documentaries and photographic studies, and, in 1999, I finished my PhD in Communication and Semiotics. In this course I dedicated myself to the study of Documentary under a Epistemological point of view, with a dedicated approach to the study of Representation of Reality (Souza, 2001).

The activity of research and production of stereoscopic films and photographs, was influenced by a member of my family, a collector of stereoscopic photo cards. I had access to numerous stereoscopic photographs of the nineteenth century, which could be observed through an antique Holmes Stereoscope, belonging to that collector. This motivated me to investigate the state of the stereoscopic art in your current digital format.

Binocular vision is part of our human nature and the world we see has three dimensions; so if we want to represent the Reality or the Physical Space, in films and photographs, we should naturally incorporate Relief vision (as the French language calls stereoscopy):

> "The essential cause that contributes most to the perception of relief is binocular or stereoscopic vision. Almost all humans and certain animals, enjoy the power to evaluate the relative distances, through an unconscious processing of images captured by two eyes. Only people who suffer from visual anomalies can't see in relief. Everyone, or nearly all, practice thus stereoscopy." (Cahen, 2011, p. 17)

The importance of the study of stereoscopy can be verified by some authors who have dedicated themselves also to this research. The historical approach is one of the aspects of the stereoscopic studies, since the origin of this technology dates back to 1833, as told by R. M. Hayes:

> "In 1833 Sir Charles Wheatstone created a mirror device for viewing two slighty different angles of the same picture that resulted in a three-dimensional rendering of the original painting or drawing. In 1838 he published his correct theories on stereopsis and, with the realization of still photography in 1839, it was only a few years before photographs would replace paintings in his viewing device. By 1844 Sir David Brewster utilized a prismatic lenses, to create his new viewing apparatus. (...) In 1862 Olliver Wendell Holmes, Jr., and Joseph Bates started marketing an inexpensive

[4] Stereoscopy is the technique of re-creating the perception of spatial depth from two 2D images, relating to the view of each of the two eyes, these images to be viewed separately and independently in each of the two eyes, provide a reconstructed visual perception in the brain, which approximates what the human being denominates spatial depth.

[5] As a partial result of the research was produced a documentary film titled "The Lake 3D" - 1999, available at http://youtu.be/_yC2IBsSDLo (English version) and http://youtu.be/GyHsgwm_zso (Portuguese version)

[6] This author can also be found by reference to the name Godoy de Souza.

[7] "Cubatão Meu Amor" – Documentary Film, 16mm, 20min. Video avaiable at https://vimeo.com/34707379.

> stereoscope that even today is manufactured along with numerous stereo pair for use with it. Stereo photographs were made of literally everything." (Hayes, 1998, p. 01)

1953 was a year during which Hollywood produced several feature films in 3D. That same year, Herbert C. McKay, photographer and stereographer, publishes his book "Three-dimensional photography: principles of stereoscopy", which presents visual and photographic parameters for the correct production of stereoscopic photographs. We may note the author's concern with the quality of stereoscopic image, its relation to human vision and the technology available:

> "The stereo camera differs from the conventional in being two cameras joined side-by-side, and the actual manipulation of the camera must take this into consideration. Because the camera lenses have the relationship which characterizes the two eyes, it is desirable that this relationship be maintained. Thus if you stand upon a hillside, your feet, ankles and legs are so positioned that the body is maintained in a vertical position, and your eyes are maintained in a common, horizontal axis. When you use the stereo camera, you should take great care to see that the camera is not tipped up at either end." (McKay, 1953, p. 98)

Another important researcher of stereoscopy, is Lenny Lipton, who contributed significantly to the development of a leading stereoscopic projection systems at movie theaters, the "Real D" used worldwide. His book "Foundations of the stereoscopic cinema: a study in depth" (1982), presents a highly technical text about the calibrations needed to obtain correct stereoscopic images in film cameras:

> "In the course of this study, it occurred to me that there were three useful methods for optically calibrating a dual rig stereoscopic camera: (1) with photographic tests, (2) by sighting through the camera lens and aperture with an optical instrument, and (3) by turning the camera into a projector.
> (...)
>
> The following important optical properties can be evaluated using the enumerated techniques: horizontal alignment of left- and right-lens axes, focus, recentration of axes due to focus, matching focal lengths, recentration of optics for lenses of different focal lengths, or for different focal lengths for prime lenses, and aperture calibration (using a spot meter). Setting up a dual-camera rig to perform adequately is a relatively tedious task. All the photography I have seen taken with such rigs has exhibited, to some extent, some miscalibration in one or more of these areas. Because the equipment can get out of alignment very easily, calibration procedures which can be used in the field ought to be developed. The only possible salvation of the resulting errors may be costly and image-deteriorating optical printing." (Lipton, 1982, p. 252)

It is easy to see that the problems of calibration of stereoscopic camera systems are so complex that the production of a documentary film stereoscopic, however simple it may be, is already a great achievement. To develop my research I had to adapt some knowledge already established in the field of photography and film analog to the new digital video equipment. This was done using forms of monitoring the images through computers, so that I could see the images before and during filming. For this, the exchange of information in groups on the internet was very useful.

Both Lipton as McKay, inspired me to develop a working methodology in which the production of movies and 3D pictures, provided an understanding of the whole process, and also allowed the development of some theoretical reflections on the audiovisual language 3D movies. In the process of production of stereoscopic images, I developed some equipment, initially very simple, and then more

sophisticated, but the last ten years, as the audiovisual industry developed new equipment, my filming activities also were incorporating these industrial equipment. Experience with stereoscopic filming, developed over the last ten years, also allowed theoretical reflection on aesthetics and semiotics, related on documentaries S3D.

In 2009, the book "3D Movie making: stereoscopic digital cinema from script to screen," by Bernard Mendiburu, I found, in the quotation from two experts, a confirmation of my methodology:

> "Phil McNally, alias "Captain 3D" and a global stereoscopic supervisor at PDI, teaches stereoscopic 3D to hundreds of artists who have already mastered animation 3D. After many years of producing 3D movies, he is often quoted as saying: 'One can teach the whole theory of stereoscopy in two hours. You can learn all about 3D moviemaking in two months. That will never give you the 10 years of experience needed to master it. Good movies are made with experience, not with knowledge.'
>
> Another very experienced stereographer, Kommer Kleijn, says: 'A good cinematographer can study 3D, and in two weeks, he'll know how to avoid mistakes that hurt the audience, and make 3D work nicely. Nonetheless, he would use the 3D just as a technique, not as a full-fl edged and compelling storytelling tool. He would produce a 3D-converted movie, not a 3D-intended movie. That would take him years to master.' " (Mendiburu, 2009, p. 35)

The main conclusion to which I got during the years I was dedicated to this research was that the audiovisual language is strongly influenced by the stereoscopic technology, resulting in changes in aesthetic and semiotic forms previously established by the cinema in the last 60 years.

The stereoscopic film technology used in S3D films makes use of two synchronized cameras to be positioned side by side to give a pair of stereoscopic images. The biggest problem of stereoscopic cinema activity is in the correct determination of the distance between the optical axes of the lens of these two cameras. This distance is called in Portuguese "base-estéreo", taking borrow this term from its English equivalent "stereo-base" (also "interaxial distance") and is the result of a function that relates the focal length of the lens and the distance between the subject and the camera.

> "The general formula for calculating an accurate interaxial distance is Bercovitz's formula [8]. Here is a simplified version, assuming that the distance from the camera to the scene is large relative to the focal length. This formula is therefore suitable for cinema or television, but not for macrophotography" (Michel, 2013, p.91)

Some experts have developed calculators that greatly facilitate the work of determining the stereo-base during filming. However, it has not resolved the operational needs of quick decision making during the filming of documentaries. In these cases it is very difficult to stop the cameraman filming process, calculate the stereo-base, and also place the cameras at correct distance.

In some cases in 3D stereo shooting, in which there is broadcasting, computer analyzers are used for stereoscopic images to send, via feedback, information control of the stereo-base for the drive motors that control screws that determine the position of cameras. To this, are used RIGs fully motorized such as the model TS5 by 3alitydigital[9] or the camera carried by Disney-Zurich Research (Heinzle et al., 2011)[10]. Thus there is a control done directly on the parallax through the stereo-base. It is necessary to distinguish between two types of Rigs, the first is the Side-By-Side Rig, in which two cameras are

[8] The Berkovitz's formula is available at: http://nzphoto.tripod.com/stereo/3dtake/newversionberk.html
[9] Video available at http://www.youtube.com/watch?v=iJGxpKoYzQs, accessed on 27/12/2011.
[10] Video available in mp4 http://people.csail.mit.edu/wojciech/CompStereo/index.html, accessed 28/12/2011.

juxtaposed; the other, more complex, is the Beam Splitter Rig [11]. This is the situation of the state of the art of the stereo filming systems of S3D films, however, the size and weight of equipment end up making their use impractical in documentaries.

On the language side, the parallax[12] is the primary variable to be considered in a S3D film, to determine the sense of depth during playback. This depth has semiotic nature, as it represents the space itself, but can also, so metaphorically represent other narrative dimensions of the film. In a fictional film, where there is greater control over the process of building image, the stereoscopic aspect may represent a sense of expanding space, or of feelings of oppression obtained by the viewer as a function of spatial perception promoted by parallax. Also other relations could be established between the depth and the nature of the characters or in relation to the development of plots at a narrative structure. It should be noted that the use of stereoscopy and its relationship to the narrative structures is still being set by the authors, directors and producers.

However in a documentary film the question becomes much more complex. Control parallax during filming is often hampered by the unpredictability of events to be filmed. It is known that visual perception is more immersive, which can be used for a better understanding of events or spatial structures present in a film. The spatial relationships become more evident, but to better represent it, needs a greater operational control at the time of filming.

Therefore, compared to the considerations presented above, it is evident that all methodological procedures for filming documentaries that have arisen since the American Direct Cinema in USA, and Cinema Verité in France at the 60's, and which constituted the paradigm for the technical and artistic achievement of documentaries worldwide (Jacobs, 1979; Rosenthal, 1988; Barnow, 1993 and Gauthier 1995), require good review with the appearance of the stereo 3D film.

Erick Barnow in his epic book, "Documentary: the history of the non-fiction film", describes the paradigm shift that occurred in that period, at the end of the 50s of the twentieth century:

> "Among Americans documentarists, maneuverable 16mm equipment rapidly displaced 35mm during the 1950's. Use of the tripod, once regarded as essential, was in decline. Yet mobility was hampered by several remaining problems. The documentarist, for optimum quality and editing flexibility, preferred to record image and sound separately. But to maintain synchronization, camera and tape recorder had to be connected by cable. This meant that a synchronized-sound shooting team was, at best, an awkward four-legged creature. For full maneuverability the cord had to be abolished. Some alternative synchronization method was needed.
> (...)
>
> During the late 1950's, groups in various places were striving for these goals. One such group was formed at Time, Inc., in New York, by Robert Drew. He persuaded the organizations to finance experiments that would carry the candid photography tradition Life magazine forward into film, with mobile, synchronized-sound shooting."(Barnow, 1993, p.235)

At that time, the emergence of synchronous sound, with Nagra audio recorders and Eclair cameras (with a revolutionary ergonomic design - the camera on the shoulder) played a big difference around

[11] Beam Splitter Rig is a support for two identical cameras, positioned orthogonally, and pointed to an inclined semi-mirror 45 degrees, enabling stereoscopic footage from nearby objects to the camera with a very small distance between the two optical axes; a camera records the reflected image and the other image refracted by the half mirror.

[12] The stereoscopic image contains a separate representation for the vision of each eye, the differences from one image to another is called a parallax, which is the distance between corresponding points on the left and right eye stereoscopic image projected on the screen.

the freedom and mobility and miniaturization necessary for the proper development of the documentary activity. Today with stereo 3D recording systems methodology of documentary shooting almost returned to the 40 and 50. Using Stereo Rigs involves loss of mobility and portable stereo cameras released in the audiovisual market do not have the same versatility of 2D cameras. Such portable S3D cameras could not shoot a subject very closely, and objects located a great distance, could not be shot with telephoto lens, in both cases stereoscopy will not work very well. The technical problem is that it would take control of stereo-base but these portable S3D cameras do not. So on the one hand, the use of two cameras with Rigs hinders mobility and the other, portable cameras do not have control of stereo-base for the creative use of the shot frames (long shot, full shot, medium shot, close shot, close-up) during editing. In both cases, who loses is the language of film.

Thus, this article presents a summary of some of the theoretical foundations that are defining the structure of S3D films production, as well as human perceptual need, face to this type of image. Initially defines the physiological bases, then advances a discussion of the evolutionary significance of stereoscopy for humans, from the Umwelt Theory, proposes an approach to immersive role of documentaries in the development of human society and its improvement with the emergence of stereoscopic 3D documentary. At the end, presents some proposals for the advancement of research at the interface between documentary and stereoscopy.

2.0 Bio-physiological background

The Umwelt Theory proposed by Jacob von Uexküll (Uexkül, 1992; Vieira, 1994; Souza, 2001), presents itself as a fundamental tool for understanding the process of representation of space seen in stereoscopic images. Umwelt is a kind of mapping of the reality that nature, during the evolutionary process, built inside the animals.

The Umwelt is described by Jacob von Uexküll, as follows:

> "The place: a flower-strewn meadow, humming with insects, fluttering with butterflies. Here we may glimpse the worlds of the lowly dwellers of the meadow. To do so, we must first blow, in fancy, a soap bubble around each creature to represent its own world, filled with the perceptions which it alone knows. When we ourselves then step into one of these bubbles, the familiar meadow is transformed. Many of its colorful features disappears, others no longer belong together but appear in new relationships. A new world comes into being. Through the bubble we see the world of the burrowing worm, of the butterfly, or the field mouse; the world as it appears to the animals themselves, not as it appears to us. This we call the phenomenal world or the self-word of the animal." (Uexküll, 1992, p.319) 13

The human species also represents the reality in its Umwelt. The audiovisual systems can and should be considered as extensions or prostheses of human sense organs, whose elaborations of signs have been collaborating for the Expansion of its Umwelt[14].

Uexküll's theory recognizes a reality external to the subject, who acts influencing him. Therefore in animals that have great learning ability can be observed a dilatation of the Umwelt in order to move towards, growing an understanding of reality, adapting and maintaining the conditions of survival. Without a "flexibility" to adjust these conditions, it is difficult to keep alive in an environment

[13] Originally published in "Instinctive Behavior", trans. By Claire H.Schiller (ed.), 5-80. Madison, CT: International University Press, 1957.

[14] Dilation of the human Umwelt (an evolutionary characteristic of the species) occurs through semiotic development. The indexical signs that show different aspects of reality are not observable by organic transducers that humankind has, alone are insufficient to transcend the limits of the subjective universe bubble (Umwelt). It is necessary to develop more complex signs, which give coherence to aspects of reality that are hidden as indexical data the world. As discussed in "Documentary, Reality and Semiosis" (Souza, 2001: 130), a documentary is one of these forms of semiotic complexity that can ensure the dilatation of the Umwelt.

characterized by continuous change. To account for this connection between the subject who has access to Ultimate Reality through a phenomenological process, the Umwelt theory brings the concept of Nature's plan, which tells us that there is perfect complement between the biological apparatus of the animal and reality.

Thus, we can say that the human frontal binocular vision is a necessary consequence and at the same time the cause of three-dimensional perception of physical space. It is known that the predators need the stereoscopic vision, widely used in pursuit of their prey. In the case of primates, arboreal origin seems to be the motivation/cause of the frontal binocularity.

Scholars of stereoscopy (Galifret, 1954; Okoshi, 1976; Lipton, 1982 and Mendiburu, 2009) dedicate part of their studies to understand the functioning of visual depth perception in humans, according to the Theory of Cues. According to the aforementioned authors, the Theory of Cues, proposed the existence of depth perception inductors, which can be classified into two categories: physiological and psychological.

Initially, as inductors pertaining to psychological category, should be considered:

1. 1)The relative size of the images of objects, so that the largest seem to be closer to minors;
2. Linear perspective, as a form of representation that occurs on the surface of the retina and to some extent is related to the proper techniques of artistic design, developed in the quattrocento[15];
3. Atmospheric perspective, the images of the objects become more cloudy with increasing distance because the diffusion of light by atmosphere;
4. Occlusion of objects, opaque objects closer to hide the more distant objects;
5. The shading and shadows, the incidence of light to cause the appearance of the shadows leads the production of the shapes of objects and reliefs;
6. The gradient of textures, it is an aspect of view related to the texture patterns that become more apparent the closer, can be cited as an example the image of a wall exposed brick, stone or a street, that become smaller, almost imperceptible as they get farther from the observer.

These inductors are widely used as a form of representation of spatial depth in pictorial expressions present in drawing, painting, photography, film and video.

For inductors of the physiological category must be considered:

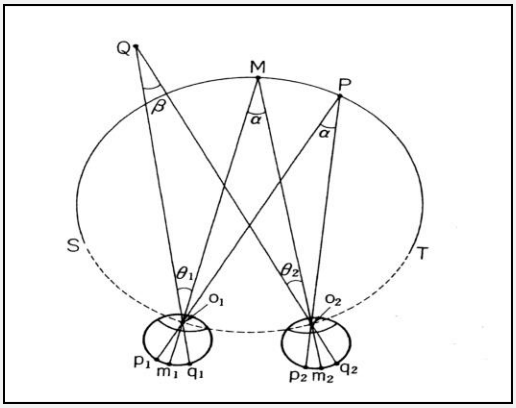
1. Monocular vision accommodation, it is self-perception of tension of a muscle exerted by the ciliary body of the eyeball, which controls the adjustment of the focal length of the lens by changing its curvature, this realization is suitable only for distances less than 2 meters away;
2. Monocular motion parallax: it is the depth perception when there is shift in the position of observation of objects, allowing for display of multiple viewpoints, with the moving observer, the objects seem to move closer to a greater speed that the most distant objects, this inductor is widely used in film through the camera movements known as "traveling" and "cranes" [16];
3. Eyes convergence: it is the angle between the axes of the two eyes when looking to a certain point on an object, are the tensions of the muscles that rotate the eyeballs to send this information to the brain;

[15] as already highlighted in "Documentary, Reality and Semiosis, the audiovisual systems as sources of knowledge"(published only in portuguese as: Documentário, Realidade e Semiose, os sistemas audiovisuais como fontes de conhecimento -AnnaBlume/FAPESP) (SOUZA, 2001), the central perspective was a gain in the forms of spatial representation, so that was spread across the planet (photography, cinema and television). The spatial representation of the central perspective simulates the space, not because they mimic the space, but because it is a model consistent with the way in which Homo sapiens maps the space in its Umwelt.

[16] according to Christian Metz, an " stereocinetics effect, whose importance for the film was stressed by Cesare L. Musatti in his article titled "The stereocinetic phenomena and the effects of normal stereoscopic cinema," an article of the Revue International de Filmologie, N29 January / March 1957. (Metz, 2004: 20)

4. The parallax or binocular disparity: it is the main inducer used by the stereoscopic image, when the eyes fix a point of an object M, the light rays leaving this point strike the retina in the central fovea (a region of the retina with large amount of photosensitive cells), the two points (m1 and m2) of the central fovea of the retina of each eye are matched and designed by targeting that point object on the fovea gives indications about the convergence of the eyes, there will always be correspondence between the projection of points on the retina, those objects (M and P) which is situated on a circle determined by the point of the object, and the midpoints of the two pupils of the eyes observers (O1 and O2), this circle is called holopter; disparities between the position of projected points on the retina, designed by objects placed on (M and P), inside and out (Q) of the holopter will induce the perception of depth. In the diagram below, the circle represents the SMPT holopter.

Figure 01: Graphical representation of the holopter (modified from Okoshi, 1976: 51)



That said, it should also consider that the distortions on the image of each object represented on the retina appears to contribute to the perception of spatial depth. Take up here, the Umwelt Theory that is used to justify the use of stereoscopic image as a representation of the three-dimensional space. Apparently, this form of pictorial representation is presented in a high degree of consistency with the representation of space in human Umwelt. It can be argued that the improvement of this form of representation would allow the development of activities of knowledge production and dilation of the Umwelt, more sophisticated than those permitted by current documentaries and their two-dimensional images.

3.0 Evolutionary reflections

Starting from the premise that human beings changed their relationship with their visual representations to a more complex level, it is observed in the historical evolution of forms of visual representation of space a trend toward increasing representation consistent with the way the human Umwelt represents the space, just by following an objective manner the Plan of Nature according to the concepts of Uexküll.

In the Renaissance the figurative representation progresses considerably, reaching an impressive setting. This great revolution in the image was caused by the discovery of the representation of space from the "perspectiva artificialis", which is a technique of representing three dimensional objects on a two dimensional surface.

Regarding the function of the perspective view of the arts are here only the point of view bio psycho-physiological: it is believed that such a representation is coherent with the human perceptual system and therefore, although not exactly as human being sees the world through binocularity, the artificial perspective, begins to act from aspects of human vision to reach an encoding.

Thus, the discovery made in the Renaissance can be classified as an Expansion of the Human Umwelt, which was based on the same principles inherent to visualization space by mankind, but externalized in the form of image (Souza, 2001). That said, can be considered the leap that perspective was to the figurative representation. It can be seen, for example in Figure 2: the image became more similar to the way human viewing of space. In this work of Raffaello Sanzio[17], changes caused by the figurative revival of classical antiquity introduce a new approach to space representation, inductors of perception that exist in the image are: occlusion, shadows, image size, artificial perspective and texture gradient.

Figure 02: Raffaello Sanzio. School of Athens 1509

With photography, inductors of depth perception remain the same. This is also due to the fact that both the Renaissance picture and photography have been influenced by the same technical principle, the dark chamber, which in turn has a behavior similar to the human eye. For example, the hole through which light enters the camera known as the diaphragm, in the eye is the iris, since the bracket where the image is formed in the photochemical device is the film or CCD or CMOS for digital imaging, and in the biological system the image is formed on the retina where they are photoreceptor cells that decode the image light making it a neurochemical signal and sending it to the brain.

It is considered that the fundamental difference between painting and photography is the indexical aspect of the latter. The effect of indexicality in photography that has emerged lies in the ontology of its image. The relationship with the object it represents is physical, ie, there is the action of light that automatically impresses the sensitive material. Within the Peircean Semiotics, we can say that this sign is a genuine index, unlike the imagistic representations presented so far (Santaella, 2005).

The emergence of cinematic device at the end of the nineteenth century, added motion to the figurative representation, and thus, also incorporated the inductor motion parallax. The perspective is fully realized on film or photographic image if and only if there is enough depth of field, otherwise the loss of focus blurs the lines of continuity perspective.

At the end of the nineteenth century, there was also a spread of three-dimensional photographs. These photographs availed themselves of the discovery of Charles Wheatstone, who in 1838 built an apparatus called "stereoscope" allowing drawings to reproduce three-dimensional geometric figures and objects. The stereoscopic photographs were sold in collections that included devices for viewing. According to Adams (2001), the process of stereoscopic viewing was in the habit of the upper middle class families, who gathered around the display of photographs of exotic places. Much of the known photographs from that period were stereo.

These stereoscopic photographs entered into commercial decline, but found scientific applications in aerial photogrammetry and photo interpretation of satellite images. In the '50s, the American studios

[17] Raffaello Sanzio (1483, 1520), italian renaissance painter. Image available at: http://www.wga.hu/art/r/raphael/4stanze/1segnatu/1/athens.jpg , access 30/07/2012.

used the cinema in the third dimension (S3D), for a short period, in regaining the public lost to TV. were produced several films S3D such as House of Wax (1953) directed by Andre de Toth, Creature from the Black Lagoon (1954) directed by Jack Arnold and Dial M for Murder (1954) directed by Alfred Hitchcock.

It is good to consider that the stereoscopic television, not economically structured because of technical reasons: the degradation of the analog video signal hurt the image quality that is essential for a good three-dimensional visualization. This limitation of technological order has already been overcome.

With the development of digital video technology, the possibilities of preservation of information of the video signal and the ease of manipulating images, provide better conditions for obtaining a stereoscopic image. The development of technology of glasses with liquid crystal shutters filters allowed the emergence of a new method of stereoscopic viewing. These glasses from the eighties were items of consumption among users of computer enthusiasts and involved with the development of scientific and technological projects that needed S3D viewing, such as aeronautical engineering, automotive, marine and oil extraction.

Nowadays you can find yourself some TV stations that already broadcast in S3D. There is increased demand for coverage on these channels of sports, concerts and dance performances. The documentary also shows up on schedule with some attention, especially those that deal with environmental issues. Internationally, it is known that the system of issuing S3D does not provide the appropriate economic return on investment due to the absence of an adequate number of S3D television sets installed in homes. It is assumed that the FIFA World Cup in 2014 is possible to achieve the minimum number of televisions from which the business of issuing S3D is made possible.

Thus, we also find a small exhibition of documentaries in S3D, most of them still related productions made for theaters IMAX3D[18]. It is not intended here, in this paper, a detailed survey of these works, but an analysis of aspects related to the insertion of stereoscopy in film language, in the discourse documentary and its immersive function.

4.0 Immersive aspects of documentary and the s3d

The article also does not want an exhaustive definition of the term "immersion", only it is believed to be a parameter around which to develop a comparison between film language gains obtained in the 60's and the gains from the S3D image in the documentary.

So it will use the following definition of immersion: is a mental state in which the individual's consciousness becomes involved with another dimension of time than that usually experienced, or even by a space almost similar to the representation that the brain makes three-dimensional space. It has obvious links here with the concept of Metz[19] "impression of reality", or with the ideas of denial of discontinuities assembly promoted by the illusion of narrative continuity, as defined in the way by Baudry[20].

Consider then the effects of immersion narrative provided by portable technology used by American Direct Cinema, or the French Cinéma Vérité. In *Primary* (1960) by Robert Drew, film paradigmatic of Direct, immersion occurs in time / space of a presidential campaign developed in the United States. The mobility of the camera and direct sound puts the viewer in the middle of events, increasing the "impression of reality", or according to the ideas of Uexküll, the events are represented in a very consistent and compatible with the human Umwelt, allowing the involvement of the senses. The

[18] IMAX 3D projects films on large screens (the default is 20m wide by 16m high), in which the sense of immersion is very intense because the viewer does not include the edge of the screen in your field of vision. The shooting system using large format cameras (65mm) at base-stereo set at 64mm distance between the objectives, which causes occurrence of large parallax images.

[19] In Metz text entitled: "Concerning the impression of reality in cinema" (Metz, 2004)

[20] In text by Baudry titled "Cinema: ideological effects produced by the basic unit" (in Xavier, 1983).

camera movements are perceived as a displacement that a person would perform in the events portrayed by Drew movie. The highly engaging sounds, the voices of people in sync with your images and movements resulting from this synergy, have promoted immersing the viewer in the narratives presented in the documentaries that were made since this model.

The mobility gains made possible by technology from that time (ergonomic cameras, direct sound) suffer a major setback with the emergence of technology S3D mainly in documentaries produced for the IMAX 3D. The large format cameras do not have mobility, unless supported by displacement systems such as cranes and dollies. Thus, virtually all S3D documentaries produced between 1990 and 2010 for IMAX, does not contain images from camera displacement with the same flexibility you see in 2D documentaries post Direct/Vérité.

However, it should be appreciated that there is another level of immersion promoted by these S3D documentaries as regards the three-dimensional space. Here these documentaries show the spatial and volumetric elements that justify the existence of stereoscopic systems themselves. Movies like: *Galapagos* (1999) Al Giddings and David Clark; *Space Station* (2002) by Toni Myers; *Bugs!* (2003) directed by Mike Slee; *Hubble* (2010) by Toni Myers; despite presenting dynamic narrative, documentary films similar to the previous Direct / Vérité, they allow a spatial immersion never seen in documentaries.

In the case of films for IMAX 3D the lack of mobility is explained by the size of the camera, more than 100kg with two objectives side by side. These cameras while allowing a high-resolution image, are impeding the realization of a documentary more dynamic and agile. Also digital technology has not solved this aspect of mobility. At the beginning of this paper was discussed that the Rigs, which support the two cameras involved in the filming S3D, are also bulky and heavy equipment. Since stereo portable digital cameras, with twin lens, manufactured by JVC, Panasonic and Sony, have stereoscopic problems, because the lenses are always located the same distance (without control of the stereo-base). Although this type of camera solve the problem of mobility is indebted in the issue of representation of stereoscopic three-dimensional space, especially on objects located at large distance (large general plans) and objects in close proximity (close-up).

However the technology evolves and the demands of language eventually create pressure for improvement of this technology. This is what emerges from the analysis a small digital documentary film made for German television ZDF, entitled *Die Huberbuam*[21] (2011) by Jens Monath. The documentary is about the work done by mountaineering two brothers. The S3D images using 10 different types of cameras suitable for every situation in the movie: interviews with the two brothers in a house, air travel between the mountains, climbing the side dishes in close proximity. The result is extremely immersing a film, both in terms of temporal narrative (in the monitoring events), as well as within the three-dimensional space. It is evident that the documentary *Die Huberbuam* appropriates S3D technology without losing sight of the acquisitions of film language taken from the Direct and Verite. Despite being a documentary, made under controlled conditions, the use of different cameras, overcome the allowed limits of language that the use of a single stereo camera would entail. Despite all these qualities the film contains serious problems of excessive parallax, and obviously a very expensive mode to do documentaries.

It is assumed that we will soon have major changes in the narrative structure of S3D documentary, enabled in part by technology, and partly by a method that uses different cameras for different immersions along the narrative. The technology relies on advances in knowledge of the computer processing of images that is in the hands of computer engineers, but the method of filming, yes this is still the large representational area of articulation of the documentary.

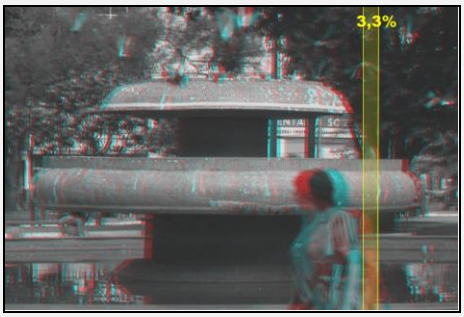
[21] Video available at: http://huberbuam.zdf.de/ZDFde/inhalt/7/0,1872,8352935,00.html?dr=1, accessed on 21/12/2011

5.0 Final

The effect of three-dimensional perception of space allowed by stereoscopy is determined by controlling the parallax between the two images. There is very precise knowledge for the determination of this parallax within parameters acceptable to the visual comfort and also for formation of a three-dimensional image in the brain. Ophthalmic Studies (Banks et al., 2011) showed that it is possible to determine the most appropriate parallax from the proportions relating to the width of the screen. It is thus possible, through an analytical monitoring, determining values for parallax, with high precision by setting the depth perception of the stereoscopic image.

Herein it lies an important point, albeit partial, of the method to be used by documentary: it is necessary and possible to determine the parallax without using special glasses for viewing parallax. Figure 03 presents a stereoscopic anaglyphic image in which it is possible to observe the different parallaxes[22] existing in the construction of three-dimensional perception of space.

Figure 3: Example of anaglyphic image being used to monitor the percentage of negative parallax relative to the width of the screen.



Steve Schklair[23] (Mendiburu et all, 2011) affirms and defends the idea that the glasses should be used only to confirm that an excess of parallax will not hurt the eyes of the spectators, but that decision must be made by direct visualization (not mediated by glasses) of two-dimensional representations of negative and positive parallax observable in images similar to that shown above[24].

The problem can still be observed in S3D portable domestic camera systems. The manufacturers have not incorporated this method and both Panasonic and Sony, manufacturers of these cameras, insist visualization on auto-stereoscopic display [25] as a means of obtaining the information needed for stereoscopy of a particular scene. Unfortunately this type of visualization is very bad for decision-making about the parallax in the context stereoscopic it does not have the precision necessary for this activity. Thus, systems are still required external monitoring of the cameras in order to have access to more accurate parallax, so that even with the use of a handheld camera, we must also incorporate the monitoring system, a fact which is in the way of portability. It seems that in the professional camera models this kind of question is solved with introduction of monitoring images of information on parallax [26].

[22] It is understood by positive parallax the perception of images of objects located in a plane located behind the screen, whereas, for negative parallax refers to the perception of images of objects located in front of the screen. The perception of images of objects in the plane of the screen, is called parallax zero.

[23] Steve Schklair is a producer specializing in S3D, responsible for the studios of 3ality Technica (ex 3ality Digital), one of the companies that invest in R & D for technology development S3D for transmissions in real time and participant in many of the films S3D blockbuster .

[24] There are various 2D images that seek to represent the different parallax: depth maps, differences between left and right, 50% -50% mixture, among others. The author chose to use the images anaglíficas for reasons of technology.

[25] Auto-stereoscopy allows stereoscopic visualization without the use of glasses.

[26] See the following cameras recently launched at the market: Sony PMW-TD300 and Panasonic AG-3DP1.

I also realized two clear aesthetic approaches being used in S3D cinema. The first, common in fictional films, which usually use the Beam Splitter Rigs, sets the direction of the gaze of the viewer by positioning the image of the object of interest in the position of zero parallax, ie exactly over the screen. For this to be possible, it is necessary that during filming there is a direct determination of this position, by setting the base stereo, made in the Rig. The second approach, let the viewer's gaze search the images of objects that matter to him, either in front of the screen, on screen or behind the screen (negative parallax, zero and positive); this approach is possible when using cameras with two lenses and two sensors (or a Side-By-Side Rig) and is not intended to determine the direction of the gaze of the viewer. This second approach has a realistic nature as the image respects the freedom of the viewer without beforehand shaping his interest.

Another aspect to be investigated is the relationship that the stereoscopic image sets, with the theories of viewing, developed by James Jerome Gibson (1904-1979). Emphasis should be given to Affordance Theory that proposes a bold proposition about the way humans do to obtain information by light array in the environment. The set of Gibson's ideas, which differ from the Theory of Cues, can contribute to the knowledge of the effect that the stereoscopic images cause in humans (Gibson, 1986; Anderson, 1998; Smith, 2010)

This article will be closed with a clear explicitness of relationship between the effects of technology on the method and language of the documentary S3D. This does not represent a new, since the recent history of the film, is in large part mediated by the ratio among technology, method and language. However, when the technology is interposed to the development of film language, will be the method that experience the true limits and determine the expressive possibilities of the documentary.

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