

# Documentary realism, sampling theory and Peircean Semiotics: electronic audiovisual signs (analog or digital) as indexes of reality

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**Resumo:** Este artigo trata do Realismo Documentário colocando o enfoque no fenómeno físico da transducção que ocorre nos sistemas audiovisuais analógicos e digitais que será aqui analisado à luz da *Teoria da Amostragem* enquadrado na *Teoria da Informação* de Shannon e Weaver. Transducção é um processo pelo qual um tipo de energia é transformado em outro, ou pelo qual a informação é transcodificada. Sob a abordagem de um Realismo Documentário não poderá ser reivindicado que os signos dos meios audiovisuais, pelas suas características conduzem a uma ruptura com a realidade. Pelo contrário, o documentário digital baseado em tecnologia digital é ainda um índice da realidade.

Palavras-chaves: Realismo documentário, transducção, índice.

**Resumen:** Este artículo trata del realismo documental, centrándose en lo fenómeno físico de la transducción que ocurre en sistemas audio-visuales análogos y digitales, adjunto analizados en la luz de la *Teoría de la Muestraje*, enmarcado por la *Teoría de la información* de Shannon y Weaver. Transducción es un proceso por el cual un tipo de energía es transformado en otro, o por el cual la información es transcodificada. Dentro del alcance del Realismo Documental, no puede ser demandado que los signos de los medios audiovisuales, debido a sus características digitales técnicas conducen a una ruptura con realidad. Al contrario, el documental digital, basado en la tecnología digital sigue siendo un índice de la realidad.

Palabras clave: Realismo documental, transducción, index.

**Abstract:** This paper addresses *Documentary Realism*, focusing on the physical phenomena of *transduction* that take place in analog and digital audiovisual systems, herein analyzed in the light of the *Sampling Theory*, within the framework of Shannon and Weaver's *Information Theory*. Transduction is a process by which one type of energy is transformed into another, or by which information is transcoded. Within the scope of *Documentary Realism*, it cannot be claimed that electronic audiovisual signs, because of their technical digital

features lead to a rupture with reality. Rather, the digital documentary, based on electronic digital cinematography, is still an index of reality.

Keywords: Documentary realism, transduction, index.

**Résumé:** Cet article traite du Réalisme Documentaire en relation avec le phénomène physique de la transduction qui se manifeste dans les systèmes audiovisuels analogiques et digitaux qui seront ici analysés à la lumière de la *Teorie de l'Échantillonnage*, partie de la *Teorie de l'information* de Shannon et Weaver. La transduction est un processus par lequel un type d'énergie est transformé dans un autre, ou par lequel les informations sont transcodées. En se plaçant du point de vue du Réalisme Documentaire, on ne peut pas soutenir que les signes des moyens audiovisuels, en raison de leur origine digitale, conduisent à une rupture avec la réalité. Au contraire, le documentaire digital, basé sur la cinématographie électronique digitale, est encore un indice de la réalité.

Mots-clés: Réalisme Documentaire, transcodage, indice.

**A**s a follow-up to the research conducted since "*Documentary, Realism and Semiosis*" (Godoy-de-Souza, 1999) presented a thesis at the Ph.D. Program on Communication and Semiotics at the Pontifícia Universidade Católica de São Paulo - in which epistemological conditions in support of a New Documentary Realism was deepened - it is now necessary to bring to light some aspects of the research that have not been shown to the scientific community.

In previous communications ("*Paradigm to the Basis of a Realistic Theory on Documentary*", presented at 8th Compós and "*Marey and the visibility of the invisible*", presented at IV SOCINE and at XXIV INTERCOM), aspects from the Umwelt Theory of Jacob von Uexküll (Uexküll, 1992) and from the Reality Theory of Charles Sanders Peirce (Vieira - 1994; Ibri, 1992 and 1994) were introduced as theoretical support to the reaffirmation of Documentary Realism and as a criticism to the Nominalism<sup>1</sup> of certain authors that doubt the capacity of a reality representation of the Documentary.

<sup>1</sup> "Under all kinds of Nominalism there are some presuppositions: the reason organizes things that are by its own no-organizable, or at the contemporaneous form: a language represents and subdues the object to their semantic and syntax rules." (Ibri 1994:26)

The Documentary must be affirmed in its function of **Indexical Sign**, as a connection between reality and the **Subjective Universe**, the Umwelt. According to Jacob von Uexküll, Umwelt must be understood as a Reality representation developed in any animal species intellect. Umwelt is a kind of “cinematographic screen bubble”, a map of reality, that is carried by animals as a form of reality reference coherent with objects and phenomena that exist in the real world. Therefore, what humanity naively takes as reality is only a mental representation.

The Reality Theory of Charles Sanders Peirce points out a complexity of the reality concept, as he proposes a Reality composed by 3 categories named: **Firstness**, **Secondness** and **Thirdness**, respectively. According to this philosopher, Secondness is the category that best fits into our conception of existing things. It is into Secondness that things come to existence, where they oppose to one another and that, by contrast, they exist by themselves. Thirdness is a category of the *eidōs* – **the world of the ideas**, which occurs into thoughts (universe thoughts), generically, where the universe laws settle, and that has its origin in habit additions. The conception of universe itself as an expression of a bigger and absolute mind points out the complexity of the Reality concept which involves a Documentary issue.

This article proposes a deepened criticism to the latent Nominalism on positions of authors such as Arlindo Machado, Bill Nichols, Brian Winston and Edmond Couchot (Machado, 1993 and 1997; Winston, 1995 and 1996; Nichols, 1991; Couchot, 1993). These authors, in higher or lower level, doubted the evidence of audiovisual electronic signs. There are statements that the analog electronic systems, because of their image physical characteristics, began a disbelief process of the world revelation through audiovisual systems. Others insist that, with the appearance of digital image and sound and its infinite manipulative capacity, all connection with reality would completely disappear.

As an example, in case of an analog video, Arlindo Machado states that the fugacity of image produced by the electron sheaf scanning into the TV picture tube breaks with the real representation. In Machado's words:

“The reality issue is not put in the video universe as it is put in other significant systems based on technical image . It is even possible that this issue is not put, or that it does not even become known. Having

or not a material reference in the so-called objective world is a dilemma which is meaningless to the electronic image, because what it shows never remains intact, entire, immediately recognizable as a mirror reflection." (Machado, 1993: 52).

In case of invalidation of the digital images as world's indices, the argument used points out the fact that the numerical organization of this image does not have any reference in reality. Then we can quote, also as an example, the following statement of Bill Nichols:

"Digital sampling techniques, whereby an image is constituted by digital bits that are subject to infinite modification, renders this argument for the unique, indexical nature of the photographic image obsolete. The image becomes a series of bits, a pattern of yes/no choices registered within a computer's memory. A modified version of that pattern will be in no sense derivative from the 'original': it becomes, instead, a new original." (Nichols, 1991: 268).

The author eventually states that his studies of representation of reality would be limited to non-digital images. (Nichols, 1991: 05).

There is a basic mistake in these statements because there is no possibility of denial of the indexical characteristic of analog electronic audiovisual or digital signs from their physical-technological characteristics. Exactly the opposite, a detailed analysis makes us understand these indexical signs much more by their likenesses with the traditional photographic indexical signs (photochemistry) than by their differences. To do so, it is enough to consider the definition of **Indexical Sign** in C.S. Peirce (Nöth, 1990) and some technical issues based on **Sampling Theory** developed by Shannon and Nyquist (Wilson, 1983; Mathias & Peterson, 1985; Pohlmann, 1990).

According to Peirce, a sign is an index when it "is physically connected with its object", what "involves the existence of the object as an individual entity". It is also said that the terms **signal, index and symptoms** can be considered synonyms. (Nöth, 1990). In Peirce's words:

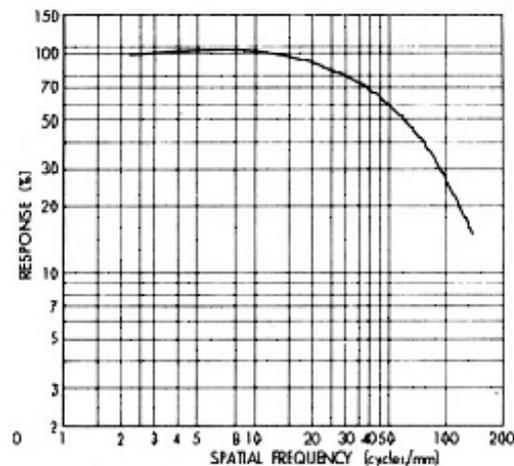
"A photograph, for example, not only excites an image, has an appearance, but, owing to its optical connection with the object, is evidence that that appearance corresponds to a reality. (CP 4:447)"

According to the Sampling Theory, it is possible to recover a continuous signal from a sample collection of original signals, obtained in a certain period of time. That is, the phenomena that are presented in

Reality as endless continuities can be recovered in all their extension by using , as a starting point, a finite collection of discrete samples of that continuity. For that, the samples have to be made in a quantity sufficient for the information contained in the original signal to be recovered later. Thus, according to the Sampling Theory, there should exist at least two samples for each signal cycle so that it may be recovered later. It is through the Sampling method that Science has made assertions about reality; that the image has been produced on photographic emulsion and on CCDs of video cameras; and also that the transformation of analog into digital signals has been carried out. Moreover, it is also through the Sampling process that the senses are able to coherently organize information about the environment and contribute to the construction of Umwelt.

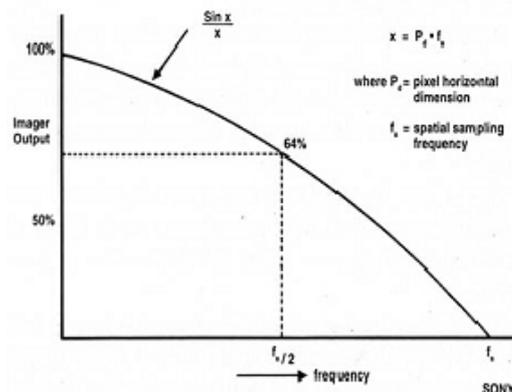
There are millions of cells in the human eye that are sensible to light, called cones and rods, distributed on the retinal surface. When these cells receive light, they emit nervous impulses that are transmitted to the brain. All the infinity of lights that fall on the retinal surface is represented by a finite sample of nervous impulses sent to the brain. Moreover, the eye is not static when it focuses a scene, it moves scanning the space and producing samples that will be compiled by the brain. This is an illustration of the Sampling Theory among living beings.

Figure 01  
Transfer modulation curve (Wilson, 1983)



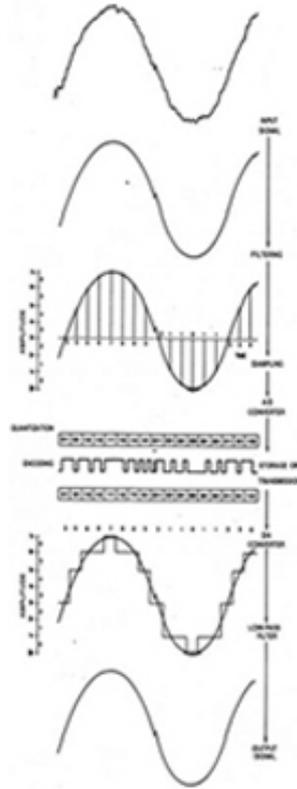
In the case of a photographic film, the image is formed through two-dimension spatial sampling of the luminous incidences at the back-ground of the dark camera, performed by silver salt crystals. Post-developed, each metallic silver grain represents a sample of incident light at the photographic emulsion. Through a **Transfer Modulation Curve (Figure 01)**, traditionally used on photography, it is possible to observe the incidence of the Sampling Theory. This kind of curve expresses the capacity of an emulsion to represent a picture of vertical bars in which there is a width and length reduction between the bars, that is, a picture that has a great variation of space frequency of light intensity during a horizontal scanning of this picture. The curve data are given by a Microdensitometer, a kind of photometer that, when supplies a fine luminous shaft to the exposed film, develops a measurement of the emulsion response capacity to each variation of luminous intensity of the picture that was photographed. It is an analysis of the two-dimension space resolution capacity of the film (Wilson, 1983). This curve represents a sampling function that can be expressed by the formula  $\sin x/x$  (sine of  $x$  divided by  $x$ ). According to the Sampling Theory, this sampling function can be found in the frequency domain. Therefore, it is possible to conclude that the Sampling Theory is also present in the representational process of the photographic system of the photochemistry type.

Figure 02  
CCD response curve (Thorpe, 1994)



The space sampling theme also occurs in the video, since in the Coupled Charge Devices, the CCDs of the electronic cameras, there

Figure 03  
Analog-digital-analog conversion (Pohlmann, 1990)



are hundreds of thousand of photoelectric cells called PIXELS, distributed on the surface of the photo sensitive CCD. However, beyond the space sampled function, there will also be a transformation of the electronic responses of each PIXEL in a time variation of charges into the electric current produced at the exit of the apparatus. That means that what, in the photographic film, was an exclusively spatial sampling is, in the case of the CCD, also changed into a timing sampling. The variation of electric charge in each PIXEL must be transformed into an electric current whose frequency will be able to respond to the sampling of luminous intensity made on each photoelectric cell that composes the device. The curve that represents the response capacity of a CCD to a picture with vertical bars (**Figure 02**) has the same formula "sine.x/x" of the Transfer Modulation Curve of a photographic film (Mathias & Pet-

terson, 1985; Thrope, 1994). By logic correspondence, it certifies the incidence of the Sampling Theory into the electronic image processing.

As for the digital audiovisual systems, the alternate electric current of the out poles of a CCD, or of a microphone capsule, should be transformed or transduced into an electric current of yes/no type, containing a binary number sequence that will represent timing samples of continuous values of amplitude of the original analog electric current (Pohlmann, 1990). The electronic system for the digitalization of the analog signal, an **Analog-to-Digital Converter**, is only a type of transducer that will play two main roles: a **Sampling** and a **Quantization**. **Sampling** is done through a sampling frequency and plays the role of defining a certain number of samples necessary to recover the analog signal. This frequency, according to the Sampling Theory, must be at least twice higher than the highest band frequency of the analog signal. The digital audio systems have sampling frequencies of about 40,000 Hertz (or 40,000 samples per second), because the audible sound bandwidth is located between 20 and 20,000 Hertz (or 20,000 cycles per second). **Quantization** is the determination of the amplitude values of each sample, expressed by the binary numbers.

As an example, let us consider a digitalizing system made by binary numbers of 8 bits, that are composed by binary words containing 8 possible combinations of “zeros” and “ones”. A quantization system of amplitude values based on numbers of 8 bits will be able to represent only 256 different values in a band of continuous values contained between the highest and the lowest amplitude of the analog signal. Therefore, quantization performs a kind of sampling in the amplitude value field. Thus, an analog-to-digital converter produces sequences of binary words that represent the analog signal provided at the system entrance. This sequence of binary numbers will be available for any logic manipulations before being re-converted to its original analog form, so that it can be, once again, perceived by our biological sensors. The return to the analog forms is obtained because of an electronic device, called **Digital-to-Analog Converter**, located at the exit of the electronic system, that does exactly the opposite that the Analog-to-Digital Converter did at the entrance. All these operations (**Figure 03**) are performed through the electronic contacts processed by logical electronic circuits regimented by **Operators** of the **Boolean Algebra**(Pohlmann, 1990).

None of the stages lose the physical contact, what effectively connects the sign and its object. Besides, it configures clearly a **Semiosis** process where the sign can be transformed into another sign generating complex meaning processes. This way, even the signal digitalized from an analog signal remains connected in some way to an individual entity, an **existing object** into the real world.

To Peirce, there is an **Objective Logic** that rules the mental operations in the universe. According to Ivo Assad Ibri, it is a conception "... according to which the Universe contains a logical process of its own and, for this reason, is Real independently of the idiosyncrasies of human thoughts." (Ibri, 1992: 119).

Thus, it must be considered, as an effect of this Objective Logic, that if there is an incidence of the Sampling Theory in the photochemistry process of image formation, and if this process is undeniably indexical, the incidence of the Sampling Theory in digital and analog electronic process is a testimony to its indexical ability. This makes ineffective the nominalist statements of the authors mentioned at the beginning of this article.

As a conclusion, a Philosophic Realism is reaffirmed as source of thoughts that should support reasoning face to the issues put nowadays into the documentary field. It is also reaffirmed that the issues about the manipulative possibilities of the digital audiovisual signal cannot be used as definitive evidence of the loss of reference with the real world. These issues, important in themselves, should be transferred to a debate of Ethical, Political or Ideological order and never again be used as speculations about the denial of the Epistemological statute of the Audiovisual Systems.

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