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Synopter: Rebuilding the Three-Dimensionality from the Bidimensional World

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Abstract: This paper presents an optical instrument called synopter, which consists of an apparatus whose objective is to transform two-dimensional images into three-dimensional, without using any electronic or digital circuit, working in a way that is known as “3D cinema”, providing a sensation of tridimensionality. The analysis of the present paper will focus on the functioning of the apparatus as a whole and its differences and advantages relative to other similar technologies.

Key words: synopter, three-dimensionality, optical instrument.

1. Introduction

The group of Tutorial Education in Physics of the State University of Maringá has, among its aims, to increase the interaction between the academic community and the external ones. For this, the group seeks to propose activities that arouse the interest of the community by physics and sciences in general. In this way, we present the synopter in this paper as an optical instrument to rebuild the bidimensional world in a three-dimensional view. It is a device invented in 1907 by the polish Moritz von Rohr, able to transform two-dimensional images into three-dimensional. Originally presented to art galleries as a tool capable of giving depth to the paintings’ images. However, what looked like an instrument of sophisticated three-dimensional perception eventually resulted in a major failure. A century later, Rob Black, a psychologist specializing in visual perception, perfected Moritz's invention by assigning the new name to the device: The I.

2. A Very Short History

As mentioned earlier, in 1907 Moritz von Rohr, a polish optical scientist introduced synopter, which was patented by Carl Zeiss, under the instruction of Moritz himself. It was a device whose purpose was to aid in the viewing of paintings, allowing two-dimensional images to appear three-dimensional. Even at the time, the device showed perfect functioning, however, due to its relatively high cost, the project was forgotten. The device consisted of the use of the so-called “plastic effect”, historically known for its surprising impression of depth in the pictorial space. The conventional explanation of the plastic effect is that, under normal conditions, the

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physiologically coded flattening decreases the depth of the pictorial space. With this depth removal, the pictorial content becomes more “plastic”, that is, more articulated in depth, giving the impression of three-dimensionality.

3. How does the Instrument Work?

The device, which does not use any electronics or digital imaging technology, and works on videos’ or two-dimensional images, had its principle opposite to the 3D system used in theaters. In the cinemas, the images on the screen are filtered so that each eye sees a slightly different perspective, known as binocular disparity (Figures 1a and 1b) – “distracting” the brain to perceive depth.

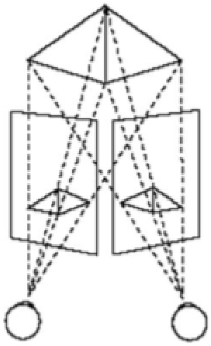


Figure 1(a) Binocular Disparity (IMAGEM, 2016)

Figure 1 (b) Binocular Disparity in Detail (TOSHIBA, 2016)

Due to the different positions of our eyes, we see the objects from two different angles, in parallax. At the center of our field of vision we have the sobreposition of a part of the image. The small differences in the images that each eye sees are processed by the brain giving the impression of depth (Figures 2a, 2b and 2c).

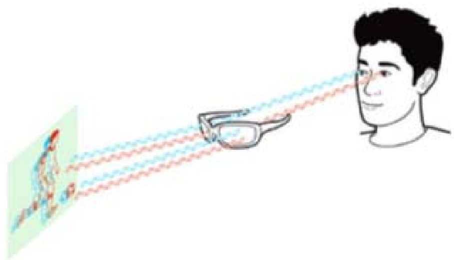
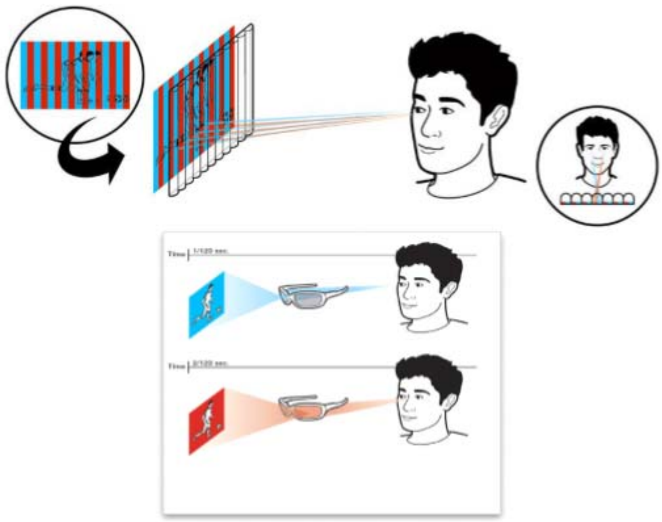


Figure 2(a) Filtering a 3D Image - Cinema (TOSHIBA, 2016)



Figures 2(b) and 2(c) Principle of LCD TVs (TOSHIBA, 2016)

In a 3D movie theater, the screen shows the images shot from two distinct perspectives, each of them using light with a different polarization. Polarized glasses filter only one perspective for each eye. In movie theaters, the eyes need to concentrated on the screen to see the objects in focus, but 3D effects can, instead, force the viewer to focus to a several meters in front of the screen. “Even with the best 3D kit in the world, it can still present conflicting perspective information” (Swain, 2010).

The instrument known as The I ensures that the two eyes see a computer image or screen in exactly the same perspective, where depth is not associated with binocular disparity, but rather with the brain, which assumes that it is viewing a distant 3D object instead of looking to a 2D image. As a result, the image is perceived as a window that the viewer is looking at, and the details of images are interpreted as objects scattered across the landscape.

This perception, called the synoptic view (Figure 4), manifests itself in any two-dimensional image, but is especially marked where there are other depth tracks. For example, the brain naturally assumes that an object in the 2D image is in the foreground, if it is large, or if it is far away, or, also, if it is small.

Figure 4 Synoptic Vision (Neves et al., 2017)

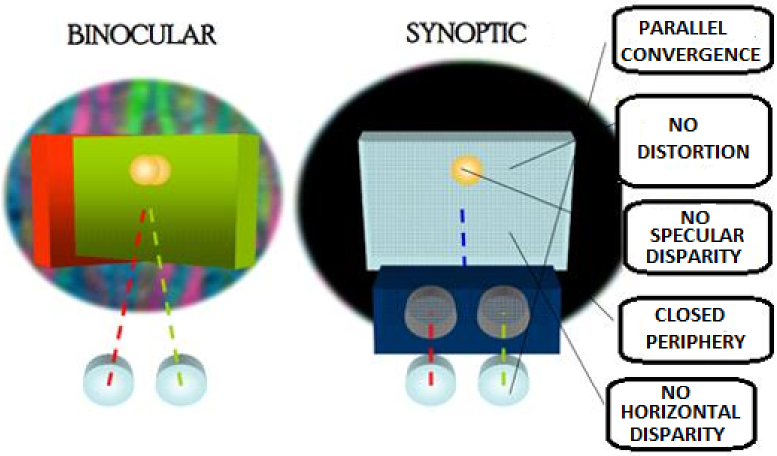


Figure 5　Binocular Perspective Versus Synoptic Vision — Using the Synopter (Black et al., 2006)

Black (2010) says in an interview with New Scientist Magazine (Swain, 2010) that the device also avoids the headaches associated with other 3D technologies. In cinemas, the view must be constantly directed on the screen to find the focus of the objects, presenting conflicting perceptual information. Already, the Black's device there is no type of filter, not requiring to the viewers an effort to find the focus. Instead, they can focus naturally any object in the image, using other features such as object size, and "deciding" how deep they take up. Using the synopter, it is possible to see images of wide sizes, varying the distance and the field of view. Black et al. (2006) states that "by disabling conflicting information, we can enjoy the scene in the same way that the artist wanted to portrayt" (Swain, 2010).

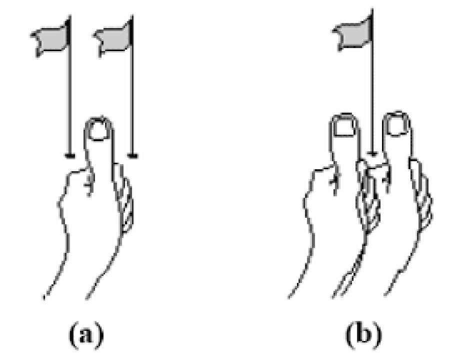


Figure 6(a) and 6(b)　Perceptual Conflict (Focus) (IMAGEM, 2016)

Figure 7　Flag for Practical Experiment (SHOP, 2016)

The conflict in obtaining a focus can be given by the following experiment: aligning the thumb of the left hand with a flag and the nose and focusing on the finger, it would be see the flag “divided” (like two images), one for each eye (close one eye and open the other and then reverse), as shown in Figure 6a. Now converging the vision for the little flag, the view that will have with the two eyes open is shown in Figure 6b — the thumb is now seen as two. Currently the device is still a prototype, but Black et al (2006) hopes that its synoptic viewer will one day be incorporated into existing 3D systems. “I think 3D is impressive right now, but with that we'll be significantly closer to reality simulations” (Swain, 2010).

4. Da Vinci Studies and the Dutch Synopter

Among the Leonardo da Vinci studies, we find detailed anatomical studies of Leonard’s vision and understanding the process of image formation (Figure 8) (Neves et al., 2017).

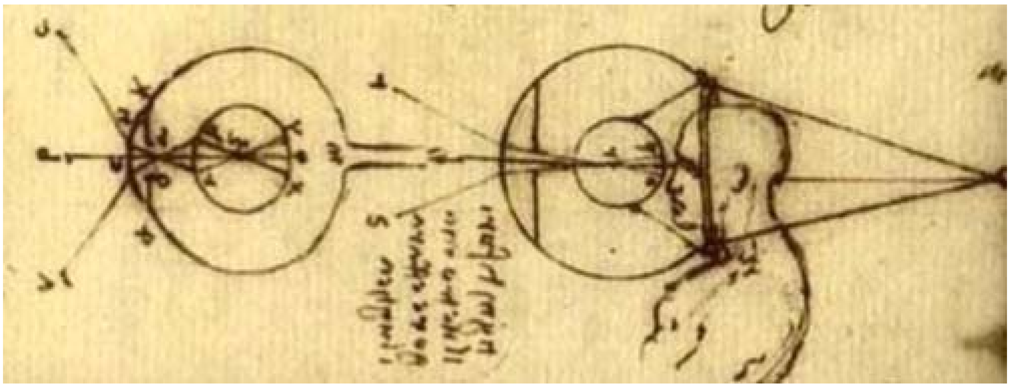


Figure 8 Studies on the Vision of Leonardo da Vinci (Neves et al., 2017)

Due to the invention of so-called Google glasses, a digital device that could be used as a glass, it was widely divulgated around the world by the web that the Italian genius Leonardo could have anticipated this idea (Figure 9). It was attributed to a certain Dr. Burt Wilde of the University of Illinois the discovery, among the da Vinci manuscripts in the Ambrosian Library, that Leonardo could have anticipated the invention of a glass that could retrieve the visual memories of places and their three-dimensionality (Figure 9). However, it was all a joker of April 1, 2013 conducted by Mashable’s site (Ulanoff, 2013).

However, virtual reality glasses are present today in the everyday entertainment technology, in the technology popularized by Cardboard Google Glass. In a similar vein, researcher Maarten Wijntjes, from the Delft University of Technology in the Netherlands, resurrected the old idea of the synopter but in a cardboard construction (Figure 10). The glasses use the binocular vision creating the false effect of three-dimensionality for drawings and, especially paintings (Wijntjes, 2016). The glasses were also presented at the VI Paranaense Art-Science Workshop and 4th International Meeting on Art-Science held at the State University of Ponta Grossa (Brazil) by a paper sent by Prof. Wijntjes as a speech of his invention, and other realized by the group of the Tutorial Education in Physics.

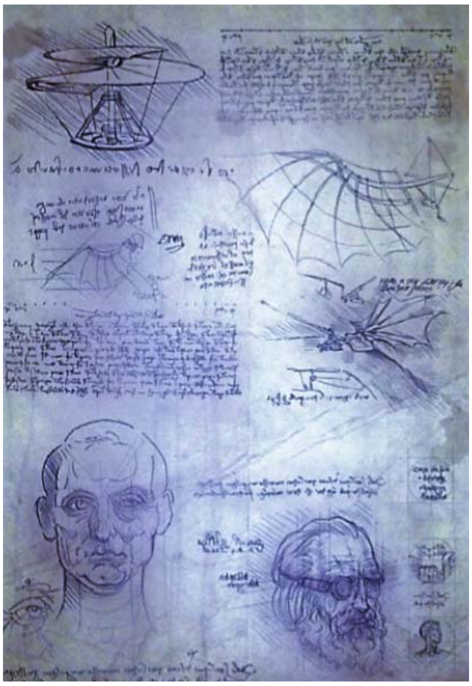


Figure 9   The sketches of Da Vinci with the False Insertion of a Prototype of Google Glasses (Ulanoff, 2013)

Figure 10   Cardboard Synopter — Designed by Maarten Wijntjes (2016)

5. Conclusion

The effect created by the use of the synopter is very real and induces a complete immersion sensation that enhances the experience of seeing, for example, a masterpiece in a Museum. The materials are easy to obtain: using lenses with short focal lengths, that can be replaced with Fresnel lenses (plastic), and the semi-transparent (diagonal) mirror that can be replaced with low-cost car rear-view mirrors, the synopter becomes a hands-on optical instrument to reconstruct the three-dimensional world painted by artists.

The use of devices, through geometrical optics, is welcome in the experimental Physics' teaching, since the classes are restricted almost exclusively to a theoretical and tedious treatment, using mnemonics as a technique of assimilation of image formation, without no real-world connection to lenses and mirrors. The synopter is therefore a great aid to the understanding the process of imaging, using geometric optics and the concepts of reflection, refraction and transmission of light, besides being essentially inter and transdisciplinary learning, linking inexorably art and science and arousing interests in several areas of knowledge.

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