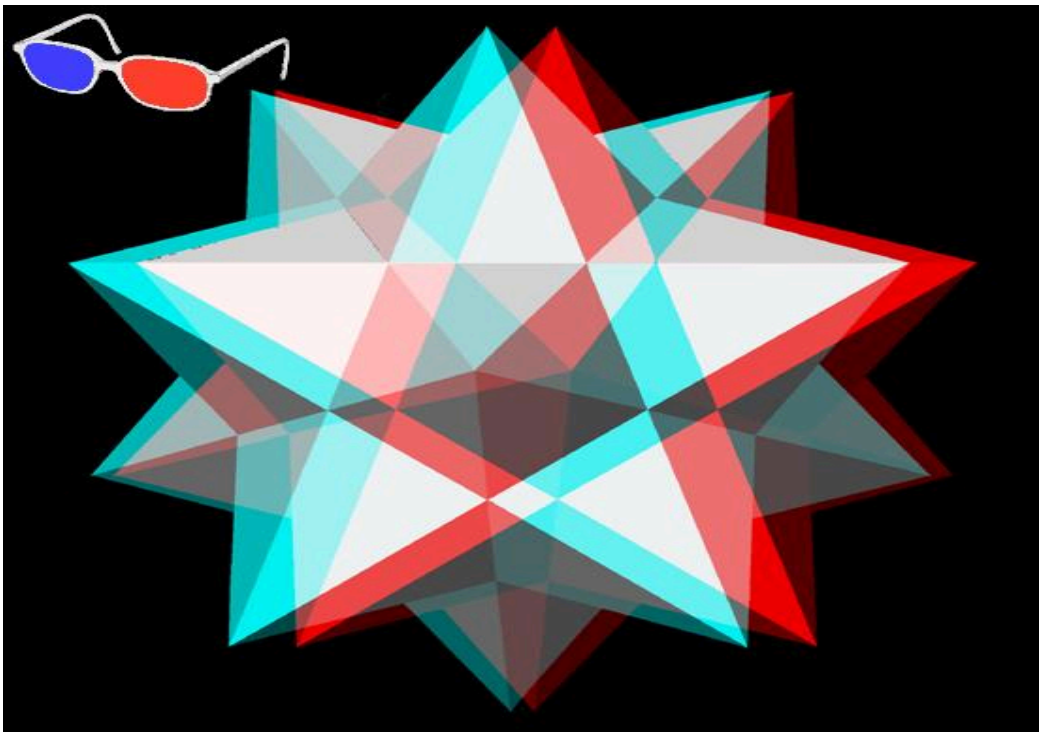
The importance of binocular vision in VR technology



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Would you buy a pig in a poke? Me neither. Mostly, because I like to be sure that I spent my money wisely. I think all of us do. And still, when it comes to VR headsets not many people know what makes them functional. What if this thing is dangerous? Have you thought about your safety? What if VR melts your brain? Don't worry… I'm only joking. The secret behind the utility of the headset is not rocket science. The answer is binocular vision.

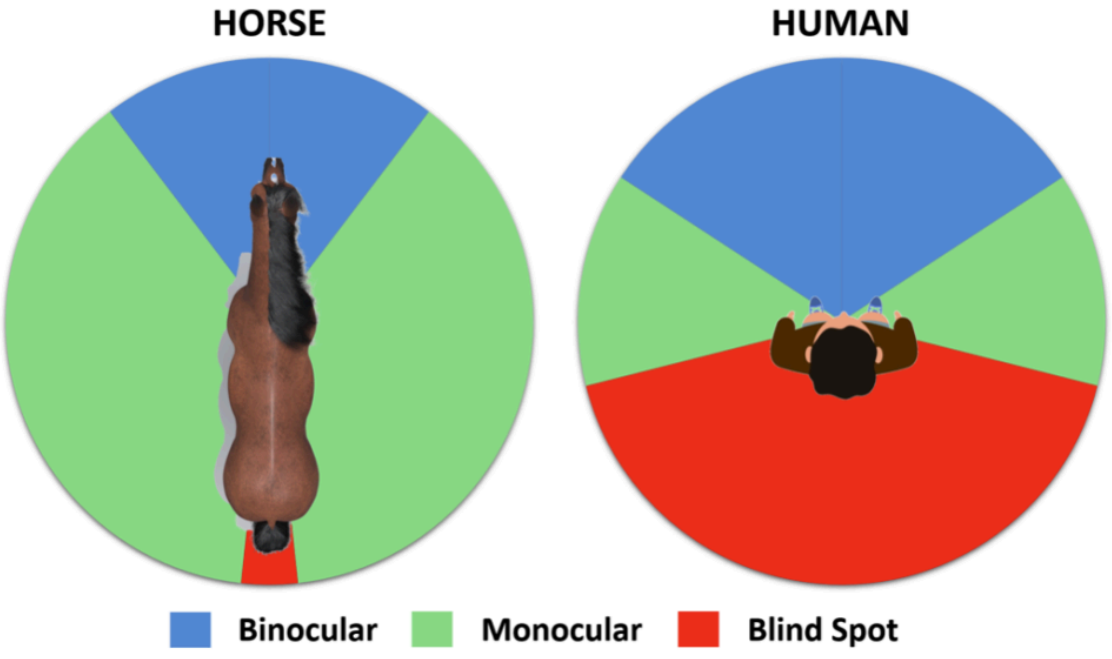
How do we use binocular vision?

Binocular vision is simply a type of vision which is provided by two eyes, but what's more important, it provides the ability to see in 3D which is called *Stereopsis.* To explain this phenomenon, let's do a simple experiment. Grab two things and place them in front of you. Let one be closer to you than the other. Can you tell which pencil is nearer to you? That's what I thought. Now, try it with one eye closed. It's not so easy anymore. Assessing the distance is one of the functions of binocular vision. Because our eyes are placed on different positions on the face, they give the brain a slightly divergent perspective of the same view. The brain then compares them, forming a single vision. This function of our brains is called *sensory fusion*. For its occurrence some certain conditions must be met. The images, for example, should be in the same size, brightness and sharpness. So to ensure that these qualities are the same, we possess the skill to align the eyes in this way, which is called *motor fusion.* Stereopsis is also a part of egocentric localization, which is the method of object

localization with the respect of one's body. This is the most deep and accurate method people have developed.

Is binocular vision exclusive for humans?

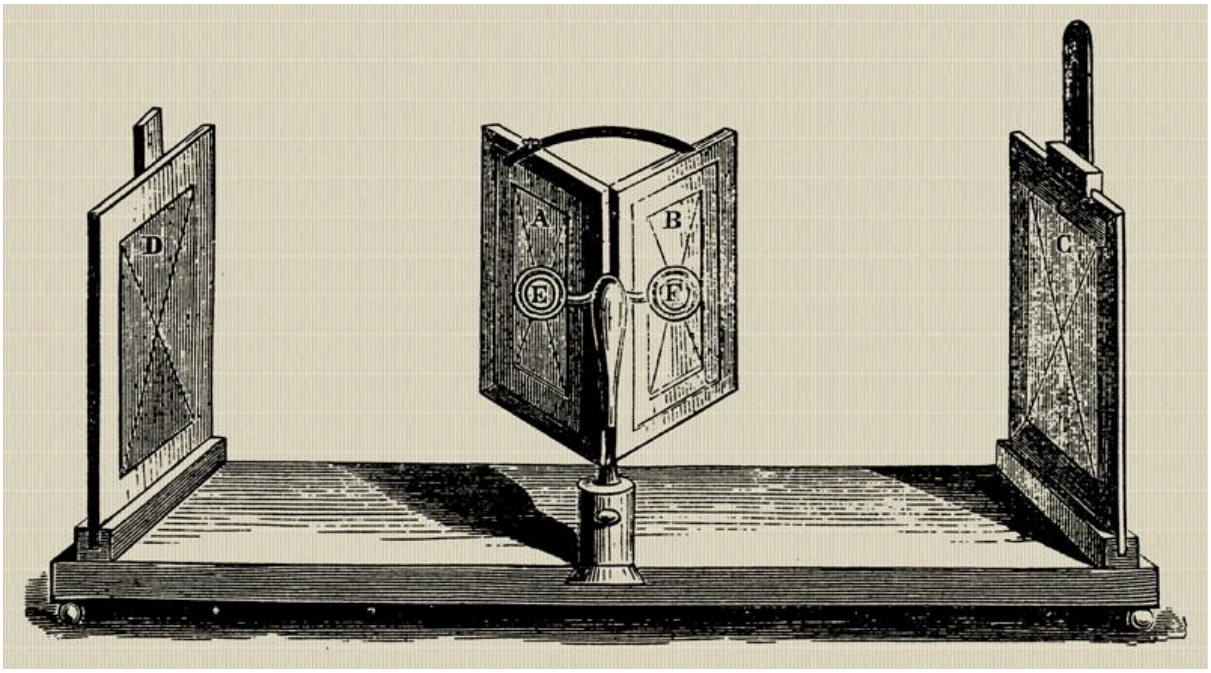
The studies of binocular vision have always been rather anthropocentric, however, it has been proved that binocular vision is not reserved only for humans. Even so, compared to us other species use it very differently, for instance birds. For these animals two things are essential. Optic flow, which is the occurrence of the movement of the objects around us when we're moving, and center of expansion, which is this one place where nothing is moving in respect to one's body. It's usually the direction of our destination. A bird has to quickly determine the right course where it's flying, and, although stereopsis has a lot of advantages, it's time consuming. Hence, even though birds have a binocular lap, they see the center of expansion with each eye individually. Horses are also an extremely interesting example and they stand for a counterpoint example. As I emphasized before, binocular vision and stereopsis connected with it have many benefits, however we had to resign from some potentially useful quantities, like range of vision. Horse's eyes are placed on the sides which means that its binocular overlap is very small, nevertheless it exists. More important for this animal is its monocular vision, because every eye has a colossal range of vision. Thus the horse's eyes cover approximately a 340-degree angle. For comparison, a human's vision has a range of 180 degrees.



source: https://askanimalweb.com/equine-vision/

How is it used in VR headsets?

It’s commonly known that the essential advantage when it comes to VR technology is total immersion, one part of which is 3D vision. We can achieve this effect by using stereopsis to our advantage. Actually, the origins of this solution are much older than the VR tech itself. Everything started with Charles Wheatson and his invention from 1838, stereoscope.



https://en.wikipedia.org/wiki/Stereoscope#/media/File:Charles_Wheatstone-mirror_stereoscope_XIXc.jpg

This device allowed people to get a three dimensional view by looking at 2D pictures. Stereoscopes started a craze for trying to understand how our binocular vision works and how our brain combines the views to receive one 3D image. This invention was later improved by David Brewster, who added lenses and made stereoscopes a little more practical.

https://artsandculture.google.com/asset/brewster-lenticular-stereoscope-museo-nazionale-della-scienza-e-della-tecnologia-leonardo-da-vinci-sir-david-brewster-1781-1868/JAHqz_OrScXwmw?hl=en

His invention also became very popular, especially because of its portable form. In the 20th century lenticular stereoscopes were improved by combining its achievements, electronics and computer technology. In modern VR headsets we use slightly different displays for each eye. Sometimes on one screen and sometimes on two. The choice of displayers also play a pivotal role in this type of technology, because we want to mimic the natural function of the human eye as accurately as possible. If something's not right we can experience visual discomfort or distortions. That's why the commonly used displayers are liquid crystal displays (LCDs) which provide low-latency and high-resolution capabilities. The other type which often occurs is organic light-emitting diodes (OLEDs) which are superior in terms of contrast and color reproduction.

The potential for the future

Binocular vision has many unanswered questions. We don't know yet how our brain combines the images or why some people have better stereopsis than others. That's why the research on binocular vision is still in progress. VR technology is still an emerging discipline and we don't have a lot of information about it, which is an obstacle in popularisation of this tech in everyday use. By deepening our knowledge of binocular vision we might find our solutions for preventing discomforts such as cybersickness. Additionally, developers will be one step closer to creating displays that match the human eye's resolution.

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