Virtual world authenticity

The primary attribute that SP stereovision adds to typical video viewing is the ability to stimulate the human sense of stereovision. In normal viewing of the world, each of our 2 eyes views the world from a slightly different angle because of their lateral displacement in the head. As result each eye receives a slightly different image of the world and the relative locations of objects as viewed by each eye will be different if the objects are at different distances from the person. This can be easily demonstrated by holding up one finger from each hand, one farther away then the other, and then alternately viewing the 2 fingers with each eye and noting the difference in their location relative to one another.

The visual system is very sensitive at detecting these differences in relative object location (referred to as “disparities”) and translating them into a sensation of depth called “stereovision” – a sensation that requires binocular vision. Stereovision is a strong cue to appreciating depth in a scene – however, it is not the only cue to experiencing depth. There are also numerous monocular cues such as geometric perspective, vertical location in the scene, visual overlap, relative size, and movement parallax that are also used to experience depth. These monocular cues (except for motion parallax) exist in drawings, paintings, and photographs; they all also exist in typical video presentations. The figure below shows several of the elements of monocular perspective, along with an illusion that shows discordance of cues

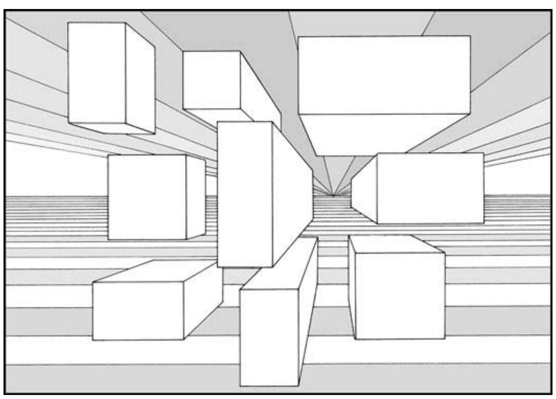
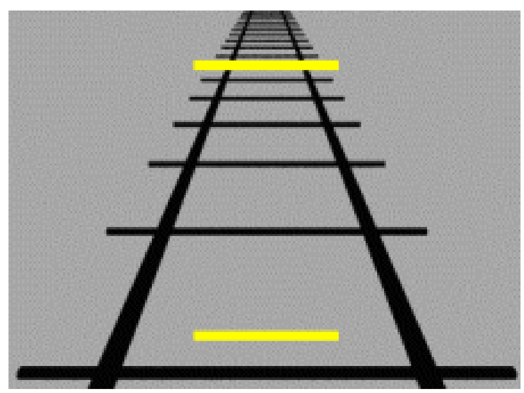

Figure. The picture on the left shows the sensation of depth that is created with various monocular cues to depth such as geometric perspective, visual overlap, and relative size all properly calibrated with one another. The picture on the right shows how improper calibration of geometric perspective and relative size can result in distorted perception; the 2 yellow (white) lines are actually the same size.

In the real world there is almost always perfect concordance of the various cues to depth – i.e. they work in harmony with one another and the various cues to depth are rigidly calibrated with one another. In drawings or paintings the cues to depth can sometimes be discordant with one another. For example, the relative sizes of objects may not match with the geometrical perspective cues creating a scene in which objects appear curiously distorted in size, shape, or location. An illusion using these principals is shown above.

There are 2 ways in which SP stereovision offers opportunity for cue discordance.

- One way is entirely dependent upon the software that drives the video imaging.
- The other way is inherent in all methods (including the SP method) of artificially creating stereovision.

Software-dependent cue discordance

The software drives the disparity between the images presented to each eye – hence the depth signal from the stereovision sense is controlled by the software. Whether or not it is properly calibrated with the monocular cues to depth such as size, location and perspective is in the hands of the software designer.

In order to design the software so that binocular and monocular cues to depth are properly calibrated with one another, the designer needs to design for a particular viewing distance of the display from the eyes, and it requires that the display be viewed at the designed distance. There is certainly no control over the distance at which the viewer uses the display and the extent to which designers pay attention to calibrating the binocular and monocular depth cues is unknown to this writer (who suspects that it is also not widely known within the industry).

The discordance of binocular and monocular depth cues can cause the video scene to appear unreal – for example stereovision could be used to overemphasize the depth of objects in order to create the sensation that an object is propelled closer to the viewer than the monocular cues would indicate. The discordance can be used by the designer for effect, or it can occur simply by neglecting to attempt to design proper calibration.

By creating conflicting cues, the virtual world appears different then the real world. Just as conflicting monocular depth cues can create odd sensations in a painting, conflicting binocular and monocular cues in SP stereovision programming can create odd sensations. The conflicting cues can cause the viewer to feel somewhat disconnected from the real world and even disoriented. This could potentially contribute to feelings of disorientation, discomfort, or even nausea.

Stereovision method-dependent cue discordance

All of the most common methods of artificially stimulating human stereovision unlink the normal calibration between the human focusing function (called "accommodation") and the eye crossing function (called ocular "convergence"). This occurred in the earliest methods such as hand held devices based upon the Brewster stereoscope, in the cinematic approaches using either polarizing or red-green glasses, and also in the SP stereovision technique.

When we view objects in the real world, the magnitudes of required ocular accommodation to focus on the object and the amount of ocular convergence to see it singly are rigidly calibrated with one another. Each viewing distance requires the same paired amount of accommodation and convergence.

In all of the common methods of artificially inducing stereovision, the images presented to each eye are displaced laterally from one another (thereby requiring convergence), but the images are all presented on an essentially flat screen at the same viewing distance and hence all require the same level of accommodation. In order to fixate and view objects at varying simulated distances, the viewer must alter convergence without altering the accommodative response of the eyes.

In the human visual system there is a neurological connection and relationship between the amount of accommodation and convergence that occurs. This is controlled in the brain by the Nucleus of Edinger-Westfall. Although there is a neurological connection between accommodation and convergence, it is not nearly as perfectly rigid as the stimuli are linked in the real world. Most people have considerable flexibility in the relationship between accommodation and convergence and hence are able to adequately disconnect them from the typical relationship encountered in the real world in order to meet the relationship demands in the created virtual world.

However, some people will have difficulty meeting the unusual accommodative and convergence demands of the simulated stereovision condition. In such cases the person can experience visual discomfort such as eyestrain, pain in the eye, eye fatigue and headache.

It must also be noted that quite a few people can have natural imbalances in their convergence and accommodation relationships. For example, in an adult clinical population with eye problems related to using a computer, more than 30% were diagnosed with these types of disorders (Sheedy and Parsons). These types of imbalances are diagnosable vision conditions that cause symptoms of discomfort such as eyestrain, eye pain, eye fatigue, and headache. One of the treatments for this type of disorder is vision training. A common form of vision training is to use prism, lenses, and various stereo viewing devices to disassociate accommodation from convergence and hence to train and improve the flexibility of the relationship between the two functions (Grosvenor). Such training is very similar to the dissociation caused by the various stereovision methods. Therefore it could be argued that viewing a stereovision display such as the SP stereovision provides helpful training to the visual system.

In summary, the SP stereovision technique offers considerable opportunity for the virtual world to stimulate vision in ways that are different from the real world. The dissociation between accommodation and convergence has existed in all previous methods of manufactured stereovision. This can cause eye-related symptoms in some subjects, although an argument can also be made that it also helps to train flexibility in the visual system. While the SP stereovision technique also can be used to create discordant depth cues, this is a matter of software design. Such cue discordance can create illusions, distorted perceptions of space, and might even contribute to transient feelings of disorientation, discomfort, or even nausea as discussed below.

Immersion in the virtual world

All videographic systems essentially create a virtual world for the viewer. The content of the programming can create the sensation of movement. This can be perceived as movement of the scene, or as movement of the viewer within the scene. The sense of vision is used to create the sensation that the viewer is moving; however all of the other senses (e.g. vestibular and kinesthetic) are not sensing movement because the observer is (likely) seated in a room. The sensory disconnect can cause symptoms such as imbalance, dizziness or nausea (Howarth and Costello, Howarth and Finch, Morse and Jiang, Regan and Price).

Obviously the software programming has a considerable impact on the movement sensations that are generated. Creating such sensations is clearly the intent of some programming such as in some video games. Movement sensations are also intended in the video presentations in some amusement park scenarios. The intensity of the movement experience can be affected by the level of immersion in the scene. Greater immersion in the scene means the viewer has less connection with the real world around them and therefore the movement experiences in the video scene are more compelling. The level of immersion is increased with larger screens, closer viewing distances, and room darkness.

These immersion effects exist in nearly all movie and video experiences. They are heavily influenced by program content and viewing conditions. This is also true for SP stereovision. However, because SP stereovision provides an added sensation of depth that can be used to intensify the sensation of movement, it has potential to create greater mis-match between the sense of vision and the other senses. Therefore it has greater potential to create the symptoms such as imbalance, dizziness or nausea. That being said, however, movies, video games, and amusement park shows have all been used to provide quite intense movement experiences and reports of symptoms are rare. For example the 360 degree viewing experiences provided in amusement park shows can create a very real sense of movement. Even in this type of show the viewers are allowed to stand – although hand rails are provided to allow people to maintain balance. It is unlikely that SP stereovision will create significantly higher risk for symptoms than previous technology implementations.