# Chapter 15
# Effectiveness of New Technology to Compose Stereoscopic Movies[1]

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## ABSTRACT

*The most widely known theory of motion sickness and asthenopia are based on the concept of sensory conflict, a disagreement between vergence and visual accommodation while viewing stereoscopic images. Visually induced motion sickness (VIMS) can be measured by using psychological and physiological methods. We quantitatively measured vergence, visual accommodation, head acceleration, and body sway before and during exposure to conventional and new stereoscopic movies. Sickness symptoms appeared with exposure to stereoscopic images. We found that some analytical index for stabilograms increased significantly when the subjects viewed a 3D movie. VIMS could be detected by using these indices. While lateral sway is dependent on the transverse component of head movement while watching the conventional stereoscopic movie, we examine whether this tendency is reduced by Power 3D.*

## INTRODUCTION: DEPTH ESTIMATION AND VIEW SYNTHESIS

With rapidly growing market for three-dimensional (3D) movies, 3D TVs, and 3D gaming, we may now be entering a time called the "Era of 3D". The general public has also started to become comfortable with stereoscopic vision. However, there are concerns about the effects on the human body from continuously watching 3D images, for examples, visually induced motion sickness (VIMS), visual fatigue, and asthenopia. Although their mechanisms are still not fully understood, there is a great need for more knowledge about the effects of those products on users and guidelines

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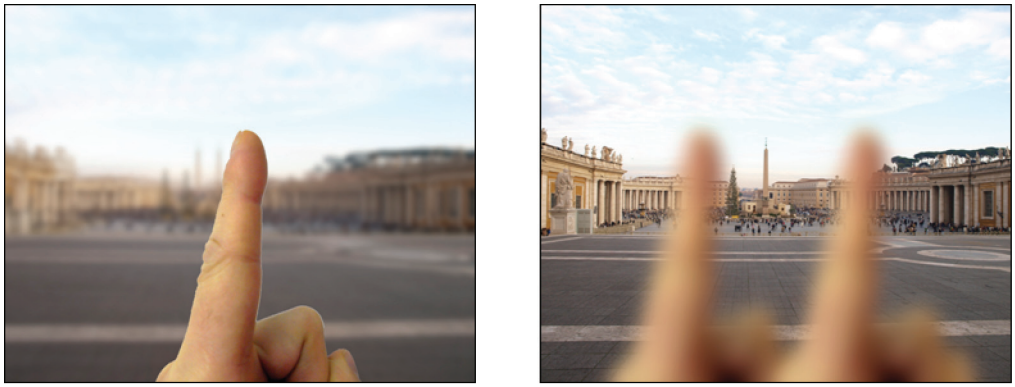
*Figure 1. Binocular parallax. (a) near vision and (b) far vision*



(a) (b)

for safety watching 3D images. We herein show the effects of stereoscopic images that may cause the VIMS or the simulator adaptation syndrome (SAS) in human. The goal of this chapter is to present a new technology to counter the causes of the VIMS.

On the other hand, an increasing number of people need to perform near-visual tasks such as operations on video display terminals (VDTs) with the development of computers and the widespread use of the Internet. Working under such conditions for several hours induces the contraction of the muscles involved in focus adjustment around the eyeball, such as the ciliary muscles. The abnormal contraction of ciliary muscles due to the performance of a near-visual task for several hours causes various vision problems such as asthenopia and visual loss. Further, this contraction has been reported to induce the cervicobrachial and psychoneurotic syndromes (Gomzi, 1994; Nakazawa *et al.*, 2002).

For persons afflicted with pseudomyopia, performing stretching exercises of the ciliary muscles alleviates strain and temporarily improves the myopic condition. These exercises can be performed by alternately repeating the negative and the positive accommodation of the eye. Miyao *et al.* (1996) experimentally demonstrated that the accommodation of the eye was possible by gazing at stereoscopic images displayed on a liquid crystal display (LCD) or a cathode ray tube (CRT).

Human beings perceive three-dimensional (3D) objects by the simultaneous vergence and lens accommodation in natural binocular vision. The depth of vergence and accommodation agreed under natural viewing conditions. They also perceive virtual images by using the same mechanism. A general stereoscopic view is obtained by using the binocular parallax (Figure 1).

It has been commonly explained that lens accommodation makes us focus on the surface of a display although the *optical axes of lens* are crossed at the virtual image (Figure 2) while viewing stereoscopic images (Cruz-Neira *et al.*, 1993). There is discrepancy between vergence and accommodative focus. That is, there is contradictory depth information between vergence and accommodation, called discordance, in the visual system. According to previous textbooks on 3D imaging, the VIMS and asthenopia are caused by this discordance. However, it seems to be an incorrect explanation. It has been shown that our focus is not always fixed on the surface of a display while viewing a stereoscopic image as follows: