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Study of 3D Size and Position Estimation through the Horizontal-Size-Ratio, Vertical-Size-Ratio and HVS Parameters

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ABSTRACT

This paper represents Horizontal Size Ratio (HSR), Vertical Size Ratio (VSR), Eye position signal (EP), and human visual system (HVS) to estimate perceptual stereoscopic slant. Perceptual adaptation often results in a repulsive aftereffect. A binocular stimulus consisting of horizontal lines is biased away from the adaptation stimulus .Visual system is able to measure the VSR of this stimulus. Disagreement between extra-retinal eye position signals (EP) and VSR causes a recalibration in the use of EP as used in the stereoscopic perception of slant. Visual system should weight the most reliable method .We investigate if new method represent the way which make the embedding possible in the way that human visual system could not recognize the aftereffects
KEYWORDS: Aftereffect, Disparity, EP, HSR, Perceptual slant, stereoscopic, VSR

1. INTRODUCTION

To determine stereoscopic slant , horizontal disparities or from derived quantities such as horizontal size ratio (HSR) is not sufficient, vergence and version of the eyes, the vertical size ratio (VSR), and the horizontal gradient of VSR and perspective slant cues must be available. Therefore, it appears stereoscopic estimate based on HSR and VSR, and a stereoscopic estimate based on HSR and sensed eye position. The interpretation of horizontal disparities arising from the two eyes having different views of the same surface leads to Stereoscopic vision. Horizontal disparity can be expressed as an intraocular difference in the ratio of horizontal angle subtended by a subsequent pair of points, (horizontal size ratio, HSR) and it used to clarify stereoscopic depth perception. Horizontal size disparity increases as slant increases. Horizontal size disparities offer information about the slant of a surface about a vertical axis. It denotes a horizontal size disparity as the percentage difference between the horizontal extents of the two images, signed positive when the left eye's image is larger than the right eye's image.

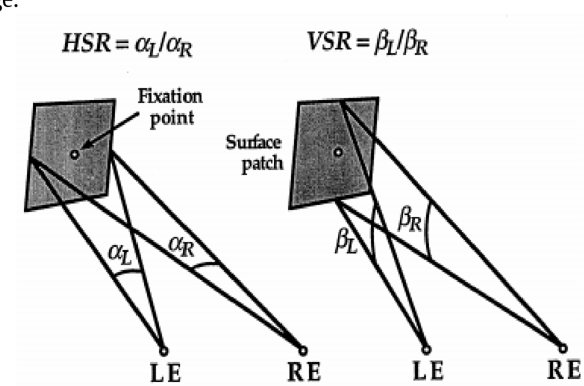

Fig 1.An oblique view from behind the observer is shown.

The fixation point on the surface patch is indicated by the small white circle. Angles $\boldsymbol{\alpha_L}$ and $\boldsymbol{\alpha_R}$ are the horizontal angles subtended by the patch at the left and right eyes. The horizontal size ratio (HSR) is defined as $\boldsymbol{\alpha_L/\alpha_R}$. Angles $\boldsymbol{\beta_L}$ and $\boldsymbol{\beta_R}$ are the vertical angles subtended by the surface patch. The vertical size ratio (VSR) is defined as $\boldsymbol{\beta_L/\beta_R}$. [2]

To identify the slant of a surface from horizontal disparities, information based on distance and azimuth of the surface would be essential. Eye position (EP) and signals provided by vertical disparities are two starting place of this information. Thus, stereoscopic slant can be estimated from horizontal disparities and eye position signals (HSR–EP), and also from horizontal disparities and vertical disparities (HSR–VSR). Stereoscopic slant perception is depend on the accessibility of VSR information Gain of EP signals in slant perception approached 1, when VSR was not available, EP gain was around 0.2 and VSR gain was around 0.8 and when VSR was available [1]. VSR is used to interpret HSR in slant perception and is exposed by changing in apparent slant that rise from artificially introducing a relative vertical size difference between the eyes' images in vertical angular subtends which is known as vertical size ratio (VSR). To specify the azimuth and distance of the surface, VSR and the horizontal gradient of the VSR exclusively are required.

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The visual system uses the vertical gradient of vertical disparity in the binocular images to proper distortion of the horizontal disparity field objects when one side of the head is closer to one eye than the other.

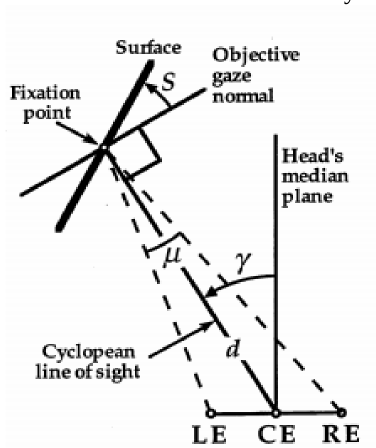

Fig.2. Binocular viewing geometry. An overhead view situation is presented.

LE and RE refer to the left and right eyes. CE is the cyclopean eye, placed at the midpoint between the left and right eyes. The head's median plane is the plane stopping at the cyclopean eye and is vertical to the intraocular axis. A surface is fixated by the two eyes at the fixation point. The lines of sight from the two eyes are represented by the dashed lines. The cyclopean line of sight is the diagonal solid line. The distance d to the fixation point is measured along the cyclopean line of sight.

In Fig.2, The slant is the angle between the surface and the objective gaze-normal plane (a plane perpendicular to the cyclopean line of sight); this angle is signed but otherwise equal to slant as defined by Stevens (1983). The angles $\boldsymbol{\gamma}$ and $\boldsymbol{\mu}$ are the eyes' version and vergence, respectively. Positive slant (S) and positive azimuth ($\boldsymbol{\gamma}$) are defined counter clockwise viewed from above.

1.1-Adaption aftereffect

VSR is measured by averaging vertical disparities across large (approximately 20°) regions of the visual field. Horizontal disparity is represented at much higher spatial resolution .When the lines are vertically larger in the left eye (VSR > 1) the binocularly fused images which seems to be slanted in the left. To produce a repulsive adaptation aftereffect, reduced activity within VSR-sensitive neurons would be expected. Conflict between VSR and EP signals causes adaptation aftereffects. The visual system may possibly recalibrate one or both signals so as to decrease constant disagreement between them. VSR is more reliable and stable about azimuth than EP, so EP signals ought to be recalibrated to be in agreement with VSR. Adaptation did not arise within a mechanism that measures VSR, and for stereoscopic slant perception VSR will used to recalibrate EP signals. A slant-nulling task would be applied to estimate slant aftereffect. Observer should be able to define VSR and it leads to adaptation stimulus which appeared unslanted. These will achieve by using a stimulus that consist horizontal lines which step by step fade from ends. When HSR have been changed ,did not cause the lines to appear slanted, but in use of unbroken horizontal lines were changed to dashed lines, changing HSR produced clear slant although it is still less than veridical caused by conflicting perspective and accommodation cues that signaled zero slant.

1.2- Recalibration in use of EP vs. perseveration of VSR

To have a pattern of vertical disparities, a gaze-normal surface in eccentric gaze is required. The gaze angle (c, in radians) is consistent to a given value of VSR in, $\boldsymbol{\gamma} \approx \frac{\boldsymbol{d}}{\boldsymbol{I}} \ \mathbf{ln}\,\boldsymbol{VSR}$ [1] where I is the intraocular distance (distance to the fixation point). Vertical enlargement did not change the visible slant of the surface in the adaptation stimulus, nor its apparent head-centric direction. It remained apparently unslanted, in forward gaze. A coefficient of 0 shows no adaptation and 1 indicates that adaptation conclude bias (in the HSR that appears gaze-normal) equipped the need of to indication gaze-normal. The adaptation to VSR causes recalibration in the use of EP for stereopsis.

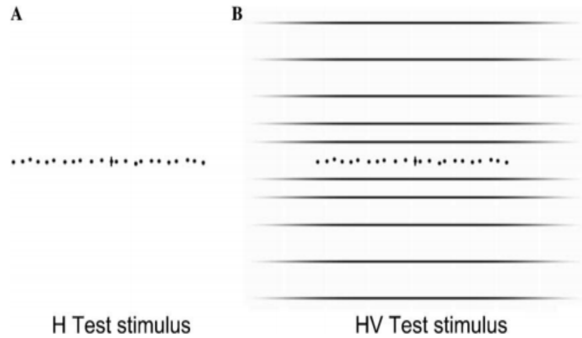

Fig.3. Test stimuli, as they appeared when binocularly fused.

The ‘‘H’’ test stimulus, left, consisted of a binocularly viewed horizontal dot row. It contained an HSR signal but no measurable VSR signal. The ‘‘HV’’ test stimulus, right, contained both HSR and VSR signals. Thus the appearance of the stimuli was similar in the H and HV conditions but it was still the case that only the HV test stimulus contained a VSR signal.

(Philip A. Duke et al. 2006) they had prepared H and HV test conditions. The HV test stimuli did not create a repulsive aftereffect as predicted, which was that adaptation occurs in the measurement of VSR. The condition H produced systematic slant aftereffects of the same sign as VSR Adapt, i.e., attractive aftereffects. The smaller aftereffects observed in the HV condition was determined from the weighted combination of a recalibrated estimate based on HSR–EP, and a fix estimator based on HSR–VSR. Because the aftereffects in the H condition were in the same perceptual direction as would normally be caused by the VSR in the adaptation stimulus, the data might also be interpreted as a ‘‘perseveration’’ of the VSR Adapt signal within the visual system, in which VSR Adapt is used to interpret the HSR signal even after the VSR signal is no longer present in the stimulus. They found an adaptation aftereffect to pure VSR signals. Despite of expectation there was no repulsive (negative) aftereffect, and stronger aftereffect were achieved for test stimuli that did not include a VSR signal, than the stimuli that contain a VSR signal. The normative value is 1.0.Base on the perseveration of VSR; its value should remain until the observer is exposed to a new value. Even in the lack of HSR or perceived slant, adaptation’s mechanism did not entail VSR to make perceptual slant estimate. But VSR perseveration is not permanent.

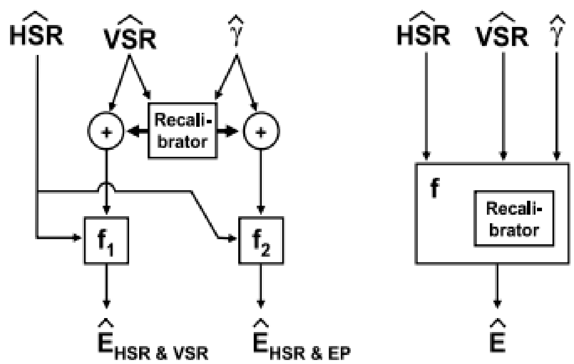

Fig.4. Two hypothetical mechanisms to recalibrate use of an extraretinal gaze angle signal during stereoscopic slant perception. Left: recalibration is before use of the signal to compute slant in f2, an estimator that uses HSR and eye position. Right: recalibration is inherent in the function that calculates slant.

1.3- HVS weighted VSR and HSR

There is no innate delay in updating the internal representation of VSR when it changes, because the visual system responds to changes in VSR no less than as quickly as its respond to changes in HSR. Substantially visual system will weight HSR–VSR, and HSR–EP, on the way that reflects their actual reliabilities. Therefore no weight leads to an estimate based on HSR–VSR in the H test stimulus. Visual system usually gives more weight to VSR. When VSR is difficult to measure by using short stimuli or stimuli composed of vertical lines, the visual system relies on sensed eye position. Slant estimate is a weighted average of the slant estimate based on HSR and VSR and the one based on HSR and eye position accounted well for the data. The weights varied across viewing conditions.

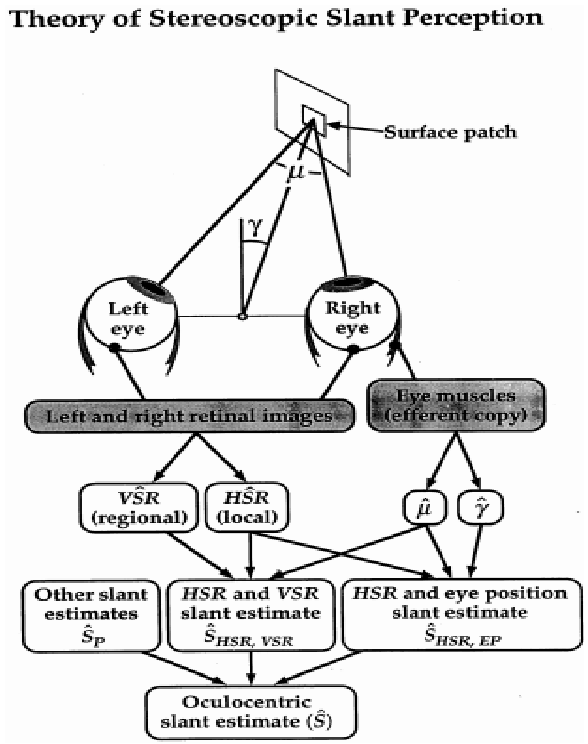

Fig. 6. Model of stereoscopic slant perception is shown. The visual system measures five signals: HSR, VSR, and $\partial VSR/\partial\gamma$ from the retinal images, and μ and γ the eye muscles. It also measures signals based on other slant cues such as perspective. It combines these signals in three ways to estimate surface slant. HSR, VSR, and μ used to estimate slant from HSR and VSR. The estimate of μ can be based either on eye position, or on the retinal images ($\hat{\mu}$,). HSR, γ, and μ are used to estimate slant from HSR and eye position . The perspective cue signal provides the third slant estimate. The Three Signal ($\widehat{S_{HSR-EP}}$, $\widehat{S_{HSR-VSR}}$, and $\widehat{S_P}$) will combine in a weighted average, with the weight assigned to each slant estimate dependent on the visual system's estimate of its reliability. The final slant estimate is done in oculocentric coordinates; specifically, the computations yield an estimate of surface slant relative to the cyclopean line of sight.

2. REVIEW OF LITERATURE

2.1- Adaptation to stereoscopic depth

Presentation an object slanted in depth for a long-lasting period causes reduction in apparent slant. Binocular depth aftereffects are mostly produced by adaptation to depth depicted in random dot stereogram. Domini et al. (2001) found that adaptation to different combinations of horizontal disparity and vergence causes depth aftereffects which varied with the adaptation stimuli, rather than their horizontal disparities .They had represent an adaptive mechanism sensitive to 3D shape. Results of Balch, Milewski, and Yonas (1977) establish that adaptation to depth from disparity or pictorial cues produced a depth aftereffect with test stimuli defined by either cue. Duke and Wilcox (2003) showed that depth aftereffects produced by adaptation to apparent depth with horizontal disparity modulations were the same as those created by the same apparent depth induced by vertical disparity modulations. They reasoned that the disparity should be constant over the test distances if disparity adaptation causes the aftereffect. Interpreting the aftereffects as degrees of slant at different distances was more alike. This result therefore argues against disparity adaptation as an explanation of the depth aftereffects of Duke and Wilcox (2003), and afterwards, of other conventional stereoscopic depth aftereffects. Matthews, Meng, Xu, and Qian (2003) showed that the induced effect as conflict of horizontal and vertical disparities.

(Backus & Banks, 1999) reasoned which an accurate prediction for relationship between viewing distance and the strength of the induced effect is complex because VSR depend on both azimuth and distance from the head. Data consistent with recalibration of EP were reported by Berends and Erkelens (2001). Their adapting stimuli contained horizontal and vertical disparities that were adjusted to make the surface appear unslanted. (Berends & Erkelens 2001; Duke & Wilcox, 2003; and also Domini, Adams, & Banks, 2001) measured the slant aftereffect via a slant-nulling task. Thus, to investigation of adaptation to vertical disparity per sec, not including confounding effects of adaptation to the apparent slant of the surface, they used an adaptation stimulus whose VSR could be defined by the experimenter, but always appeared unslanted . VSR is a useful signal for the system to be measured. (Kaneko and Howard, 1997) measured the VSR in different spatial resolution. (Philip A. Duke et al. 2006) represent HV test stimulus demonstrates nonstop effects of VSR and HSR on the perceived slant of a horizontal dot row. In the HV test stimulus the horizontal lines remained perceptually unslanted, only the dot row was seen to rotate in depth. This will is easily explained if VSR is measured regionally, but not if vertical and horizontal disparities are confused, since only the horizontal lines have vertical disparity, but only the horizontal dot row is perceptually to that disparity. Horizontal disparities are essential to the stereoscopic perception of slant.

Larger magnitude is for test stimuli which had horizontal row of dots and therefore did not include aVSR signal cause aftereffect in positive direction. For test stimuli that contain both a horizontal row of dots and horizontal lines disparity Horizontal disparity could be measured by the mechanisms [1]. Recently the relative amount of vertical size disparities between two different depth planes has been compared and studied. I., Phillip son (2010) tried to present the best definition for vertical disparity. They inspect two definitions of retinal vertical disparity: elevation-latitude and elevation-longitude disparities. Near the fixation point, all the pervious definitions will be alike, but in general, they do not dependence on object distance and binocular eye posture, which in the past was not mentioned. They present analytical approximations for each type of vertical disparity, valid for more general conditions [5].

(Philip A. Duke , Ian P. Howard ,2012) it has been investigated whether vertical size disparities are averaged across two superimposed textured surfaces in different depth planes or whether they induce distinct slants in the two depth planes. To this end, some experiments have been performed. In Experiment 1, superimposed textured surfaces with different vertical size disparities were presented in two depth planes defined by horizontal disparity. The surfaces induced distinct slants when the horizontal disparity was more than 65 arcmin. Thus, it has been concluded that vertical size disparities are not averaged over surfaces with different horizontal disparities. In Experiment 2 they confirmed that vertical size disparities are processed in surfaces away from the horopter, so the results of Experiment 1 could not be explained by the processing of vertical size disparities in a fixated surface only. Together, these results showed that vertical size disparities are processed separately in distinct depth planes. The results also suggested that vertical size disparities are not used to register slant globally by their effect on the registration of binocular direction of gaze. Considering a fixation point for a long time led to unrealistic results, so it is better to tent to" Motion cues" to depth because they provide information about the location, velocity, acceleration and direction of movement of either the viewer or an object Motion of stereo information is especially important since the visual system is more sensitive to binocular disparity when it is changing (i.e., the object is moving in depth) (Yeh 1993).

2.2- Induced effect

Induced-effect functions with a stimulus consisting of a horizontal row of dots and two horizontal rectangles positioned above and below the dot row (Ogle, 1939). Use of vertically magnifying lens before the right eye, will result an unslanted, binocularly viewed surface which seems to be slanted about a vertical axis. This occurrence, known as the induced effect and it is a corrective response to viewing geometry. And it varies from 2 – 23°. The stimulus is in forward gaze and it magnifies a vertically in one eye. VSR variations had a marked effect on slant settings when stimulus height was 6.5° or higher and had little effect on settings for shorter stimuli [2]. Use of VSR depends on stimulus height and Ogle (1939) did not. Because the horizontal dot row by itself contained no vertically, so VSR is one of necessity for explaining the horizontal rectangles separated features from which to measure VSR. Visual sensitivity and resolution are parallel across a wide range of retinal eccentricities when stimulus magnitudes are scaled according to cortical magnification. Because previous experiments made it possible to measure, this allows a more reliable estimate of VSR and, therefore, led to greater reliance on slant estimation by HSR and VSR with increasing stimulus height.

3. Conclusions

After adaptation to a pattern of horizontal lines aftereffects in a stereoscopic slant-nulling task would be achieve. Vertical disparity signalled a particular vertical size ratio. The pattern did not contain horizontal disparities, and it looked frontoparallel. Aftereffects were obtained even when the adaptation stimulus contained a VSR of 1, provided the gaze angle was eccentric (so VSR and version were in conflict). If mechanism computes version eye posture signal's slant it would be possible to obtain a pattern. When VSR can be measured, observers rely on it to null stereoscopic slant. Thus, it is sensible that the visual system would recalibrate its use of eye position when the two signals are inconsistent [1]. The results reveal that affect of vertical size disparities on the registration of binocular direction of gaze could not be applied to determine the slant globally.

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