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Saarbrücken, August 2015

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Saarbrücken, August 2015 Mohamed Gad-Elrab

Abstract

Stereoscopic and automultiscopic displays suffer from crosstalk. An effect which greatly reduces image quality, viewer comfort and distort the perception of depth. Previously, only a limited work has been done on understanding the relation between crosstalk and the perceived depth with respect to the nature of the stimuli. Moreover most of the previous work is carried on simple monochromatic scenes. Since the human visual system uses numerous other cues than disparity to estimate the depth of an object in a stereo scene, monochromatic scenes are poor choice for understanding the above mentioned relation. Moreover, the model for depth resolution via disparity as provided by the current literature fails to justify why and how the perceived depth is affected by the crosstalk. In this work, we improved and performed more generalized experimentation to see how the depth perception is affected by the crosstalk for different kinds of stimuli. Based on the result of these experiments, we derived a model for human visual system's resolution of depth from disparity that accurately measures the depth of a stimulus as perceived by the human in presence of cross-talk. Finally some improved algorithms for removal/compensation of crosstalk in automultiscopic are developed.

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Chapter 1

Introduction

1.1 Preliminaries

Discuss General idea behind crosstalk and why is it so bad. How it affects the depth and what current literature think about it.

1.2 Contributions of this Thesis

Experimentation, mitigation, HVS model.

test

1.3 Structure

1.4 List of Commonly used abbreviations

Chapter 2

Relevant Background

2.1 Depth Perception

Depth perception is the ability of the Human Visual System to visualize the three dimensional world as well as measuring the distance of an object based on two dimensional images obtained from the eyes. Depth perception is imperative for performing basic everyday tasks such as avoiding obstacles without bumping into them or interacting with the world with relative ease. In animals (specially predators), it is critical to estimate the distance of a prey for an efficient attack. Depth sensation is the term used for animals as it is not known whether they sense the depth in the same way as humans do or not[3].

Human visual system uses several monocular and binocular cues to determine the depth of objects in the view. These cues can be categorized into two categories i.e. cues extracted from a single image (Monocular Cues) and cues extracted from two images (Binocular cues)[2][3]. Figure 2.1 gives an outlook of the depth cues used by the HVS. These cues are then dynamically weighted according to their robustness by the HVS in order to estimate a depth value for each object in the view [1](Write details of those cues in Appendix).

2.2 Stereopsis in HVS

Among all the depth cues discussed in the section above, Stereopsis is the most influential of them all. Since the human eyes are located at different lateral positions

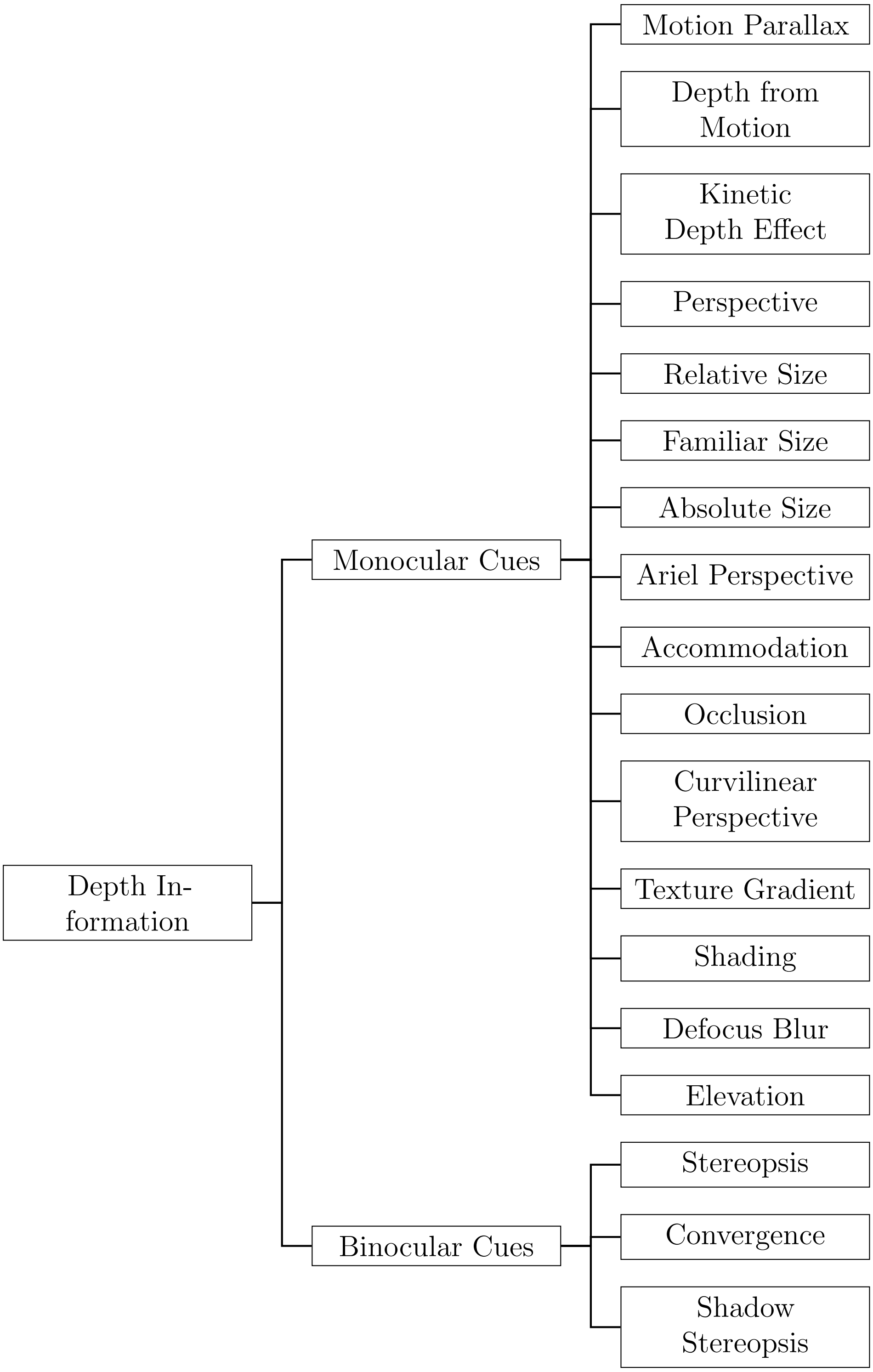

FIGURE 2.1: HVS Depth Cues

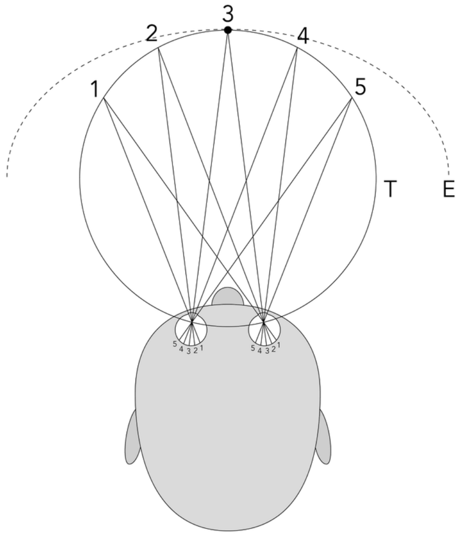

FIGURE 2.2: Representation of theoretical (T) and empirical (E) horoptor

on the head, the images formed on the retinas of these two eyes are slightly different. The difference is mainly the horizontal positions of the objects[5]. The process of obtaining a fused (Binocular fusion) image (Cyclopean image) and obtaining a depth map based on the horizontal disparities of the objects in these two images is known as stereopsis.

When the eyes verge in order to focus some object (or point) in space, that object is projected at identical corresponding points in the retinas. This means that the difference between their horizontal positions is zero. The locus of all the points in space that is projected on identical retinal points is called the horoptor[4]. Theoretically, via geometrical principles, the horoptor is a circular segment in the plane of fixation. However, Wheatstone in 1938 observed that the actual/emperical horopter is much larger than that. Figure ?? shows both the theoretical and empirical horoptor.

2.3 Crosstalk

Definitions and Factors contributing to Crosstalk Effects on viewers 70% thing etc.

2.4 Stereoscopic/Automultiscopic Screens and its cross-talk

2.4.1 CRT Screens

2.4.2 LCD Screens

2.4.3 Anaglyph Stereo

2.4.4 Active/Time Sequential Stereo

2.4.5 Passive/ Space Multiplexed Stereo

2.4.6 Automultiscopic Screens

2.5 Crosstalk Quality Metrics

2.6 Lightfields

Chapter 3

Related Work

3.1 Effects of Crosstalk on Perceived Depth

3.1.1 Thirsins's work

3.1.2 Systematic Distortion

3.1.3 Visibility Threshold and Fusion Limit

3.2 Migigation/Compensation of Cross-talk

3.2.1 Stereoscopic Screens

3.2.1.1 Subtractive Approaches

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Contribution

4.1 Crosstalk Experiments

4.1.1 Apparatus setup

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Chapter 5

Applications

5.1 Depth Adjustment for Depth Critical viewing Applications

5.2 Efficient Preprocessing for Crosstalkfree Images

Chapter 6

Conclusion

6.1 Summary

6.2 Future Work

6.3 Open Questions

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