MASSACHUSETTS INSTITUTE of TECHNOLOGY Department of Electrical Engineering and Computer Science

6.237 Modern Optics Project Laboratory 6.637 Optical Signals, Devices & Systems

Problem Set No. 6 Spring Term, 2023 Issued Tues. 04/11/2023 Due Tues. 04/18/2023

3-D Vision, Non-holographic 3-D Imaging, and Near-Eye 3-D Displays

Reading recommendation: Chapter 6 of Class Notes

Be neat in your work!

Problem 1 - Depth perception in the human eye: Dimensions and definitions Please do the recommended reading (and others) and define the following terms:

- (a) (a) Stereopsis, (b) vergence, (c) accommodation, (d) horopter circle, (e) Vieth-Muller circle), (f) disparity, (g) parallax, (h)Panum's fusional area, (i) visual cortex, (j) stereoacuity, (k) Virtual reality, (l) augmented reality, (m) light field.
- (b) Now make a 3-column table by placing the parameters listed below in column 1, inserting the values you find from your research for the typical human eye in column 2, and citing your reference with page number in column 3. Be sure to specify the units of your values. The parameters are:
 - 1. Smallest distance at which human stereopsis is lost (see double images)
 - 2. Smallest disparity, γ_{min} (image too far-cannot discern depth)
 - 3. Largest disparity, γ_{max}
 - 4. Average distance between human pupils
 - 5. Stereoscopic acuity limit at 1 meter from eyes (depth discrimination)

Problem 2 - Integral Imaging Design

An integral imaging image recording set up is shown first below for capture of a real image from a 3-D object, and then the corresponding readout geometry which reconstructs the 3-D image is shown.



- (a) Draw the geometry for capture of a virtual image of the object (rather than the real image).
- (b) Now draw the playback geometry which reconstructs the 3-D image.
- (c) Is there any advantage of one over the other (virtual vs real Image)?

Problem 3 - Cell-Phone-Based Integral Imaging System

You are given a cellular phone, and a lenslet array with lenslets of diameter d = 3 mm and focal length F = 5 mm.

- (a) The goal is to design and demonstrate a small, low-cost Integral Imaging system with these components. Draw an many diagrams as you need. Show your calculations, label all components, and describe its principles of operation.
- (b) What would you expect to be the most important limitations of such a system? List them.

[Hint: perhaps use the camera in your phone to capture the elemental image, and then the picture on the screen to generate the playback image].