ECE 299 Holography and Coherent Imaging

Lecture 12. HW catch-up and Digital Holography Introduction

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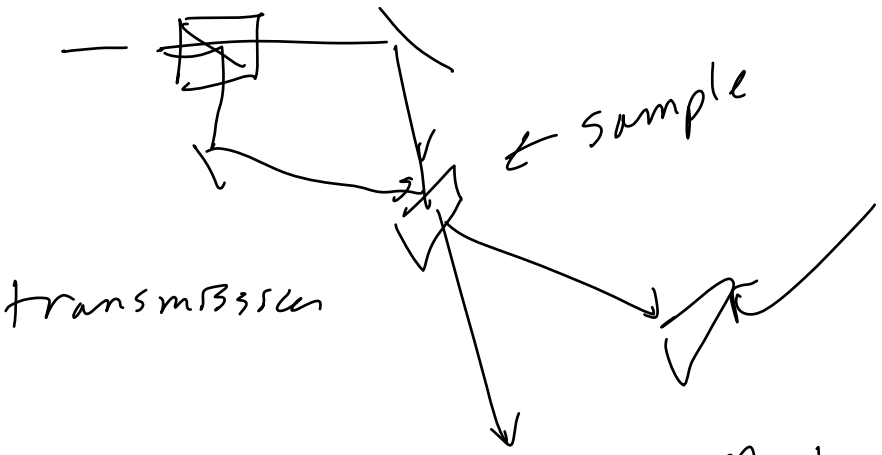
HW 5

Make volume holograms using the material described in

R. A. Bartolini, A. Bloom, and H. A. Weakliem, "Volume holographic recording characteristics of an organic medium," Appl. Opt. **15**, 1261-1265 (1976) http://www.opticsinfobase.org/ao/abstract.cfm?URI=ao-15-5-1261

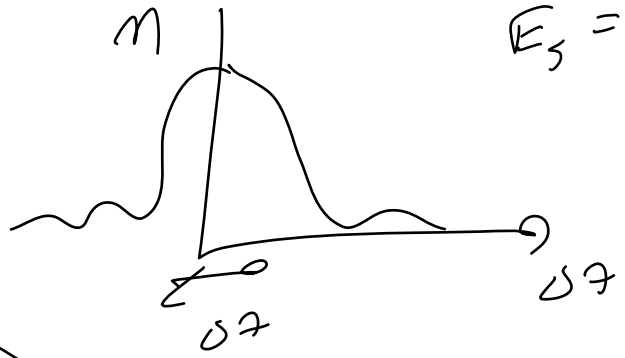
Make both reflection and transmission holograms at various recording angles. Plot the angular range of Bragg matching as a function of recording angle.

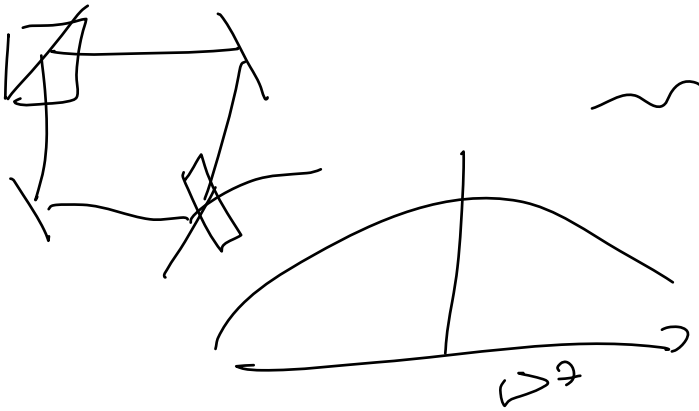
Recording Geometry



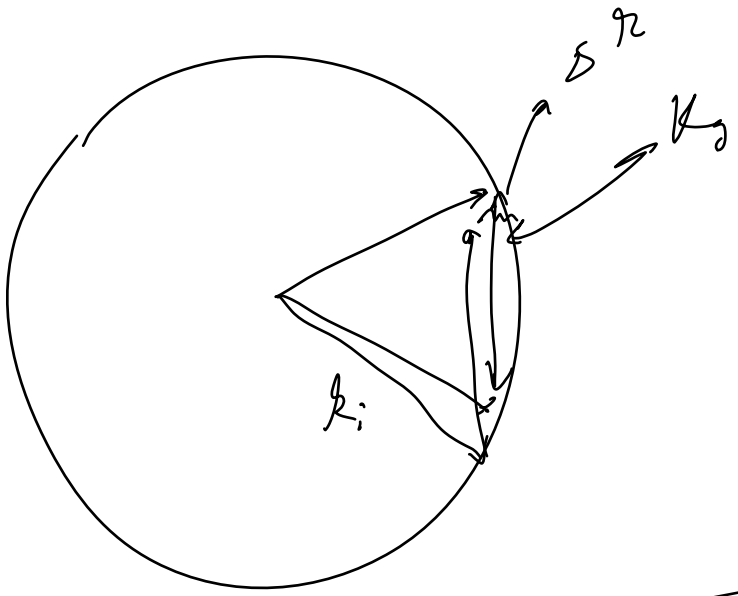
$$\delta z \sim \delta R / L$$

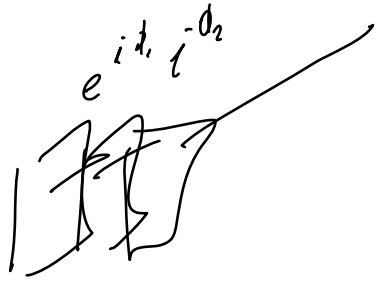
$$E_s = \int F_0 e^{i k r} n(r) dr$$





Angular Sensitivity





$$\delta k = \sqrt{| K_g + k_i |^2 - k_0^2}$$

Angular Sensitivity

$$K_s = 2k_0 \sin\theta \, \hat{i}_x$$

$$k_i = -k_0 \sin(\theta+\delta\theta)\,\hat{i}_x + k_0 \cos(\theta+\delta\theta)\,\hat{i}_z$$

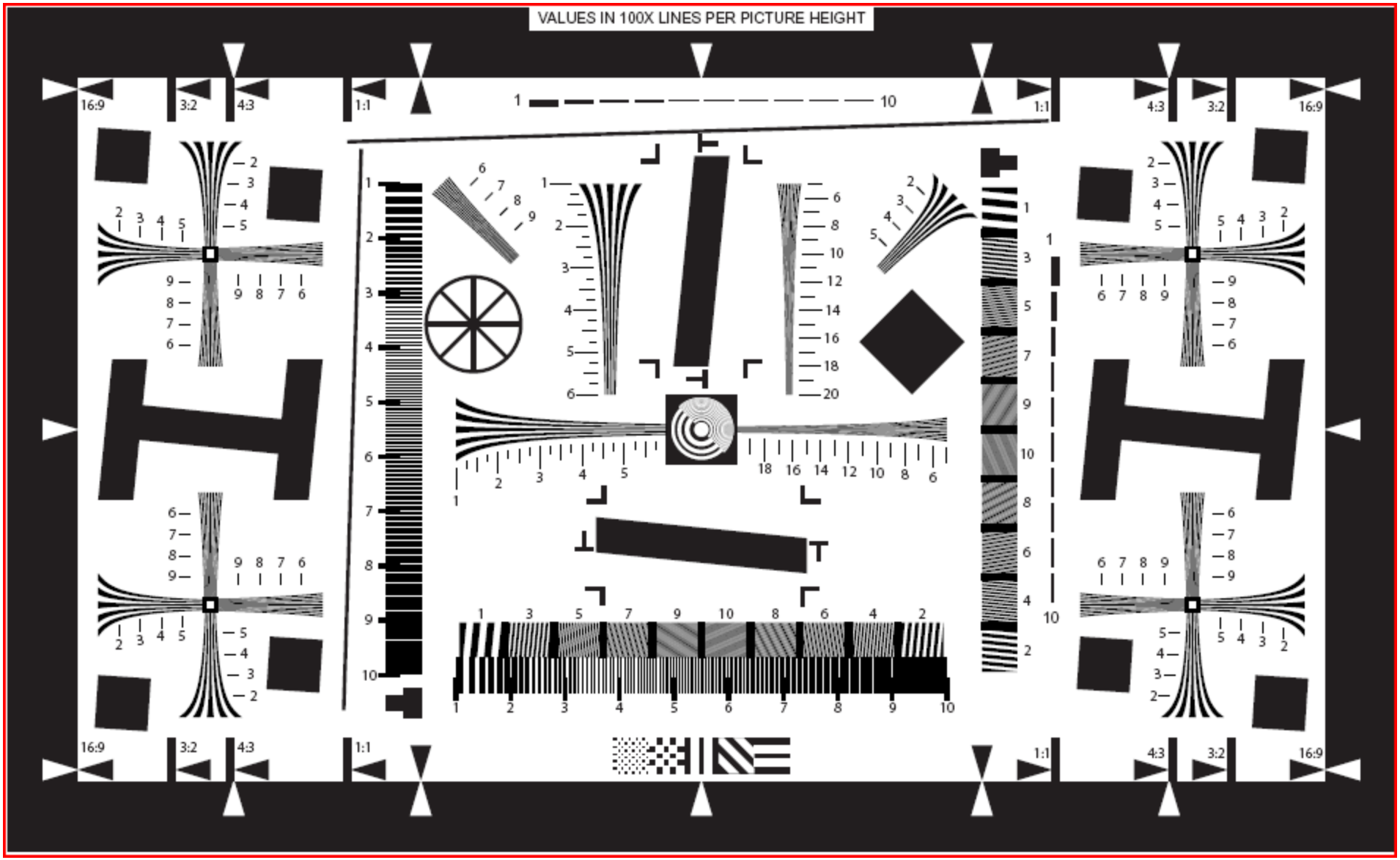
$$K_s + k_i = \left[2k_0 \sin\theta - k_0 \sin(\theta+\delta\theta)\right]\hat{i}_x + k_0 \cos(\theta+\delta\theta)\,\hat{i}_z \qquad \delta k = \delta\theta \frac{k_0}{2} \sin\theta\cos\alpha$$

$$\sin(\theta+\delta\theta) = \sin\theta\cos\delta\theta + \sin\delta\theta\cos\theta$$

$$K_s + k_i = \left[k_0 \sin\theta - \delta\theta k_0 \cos\theta\right]\hat{i}_x + \left[k_0\cos\theta - \delta\theta k_0 \sin\theta\right]\hat{i}_z$$

HW 6

Due 16 October 2009
Make a computer generated hologram using a laser printer and binary encoding.
The hologram should display your name, or a suitable shortened 4-5 letter nickname.
Make a pair of eyeglasses using the hologram and demonstrate it as described in US patent 5546198 Generation of selective visual effects using the Fraunhofer diffraction straetgy described in Simple method for demonstrating Fraunhofer diffraction Joseph van der Gracht, Am. J. Phys. 62, 934 (1994), DOI:10.1119/1.17684


VALUES IN 100X LINES PER PICTURE HEIGHT
16:9
3:2
4:3
1:1

Project Plan

1. Estimate available resolution on printer
2. Simulate CGH with estimated resolution
3. Is it enough? Find way to get higher res?
4. Make CGH

Digital Holography

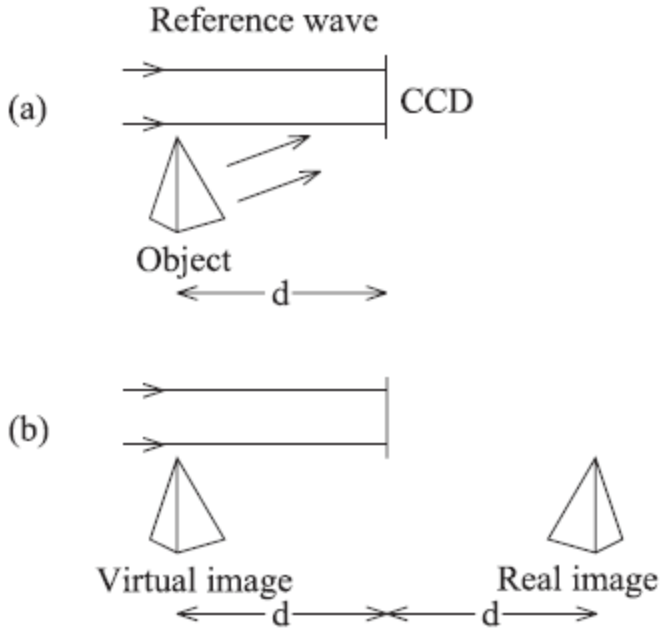
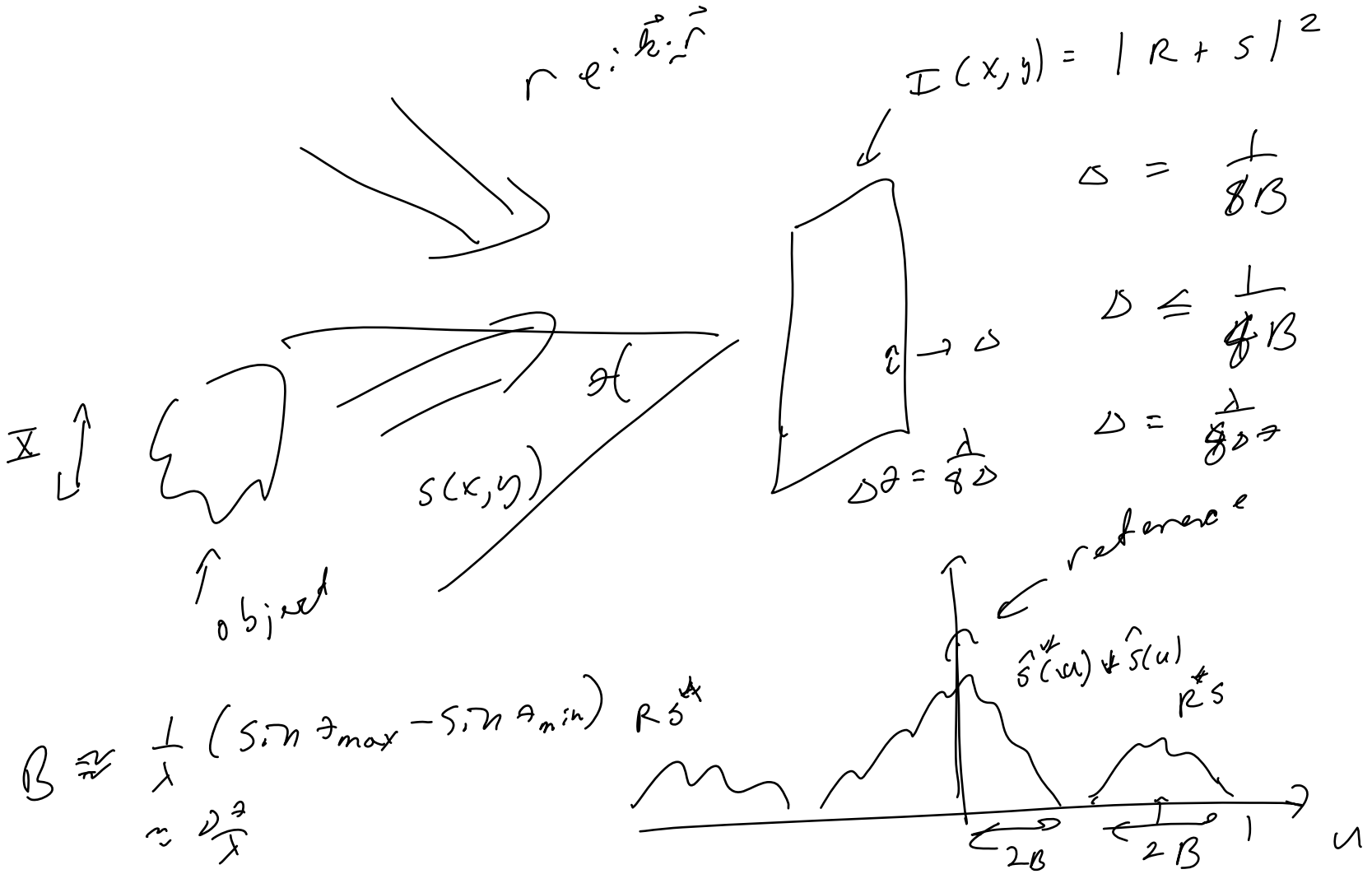


Figure 4. Digital holography: (a) recording, (b) reconstruction.

Sampling rate and digital holography



Phase shifting holography

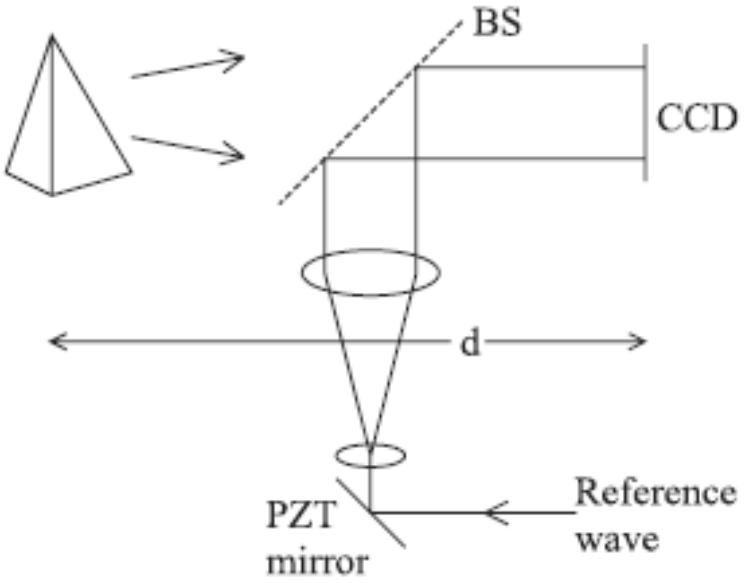


Figure 13. Phase-shifting digital holography.

$\delta\theta = \frac{\lambda}{2s}$

Theory of phase shifting holography

$$I_n(x) = |Re^{i\phi_n} + S(x)|^2$$

$$= |R|^2 + |S|^2 + 2|R||S(x)|\cos(\phi_n + \phi(x))$$

$$= |R|^2 + |S|^2 + RS^* e^{i\phi_n} + R^* S e^{-i\phi_n}$$

Digital Holography vs. Focal Imaging