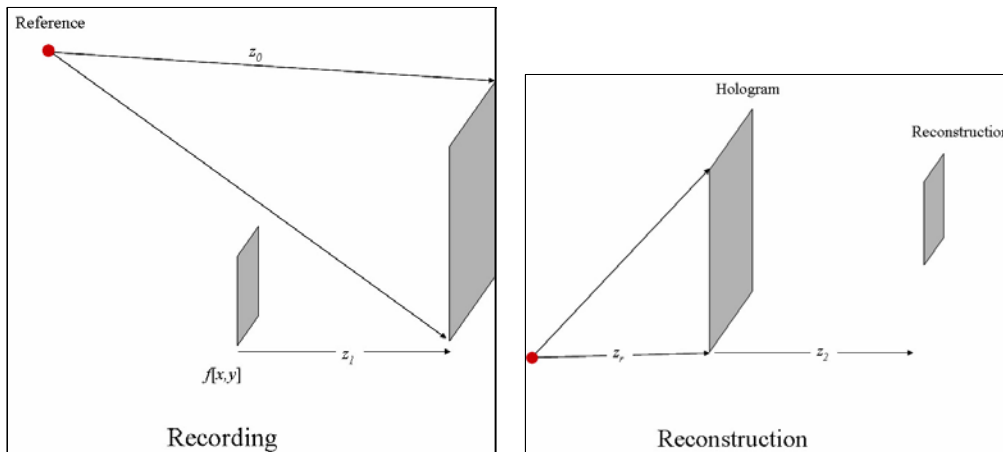


- A hologram is recorded with light from an argon laser at $\lambda_0 = 488 \text{ nm}$ and reconstructed with light from a He:Ne laser at $\lambda_1 = 632.8 \text{ nm}$.
 - Assume that the distance from the reference source to the hologram plane is $z_r = \infty$, the distance from the object to the hologram is $z_o = 100 \text{ mm}$, and the distance of the reconstructing source to the hologram is $z_p = \infty$. Determine the image distance z_i .
 - Assume that $z_p = \infty$, $z_o = 100 \text{ mm}$, $z_r = 200 \text{ mm}$ and find z_i and the transverse magnification M_T .
- Consider a holographic display that will project a real image of a planar transparency object. The recording and reconstruction geometries are shown in the figures. The reference and object are constrained to lie to the left of the hologram as shown, and the projected image must be placed on the right as shown. The hologram is placed exactly as recorded, i.e., it is not flipped to make the real image. A He:Ne laser is used for recording at $\lambda_0 = 632.8 \text{ nm}$ and an Argon laser for reconstruction at $\lambda_1 = 488 \text{ nm}$. The object transparency is a square of side 20 mm and the size of the image is to be 40 mm . The axial distance of the reconstruction source to the hologram is constrained to be $z_r = 500 \text{ mm}$. Subject to the constraints given, specify all possible axial object and reference distances that together produce the desired image.



- A hologram is to be recorded using X rays with $\lambda_0 = 0.1 \text{ nm}$. The object is a square transparency made of lead with different thicknesses to absorb the X rays. The object and reference point source are located at the same plane. The width of the object is 0.1 mm and the minimum distance between the object and the reference is 0.2 mm . The distance to the recording X-ray film is 20 mm .
 - Determine the maximum spatial frequency in cycles per mm in the interference pattern at the X-ray film.
 - (OPTIONAL bonus) Assume that the film has sufficient resolution to record all incident spatial variations in irradiance. It is proposed to reconstruct the images using visible light with $\lambda_1 = 600 \text{ nm}$. Explain why this will not work.

4. The table lists approximate cutoff frequencies in cycles per mm for four emulsions (that may no longer be commercially available!). Assume illumination at $\lambda_0 = 632.8$ nm and that the point source reference is located on the optical axis at a distance of 100 mm from the emulsion (Fraunhofer diffraction model is valid!). The planar object also is located at the same distance . For each, estimate the radius of the circle about the reference point where reconstructions of object points are visible

Emulsion	ρ_{\max} $\left(\frac{\text{cycles}}{\text{mm}}\right)$
Kodak TRI-X	25
Kodak High-Contrast Copy	20
Kodak SO-243	150
Agfa Agepan FF	300
Kodak 649F	2000
Agfa 8E75 HD	5000

5. Consider the Fresnel hologram of the two point sources that emit the same wavelength λ_0 . The hologram is processed, replaced in the original location, and illuminated by both sources. The “real-image” reconstruction of the fainter object source is measured by a detector placed at its location. The fainter source is then moved at a constant velocity in some direction while both continue to illuminate the hologram in any convenient direction. Describe the brightness measured by the detector as a function of time. Be as quantitative as possible, but a qualitative description is valuable too.