EE262 **Handout # 40**
Homework # 8

Due next Wednesday

1. On his return trip from the Trojan War, Odysseus was held captive by the giant Cyclops Polyphemus, a monster with one huge eye located in the center of his forehead. We'll compare Polyphemus' visual capabilities to those of Odysseus. Assume the Cyclops' eye aperture is a disk 10 cm in diameter, and that Odysseus' eyes are each 1 cm in diameter separated by 10 cm.

a) What is the impulse response of each of these eyes, assuming a wavelength of 0.5 um for visible light ? Plot a cut along a principle axis and label accordingly.

b) What is the transfer function (in spatial frequency space, the u-v plane) for each ?

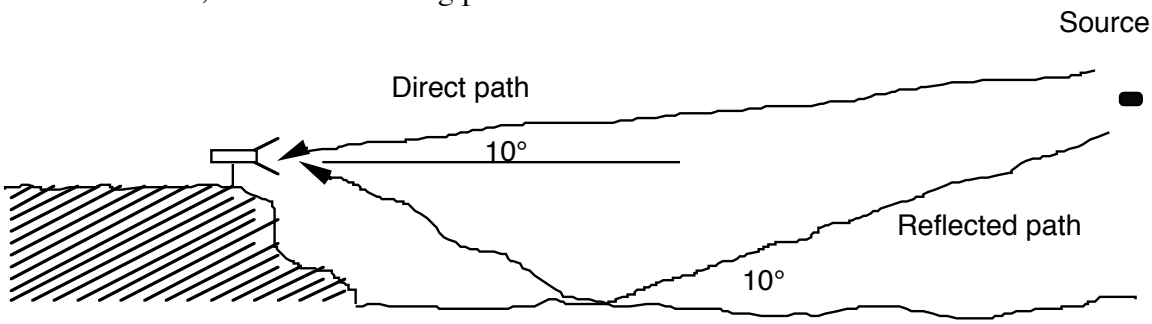
c) Suppose Odysseus is able to combine the signals from each of his two eyes interferometrically. Plot the transfer function of his pair of eyes on the same plot as a plot of Polyphemus' eye transfer function, showing the regions of non-zero response as autocorrelation islands.

d) What does Odysseus need to do in order to obtain sensitivity to all frequency components that are visible to Polyphemus ?

2. Suppose you collect the following visibility values corresponding to observations at various interferometer baseline spacings. Assuming that the complex values represent the complex amplitude of Fourier components for the spacings used, reconstruct the original intensity distribution by a Fourier synthesis technique. Note that all spacings are not available. Do not try to label the x-axis in your result in an absolute sense, a relative intensity plot will suffice. The data are also located on the class web area under the homework tab to save you typing-- the file is called hw8prob2data. (Hint: reconstruct a spatial sequence of at least 256 points so that you can observe the now-oversampled distribution easily.)

Spacing (unitless)	Complex visibility (Fourier amplitude)
0	(12.49983,.0)
1	(-2.39365,-4.68767)
2	(-2.26548,1.87618)
3	(5.64631E-02,-6.40078)
4	(-5.31869,3.09202)
5	(3.36081,3.80891)
6	(-.3187,-2.10768)
8	(1.59338,-1.52342)
9	(-1.49654,-.398635)
10	(.3893472,.6736821)
11	(-6.09056E-02,-.489339)
12	(-.212488,.3350854)
14	(-.11042,-7.87094E-02)

3. An early inteferometer was built using a reflection of a signal off the ocean instead of a second antenna, as in the following picture:

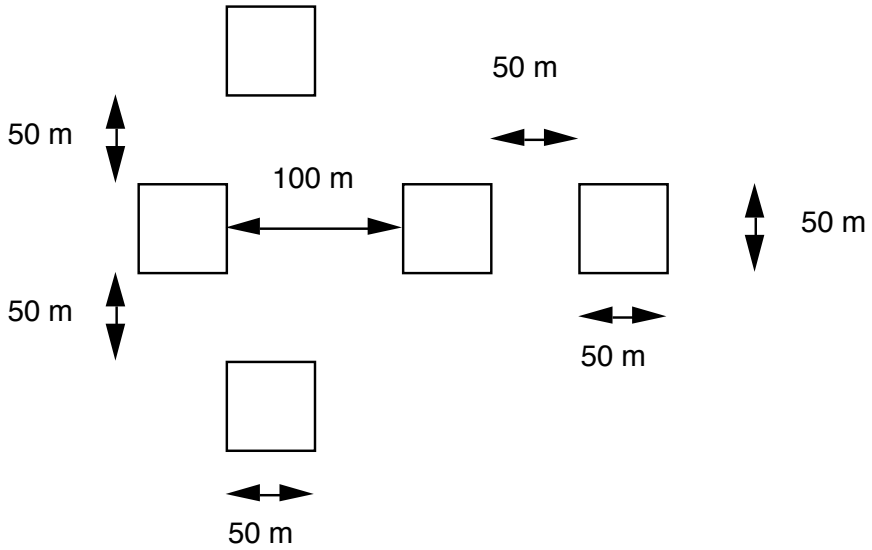


a) What is the transfer function of the interferometer assuming a round 8 m aperture pointed at the horizon, a wavelength of 2 m, and a cliff height of 400 m ? Plot the transfer function on both principle axes. A sample source at 10° elevation is shown.

b) Give an example of an invisible distribution to this interferometer.

c) How would system performance be affected by the presence of random waves on the ocean surface ? How might you use the received interferometer signal to infer the sea state, defined as the rms roughness of the ocean surface ?

4. What is the spectral coverage (non-zero sensitivity in the u-v plane) for a 2-D array of antennas as shown below ? All apertures are 50 m x 50 m, and the wavelength is 80 cm.



5. In the class homework web directory you will find an image of the sky, entitled hw8prob5data, sampled on a Cartesian grid at 71.5 millidegrees per pixel. The image is in byte format and is of size 512 by 512.

a) Let this image represent the source distribution of radio energy in the sky, and create an image of this part of the sky assuming you are viewing with a radio telescope of diameter 250 m,

again at a wavelength of 0.8 m. What is the area of the antenna in square meters ? Submit your output as a tiff file.

b) Again let the image in hw8prob5data represent the source distribution, and create a synthetic interferometer image using the array in problem 4. Now what is the antenna area in square meters ? Submit your output as a tiff file using the submit script.