Homework 2

COMP 575/770 Spring 2016

Due: February 3, 2016

Instructions Please work on the problems on your own. It is okay to discuss the problems with other students, but please write your answer independently. If you are able to find any part of the solution in a book or some source on the Internet, please acknowledge that source.

1. Consider a scene in which a unit cube frame is placed on a horizontal plane (Fig. 1, AB = 1), and you are looking from some position P. Figures 2a and 2b are two possible views when you move around. Suppose in both 2a and 2b the front and back faces are both squares, and the front faces are centered in the view. Given that AB : CD : EF = 1 : 0.8 : 2 in 2a, and AB : CD : EF = 1 : 0.6 : 1.5 in 2b, calculate:
   (a) The distance from the eye position P to the plane, for 2a and 2b, respectively.
   (b) The field of view (f.o.v.) of 2a.
   (c) (**Extra credit**) The field of view (f.o.v.) of 2b.

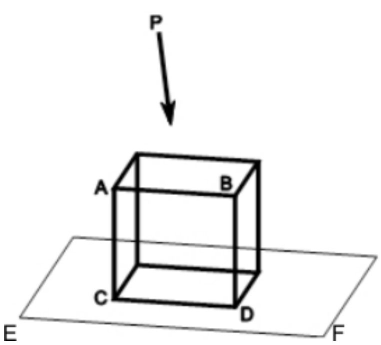
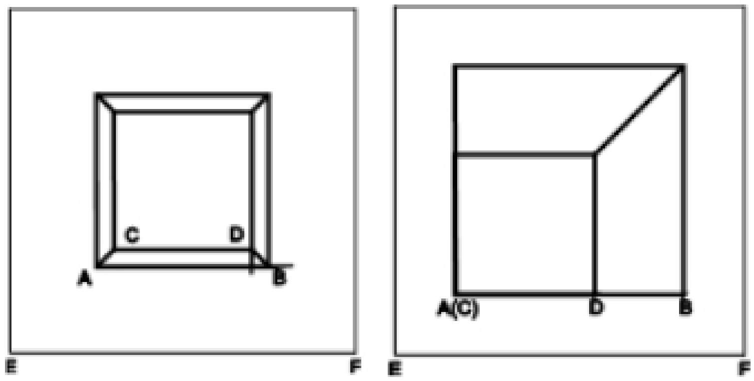


Figure 1: A unit cube frame placed on a horizontal plane.

2. We can often see the sunlight on water at the lakeshore or seashore (Fig. 3). To analyze the scene, let's consider a simple model (Fig. 4), in which 4a is the description of the model and 4b is our field of view. Our model regards the water as a plane W with a lot of waves on the surface, and ignores the fact that the Earth is round. Suppose we are standing on the bank and looking from position E towards the direction V. The viewing direction $\vec{EV}$ has an angle $\beta = 5°$ with the water. Also suppose our eyes have a maximum vertical view angle $\alpha = 30°$, which means A and B in 4a correspond to the top and bottom lines in 4b. The sun can be regarded as an infinitely far away object whose angular size is $\delta = 0.5°$, and the center of the sun is $\gamma = 5°$ above the water. In other words, we can simply think of the sunlight as a beam of light whose angle with the water ranges in $\gamma \pm \frac{\delta}{2}$.
   (a) In the field of view (Fig. 4b), H is the total height of the view, S is the portion of the view occupied by the sky, D_1 is the distance from the center of the sun to the top, and d is the diameter of the sun. Calculate S/H, D_1/H, and d/H.



(a) AB : CD : EF = 1 : 0.8 : 2. Both the front and back faces are centered in the view.

(b) AB : CD : EF = 1 : 0.6 : 1.5. The front face (the larger square) is centered in the view.

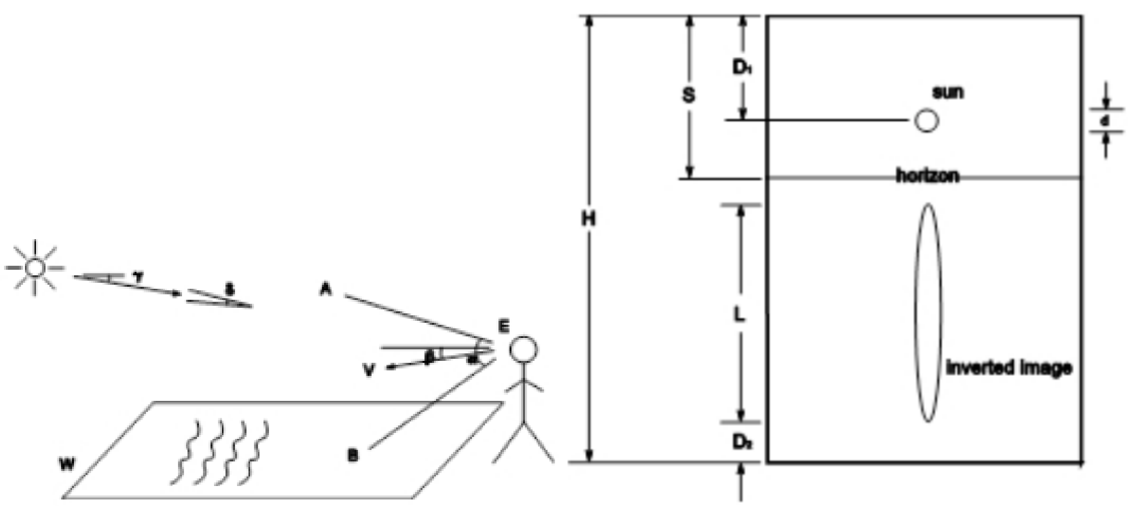
Figure 2: Two possible views while moving around.

(b) What is the shape of the inverted image of the sun if the water surface is perfectly flat?

(c) (**Extra credit**) Now take the waves into consideration. Suppose the waves have a maximum slope of 4°. The inverted image will be stretched because larger areas of water surface can reflect the sunlight to us. Let L denote the length of the inverted image, and D_2 is the distance from the bottom of the sun's image to the edge of the view. Calculate L/H and D_2/H.

(d) A small sailboat appears in our view from far away. We find the height of the boat looks roughly the same as the diameter of the sun, but its actual height is 16 feet. Calculate the approximate distance to the boat. Again, ignore the fact that the Earth is round.

Figure 3: Sunlight on water. (From http://www.alaska-in-pictures.com.)



(a) The model.

(b) Field of view.

Figure 4: The model for the scene in Figure 3.