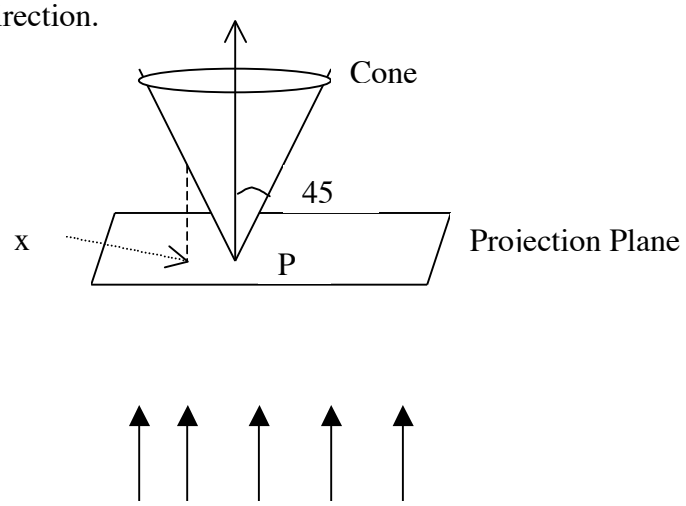
ICS186A: Computer Graphics
Spring 2002

Homework Assignment 4
Assigned: Monday, 13 May 2002.
Due: Friday, 17 May 2002

OpenGL provides ways to read/write various buffers including the depth buffer, frame buffer, alpha buffer, stipple buffer, independently. There are more than a million unique colors (with 24 bits per pixel to represent color: 8bits each for red, green and blue.)

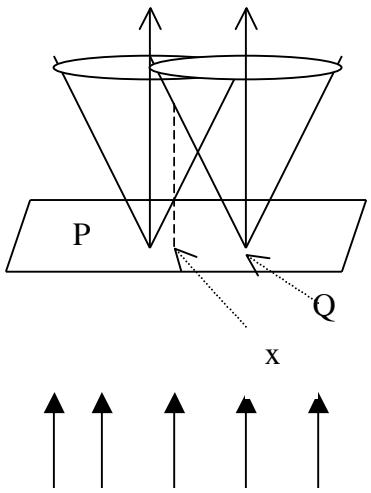
1. How do you find back facing triangles?
2. Definition: Silhoutte edges are the edges in the manifold that have one back-facing polygon and one front facing polygon incident on it.
   How do you compute the silhoutte edges of a manifold?
3. In OpenGl you can draw only back-facing polygons, or only front facing polygons. If you render the manifold, then clear the frame-buffer but not the depth buffer, then again render only the back facing polygons. What do expect to see?
4. Assume that the "thickness" of a line is an attribute of a line. Thickness of three means that the line would be drawn three pixels "thick". In question 3, if the thickness of the line is increased only for the second rendering (rendering of back faces), what do you expect to see? Compare your results with Question 2.
5. I have a million polygons. Given an algorithm to find all the polygons that are visible from the view point up to an accuracy of a pixel.
6. Consider orthographic projection. The projection plane is perpendicular to the projection direction.



The surface of the cone makes an angle 45 degrees with the axis of the cone. The axis is parallel to the projection direction, and the apex (P) is on the projection plane. Assume

that you are drawing the cone (and not the projection plane). What will be the depth value at any arbitrary point x on the plane? Express it in terms of the distance of x with respect to P.

7. Choose another point Q on the plane, and construct a similar cone as the one resting on P. The cone resting on P is colored red, and the one resting on Q is colored green. After projecting these two cones, the pixels on the projection plane would get the color of the point on the cone that is closer to the projection plane. For example, the vertical line at point x intersects the cone at P first and hence point x would get the red color. Use your answer to Question 6 and interpret the colors of the pixels.



Projection Direction

8. Certain region of pixels in the projection plane would get red color and certain region of pixels would get the green color. Interpret the boundary of the regions with red color and green color using your answer to Question 7. What will be the shape of the curve of this boundary (straight line, circle, ellipse, etc.)?
9. A 2D Voronoi Diagram of a set of sample points on a plane is the partition of the plane such that any point in one partition is closer to one of the sample point that to any other sample point. For example, if P1, P2, .. PN are the sample points in a plane, then there are N regions R1, R2, .. RN that partition the plane (partition means that the intersection of the interior of any two regions is a null set, and the union of all these regions is the complete set, ie the complete 2D plane). Consider any point x in R1. This arbitrary point x is closer to P1 that to any other given sample point. Clearly, the boundary between R1 and R2 will be the points that are equidistant from P1 and P2. If P1 and P2 are the sample points P and Q as mentioned in Questions 7 and 8, compare the red and green regions of Question 8 with R1 and R2.
10. Use your answers till now to describe a procedure to visualize the 2D Voronoi diagram of a set of points in the projection plane of Question 7.