Worksheet IV

Answer all the problems completely on a separate sheet of paper. Read all the problems closely, and ask if you have any questions on what a problem means. This worksheet is due at the start of class on Mon, Oct 13.

Problem 1 (5 pts)

Using cross products, construct a **view matrix** for camera with the positioned at `(0,1,0)`, looking at the point `(0,-3,0)`, and with a view-up vector of `(1,1,0)`. Show how you would set up the cross products, though you can (and should) use a calculator to actually compute them.

Problem 2 (4 pts)

What is the difference between an orthogonal projection and a perspective projection? If you were rendering a rectangular solid (a stretched cube), what difference(s) would you see between one shown with an orthogonal projection and one shown with a perspective projection?

Problem 3 (3 pts)

Give the viewport matrix required for a system in which pixel coordinates count down from the top of the image, rather than up from the bottom (as in the HTML5 canvas).

Problem 4 (3 pts)

As discussed in class, We cam remove backfacing triangles from a polyhedral object with triangular faces by transforming each set of triangle vertices P_0, P_1, and P_2 into perspective space to obtain transformed points P'_0, P'_1, and P'_1, then computing a normal to the "prime" (perspective transformed) triangle, and finally checking the sign of the z component of this normal.

(a) Explain why this computation correctly allows us to identify backfacing triangles.

(b) Why do we need to compute the normal of the perspective transformed triangle? Why can't we just use the normal of the triangle in world space?

Problem 5 (2 pts)

Consider the depth-buffer algorithm we discussed in lecture. Explain how to modify the algorithm so as to completely compute the final image color at one pixel before proceeding to the next. *Consider:* in what circumstances might this be a desirable thing to do?

Bonus Problem (4 pts)

"Forced perspective" is a classic trick in photography. For example, two friends Nero and Farley pose for the camera, with Farley standing much farther away than Nero. Nero then holds her hand up in such a way that in the resulting photograph she appears to be holding a tiny statue of Farley in her upturned palm. The photograph on the right gives an example.

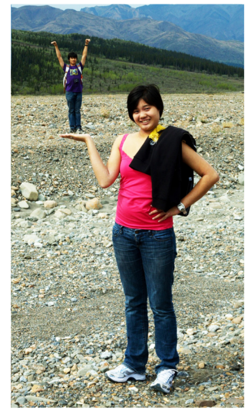

Photo by Shane Huang

Assume that the ground is perfectly level, and that the photographer, Nero and Farley stand in a straight line. The photographer holds the camera at height h_C above the ground. Nero's body (including her hand) is at distance d_N from the photographer (measure d along the ground). Her hand is at height h_N above the ground.

(a) Assuming that you are given h_C, d_N and h_N , find an expression for d_F, the distance required between Farley and the camera, in order to ensure that his feet rest precisely in Nero's hand. (You may wish to draw a diagram of this scene as viewed from the side.)

(b) Assume that Nero and Farley are of identical heights. At what height h_N must Nero hold her hand so that in the photograph, Farley appears to be exactly 1/10 as tall as Nero?