Fall 2017
CAP 5705 Computer Graphics
Homework #2 Due November 13th 3:00pm

<u>Viewing Transformations</u>

1. The matrix transformation pipeline transforms points from *object space* to *world space* to *camera space* to a *canonical view volume*, and finally to *screen space*.

   (a) In $1 - 2$ sentences each, explain what happens in each of these pipeline spaces.

2. Assume a perspective projection, and the following parameters (Ch. 7 naming conventions):

   - Bounding planes for the orthographic view volume
     $[l, r] \times [b, t] \times [f, n] = [-5, 5] \times [-5, 5] \times [-30, -5]$
   - Screen size: $nx = 1000$ pixels, $ny = 500$ pixels
   - Camera: $e = (1, 1, 0), g = (0, -1, 1), up = (1, 1, 0)$
   - Point of interest: $p = (5, -20, 15)$

   (a) Starting from the world space point p, write the matrix required at each stage to transform the point p from its world space position to its screen projection. You should have three matrices that achieve the three transformations (world to camera, camera to canonical view volume, canonical view volume to screen space). Be sure to use the data provided to assemble the specific entries in your matrices.

   (b) Finally, compute the pixel coordinate of the world space point p.

Signal Processing

1. A $1D$ filter can be used to reconstruct a continuous function $g(a)$ from a set of discrete samples $s[i]$. For each of the following cases, sketch the shape (profile curve) of a $1D$ filter that can produce $g(a)$ with:

    (a) C^0 continuity

    (b) C^1 continuity

    (c) the interpolation of $s[i]$

2. Consider the following equation: $a_2 \left[\, i, \quad j \, \right] = a_1 \left[\, i \, \right] a_1 \left[\, j \, \right]$ where a_2 is a 2-D filter.

    (a) What does the equation tell us about the filter?

    (b) What property does this allow and how is it used?

    (c) State and explain the key advantage of this operation. Specify when it is most effective.

    (d) What extra infrastructure must be provided in your implementation to support this operation?

3. Most standard graphics filters are ripple free.

    (a) Describe the terms *overshoot* and *ripple* as it relates to filters.

    (b) Under what conditions can ripples be introduced to a filter that is currently ripple free?

4. An image rescaling editor reduces the size of images by dropping duplicate pixels.

    (a) Explain the disadvantage of this approach.

    (b) Can you suggest a better method? (short answer)