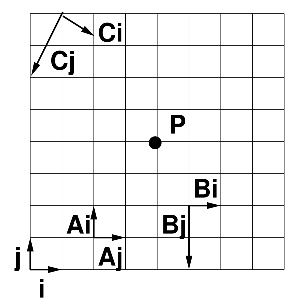
CPSC 314, Written Homework 1

Out: Fri 28 Jan 2005
Due: Fri 4 Feb 2005 4pm
Value: 5% of final grade
Total Points: 100

Note: solutions will be handed out Mon 7 Feb at 10am, so no late homeworks will be accepted after then.

Transformations (50 pts)

1. (9 pts) The point coordinate P can be expressed as P = 4*i + 4*j, where i and j are basis vectors of unit length along the x and y axes, respectively. Describe the point P in terms of the 3 other coordinate systems given below.



2. (10 pts) Derive a transformation that takes a point from frame C to frame B. That is, determine M_{C2B}, where $P_B = M_{C2B}P_C$. Verify your solution using your answer to the question above.

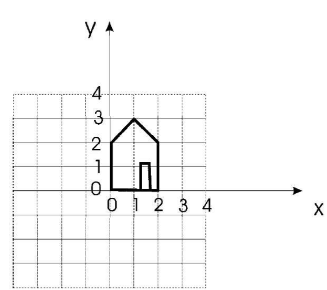
3. (3 pts) Write down the 4x4 matrix for translating an object by 2 in Z.

4. (3 pts) Write down the 4x4 matrix for nonuniformly scaling an object by 3 in X and 2 in Y.

5. (6 pts) Describe in words what this matrix does (be specific about the order of operations)

$$\begin{bmatrix} 0 & -1 & 0 & -1 \\ 1 & 0 & 0 & -1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

6. (5 pts) Draw a picture of the object below transformed by the above matrix



7. (6 pts) Give the series of matrices needed to rotate a scene by 45° around the x axis with a fixed point of (1,2,3,1). Use column vectors for points, so that $p' = M_1 M_2 ... M_n p$.

8. (5 pts) Give the sequence of OpenGL commands necessary to implement the above transformation.

9. (3 pts) Normalize the homogeneous point (3,2,5,6).

Viewing (50 pts)

10. (4 pts) Give the viewing transformation matrix for an eye position (7,2,0), a lookat point (-1,-1, 0) and an up vector (0,0,1).

11. (4 pts) Give the perspective projection matrix with a near plane of 1, far plane of 20, right plane 10, left plane -8, top plane 11, and bottom plane -9.

12. (6 pts) Give the NDC-to-viewport transformation matrix for a viewport 100 pixels wide and 50 pixels high, where that window's upper left corner is at location 200,300 from the origin at the upper left of the display.

13. (6 pts) A unit square has points A=(0,0,0,1), B=(0,1,0,1), C=(0,1,1,1), D=(0,0,1,1) in world coordinates. Give the coordinates of these four points in the camera coordinate system, after the viewing transformation above has been applied.

14. (6 pts) Then give the coordinates of these points in the normalized device coordinate system, after the perspective transformation above has been applied.

15. (6 pts) Finally, give the point coordinates in the display coordinate system described above, after the viewport transformation.

16. (8 pts) Draw a cavalier projection of a cube of size x=4, y=2, z=3. Use a 45° projection (that is, the z axis in the scene should make a 45° angle with the x axis in the projection). Label the points in your drawing with (x,y) locations.

17. (10 pts) Give the 4x4 matrix that would produce the above cavalier projection. Hint: remember to ensure that points in the xy plane are not changed by the projection.