

1. (10%) Let C be a circle in 2D with radius one, centered at the origin as shown in Figure 1. Define a transformation matrix T that transforms the circle to an ellipse rotated clockwise by $\pi/4$ with major axis of length 2 and minor axis length 1, as shown in Figure 1.

(You may define T as a composition of elementary transformation matrices)

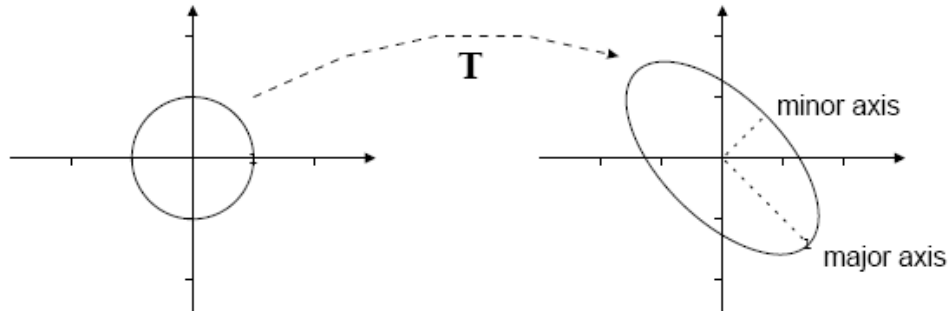


Figure 1. Affine transformations.

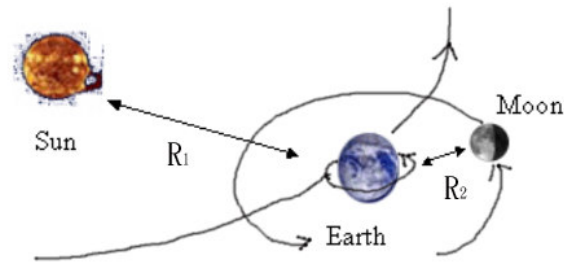
2. (10%) If we have a transform matrix M which transforms object from modeling (object) coordinates to world coordinates.

- What if we use this M to transform the object's normal vectors? Is it OK or not?
- If not OK, how to tackle this problem?

3. (15%) It is said that Microsoft game machines X-Box (1, and 306) are costing more than their sale prices, and then use the game software revenue to compensate for the loss in hardware.

- If this is true, what advantages for Microsoft in developing the hardware platform can be predicted from this business model?
- In the above case, is it easy for companies from Korea or Taiwan to develop their own game machines or clones of these machines? Why and why not?

4. (10%) Transformations



- (a) (5%) Mr. J wants to implement a program to simulate solar system for MIB institution. please help him to design the transformation matrix, which represents the behavior of the rotation (自轉) and the revolution (公轉) of earth. In the above picture, where R_1 is the average orbital radius around sun, and R_2 is the average orbital radius around earth.
- (b) (5%) Assume that moon has faced toward earth with the same side for billions of year, please try to design and describe the transformation matrix of moon in the solar system.

5. (15%) Visible-Surface Determination

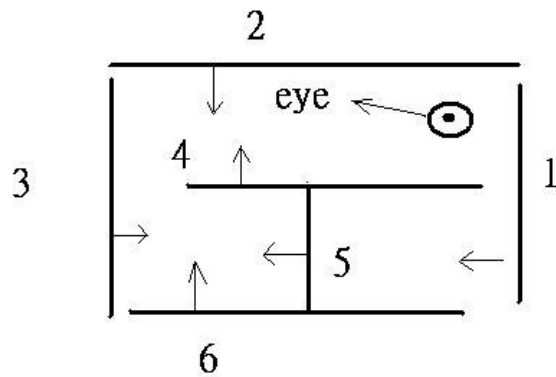
In general polygon rendering, the Z-buffer technique is used for visible surface determination. Some modified techniques can be applied to reduce the rendering time in implementation.

- (i) Using depth sort + Z-buffer (always display the nearest polygon first)
- (ii) Only using Z-buffer.
- (a) (10%) Let the screen width = W , height = H , and there are N polygons in the building model. Based on your experience, using the teapot model and CSIE department building model, how will you describe the improvement (speedup) using (i) over (ii)?
- (b) (5%) Compare the computational complexity of the two methods above, in terms of worst case and average case.

6. (15%) BSP tree

- (a) (10%) Construct the Binary Space Partitioning (BSP) tree of the model in Fig 3. (use polygon 1 as the root, and always use smaller number polygon to the left of the tree)
- (b) (5%) From the BSP tree in (a), derive the correct display sequence in terms of the viewing position (eye).

Figure 3.



7. (5 %) What is your term project for this semester? What are the technical difficulties involved in the project? (You can refer to the project listing).

8. (10 %)

In 2D, please consider if a rotation transformation by angle A can be specified as a series of shear transformation matrices. Give these matrices, or if it can't be done, prove it.

9. (10%) If we have four control points for the Bezier curve. $P_1 (1, 2, 4)$, $P_2 (3, 8, 6)$, $P_3 (6, 6, 4)$, $P_4 (8, 2, 2)$.

(a) (6%) In order to draw this curve, we split it by half. What are the new control points of the two split curves? (Please give exact numbers).

(b) (4%) To design airplane wings, which kind of curve should be used? Bezier curve or B-splines? Why? (please give short answer).