

Assignment 3

Modeling for Computer Graphics

Total Marks:100

1. (15 marks) Answer the following questions briefly.
 - (a) Does every closed 2D manifold necessarily divide the space into an inside and an outside? Justify your answer.
 - (b) Show that general cones and general cylinders are special cases of Coons surfaces.
 - (c) Find a set of subdivision filters that guarantees C^4 continuity. You may ignore boundary conditions.
2. (20 marks) A closed mesh (i.e. no boundary vertices) is saved in a half-edge data structure. For a given face f , write, in pseudocode, an algorithm that
 - (a) finds all faces adjacent to f
 - (b) all vertices that are on f or connected to f by an edge.
3. (20 marks)

Consider the following local subdivision matrix for a new subdivision scheme (a modification of the vertex mask of cubic B-spline):

$$S = \begin{pmatrix} \frac{1}{6} & \frac{4}{6} & \frac{1}{6} & 0 & 0 \\ 0 & \frac{1}{2} & \frac{1}{2} & 0 & 0 \\ 0 & \frac{1}{6} & \frac{4}{6} & \frac{1}{6} & 0 \\ 0 & 0 & \frac{1}{2} & \frac{1}{2} & 0 \\ 0 & 0 & \frac{1}{6} & \frac{4}{6} & \frac{1}{6} \end{pmatrix}.$$

Its eigenvalues are $\{1, \frac{1}{2}, \frac{1}{6}, \frac{1}{6}, \frac{1}{6}\}$.

- (a) Compare the smoothness of this scheme with the cubic B-spline subdivision scheme.
 - (b) Is the resulting curve “coordinate free”? Justify your answer.
4. (15 marks) Consider a mesh with e edges, v vertices, and f faces. Compute the new number of edges (e'), vertices (v'), and faces (f') after one level of subdivision in the cases of the Loop and Doo-Sabin methods. Show your calculations. Assume the mesh doesn't have any boundaries.
5. (10 marks) Show that Loop subdivision has the strong convex hull property.
6. (20 marks) For Catmull-Clark subdivision, we would like to subdivide only a particular area of the mesh using an adaptive subdivision method.
 - (a) Extend the simple (naive) T-junction insertion method of Adaptive Loop subdivision to create an Adaptive Catmull-Clark subdivision. Draw a figure to support your description.
 - (b) Describe the disadvantages of this simple adaptive subdivision.