P08 – Smooth shading and ball rolling

Team project: teams of up to 4 people
Due Thursday Oct 30 before class
Deliverables: source code, short write up, and video per team

Required content of the write up:
Let $N(u,v)$ denote the surface normal of a point $V = S(u,v)$ on a coons patch.
Let $A = S(u - e, v)$, $B = S(u, v + e)$, $C = S(u + e, v)$, and $D = (u, v - e)$,
Persent 3 formulations for $N(u,v)$:

- $N_1 = \overrightarrow{VA} \times \overrightarrow{VB} + \overrightarrow{VB} \times \overrightarrow{VC} + \overrightarrow{VC} \times \overrightarrow{VD} + \overrightarrow{VD} \times \overrightarrow{VA}$

- $N_2 = \overrightarrow{AC} \times \overrightarrow{BD}$

- $N_3 = $ like N_1 but with a smaller value of e

Discuss and prove/disprove whether the normalized versions of pairs of these normals are identical. Include a picture showing these as lines (scaled up for visibility) in different colors. Decide which one is best and use it for Gouraud shading (below).

Required functionality of the code:

1. For the animated coons patch, produce a grid of sample points (you can store them, or you can produce them on the fly as needed), as those used for displaying the quads. For each sample point, V, compute its normals (the normalized versions of N1, N2, and N3) and show each one of them as a line segment from V that is 30 units long or so, but painted in a different color for each normal, so that you can see whether they are the same or not.

2. Place the center of a small sphere with radius r about the length of the distance between two consecutive samples (length of the edge of a quad) at distance r from a sample point V along its normal (pick one of the normals discussed above). At each frame of the animation, check whether any of the 8 grid neighbors of V is lower than V. If so, snap the sphere so that it is touching the lowest of these neighbors. This should produce an animation of the sphere sliding down, but the dynamics will not be correct. Why?

3. Provide a toggle option for painting the face of one member of the team as a texture on the animated surface. Pressing the toggle key again should swap team members. To do so, you need to declare a texture (the image of your face) and bind it before you render the patch. Then, use a vertex() commands with 5 parameters, including the texture coordinates when displaying a quad. Provide a toggle key for using the texture or not.

4. Provide a toggle between 2 options (when no texture is used): a) shading the animated surface using flat shading (default in Processing), and b) using Gouraud shading. Read-up on how to use Gouraud shading. It requires a very small modification of the quad rendering and will use the normals that you have computed. Experiment rendering the animated surface with very few patches and decide what is the minimum acceptable number for which the surface still looks OK and the animation does not exhibit horrible shimmering effects.