Collision/Acceleration II

Review: Select/Hit Picking
- assign (hierarchical) integer key/name(s)
- small region around cursor as new viewpoint
- redraw in selection mode
  - equivalent to casting pick “tube”
- store keys, depth for drawn objects in hit list
- examine hit list
  - usually use frontmost, but up to application

Correction/Review: Hit List
- glSelectBuffer(buffer size, “buffer”)
  - where to store hit list data
- on hit, copy entire contents of name stack to output buffer.
  - hit record
    - number of names on stack
    - minimum and maximum depth of object vertices
      - depth lies in the z-buffer range [0, 1]
    - multiplied by 2^32 - 1 then rounded to nearest int

Accelerating Collision Detection
- two kinds of approaches (many others also)
  - collision proxies / bounding volumes
  - spatial data structures to localize
- used for both 2D and 3D
- used to accelerate many things, not just collision detection
  - raytracing
  - culling geometry before using standard rendering pipeline

Collision Proxies
- proxy: something that takes place of real object
  - cheaper than general mesh-mesh intersections
- collision proxy (bounding volume) is piece of geometry used to represent complex object for purposes of finding collision
  - if proxy collides, object is said to collide
  - collision points mapped back onto original object
  - good proxy: cheap to compute collisions for, tight fit to the real geometry
- common proxies: sphere, cylinder, box, ellipsoid
  - consider: fat player, thin player, rocket, car...

Spatial Data Structures
- can only hit something that is close
  - spatial data structures tell you what is close to object
    - uniform grid, octrees, kd-trees, BSP trees
  - bounding volume hierarchies
    - OBB trees
- for player-wall problem, typically use same spatial data structure as for rendering
  - BSP trees most common

Unified Grids
- axis-aligned
- divide space uniformly

Quadtrees/Octrees
- axis-aligned
- subdivide until no points in cell

Review: Collision Detection
- boundary check
  - perimeter of world vs. viewpoint or objects
    - 2D/3D absolute coordinates for bounds
    - simple point in space for viewpoint/objects
  - set of fixed barriers
    - walls in maze game
    - 2D/3D absolute coordinate system
  - set of moveable objects
    - one object against set of items
    - missile vs. several tanks
    - multiple objects against each other
    - punching game: arms and legs of players
    - room of bouncing balls

Trade-off in Choosing Proxies
- increasing complexity & tightness of fit
  - AABB: axis aligned bounding box
  - OBB: oriented bounding box, arbitrary alignment
  - k-dops – shapes bounded by planes at fixed orientations
    - discrete orientation polytope
- decreasing cost of (overlap tests + proxy update)

Reading for Collision/Acceleration
- FCG Sect 10.9 Sub-Linear

Collision/Acceleration II
**Jaggy Line Segments**
- We tried to sample a line segment so it would map to a 2D raster display.
- We quantized the pixel values to 0 or 1.
- We saw stairsteps / jaggies.

**Supersample and Average**
- Supersampling: create image at higher resolution.
- E.g. 768x768 instead of 256x256.
- Shade pixels.
- FCG Sec 4.5, Fig 4.14.
- 3x3 unweighted filter.
- 2x2 supersampling with 3x3 unweighted filter.

**Weighted Area Sampling**
- Intuitively, pixel cut through the center should be more heavily weighted than one cut along corner.
- Weighting function, W(x,y).
- Specifies the contribution of primitive passing through the point (x, y) from pixel center.
- Gaussian filter (or approximation) commonly used.

**Supersampling Example: Image**
- Intuitively, pixel cut through the center should be more heavily weighted than one cut along corner.
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Image As Signal
- image as spatial signal
- 2D raster image
- discrete sampling of 2D spatial signal
- 1D slice of raster image
- discrete sampling of 1D spatial signal

Sampling Frequency
- if don’t sample often enough, resulting signal misinterpreted as lower-frequency one
- we call this aliasing

Sampling Theorem
- continuous signal can be completely recovered from its samples
  iff
  sampling rate greater than twice maximum frequency present in signal
  - Claude Shannon

Nyquist Rate
- lower bound on sampling rate
  - twice the highest frequency component in the image’s spectrum

Aliasing
- incorrect appearance of high frequencies as low frequencies
- to avoid: antialiasing
  - supersample
  - sample at higher frequency
  - low pass filtering
    - remove high frequency function parts
    - aka prefiltering, band-limiting

Low-Pass Filtering
- filter for low frequencies
- blur

Texture Anti-aliasing
- texture mipmapping: low pass filter

Temporal Antialiasing
- subtle point: collision detection about algorithms for finding collisions in time as much as space
- temporal sampling
  - aliasing: can miss collision completely with point samples!

Filtering
- low pass
- blur
- high pass
- edge finding