VGP353 – Week 2

- Agenda:
  - Shadow Textures
    - Improvements over planar projected shadows
    - Implementation details
    - Optimizations
- Assignments:
  - Assignment #1 due
  - Begin assignment #2

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Planar Projected Shadows

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  - Can only cast shadows on a ***flat*** ground plane
- Shadow textures fix *most* of these problems

Shadow Textures

- Algorithm outline:
  - Render shadow caster to a texture from the point of view of the light
    - Texture background is the color of the light
    - Object is rendered in black
  - Using *projective texturing* cast the shadow texture onto each shadow receiver
  - Use the sampled texture color as the light color

Shadow Textures

- Advantages?

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- Advantages?
  - Can cast shadows on non-flat surfaces
  - Can cast shadows on multiple objects
- Disadvantages?
  - No self-shadowing
    - Shadow *maps* will solve this problem...next week
  - Requires render-to-texture pass for *each* shadow caster for each light
  - Shadow receiver must sample multiple shadow textures

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Shadow Texture Creation

- Setup modelview-projection (MVP) matrix to render from the light looking at the object
  - The eye-point is actually the light position
  - Set the FoV to just enclose the object
    - The object's bounding box is helpful here
- Render object as shadow
  - Clear the color buffer to the light's color
  - Render the object as solid black
    - Can “fake” soft shadows by using distance from light (eye) to determine color: closer to the light is darker, farther is lighter

Determining Receiver / Caster

- For each shadow texture, determine which objects are potential receivers
  - If the object is *completely* on the opposite side of the near plane from the light, it is a candidate

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- Does what it says: projects a texture onto an object
- This is a *perspective* projection, so what is needed to make it “work”?
  - Divide by Z...just like perspective viewing projections
    - Uses the q texture coordinate

Projective Texturing

- Algorithm outline:
  - Use object-space vertex positions as initial texture coordinates
  - Transform object-space texture coordinate to projector-space
  - Apply perspective transformation
    - Same MVP matrix as is used to render to the texture
  - Scale and bias coordinates from [-1, 1] to [0, 1]
    - Unless one of the mirroring wrap modes is being used

Projective Texturing

- Uses different sampling functions in GLSL:
  - `texture[123]DProj` vs `texture[123]D`
  - Use these functions instead of doing the perspective divide by hand
  - Cubic textures not supported. Why?

Projective Texturing

- Uses different sampling functions in GLSL:
  - `texture[123]DProj` vs `texture[123]D`
  - Use these functions instead of doing the perspective divide by hand
  - Cubic textures not supported. Why?
    - The q component is already used as part of the texture lookup!

Projective Texturing

- What happens if the point is *behind* the projection point?

  Hint: What happens if an object is behind the eye?

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- What happens if the point is *behind* the projection point?

  Hint: What happens if an object is behind the eye?

  - It gets a *negative* Z (or q) value
  - The projection then “flips” the position
    - Because it divides by a negative number

Projective Texturing

- What happens if the point is *behind* the projection point?

  Hint: What happens if an object is behind the eye?

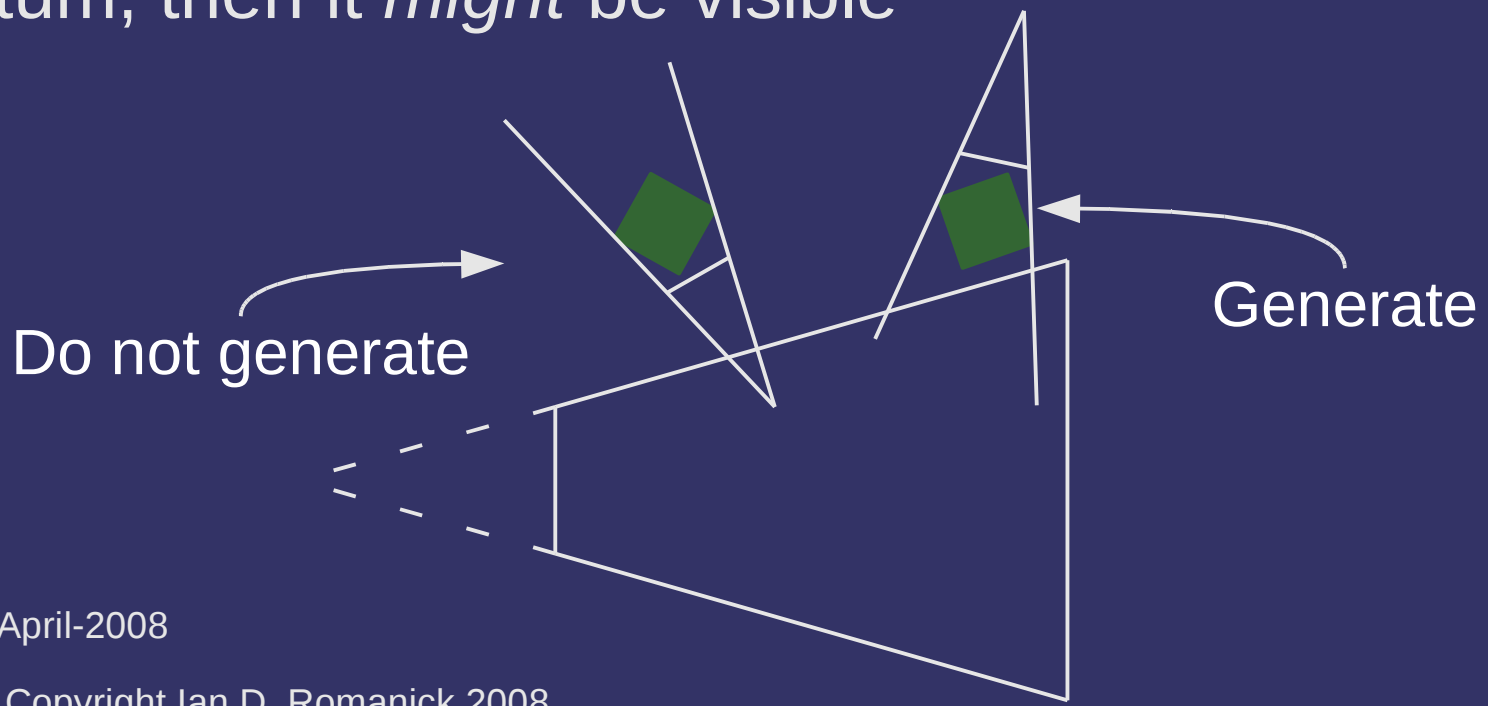
  - It gets a *negative* Z (or q) value
  - The projection then “flips” the position
    - Because it divides by a negative number
- Shadows are cast on objects on the opposite side of the light from the caster
  - Just a fact of projective texturing
  - Reject points with q less than near-plane distance

Optimizations

- Performance problems with shadow textures:
  - Lots of textures need to be generated *per frame*
  - Shadow receivers need to read lots of textures
- General speed-up techniques:
  - Regenerate a texture only if light or caster moved
  - Generate textures for shadows that might intersect view volume
  - Apply texture only to objects that might be shadowed
  - Composite multiple shadow textures together

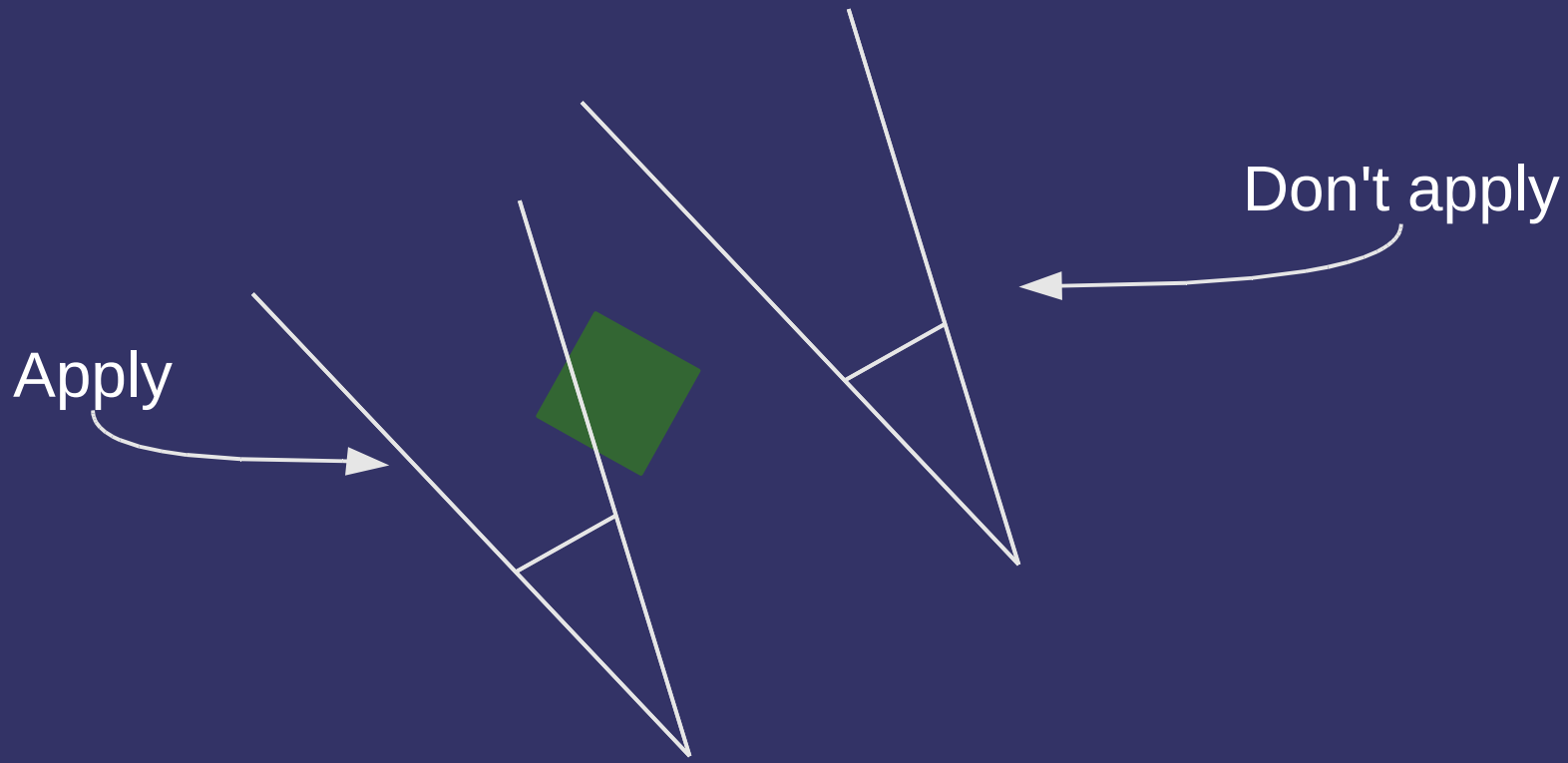
Optimizations

- Generate textures for shadows that might intersect view volume
  - Each shadow texture has an associated frustum
    - “View” frustum used to render the shadow texture
  - If the shadow's frustum intersects the view (eye) frustum, then it *might* be visible



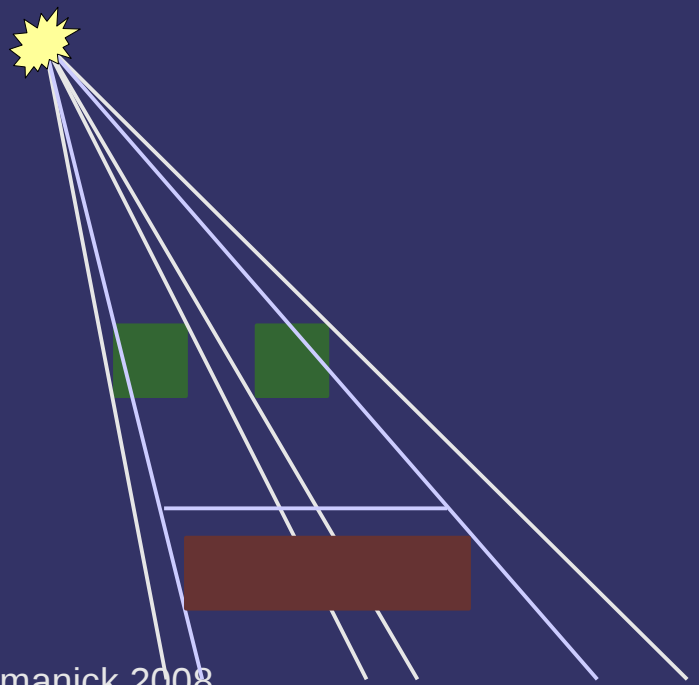
Optimizations

- Apply texture only to objects that might be shadowed
  - Any object that does not intersect the shadow's frustum is not a receiver



Optimizations

- Composite multiple shadow textures together
  - Many casters can affect all members of a group of receivers
  - Create a new shadow texture by compositing all potential casters shadow textures together
  - Project each shadow texture onto the near-plane



References

Bloom, Charles. *Projective Shadow Mapping* [article on-line]. June 30, 2000, accessed April 4, 2008; available from http://www.cbloom.com/3d/techdocs/shadowmap.txt; Internet.

Bloom, Charles, and Teschner, Phil. *Advanced Techniques in Shadow Mapping* [article on-line]. June 3, 2001, accessed April 4, 2008; available from http://www.cbloom.com/3d/techdocs/shadowmap_advanced.txt; Internet.

Next week...

- Quiz #1!
  - Shadow terminology
  - Projective planar shadows
  - Shadow textures
- Assignment #2 due
- Shadow maps
  - Similarities and improvements to shadow textures

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