

VGP352 – Week 8

⇒ Agenda:

- Interior mapping
- Parallax textures
- Displacement mapping



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Interior Mapping

- Remember the excellent “debris” demo by Farbrausch?

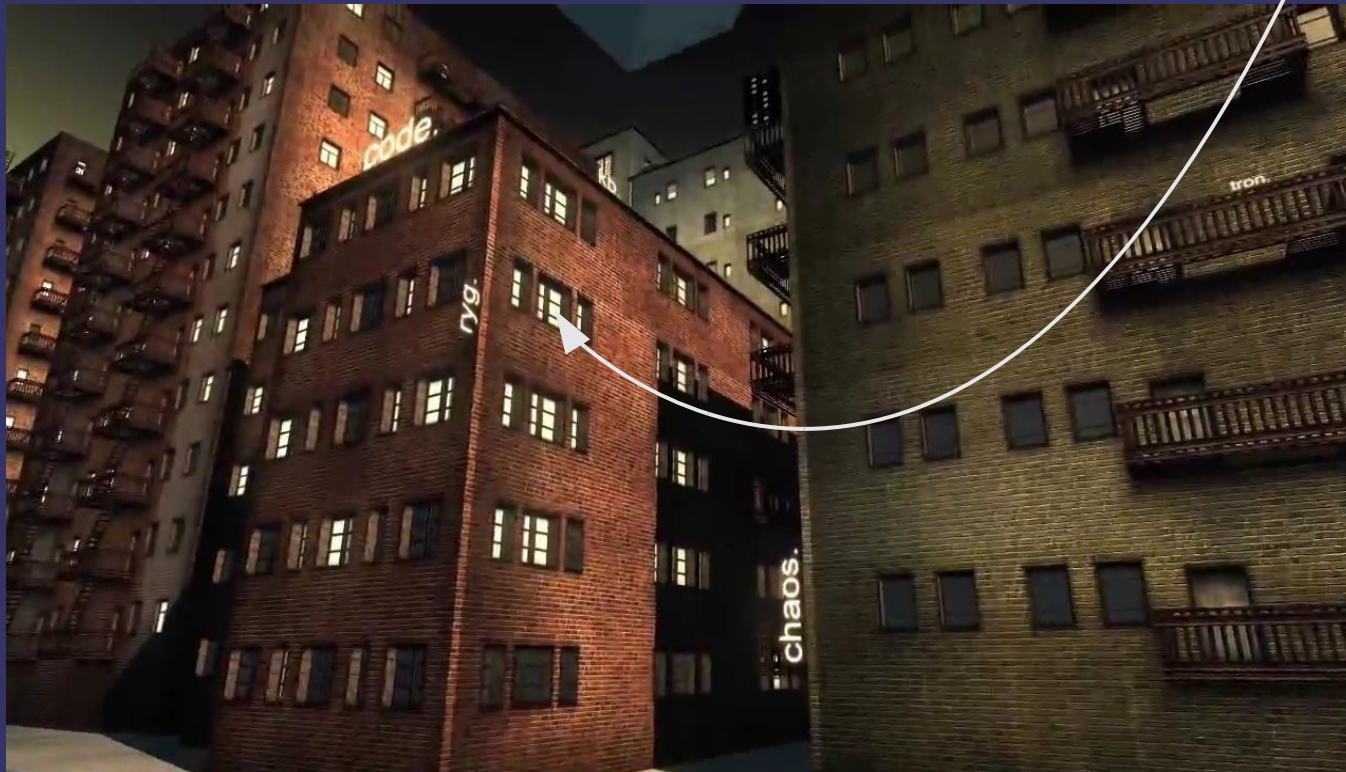


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Interior Mapping

- Remember the excellent “debris” demo by Farbrausch?
 - Isn't it odd that you can't see inside the windows?

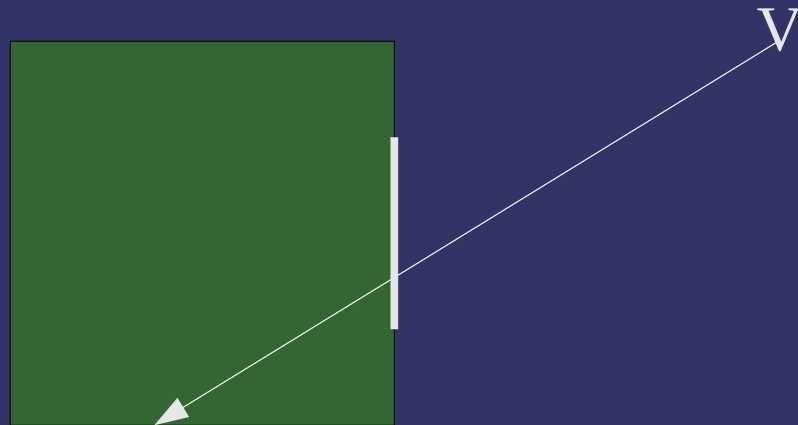


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Interior Mapping

- Determine the location *inside* the building that is visible *without* adding geometry

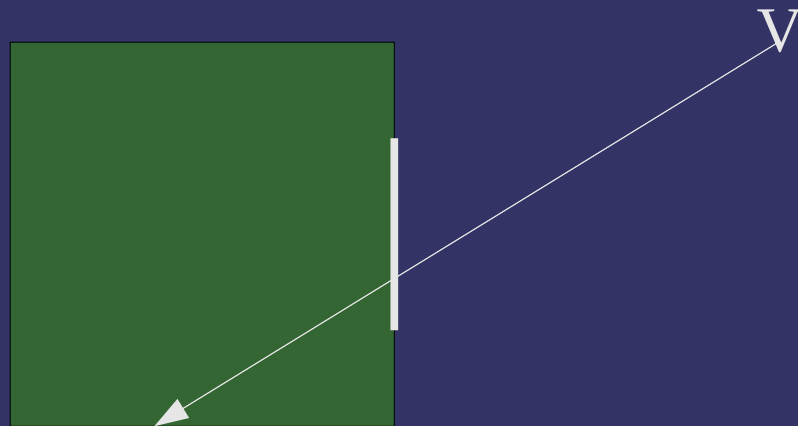


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Interior Mapping

- Determine the location *inside* the building that is visible *without* adding geometry
 - The drawing suggests the answer: use raycasting
 - Create virtual walls, ceilings, and floors inside the building at regular intervals

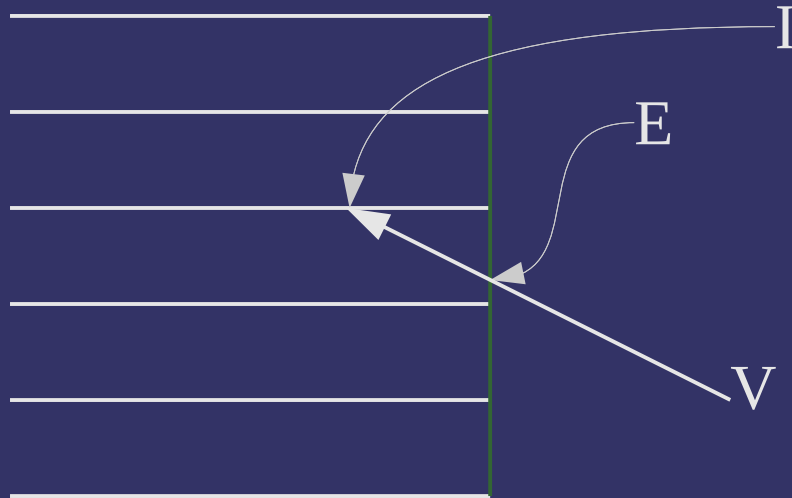


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Interior Mapping

- ⇒ Calculate the point of ceiling intersection
 - Assume all calculations are in object space
 - Exterior intersection point and ray direction are given



$$I_y = \lceil E_y / h \rceil \times h$$



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Interior Mapping

⇒ Parametric equation of V :

$$p = V + \vec{V} t$$

where $\vec{V} = E - V$

– Calculate the value of t where $p_y = I_y$

$$I_y = V_y + \vec{V}_y t$$
$$I_y - V_y = \vec{V}_y t$$
$$\frac{I_y - V_y}{\vec{V}_y} = t$$

– Use t to calculate the rest of I



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Interior Mapping

- ⇒ Perform similar calculations for walls
 - The intersection with the smallest t is used
 - Use resulting I_{xy} to generate a texture coordinate
- ⇒ Can add extra fake walls to represent items in the rooms
 - Textures for the fake walls should be mostly transparent
 - Has issues if the viewer can see in corners
 - See paper for more details



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References

van Dongen, Joost, "Interior Mapping - A new technique for rendering realistic buildings." In *Computer Graphics International Conference (CGI)*. 2008. <http://interiormapping.oogst3d.net>



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Parallax Textures

- ⇒ Normal / bump maps give shading cues to surface shape
 - No changes to silhouette
 - No self occlusion



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Parallax Textures

- Normal / bump maps give shading cues to surface shape
 - No changes to silhouette
 - No self occlusion
- Parallax textures address the second problem
 - Does so by exploiting the parallax effect



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Parallax Textures

➤ From wikipedia:

Parallax is an apparent displacement or difference of orientation of an object viewed along two different lines of sight, and is measured by the angle or semi-angle of inclination between those two lines....Nearby objects have a larger parallax than more distant objects when observed from different positions, so parallax can be used to determine distances.

- 2D side-scrolling games use this effect all the time
 - Nearer background objects scroll by faster than farther background objects

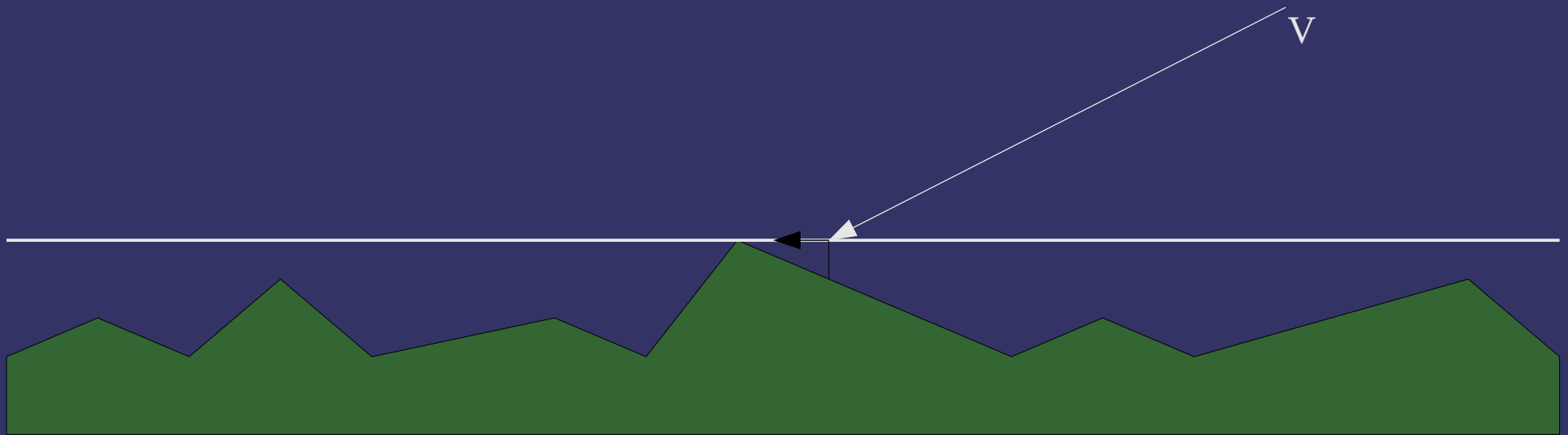


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Parallax Textures

- ⇒ Implement this for a 3D surface:
 - Use a height (bump) map to set per-fragment distance from viewer
 - As the viewer moves side-to-side *in surface space*, nearer portions of the texture will “scroll by faster”



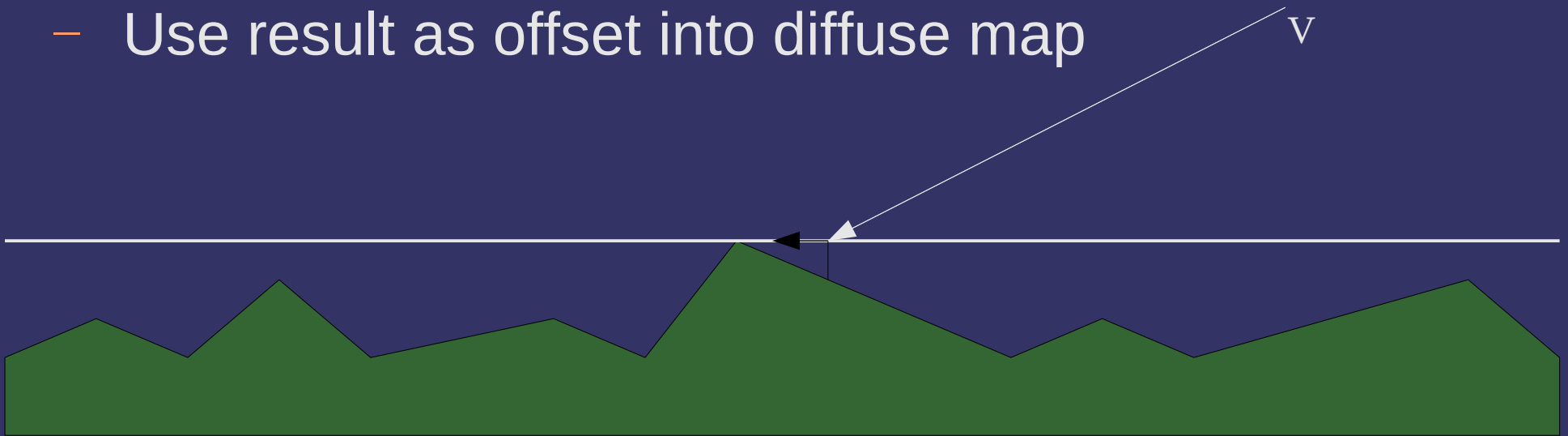
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Parallax Textures

➤ At each fragment:

- Sample the depth from the surface using the bump map
- Use this value to scale projection of the view vector on to the surface
- Use result as offset into diffuse map



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Parallax Textures

- What could go wrong? What are the shortcomings?



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Parallax Textures

- What could go wrong? What are the shortcomings?
 - Assumes a smoothly varying height field
 - Can't handle large displacements
 - Can't handle high-frequency data
 - Doesn't properly handle occlusion



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References

Kaneko, Tomomichi, Toshiyuki Takahei, Masahiko Inami, Naoki Kawakami, Yasuyuki Yanagida, Taro Maeda, and Susumu Tachi. 2001. "Detailed Shape Representation with Parallax Mapping." In *Proceedings of the ICAT 2001 (The 11th International Conferences on Artificial Reality and Telexistence)*, Tokyo, December 2001, pp. 205 – 208.

<http://vrsj.t.u-tokyo.ac.jp/ic-at/ICAT2003/papers/01205.pdf>

West, Mick. "Parallax Mapped Bullet Holes." Game Developer, May 2006.

<http://cowboyprogramming.com/2007/01/05/parallax-mapped-bullet-holes/>

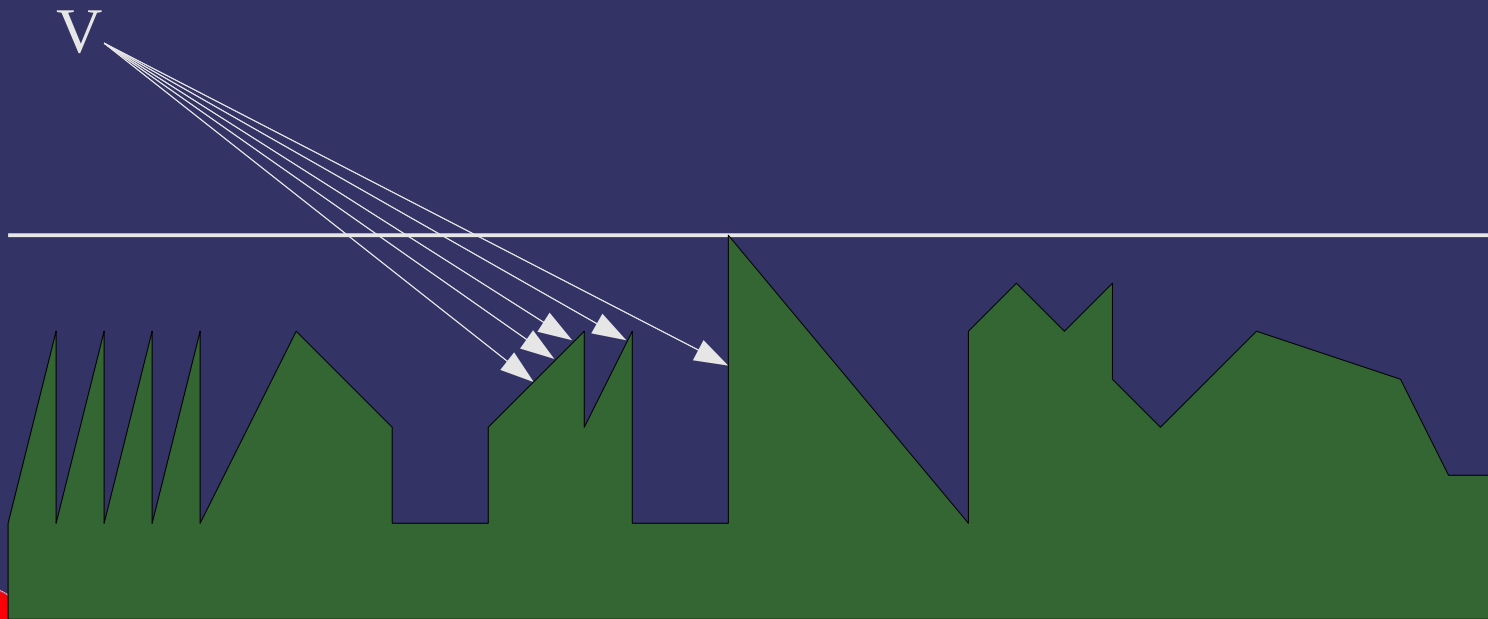


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Displacement Mapping

- We really want to raytrace into arbitrary volume data representing our surface
 - Would require a linear search through a volume texture *per fragment*



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Displacement Mapping

- ⇒ What if we knew, at every position, the distance to the nearest voxel?
 - As we walk the ray through voxel space, we could step by the distance to the nearest voxel
 - Reduces the search from n to $\log n$



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Displacement Mapping

⇒ Algorithm:

For some number of steps:

```
distance = sample distance texture at  
position
```

```
position += distance * direction
```

- Dynamic branching hardware can end loop early if `distance` is below some preset threshold
- `direction` is the normalized viewing direction vector
 - Must be rescaled from surface space to texel space



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Displacement Mapping

- ⇒ Result of raytracing is a 3D position
 - Project the 3D position onto the surface
 - i.e., just use the x and y components
 - Use the resulting projection to sample texture and normal maps



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Euclidean Distance Map

- Generate distance map using Danielsson's algorithm
 - Initialize a texture with $(0, 0)$ for elements “inside” the surface or (∞, ∞) for elements outside
 - Perform 4 passes over the image propagating distances among neighbors
 - This is the 2D version... it can be trivially extended to 3D



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Euclidean Distance Map

➤ Pass 1:

- Move the mask top-to-bottom, left-to-right
- The green element is the pixel being examined, the others are its neighbors
- Add the specified offsets to the pixel distance values, store the minimum in the pixel



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Euclidean Distance Map

➤ Pass 2:

- Move the mask top-to-bottom, right-to-left
- The green element is the pixel being examined, the others are its neighbors
- Add the specified offsets to the pixel distance values, store the minimum in the pixel



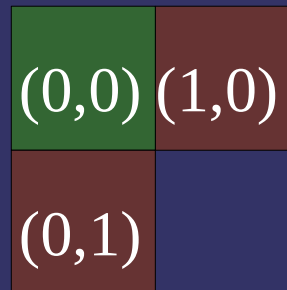
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Euclidean Distance Map

➤ Pass 3:

- Move the mask bottom-to-top, right-to-left
- The green element is the pixel being examined, the others are its neighbors
- Add the specified offsets to the pixel distance values, store the minimum in the pixel



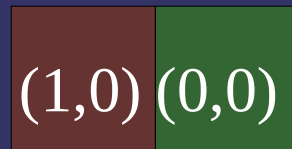
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Euclidean Distance Map

Pass 4:

- Move the mask bottom-to-top, left-to-right
- The green element is the pixel being examined, the others are its neighbors
- Add the specified offsets to the pixel distance values, store the minimum in the pixel



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Euclidean Distance Map

- ⇒ Final pass:
 - Convert the distance vectors to distance scalars



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Displacement Mapping

⇒ Caveats:

- Take partial derivatives of input texture coordinate and use those when sampling the final texture
 - Otherwise the texture filtering will be wrong in weird ways
 - Use `ddx` and `ddy` functions



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References

Donnelly, William. "Per-Pixel Displacement Mapping with Distance Functions" in Fernando, Randima (editor) GPU Gems 2, Addison Wesley, 2005.

http://download.nvidia.com/developer/GPU_Gems_2/GPU_Gems2_ch08.pdf

Fabbri, R., Costa, L. F., Torelli, J. C., and Bruno, O. M. 2008. 2D Euclidean distance transform algorithms: A comparative survey. ACM Computing Surveys 40, 1 (Feb. 2008), 1-44.

<http://distance.sourceforge.net/>

- You'll have to Google (with some effort!) for a live link to the actual paper. :(



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Next week...

- Next class meeting TBD
 - I will be traveling on business all next week
- Multiple render targets
- Deferred shading
- Quiz #4



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