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Efficient Magnification of Bi-Level Textures

Objective

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- Bi-level (aka binary) images such as road signs need sharp texturing
- Do that fast; consume only little memory

Hi-res | Lo-res | DXT1 2 x mem | Presented method same mem as lo-res

Outline

- Related work
- Thresholding and how to make it work
- Antialiasing on magnification
- MIP mapping on minification
- Optimizing the lo-res texture
- Results
- Future Work

Related Work

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- Textures with hard edges:
  - Ramanarayanan, Bala, Walter: Feature-based textures, 2004
  - Tumblin & Choudhury: Bixels, 2004
- … on the GPU:
  - Sen: Silhouette maps, 2004

Thresholding and How to Make It Work (1)

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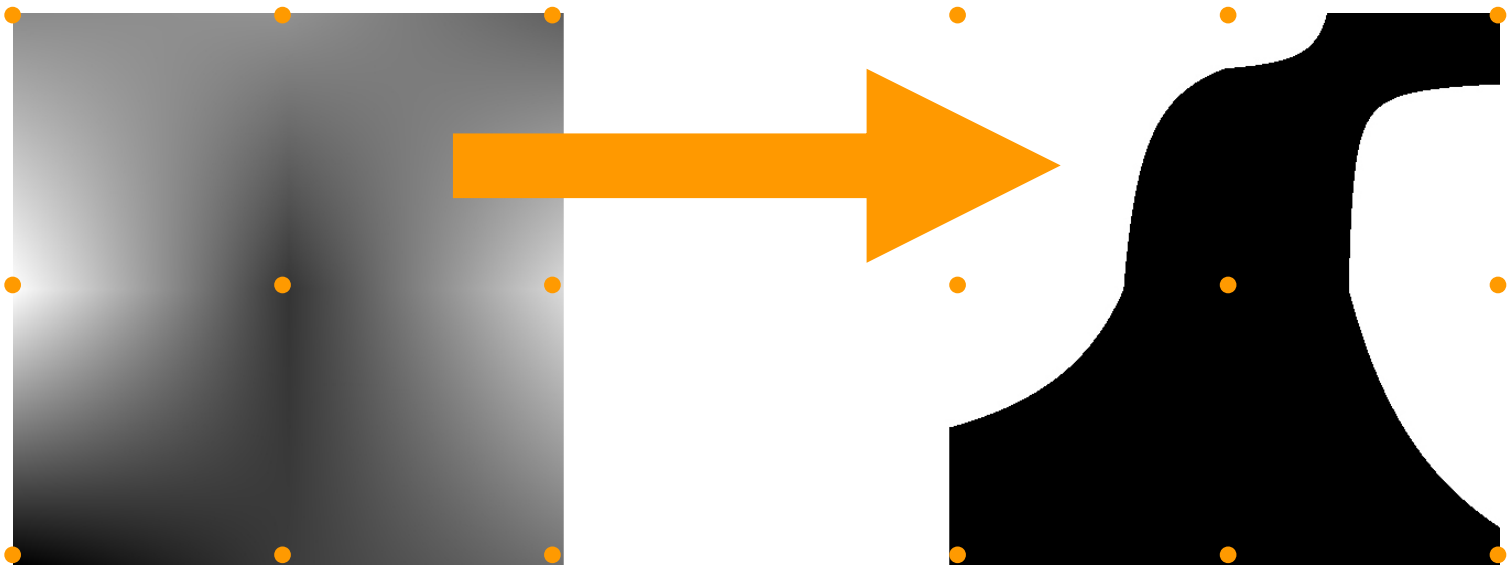
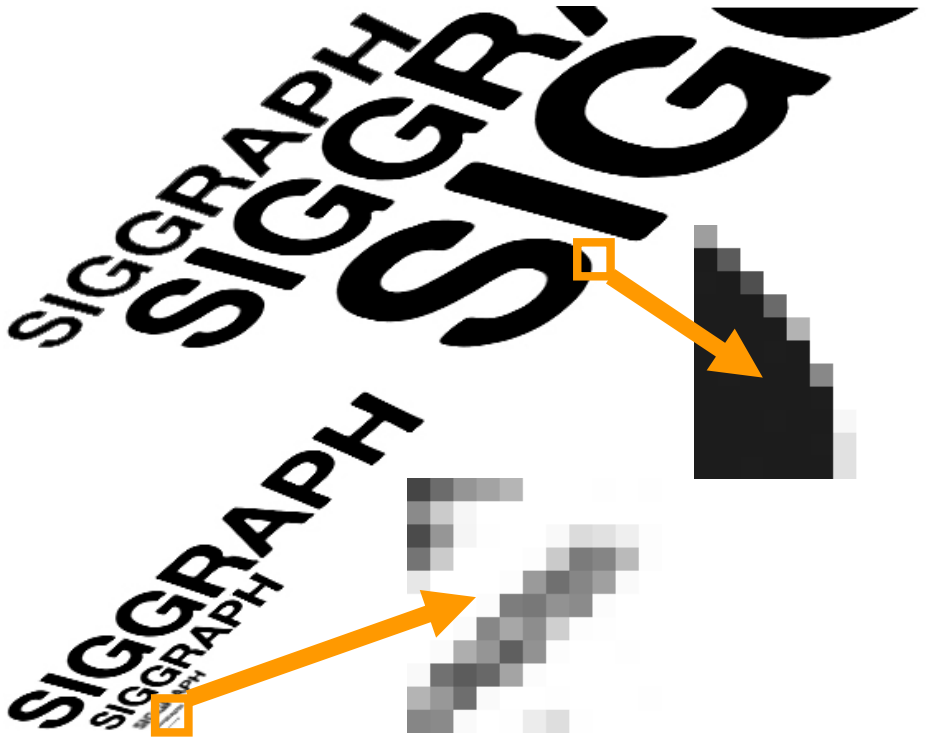
- Address only bi-level textures
- Use thresholding in the pixel shader for a bilinearly interpolated low-resolution texture



Thresholding and How to Make It Work (2)

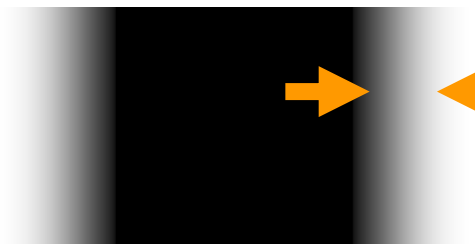
- Task 1:
  Antialiasing
  on magnification
- Task 2:
  MIP-Mapping
  on minification



- Task 3: Optimize the low-res texture

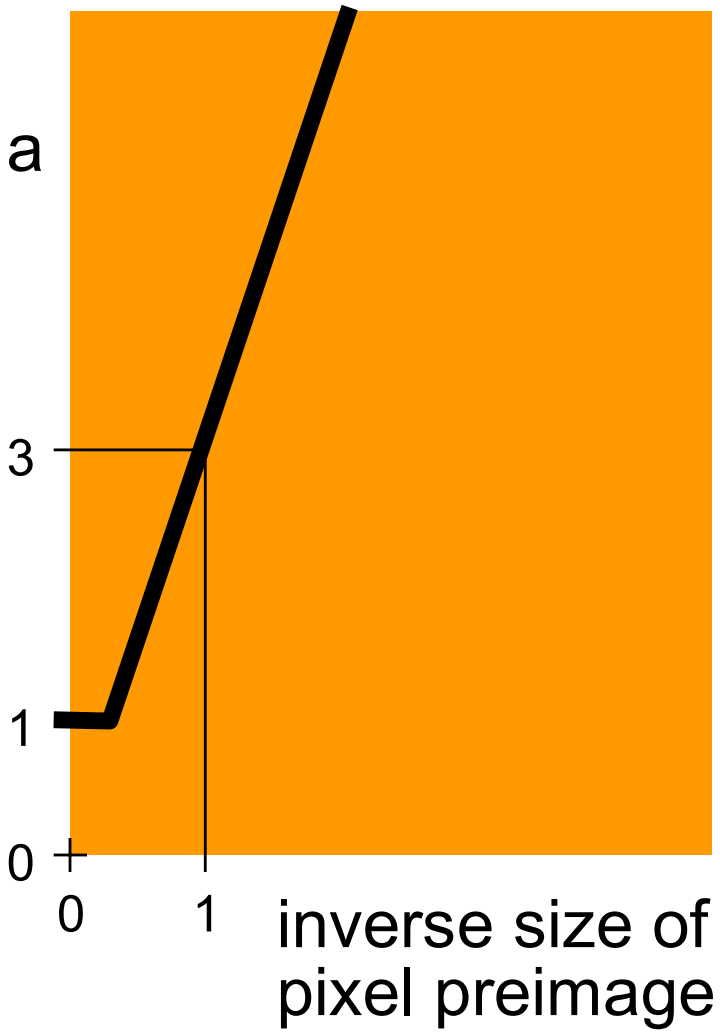
Antialiasing on Magnification

- Soft threshold with transition region



1/3 screen pixel

- Fast and cheap:
  - c = clamp(0.5 + a*(t-0.5))
  - ddx, ddy to determine size



MIP-Mapping on Minification (1)

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- On minification, sharp edges have to be increasingly blurred
- Use regular MIP mapping; all MIP levels as usual except the finest one

MIP-Mapping on Minification (2)

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- Don’t want grey halos on transition between MIP levels 0 and 1: Prohibit medium gray values (say, 112 to 143) in level 0

Optimizing the Lo-Res Texture (1)

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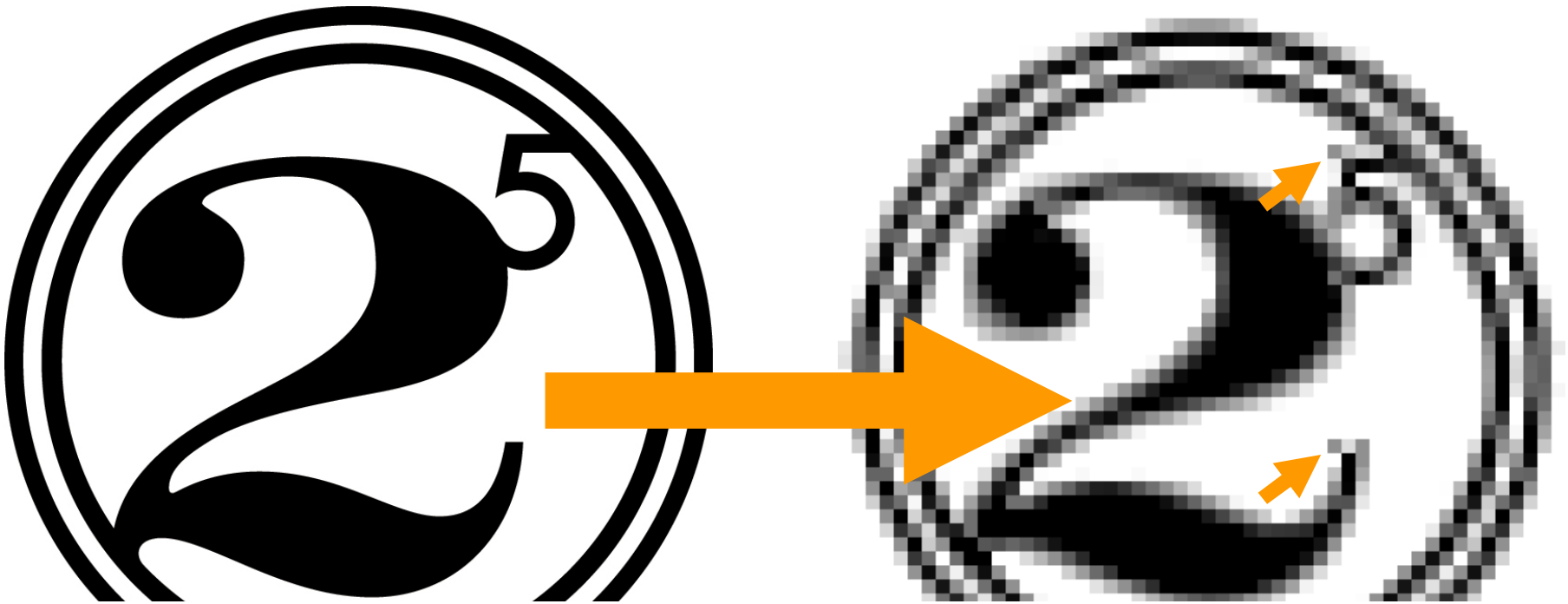
- Input: high-resolution bitmap
- Output: low-resolution texture



Optimizing the Lo-Res Texture (2)

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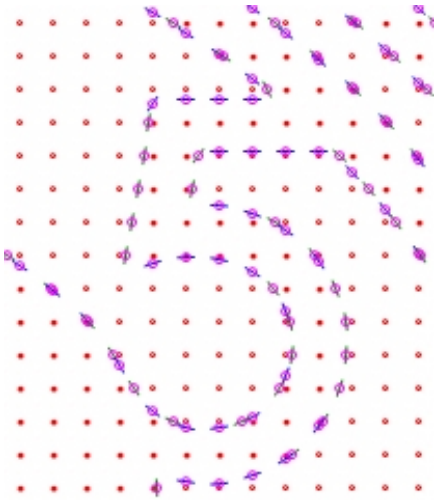
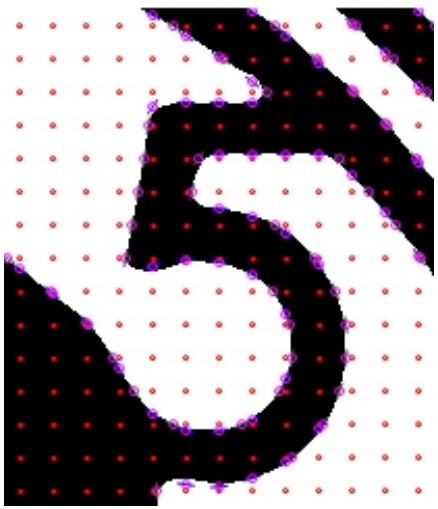
- Extract intersections/angles at edges of lo-res texels
- Try to mimic intersections/angles with thresholded lo-res texture
- Overdetermined system
- Seek optimal solution





Optimizing the Lo-Res Texture (3)

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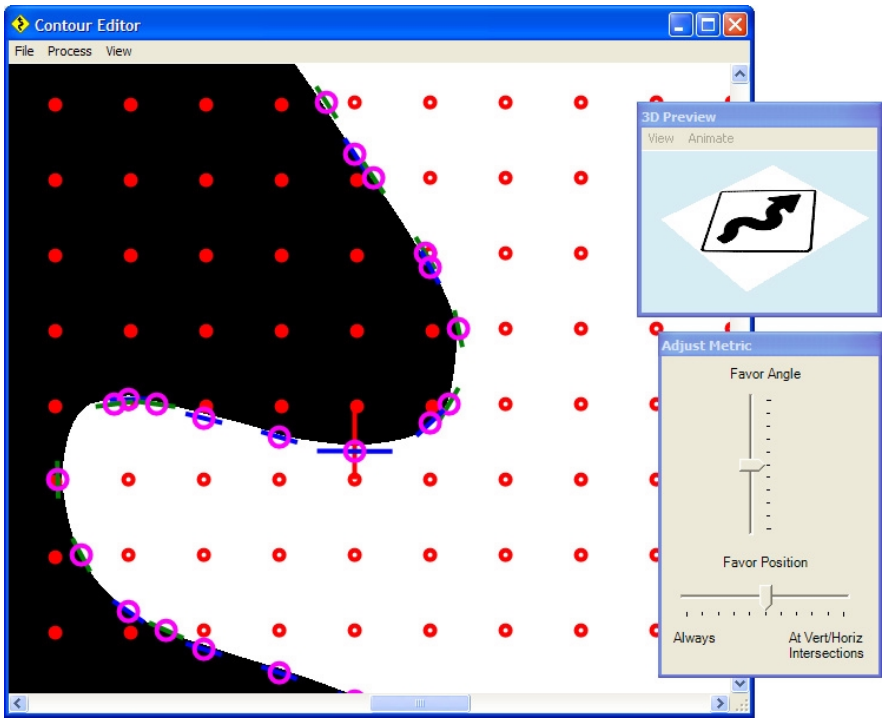
- Authoring software
  - Optimization in background thread
  - Edit extracted intersections/angles



Optimizing the Lo-Res Texture (4)

- Which metric to use for optimization?
  - Favor accuracy of position: bumpy diagonals
  - Favor accuracy of angles: varying stem widths
  - Hence: Favor positions only at nearly horizontal or vertical intersections

Results

- Sharp edges in spite of small textures
- Speed: 800 MP/s on GF 6800 GT
  (14 instructions incl. one texture request)
- Visually robust typefaces reproduced well,
  but there are obvious limits

Future Work

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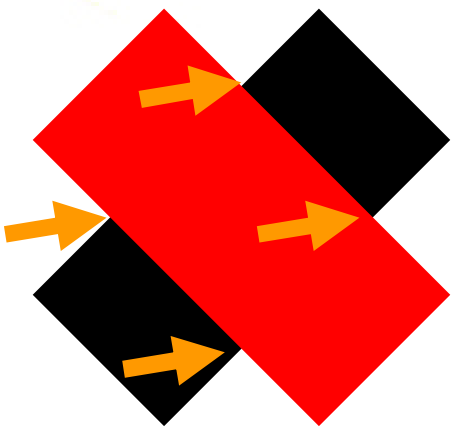
- “Intelligent” metric for optimization?
- Reverse engineer multi-color signs

to generate sharp intersections



Questions?