Considerations for an "UltraDisplay"

Jason Dale
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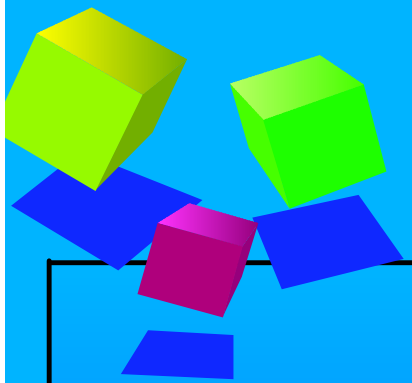
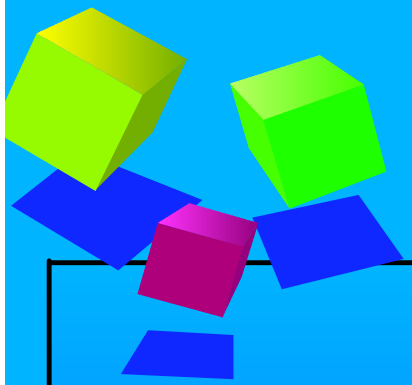


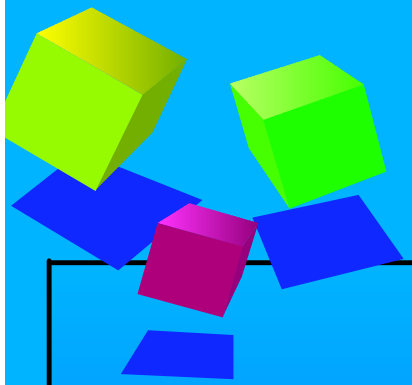
Overview

- Motivation
- Literature Survey
- Initial Assumptions
- Visual Perception
- Idea: Peripheral Texture Compression
- Experiment
- Conclusion



Literature Survey

- Display Technology
  - Micro-displays
  - HMD
- Human Vision
  - Visual Perception
  - Optics
  - Retinal Computation
- Geometry Compression
  - Foveal Rendering
- Augmented Reality



Motivation

- The Idea: An "UltraDisplay"
  - >100 Mpixel HMD
  - Overlay Capable
  - Also a Retinal Reflection Sensor
    - Augmented Reality
    - Security
  - Individually Adressable Pixels
- Large Bandwidth Required

Motivation

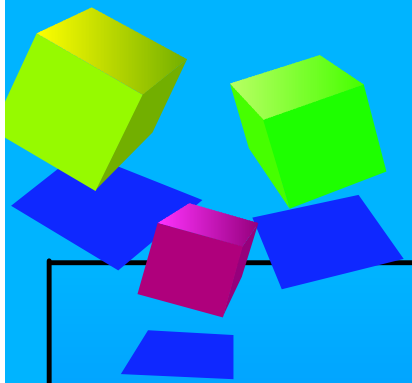
- Raster Memory Bandwidth (@ 24 bpp):

Display Bandwidth\	Ultradisplay 9282x7059	Ultradisplay 5400x6441	1080i HDTV	Game (1024x768)	SDTV DVD
Frames / sec	80	80	30	70	24
B.W. (MB/s)	31,451	16,696	187	165	25

- Total Mem Bandwidth Est. (Scaled to Game @ 20GB/s):

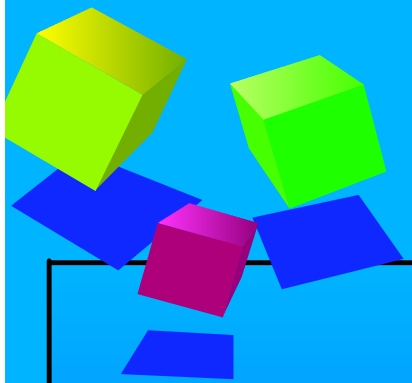
Scaled to Game	Ultradisplay Foveal	Ultradisplay Peripheral	1080i HDTV	Game (1024x768)	SDTV DVD
B.W. (GB/s)	3,809	2,022	23	20	3

- Compare To:
  - MPEG2 HDTV: ~2-3MB/s
  - Optic Nerve: 10-400 MB/s



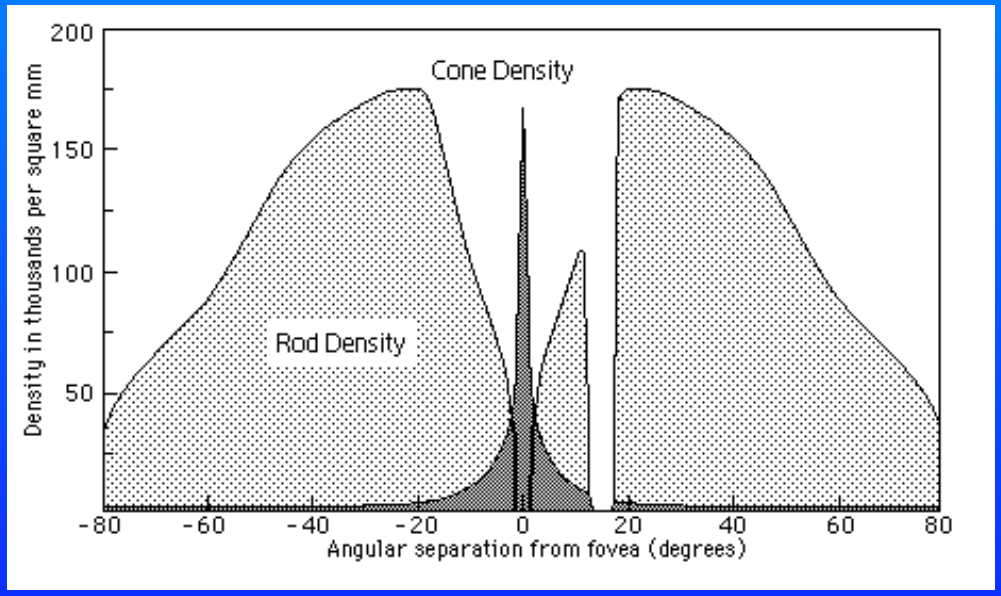
Initial Assumptions

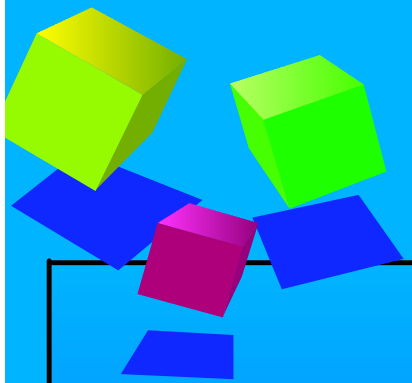
- Peripheral Vision = Low-Res Vision
  - Use Mip-Maps to Reduce Memory Bandwidth
  - Disable Antialiasing in Peripheral Areas
- This Isn't Exactly the Case...



Visual Perception

- The Human Retina
  - Rods, Cones, Neurons
  - Foveal and Peripheral vision
  - Pre-processing / Compression

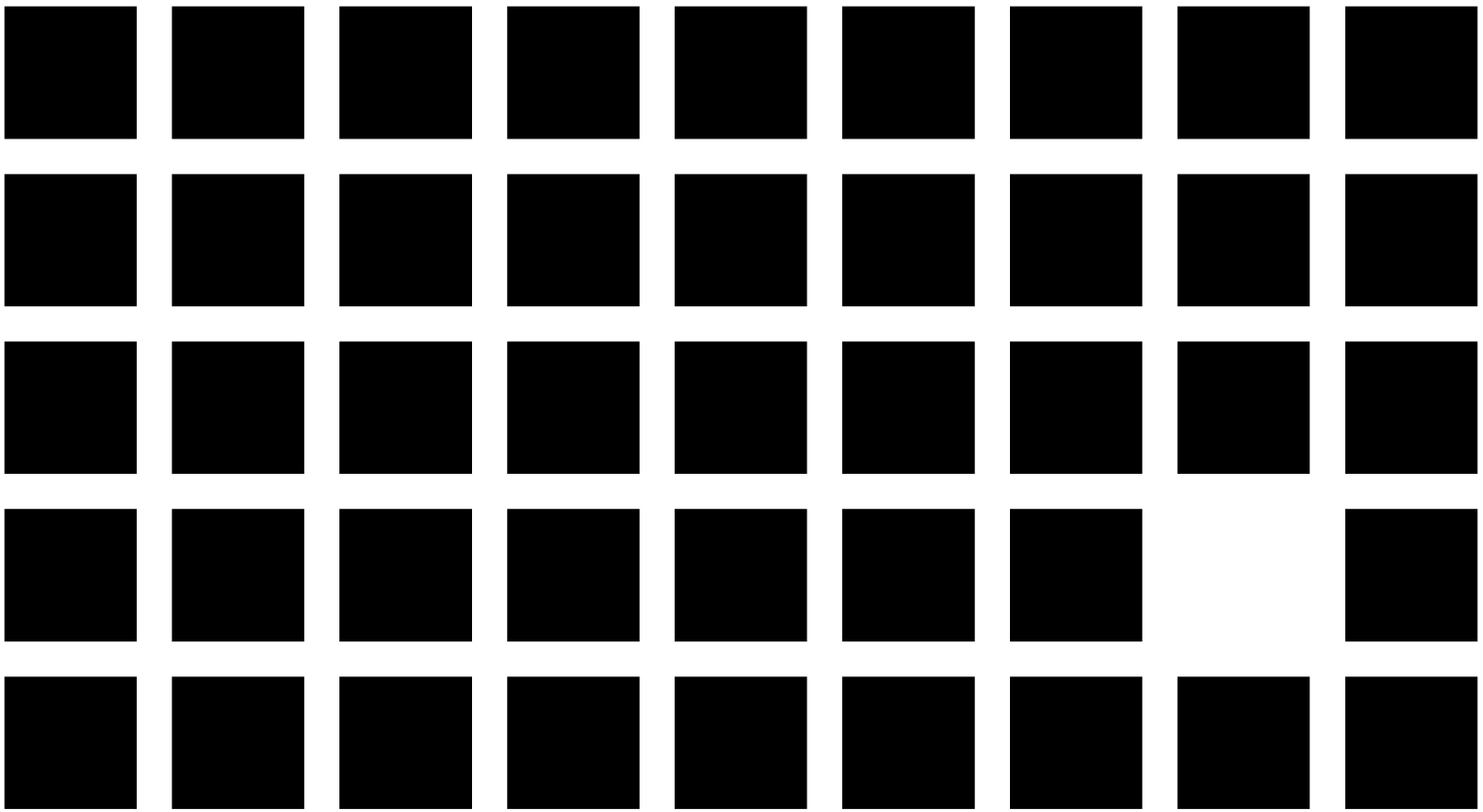




Peripheral Vision

- Progressive Acuity
- Contrast Based
- Compression
  - CSF - Neural Gabor Transform
  - Lateral Inhibition (center-surround inhibition)
- Orientation Sensitivity
- Temporal Sensitivity

Perception Example



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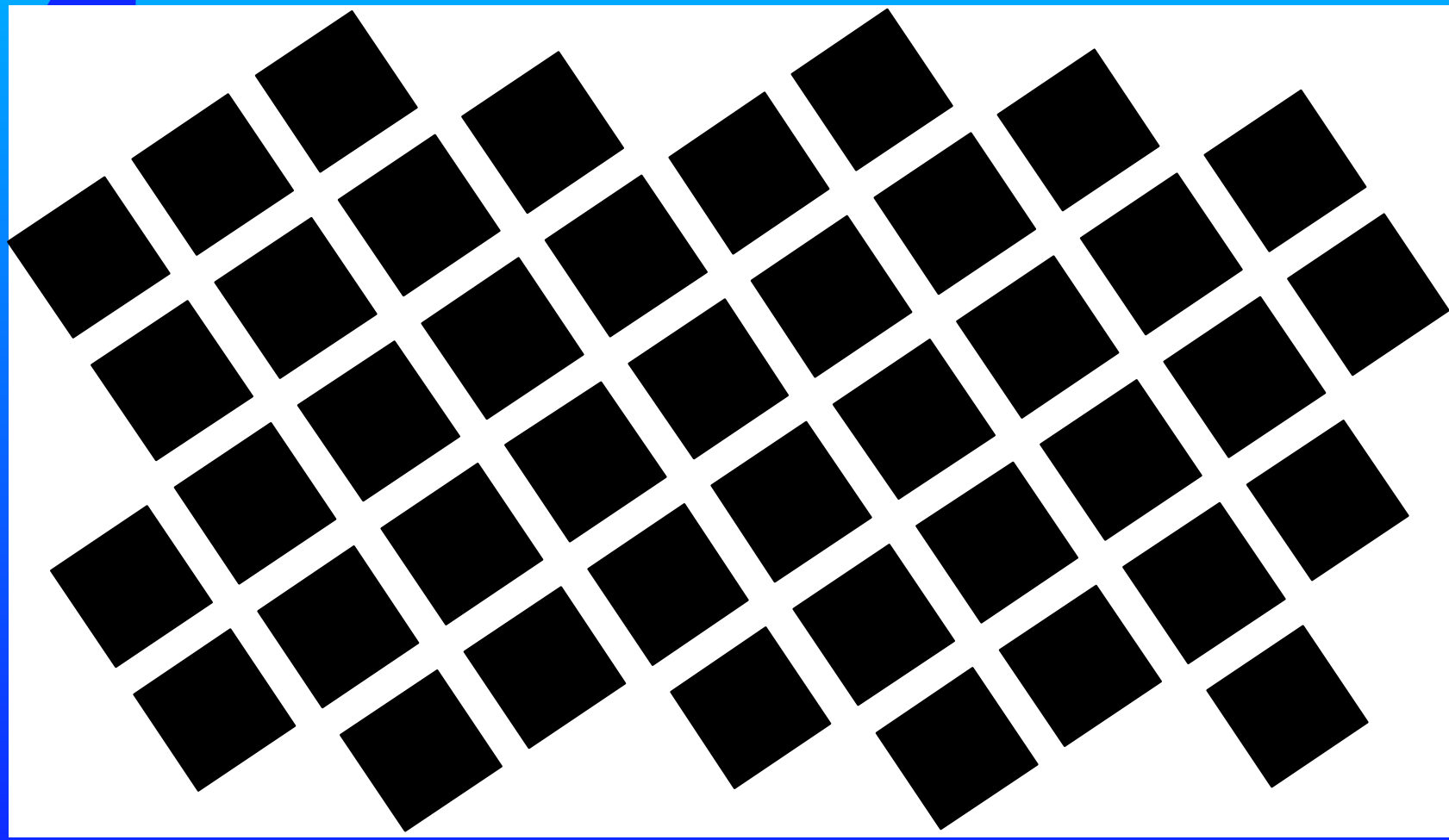

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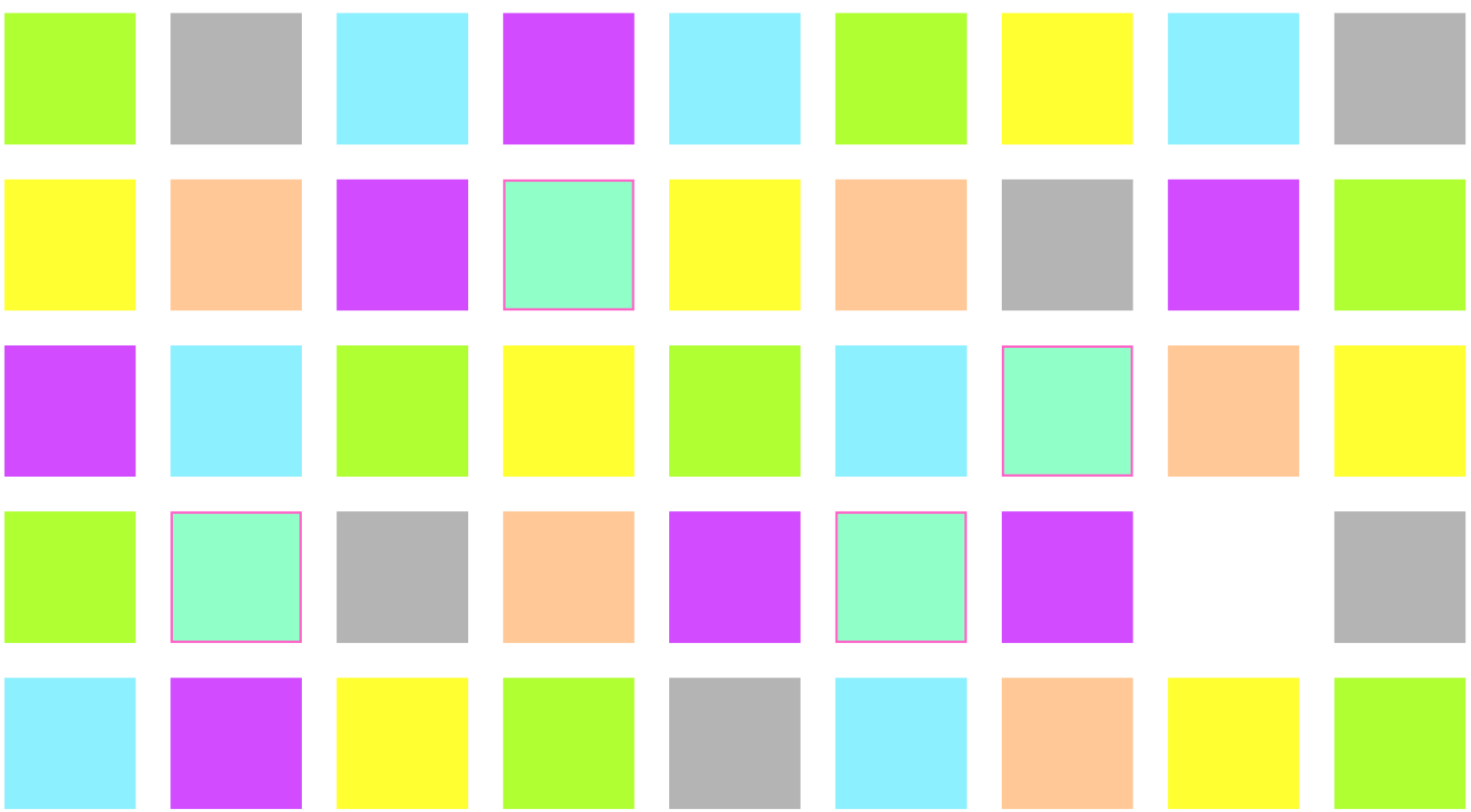

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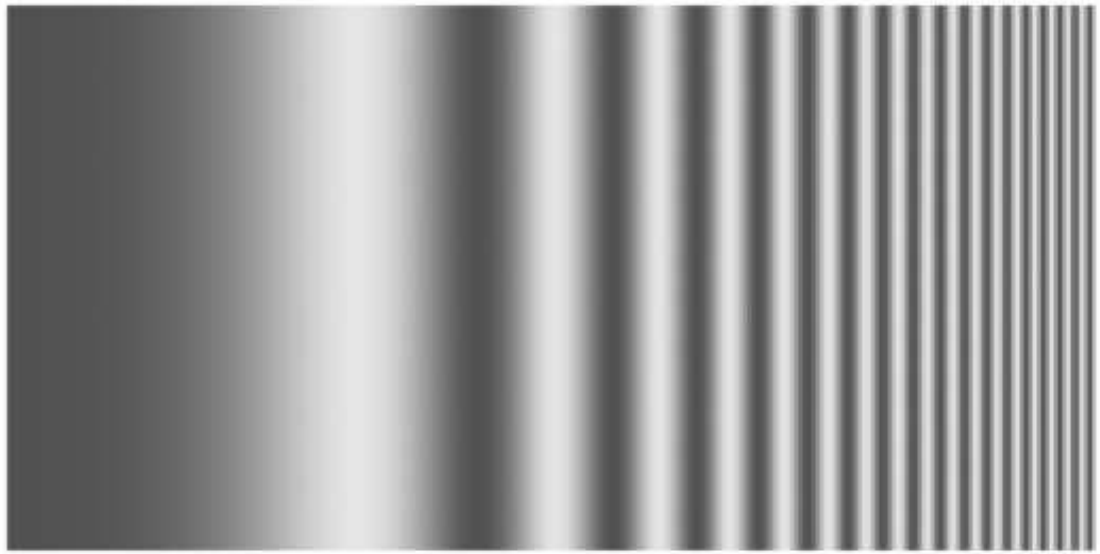

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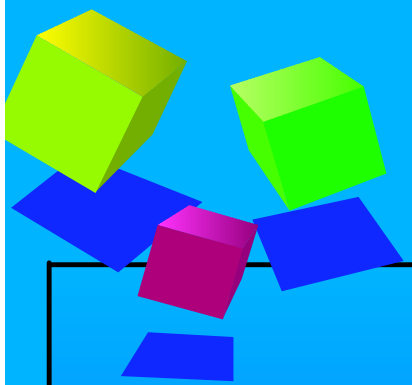
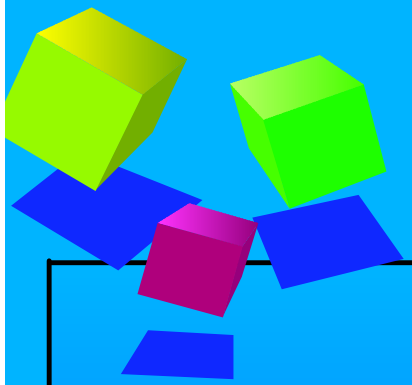


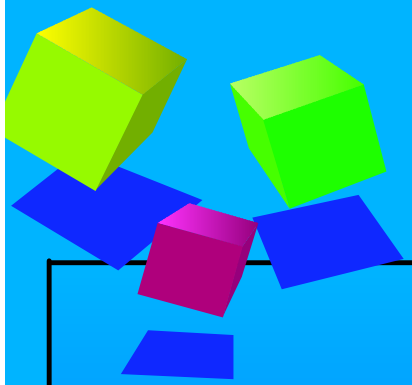
Peripheral Texture Compression

- Difficult to Optimize in a General Way
- Very Scene Dependant
  - Close / Partially Occluded Objects
  - Unpredictibilty in Augmented Reality
- Orientation Sensitivity
- Blending is Important
  - Inconsistancy = Frequency (or lack of)
  - Spatial: Boudary Mismatch
  - Temporal: Undersampling (blinking), 'Snapping'
- Consider Saccades



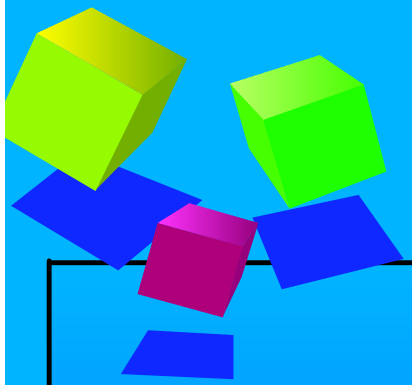
Peripheral Texture Compression Ideas

- Palette-Based
  - Requires Additional Indirection
  - Potentially Good for High-Contrast Textures
- Quantized / Truncated Color Channels
  - No Additional Textures Required
  - Multiple Loads / Pixel
    - Potentially Costly
    - Effects on the Texture Cache?
- Other Color Coordinate Systes
  - YUV, YIQ, "Opponent Encoding"



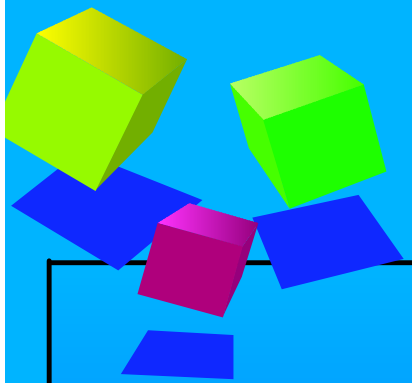
Initial Experiment

- Needed Large Textures
  - Complex Textures Often Functions
  - However - The Texas GIS Database
    - Use Austin Area as Dataset
    - Terrain Map: Medium Contrast (MC)
    - Overlay Map: High Contrast (HC)
      - Overlay Map uses Terrain for Height Map (3D)
- Evaluation
  - Printouts
    - 25.8" x 20" @ 18100 x 14000
    - ~Eye Resolution
  - Also Viewed on Monitor



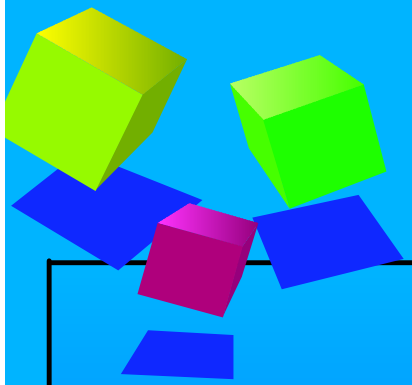
Results

- Rendering Large Datasets is Slow
  - Data Soon...
- One Yoshida-style image finished
  - 98% Bandwidth Reduction
  - Both Images Look Almost Perfect
  - Texture Compression May Not Be Needed
- 2 Pass Renderering
  - May Reduce Texture Data More Effectively



Conclusions

- Vision is Complex!
- Simple Techniques May be Enough
- Texture Compression?
  - Effective Use Depends on Scene Dynamics
  - Augmented Reality Makes this Especially Difficult
  - Low Expectations for improvements



Questions?