High-Speed Distributed Rendering in the HoloVizio System

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Holografika
3D Display Technologies

Background

- 3D images contain more information than 2D
  - Stereoscopic: 2x (L+R)
  - Multiview: ~8-16x
  - Volumetric: 20-200 slices
  - True 3D: continuous (~100x)

- Total number of beams law, points/sec rate
  - Determine the quality of any 3D solution

- Direction selective light emission
  - Common for all 3D systems having a screen
Fundamentals of 3D Displaying

- Additional independent variant to \( X, Y : \Phi \)
  - Emission range: FOV
  - Number of independent beams in the range: Angular resolution
    \[ \Phi = \frac{\text{FOV}}{n} \]
  - Angular resolution determines FOD
Fundamentals of 3D Displaying

- Vertical / horizontal parallax
  - Reduce the number of beams by omitting vertical parallax
  - Different horizontal and vertical angular resolution
The HoloVizio System

- Optical modules
  - Project light beams to the points of the screen from various angles

- Holographic screen
  - Direction selective property with angularly dependent diffusion characteristics

- Emission angle geometry determined
  - The screen performs the necessary optical transformation, but makes no principal change in directions
  - No optical road-blocks like at parallax barrier, lenticular lenses
The HoloVizio System

- Specific distributed image organization
  - A module is not associated to a direction
  - Each view of the 3D image comes from multiple modules
  - Smooth and continuous transition between views
- Light field reconstruction instead of views
The HoloVizio System

- Freedom in system design
  - Emission angle
  - Angular resolution
  - Horizontal / vertical parallax

- Scalability
  - High pixel count
  - Any aspect ratio
  - Large scale systems

- Price / Performance
  - Possible to build perfect 3D displays
Steps to get there

Historical background

• First labor experiments, basic patent 1992-93
• 21” laser based monitor 1996-97
• Color labor mock-up 1998
• 32” color display prototype 2001
Steps to get there

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32” color display prototype 2001
HoloVizio Displays

- HoloVizio Monitors
  - HoloVizio 128WD
    - 32”, 10 Mpixel, 16:9
  - HoloVizio 96ND
    - 26”, 7.4 Mpixel, 4:3
  - 128 and 96 modules
  - 50° FOV, 0.8° Φ
  - 2D equiv. res: 512x320
  - Up to 4 DVI inputs
    - 3 channels for 25 FPS
HoloVizio Displays

• Large-scale HoloVizio System
  • HoloVizio 640RC
    • 72”, 50 Mpixel, 16:9
    • 50-70° FOV, 0.9° Φ
    • 2D equiv. res: 1344x768
    • Input: Dual Gigabit Ethernet
    • PC-based render cluster
    • Control system
HoloVizio Displays

- Large-scale HoloVizio System

User computer
- Legacy OpenGL Application
- OpenGL Wrapper
- OpenGL
- Display driver

2D display

HoloVizio

Render cluster node
- Calibration
- OpenGL
- Stream renderer

Dual-Gigabit Ethernet
The Near Future

New HoloVizio Monitor

- 125 Mpixel, monitor scale
- 96 x SXGA images
- Planned for mass production
- New developments make it cheaper, smaller, and provide better image quality

Software architecture

- Basic operation
- Plug-in operation

- How to render 125 Mpixels?
Possible Solutions

• Ideal solution
  • Single graphics board rendering a 125 Mpixel image
  • Huge GPU performance in a small package
  • Lots of video outputs
  • Impossible today (?)

• Use a computer cluster
  • Multiple CPUs, multiple GPUs

• Game console cluster
  • Performance / Licensing problems
Possible Solutions

• Embedded renderer, IP core
  • Put more GPUs into an ASIC
  • Not available to small companies
  • Does GPU manufacturers have agreement with a company that could produce custom chips for us?

• GPU cluster
  • Rapid improvements these days
  • Best performance and quality
  • Only built of workstation GPUs, no desktop or mobile GPUs
  • A bit expensive
  • Custom cluster for our purposes
Thank You!

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