Scalable VR

GTC 2014: Mid-Tier VR: Cost Reducing the Cave by Embracing the GPU

Rajeev Surati Ph.D.
President Scalable Display Technologies

Bei Yang
Concept Design Lead
Walt Disney Imagineering

Some Content from Professor David LaidLaw Brown University
Ultimate Display

“The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal.”

-Ivan Sutherland Proceedings of IFIP Congress, 1965
Virtual Reality
Virtual Reality
Pixel density
Brightness
Dynamic Range
Lighting and Rendering
3D, Parallax

Becoming Ultimate
The 1\textsuperscript{st} Three

Pixel density, Brightness, Dynamic Range
Holodeck on the cheap
Details

How do drive that many displays?
The last two
3d & parallax
Tracking
MPCDI

- Multiple Projector Common Data Interchange
What about graphics information?
The real problem

Tying it all together
Shipping Data
Open Problems

- Perspective corrected rendering
- Data synchronization
  - GPU Particles
  - Lighting
- Border conditions
  - SSAO
  - Lens effects
- Data transport (framebuffers)
Putting Some numbers on the table
With Examples and Implementation
Detail
The spectrum...

Browns new cave

69 1920 1080P
120 hertz
projectors
Rear Projected
Camera Based
Tracking

720P Single
Projector 120
hertz Front
Projected, Kinect
<table>
<thead>
<tr>
<th></th>
<th>Eye</th>
<th>1998 Cave</th>
<th>2014 Cave</th>
<th>Reality Deck 2</th>
<th>iPhone 4</th>
<th>24” desktop</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Res [arc-min]</strong></td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>&lt;&lt; 1</td>
<td>1</td>
<td>1-2</td>
</tr>
<tr>
<td><strong>Stereo</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Contrast [levels]</strong></td>
<td>100-1000</td>
<td>10-100</td>
<td>100-1000</td>
<td>100-1000</td>
<td>100-1000</td>
<td>100-1000</td>
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<tr>
<td><strong>Color [levels]</strong></td>
<td>100-1000</td>
<td>10</td>
<td>100-1000</td>
<td>100-1000</td>
<td>100-1000</td>
<td>100-1000</td>
</tr>
<tr>
<td><strong>Dynamic range</strong></td>
<td>(10^{10})</td>
<td>(10^{1-2})</td>
<td>(10^{2-3})</td>
<td>(10^{4-5})</td>
<td>(10^{3-4})</td>
<td>(10^{3-4})</td>
</tr>
<tr>
<td><strong>Horiz FOV [º]</strong></td>
<td>±90</td>
<td>±135</td>
<td>360</td>
<td>360</td>
<td>±2</td>
<td>±15</td>
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<tr>
<td><strong>Vert FOV [º]</strong></td>
<td>±45</td>
<td>+45, -135</td>
<td>+75, -180</td>
<td>±30</td>
<td>±4</td>
<td>±12</td>
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</table>
- Stereoscopic 3D Projectors
- Front or Rear Projection/Screen Configurations
- Tracking Software
Stereo Scopic 3d

Active:
is very accessible today because of the big TV 3d boom – High end systems from Wolfoni, Monster 3d (rf based etc) Though less then 20% transmission. RealD and DepthQ offer Pi Cells that are excellent also – lets use use passive glasses on user. DLP Link – reduce contrast...

Passive is a good compromise for large group viewing experience  Vendors include:  Infinitec (requires color processing and 6 color so special wheels) == can get special products directly from Infinitec for NEC PA Series (with SDT Stacking Built in) Wavelength based

Polarization – Linear or Circular – off angle viewing issues can buy from many sources such as Berezin.

Omega Filters – no color processing, wave length separated , worth experimenting with.
Projectors: Lots of Options but...

Active 3d
720p 120 hertz DLP Projectors, IR or DLP Link 500 lumens
$500 dollars, Optoma, Vivitek, NEC etc

1080P ST BenQ with 720P 120 Hertz Benq $1200.00 (.5)
throw 2k lumens

UST .34 Throw 720P 120 Hertz NECu310W $1500.00 3k
lumens

Optoma TW865-NL 6k lumen 720P 120 hertz $4k dollars (3d
Sync on board)

Digital Projection, Christie, Barco/Projection
Design/LG/Panasonic
Lower End 10k-60k for 1080P 120 Hertz -- Price will come
down – 442x DLP Chipset controller out...

Barco will offer 120 Hertz 4 megapixel in the F50 at very
competitive pricing in the Summer. F35AS3d opened up
market below 60k per projector.
Christie, Barco offer 120 Hertz stereoscopic 3d at 4k.

Quality and expectations should be kept in line with
“you get what you pay for”
Rear gives best Image, but it is very expensive in terms of Space!

Recent Optical Product advances provide Ultra Short Throw for higher Lumen projectors good for caves. .19 throw 100 inch image from 31 inches away!

Rear Projection screens tend to be expensive

Front Projection can be network gry paint, screen goo, Screen Innovations RP flexible, Barco and Stewart offer the Finest materials. Barco can model and change screen density to optimize contrast!
Configurations:

- Flat dual use whiteboard/vr system
  - 3 projector 1080P UST Laser Phosphor

- Articulated Flat Disney ($100k no software)
  - CornerCave -- worldviz
  - 10 wuxga projectors

- Curved Disney 5 F35AS3d
  - 2 UST Projectors
  - Christie HoloStation
  - Barco OSV – Rear Projection Cube based seamless walls
  - Mechdyne Flex etc
Tracking

Low End Kinect, Use Multiple?

Practical Good Systems Optitrack (5k minimum), Vicon, PhaseSpace, ART (10k)
This is an area where the COST NEEDS to come down..
Software

Home Brew use Unity Engine, Panda, Unreal, Crytek on single computer

Distributed Rendering are being made available through many vendors

TechViz, Eon Reality, WorldViz, Mechdyne all offer packages that solve many issues – distributed rendering, 3difying apps etc.
Solution for under 20k recipe

2 NEC/Optoma UST projectors DLP based
1 5k Optitrack systems
Use Unity
1 K5000, i7
SDT Tools.