The Fundamentals of Stereoscopic 3D (S3D) Display Technologies for Virtual Reality, Film, and Video Games

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**Stereoscopic Vision (Stereopsis)**

- Stereopsis – “Solid Sight”
- Two Eyes
  - Interocular Distance (~2.5”)
  - Two Views
- Retinal Disparity
  - Fusion - Singleness of vision
- Limited Range (8”-30’)
- Stereo Blindness
  - ~12% of general population
**Stereoscopic Imaging (Stereoscopy)**

- **Simulation Process**
  - 1) Generate Left/Right Eye Images (Stereo Pair)
  - 2) Present Each Image to the Correct Eye

- **Interaxial Separation**
  - Normal (Interocular)
  - Hyperstereo (> normal)
  - Hypostereo (< normal)

- **Stereoscopy Artifacts**
  - Discomfort/Nausea
  - Fusion Failure (Loss of 3D)
Stereoscopic Displays

- Active Stereo
- Passive Stereo
  - Polarized Filtered
  - Color Filtered
- Autostereo
Active Stereo

- **Components**
  - Field Sequential Signal
    - Alternating Left/Right Images
  - LCD Shutter Glasses
  - Sync Signal
    - Wired
    - IR Emitter

- **Advantages**
  - Full Color
  - Single Projector/Monitor
  - Standard Screen or Monitor

- **Disadvantages**
  - Low Frame Rate Flicker
  - More Expensive and Heavier Glasses
  - Light Loss Due to Glasses
Passive Stereo – Polarized Filtered

• Components
  – Dual-projectors
  – Polarized filter
  – Polarized glasses
    • Linear Polarization
    • Circular Polarization
  – Silver Screen
    • Preserves Polarization

• Advantages
  – Full Color
  – Cheaper/Lighter Glasses
  – Reduced Flicker
  – Cheaper Projectors

• Disadvantages
  – Projector Synchronization and Alignment
  – Need Silver Screen
  – Light Loss Due to Filter and Glasses
Passive Stereo – Colored Filter

- **Components**
  - Color Filtered Stereo Pair
  - Color Filtered Glasses
- **Complementary Color Anaglyphic**
  - Color Pairs
    - Red/Cyan – Most Common
    - Blue/Green
    - ColorCode3D - Patented – Amber/Blue filter
      - 2009 Super Bowl Telecast
  - Advantages
    - Can Combine Stereo Pair into Single Image/Signal
    - Works for Prints, Images, and Video
    - Cheap Glasses
  - Disadvantages
    - Hard to Get Full Colors (Retinal Rivalry) – Best with Grayscale
- **Wavelength Multiplexing - (Infitec)**
  - Filters Divide Visible Spectrum into Six Bands
    - R1,G1,B1 - Left Eye, R2,G2,B2 - Right Eye
  - Can Achieve Full Color and Use Standard Projection Screen
Stereoscopic 3D Displays for Virtual Reality

- S3D Display Technology Based on VR System and Size of Audience

- Monitor (Fish Tank VR)
  - Active Stereo
  - Anaglyptic Stereo

- Head Mounted Displays (HMD)
  - Separate Left/Right Signals
  - Active Stereo Converted to Separate Signals

- Desks
  - Active Stereo

- CAVE
  - Active Stereo
  - Passive Rarely

- Walls/ Curved Screen
  - Active Stereo for Small Audiences
  - Passive for Larger Audiences
Stereoscopic Displays for Film and Video

- **Film**
  - **RealD**
    - 90% of World’s Stereo Capable Theaters
    - Active/Passive Hybrid
    - Single 144 Hz DLP projector
    - Z-Screen (Circular polarization)
    - Silver Screen
  - **IMAX 3D**
    - Dual-projectors
    - 70mm film format (switching to digital)
    - Linear polarization
    - Silver Screen
  - **Dolby 3D**
    - Infitec
    - Single Projector
    - Infitec Filter Wheel
    - Standard Screen

- **Broadcast TV**
  - Anaglyphic

- **DVD**
  - Anaglyphic
  - Some Active Stereo (computer based)
Stereoscopic Displays for Video Games

- **Next Wave of S3D**
  - “Avatar The Game” supports S3D
  - New PS3 S3D Games for 2010
  - NVIDIA – S3D Driver Game Support
  - 3D Ready TV’s

- **Active Stereo**
  - NVIDIA 3D Vision Bundle
    - Samsung SyncMaster (LCD 120 Hz)
    - LCD shutter glasses
    - IR Emitter

- **Anaglyphic**
  - NVIDIA 3D Vision Discover
    - Anaglyph (red/cyan) glasses