MULTIVIEW IMAGING & 3D/F TV

LOOKING FOR REAL VISION

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Pravin Kumar Rana

Sound and Image Processing Lab.(SIP)

KTH - Royal Institute of Technology

SE-10044 Stockholm, Sweden

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Outline

- Exciting Applications
- Capturing & Representation
- Rendering & Displays
- Coding & Transmission
- Future Directions

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Exciting Applications

Three Dimensional TV

Which goal post side you want to seat ?

Free Viewpoint TV

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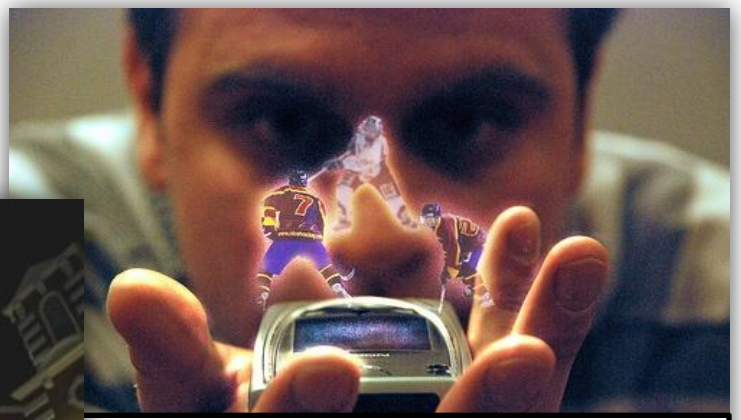
Exciting Applications

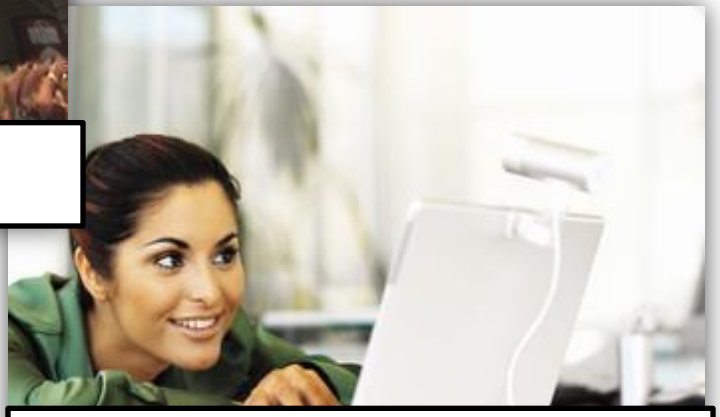
Home Entertainment



Mobile Applications

Advertisements

Interactive Gaming



Internet TV/VoIP/IPTV

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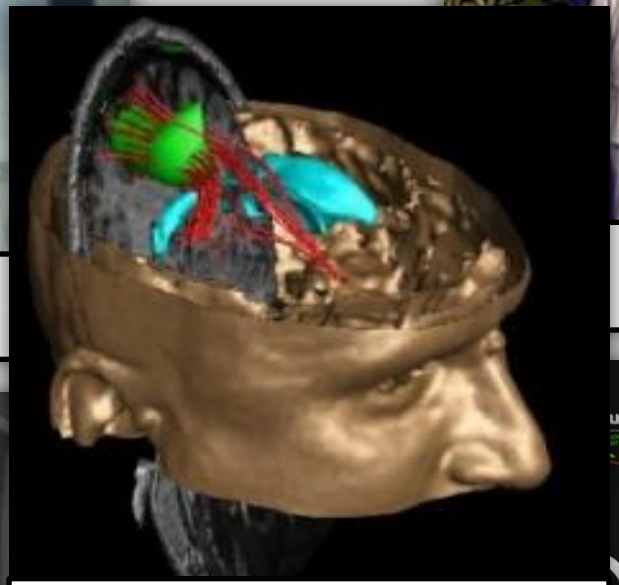
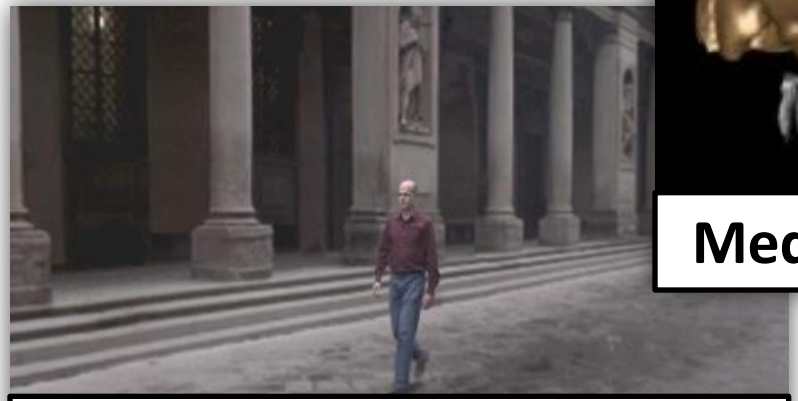
Exciting Applications

Security

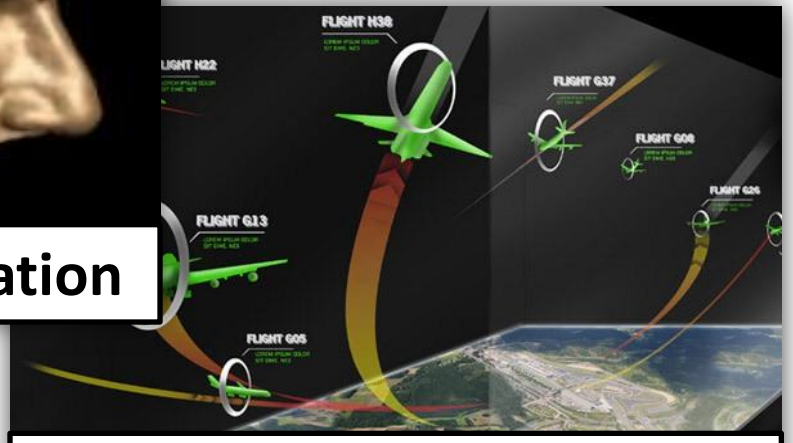


Medical Application

Telepresence



Virtual Real Time Tourism



Air Traffic Control

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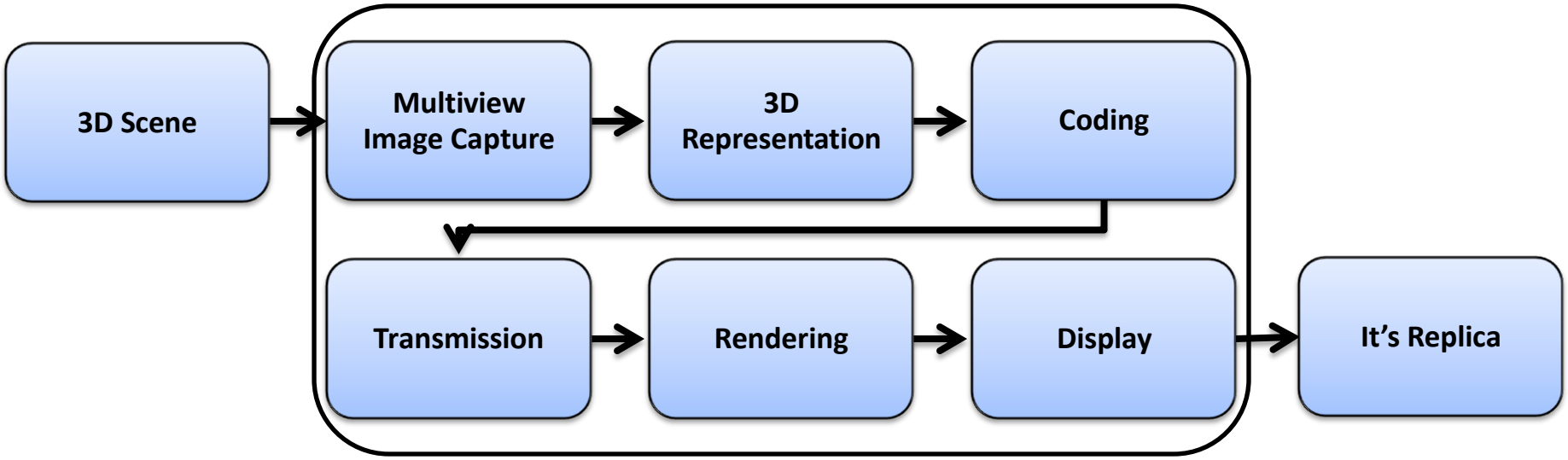
A 3DTV/FTV System



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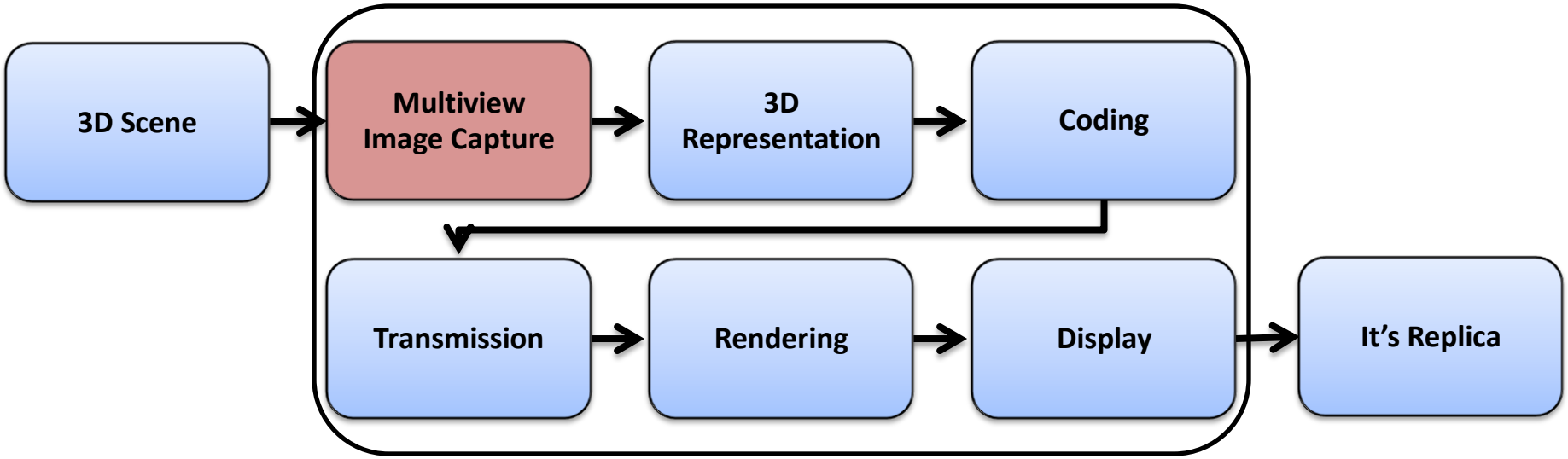

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Classical Imaging

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Multiview Imaging

- **Recording all light rays traveling from an object's surface to arbitrary observer positions**

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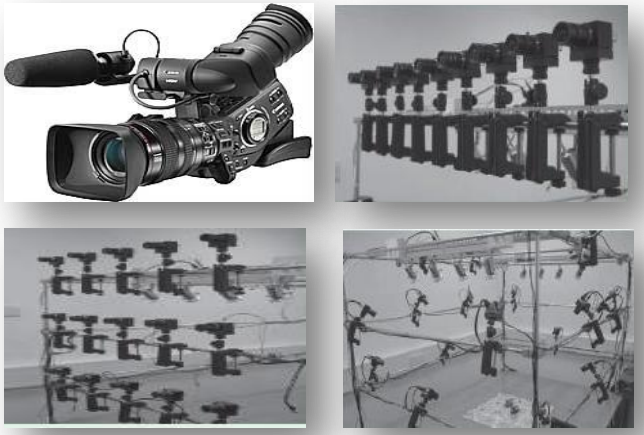
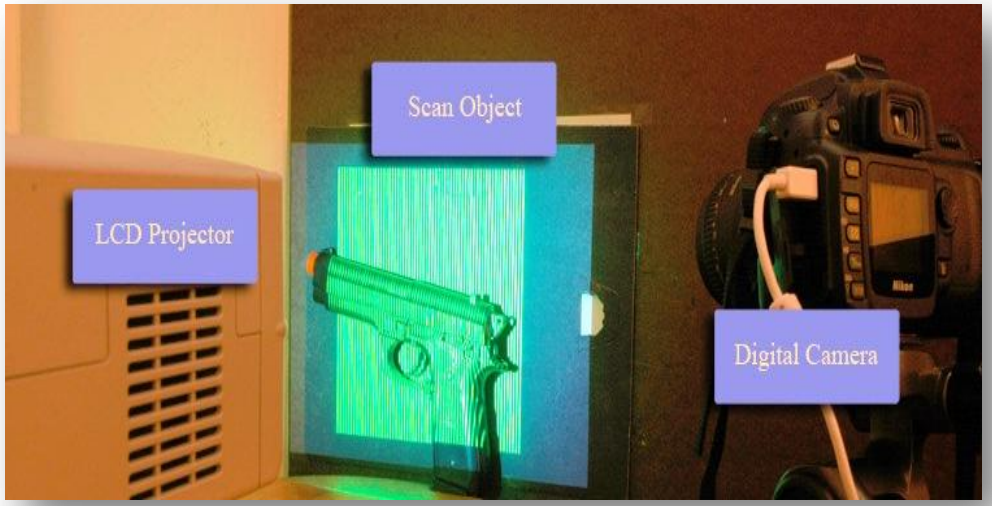
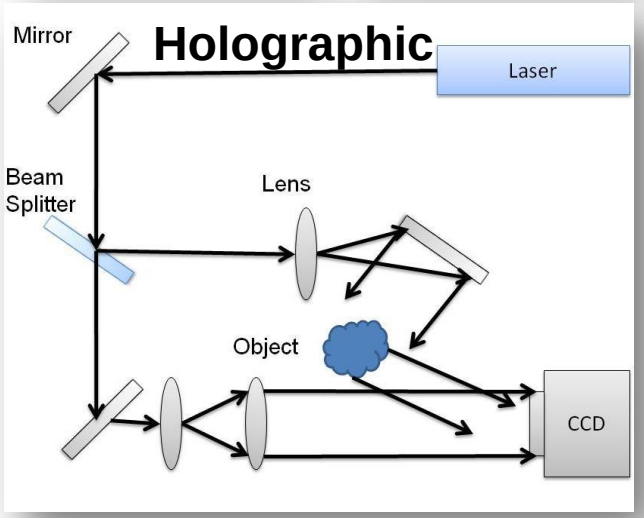
Capturing Multiview

- Single camera
- Multi camera
- Holographic
- Pattern projection







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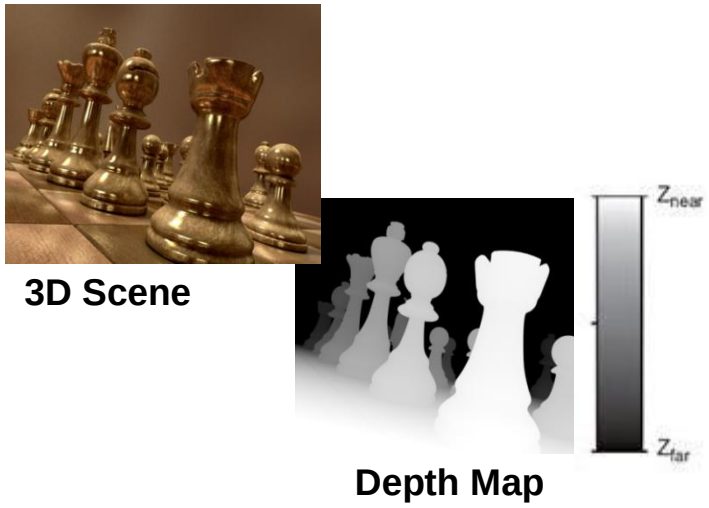
Capturing Depth Scenes

- **Techniques**
  - Time of flight
- **Advantages**
  - Depth map in real time
  - Tracking of moving objects
  - Texture-independent
  - Requires minimal processing
- **Drawbacks**
  - Aliasing effect



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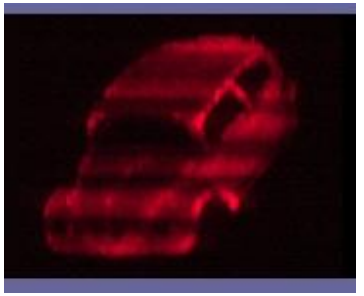
Capturing Challenges

- **Multi-camera**
  - Density
  - Synchronization
  - Color inconsistency
- **Holographic**
  - Image resolution
  - Data storage/ retrieval speed
  - True color recording
- **Pattern projection**
  - Color recognition
  - Noise sensitive



Courtesy: MIT Media Lab

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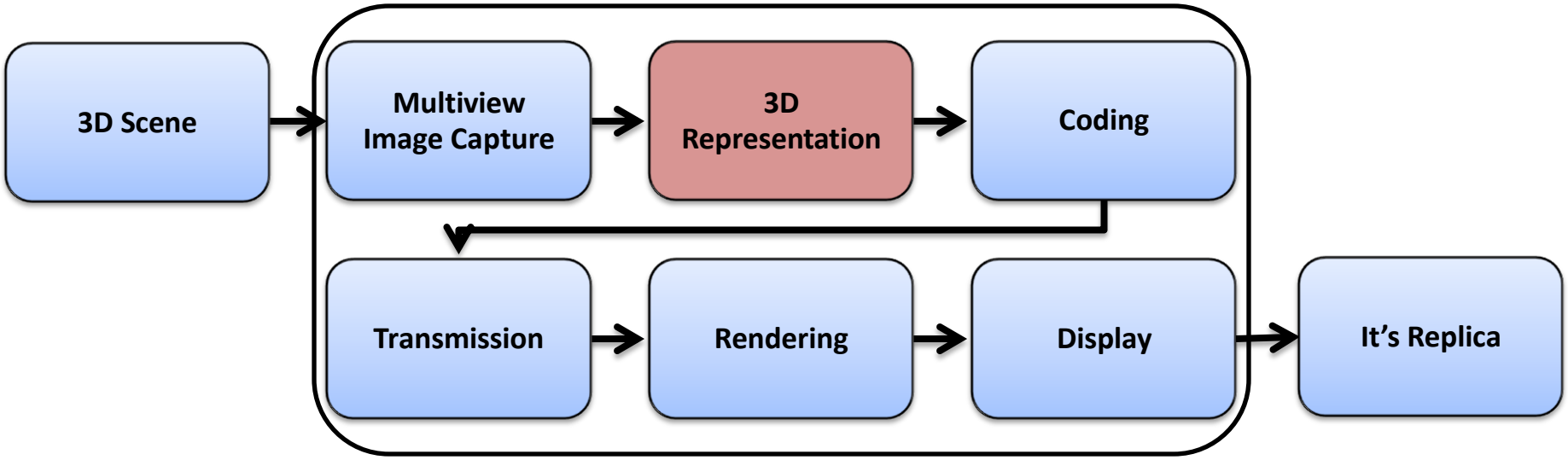
A 3DTV/FTV System



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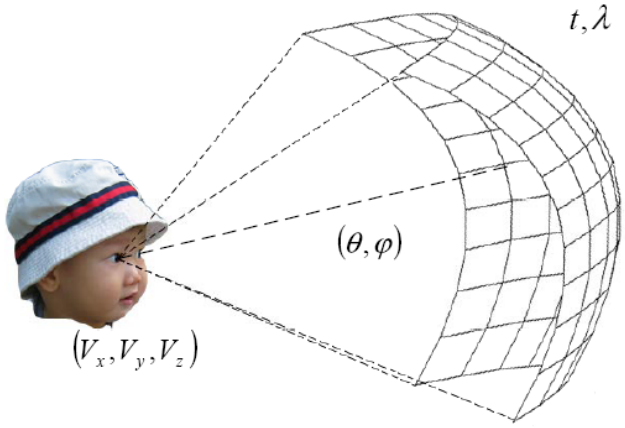
3D Scene Representation

- **Image based representation:** By using a set of images reproduce the scene correctly at an arbitrary viewpoint
- **Plenoptic function**

$$P = P_7(\theta, \phi, \lambda, t, V_x, V_y, V_z)$$



- **Techniques**
  - Light field / Lumigraph
  - Concentric mosaics
  - Panorama
  - Image mosaicing

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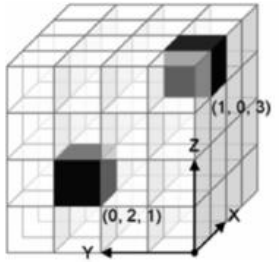
3D Scene Representation

- **Geometry based representation:** Real world objects represented by using geometric 3D surfaces with an associated texture
  - **Dense Depth Representation**
    - Represented by a number of views with associated depth maps
  - **Surface Representation**
    - Polygonal meshes
      - Arbitrary triangular mesh
    - Point-based representation
      - Context dependent dimensionless space point
  - **Volumetric Representation**
    - Voxel : the smallest amount of space with the properties of the surface



(Alatan, 2007)

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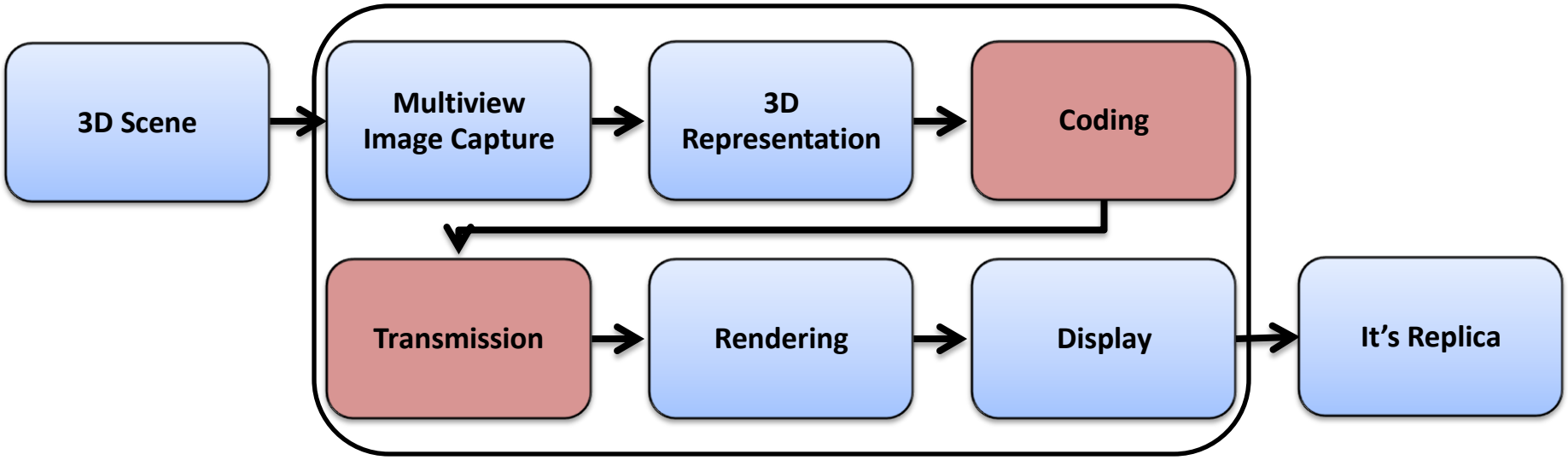
A 3DTV/FTV System



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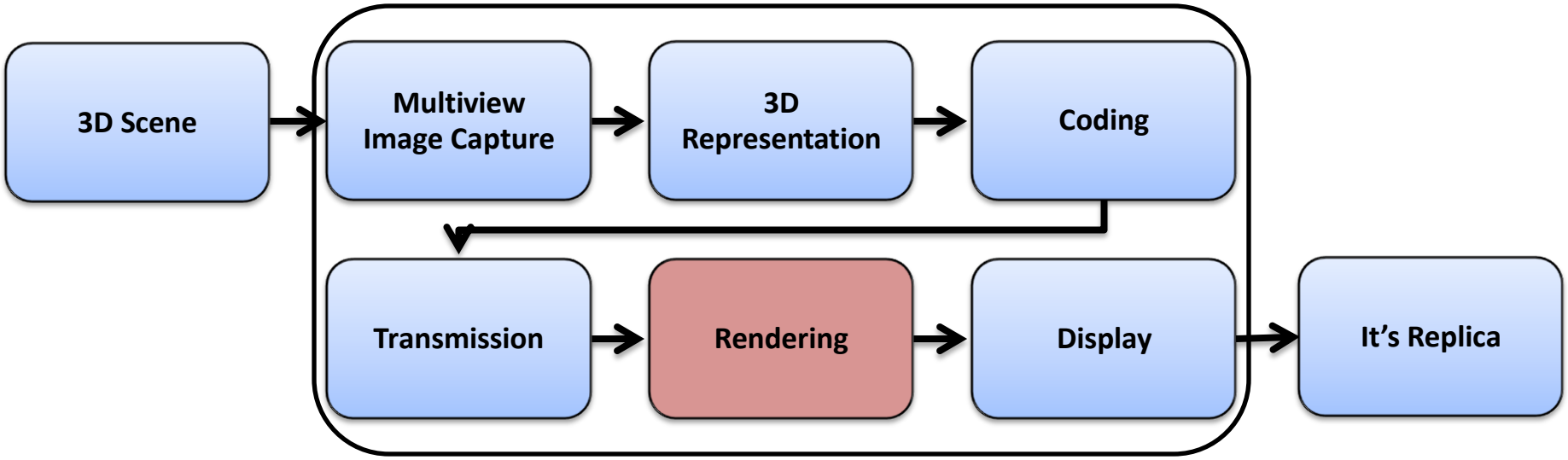

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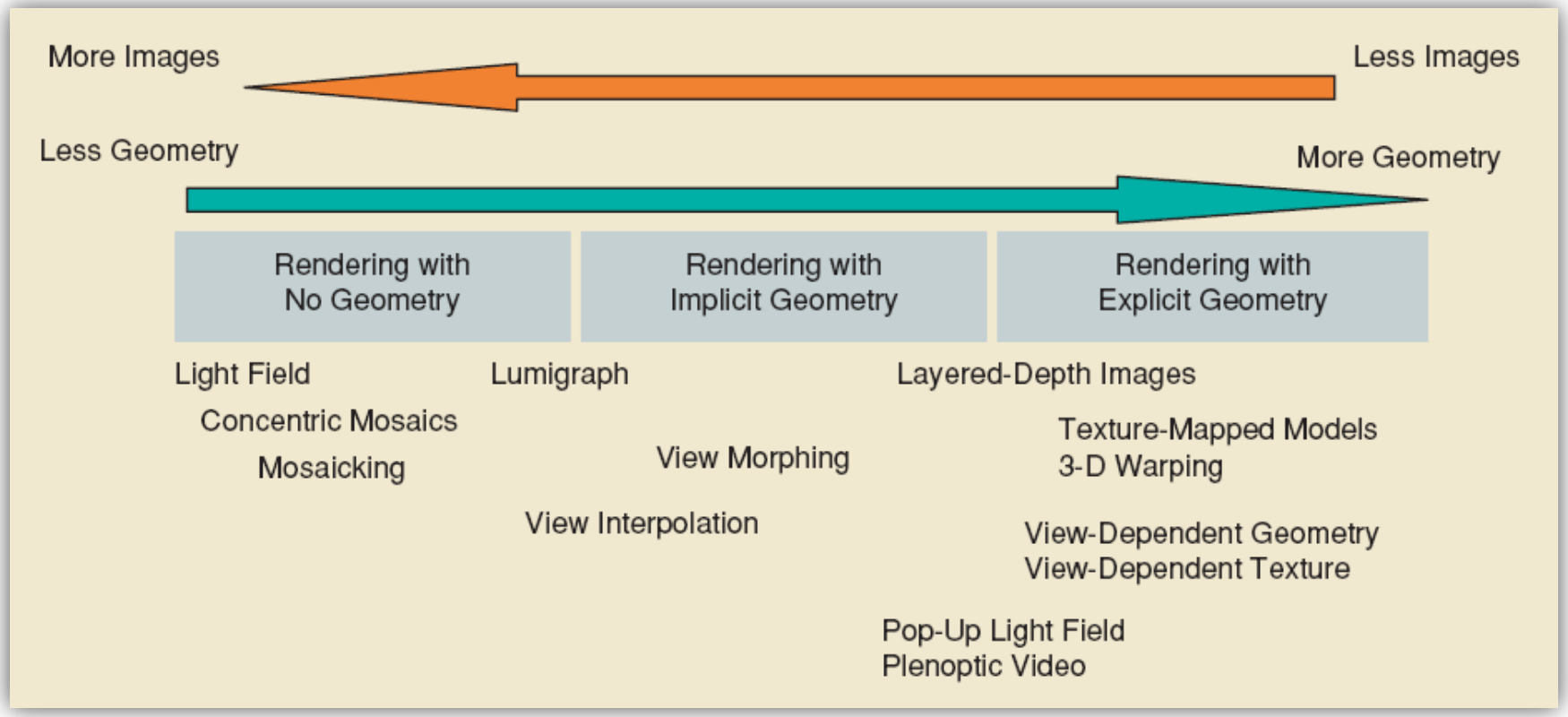
Rendering



Spectrum of Rendering Techniques

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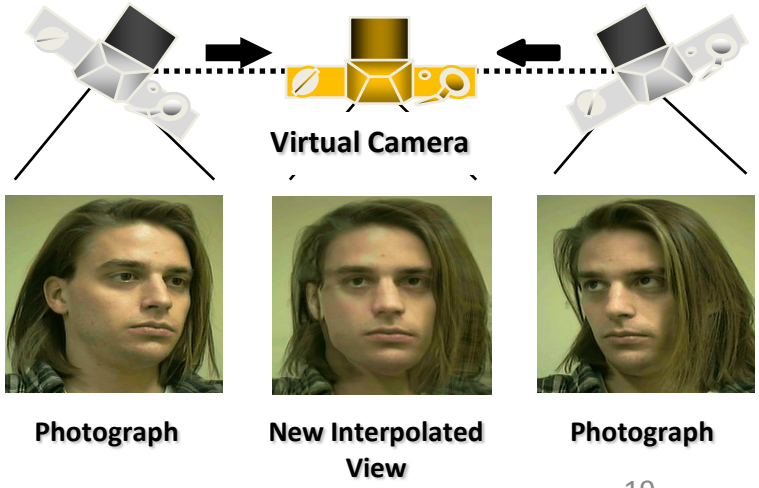
Image Based Rendering

- Used a collection of sample images to render novel views
- Based on interpolation or pixel re-projection
- Speed and cost independent of scene complexity
- Modest computation compared to computer graphics
- **Challenges**
  - Trade off between images and geometry
  - Limitation on viewpoint
  - How to reduce data effectively?



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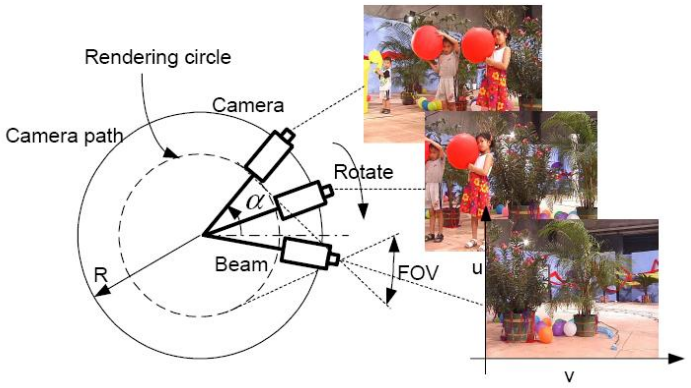
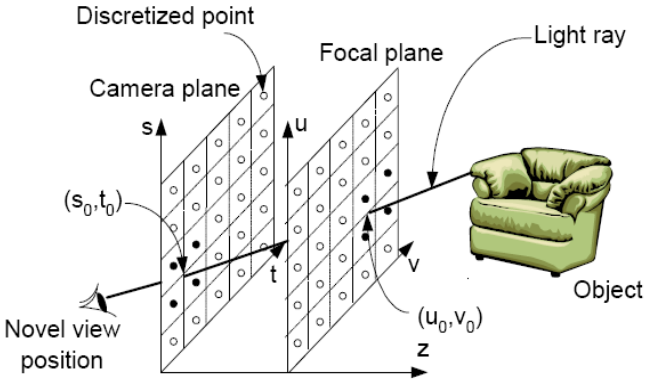
IBR Techniques

- **Concentric mosaics**
  - Slit-based rendering
  - Significant horizontal parallax
  - Lighting changes
  - Vertical distortion



- **Panoramas**
  - 360º field of view
  - Rendering from cylindrical/spherical projected images to planar projected images

- **Light fields /Lumigraph**
  - Static geometry
  - Fixed lighting



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Model Based Rendering

- Input = detailed description of real world objects
- Generates any viewpoint
- Rendering cost and speed dependent on scene complexity
- Very fast rendering on graphics hardware
- **Challenges**
  - Measuring reflectance properties of objects from image
  - A Separate model for each type of subject /object
  - High Cost and time consuming
  - Complex and human assistance

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MBR Techniques

- **Layered Dense Depth**
  - Reliable dense depth extraction
  - Graphical realism
- **Polygonal Meshes**
  - Object meshes : containing millions of polygons
  - Represent any geometric surface detail
- **Point based rendering**
  - Context dependent dimensionless space point
  - No topology or connectivity information

(Alatan, 2007)

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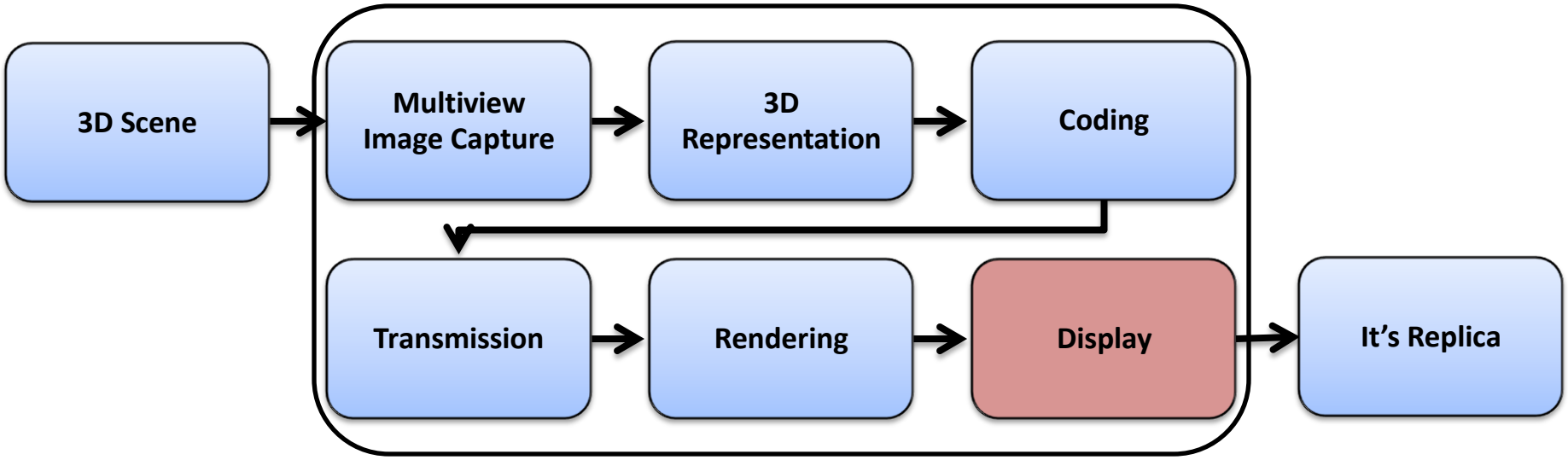

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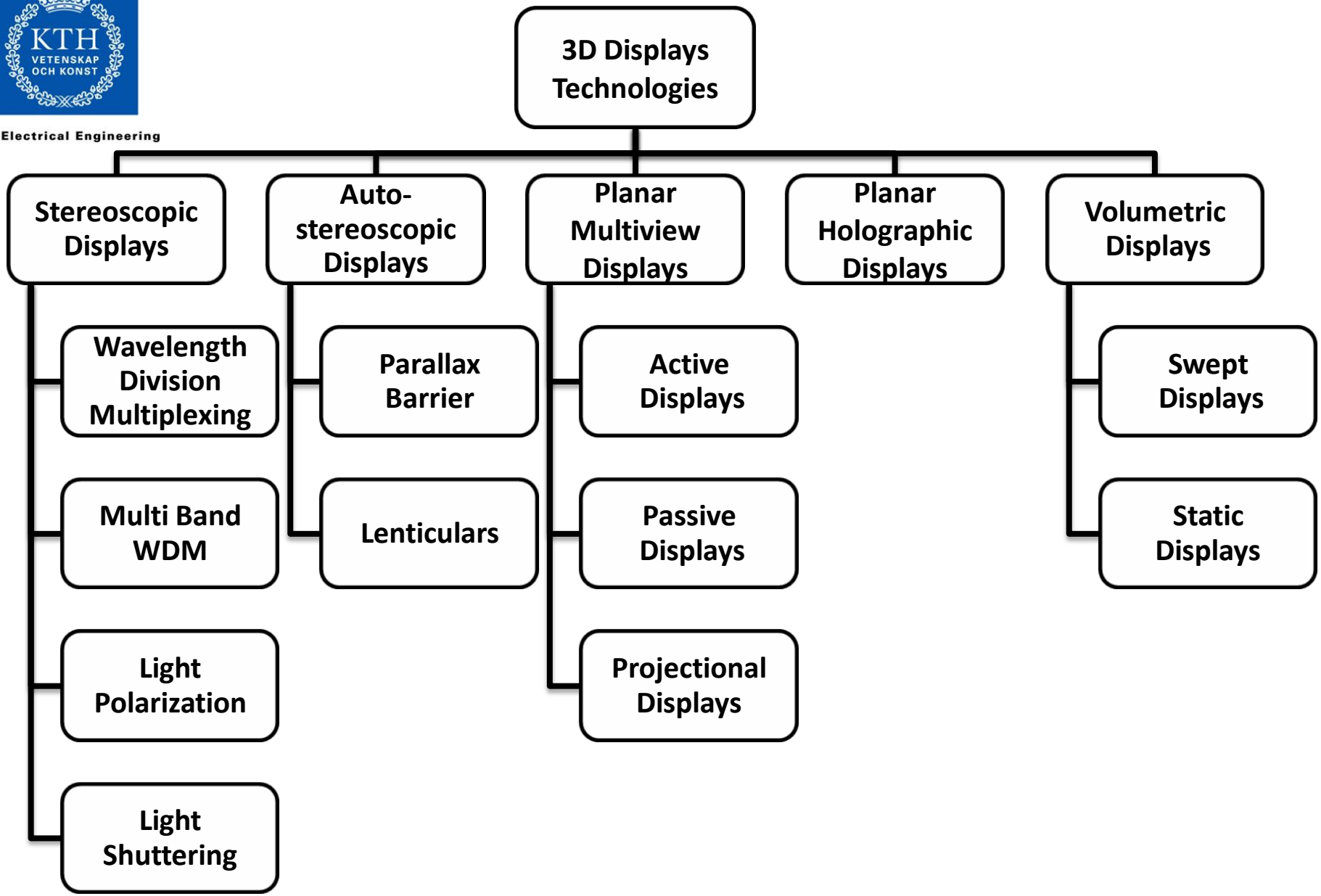

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Stereoscopic Displays

- **Techniques**
  - Anaglyph Method: Wavelength Division Multiplexing(WDM)
  - Multi Band WDM
  - Light polarization
  - Light shuttering
- **Advantages**
  - Used on any device reproducing color
  - Mass viewers
- **Drawbacks**
  - Need of special glasses
  - **Visual discomfort**
    - Optical crosstalk
    - Projector alignment

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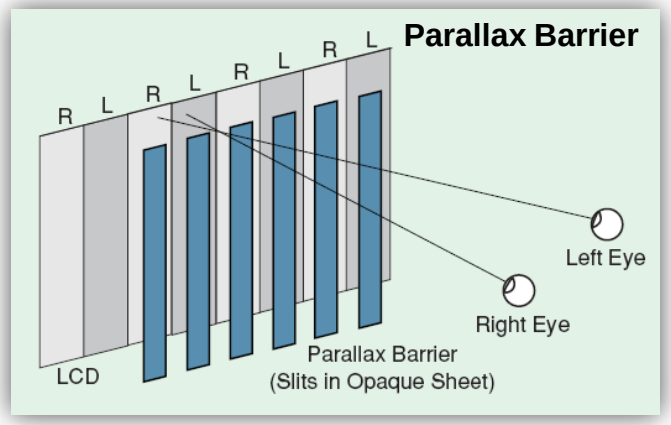
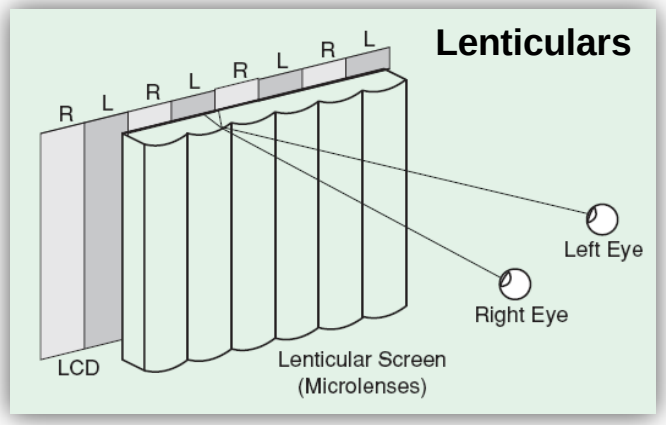
Auto-stereoscopic Displays

- **Techniques**
  - Parallax barrier displays
  - Lenticulars displays
- **Advantages**
  - No glasses
  - Applicable to electronic displays
- **Drawbacks**
  - Optical crosstalk
    - Visual confusion/discomfort
  - Light output
  - Horizontal resolution loss





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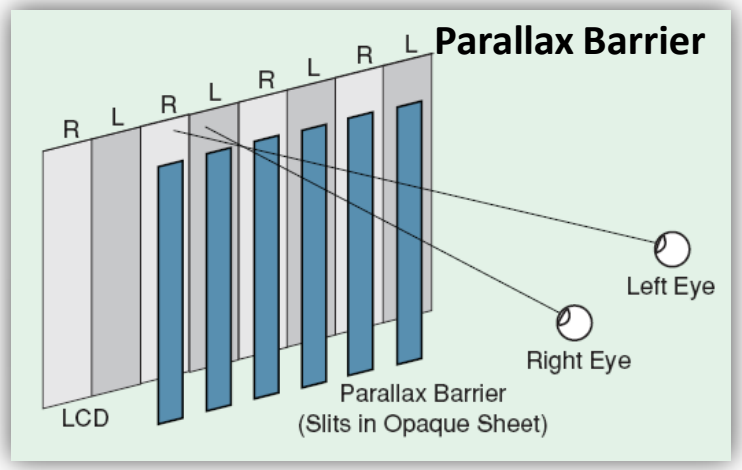
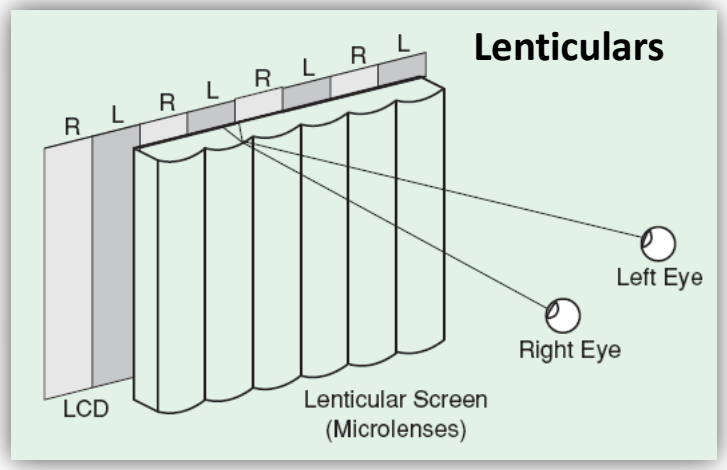
Planar Multiview Displays

- **Active Multiview Displays**
  - Single viewer Displays
  - Irregular multiplexing
- **Passive Multiview Displays**
  - No head tracking
  - Horizontal Parallax only
  - Aliasing artifacts





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Planar Multiview Displays

- **Projectional Multiview Displays**
  - Full spatial resolution for each viewer
  - Flexible choice of number of view zones

(Courtesy: Fraunhofer Institut für Nachrichtentechnik, Heinrich-Hertz-Institut, Germany)

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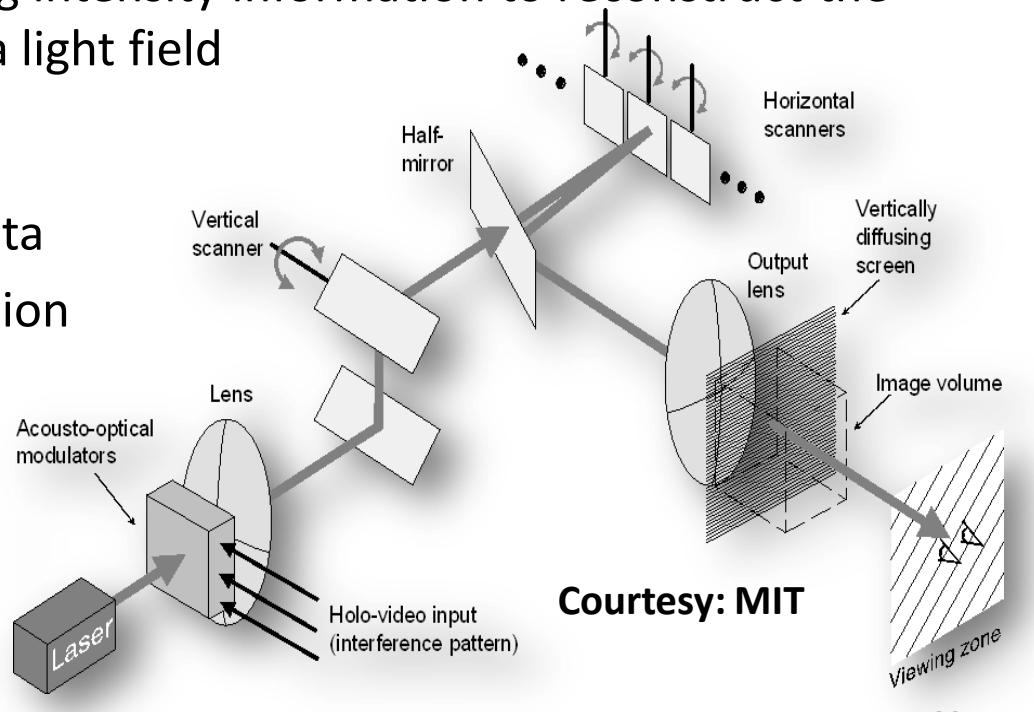
Planar Holographic Displays

- **Techniques**
  - Diffraction of light by a computed holographic "fringe" pattern
- **Advantages**
  - Use spatially/phase varying intensity information to reconstruct the intensity and direction of a light field
- **Drawbacks**
  - Record large amount of data
  - Fringe pattern decomposition
  - Resolution
  - Color reproduction
  - Information reduction



Courtesy: MIT

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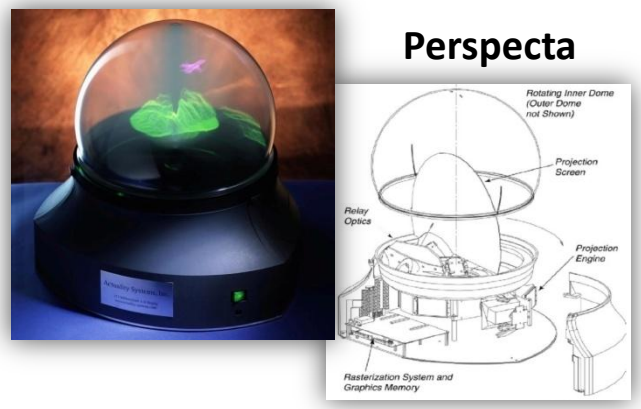
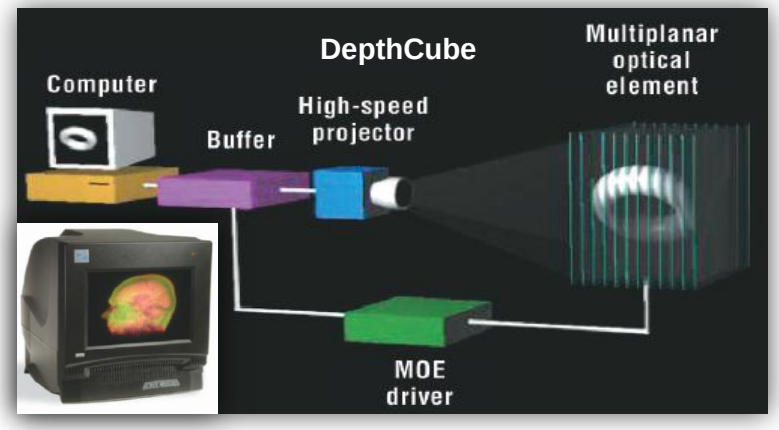
Volumetric Displays

- **Techniques**
  - 360° Viewing Angle
  - **Swept volume displays**
  - **Static volume displays**
- **Advantages**
  - Real depth cues
  - Allows multiple simultaneous viewers
- **Drawbacks**
  - Single addressable intensity value
  - Complex computation
  - Transparent images



(Courtesy: Actuality Systems)



(Courtesy: LightSpace Technologies)

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Outline

- Exiting Applications
- Capturing & Representation
- Rendering & Displays
- **Coding & Transmission**
- **Future Directions**

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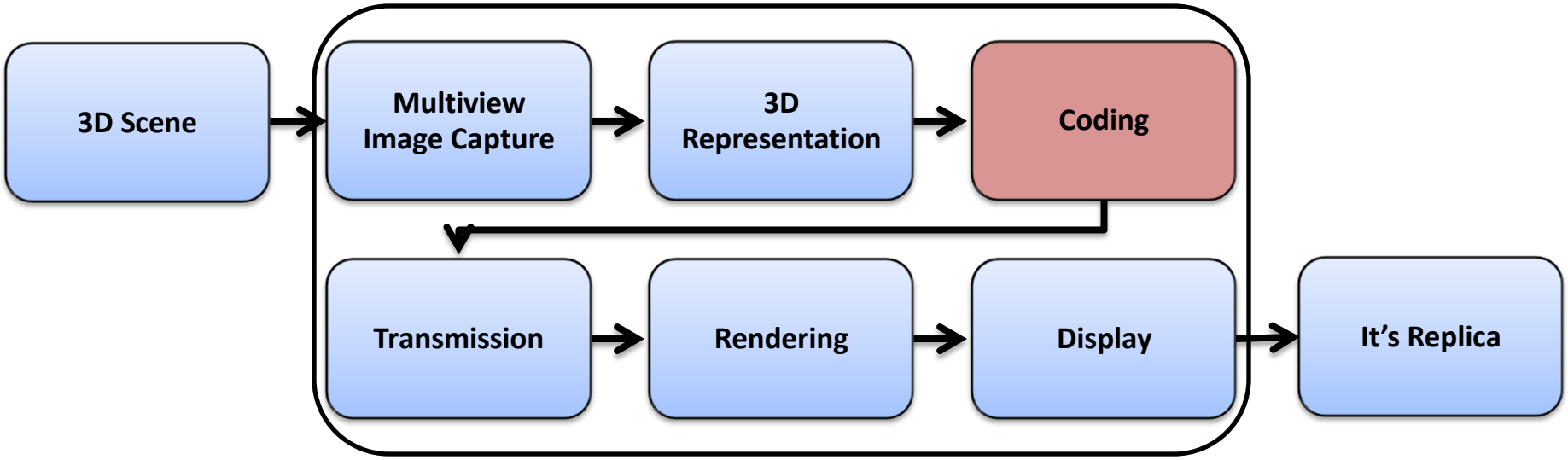
A 3DTV/FTV System



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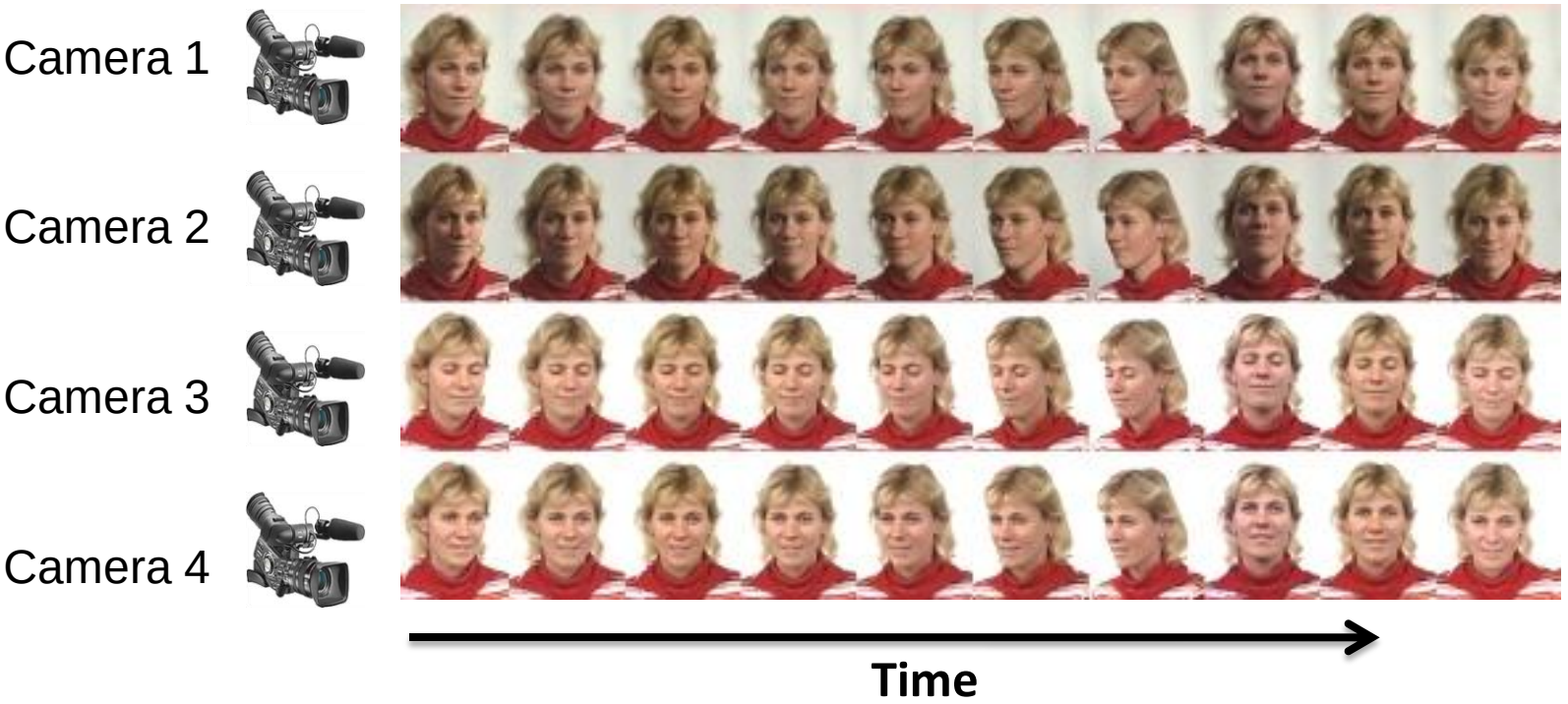
Coding Techniques

- **Multiview video coding**
  - Exploiting similarities among the multiview video images



(Markus Flierl and Bernd Girod, 2007)

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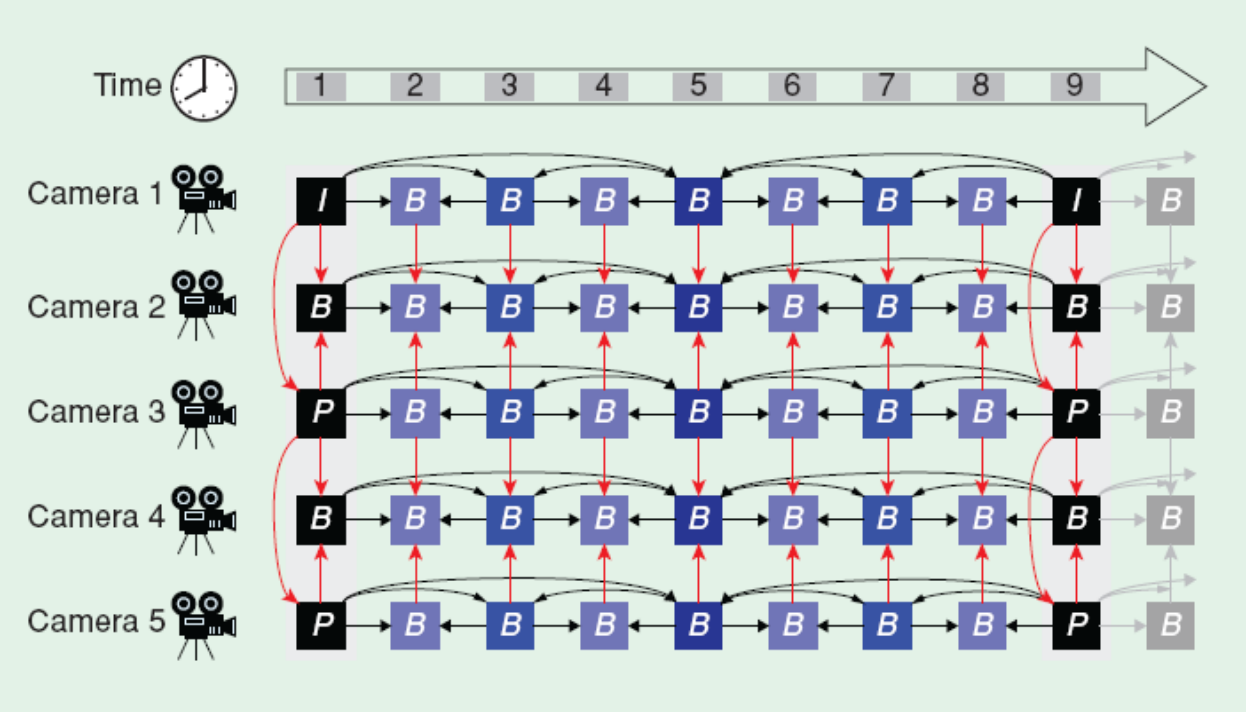

(Flierl and Girod, 2007)

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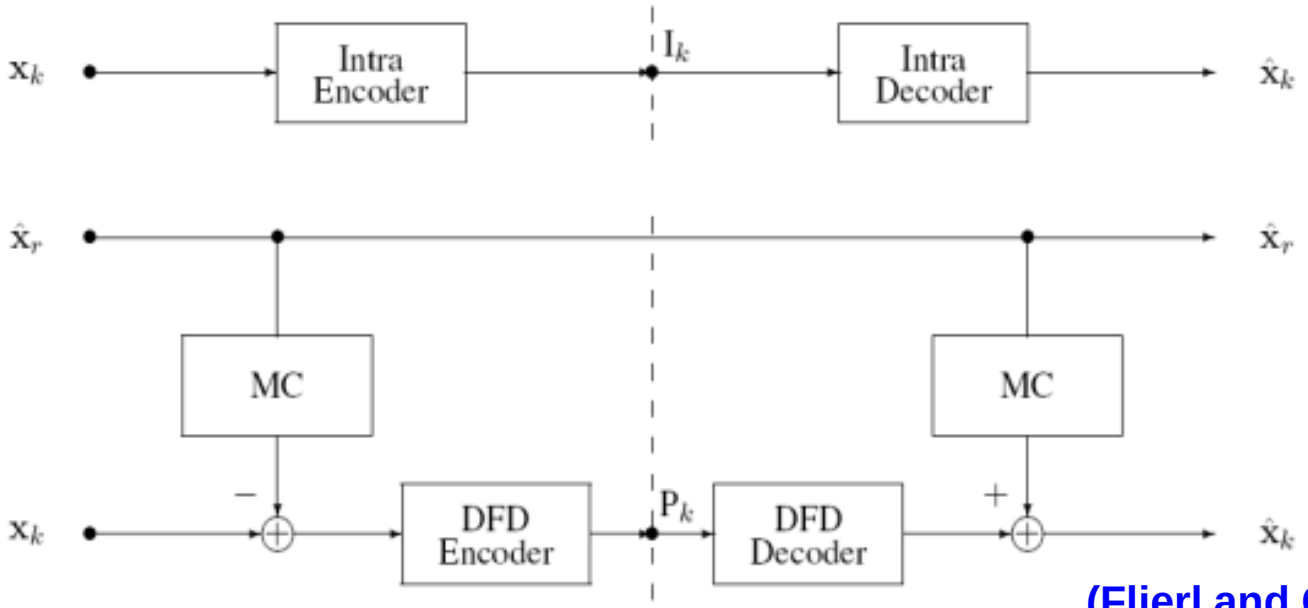
Coding Techniques

- **Multiview video coding**
  - Exploiting similarities among the multiview video images
  - **Motion compensated predictive coding**
    - Process images sequentially



(Flierl and Girod, 2007)

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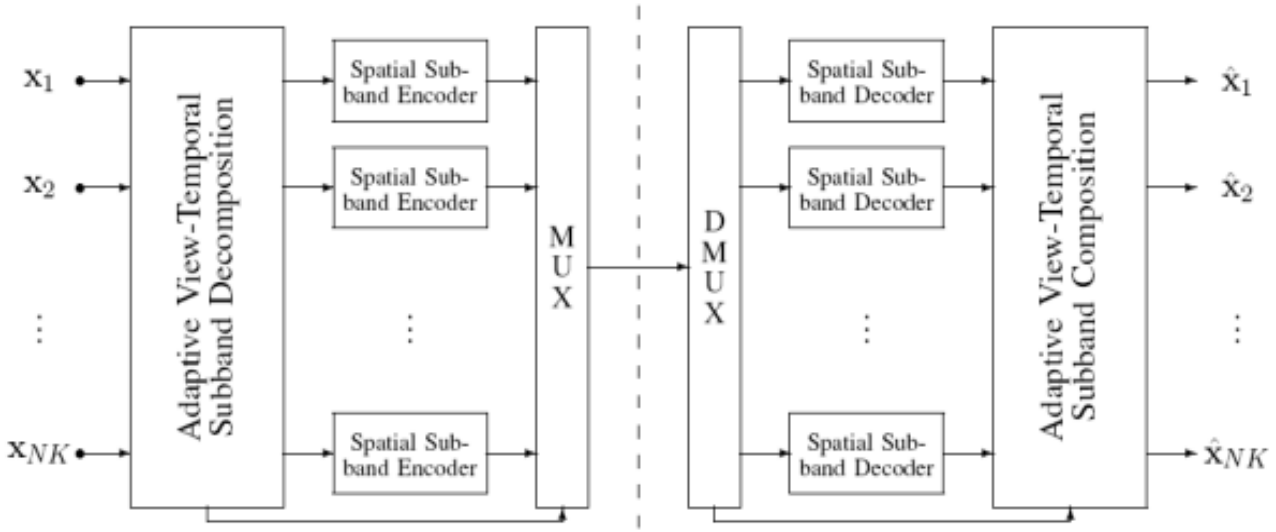
Coding Techniques

- **Multiview video coding**
  - Exploiting similarities among the multiview video images
  - **Motion compensated predictive coding**
    - Process images sequentially
  - **Motion- and disparity-adaptive subband coding**



(Flierl and Girod, 2007)

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Coding Techniques

- **Multiview video coding**
  - Exploiting similarities among the multiview video images
  - **Motion compensated predictive coding**
    - Process images sequentially
  - **Motion- and disparity-adaptive subband coding**
- **Constraints**
  - Robustness
  - Flexible adaptations
  - Delay and memory requirements
  - Random access requirements

(Flierl and Girod, 2007)

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Coding Techniques

- **Depth based coding**
  - Using depth map converting 2D image into 3D image
  - **Single View video + depth**
  - **Multiview Video + depth**
  - Limited user navigation
  - Strong visual distortions during navigation
  - Visible depth discontinuities

Original **View/depth coding ratio: 1/1** **4/1**

(Müller et al., 2007)

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Coding Techniques

- **3D Mesh Based Coding**
  - **Free navigation**: *Any viewpoint possible*
  - Animated triangle mesh based
  - **3D Geometry Compression**
    - Exploitation of Spatial/Temporal Statistical Dependencies
    - Static Mesh Compression
    - Dynamic Mesh Compression
  - **Texture Compression**
    - Single texture
      - Lake of natural lighting and illumination changes
    - Multitexture
      - Exploitation of Spatial/Temporal Statistical Dependencies

(Müller et al., 2007)

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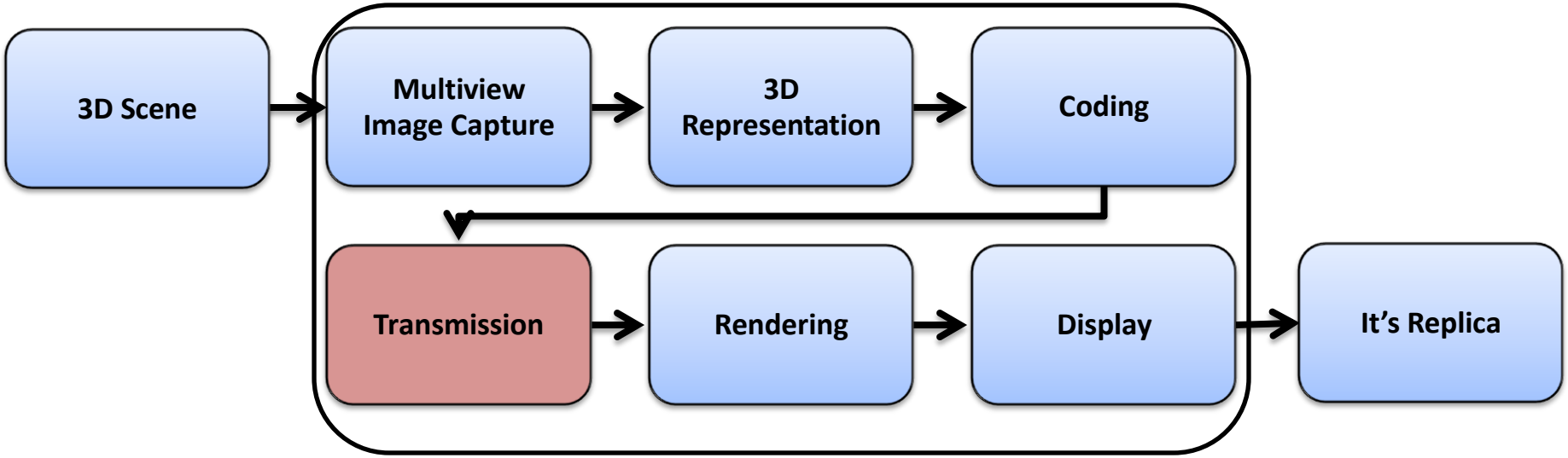
A 3DTV/FTV System



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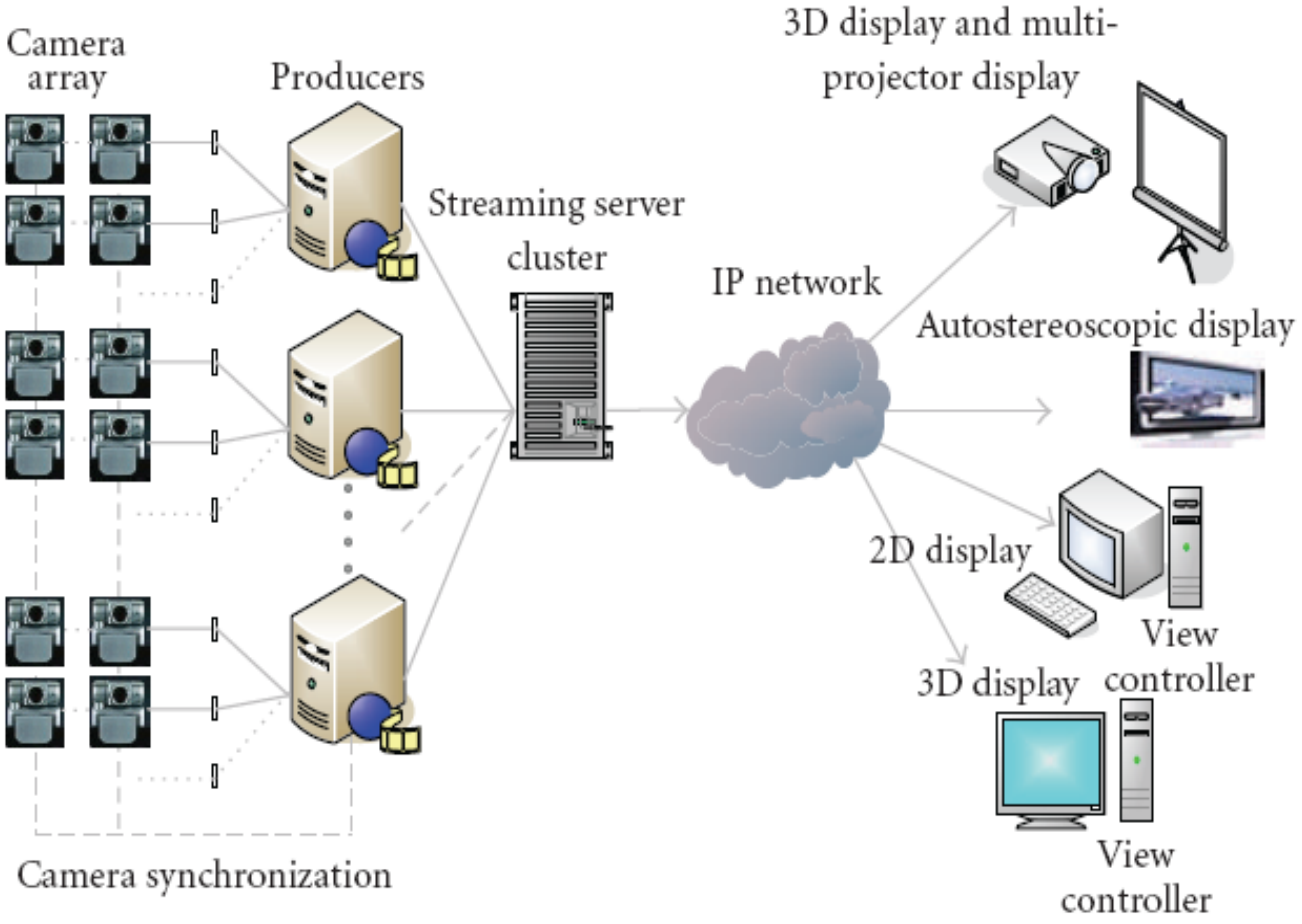
Multiview Over IP



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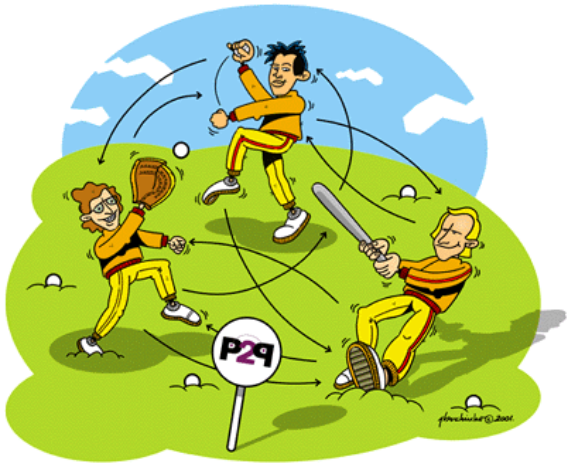
Transmission Challenges

- **Bandwidth requirement**
  - Transmitting 16 uncompressed video streams with 1300×*1030 resolution* and 24 b/p at 30 f/sec requires 14.4Gb/sec bandwidth
- **Transmission bit rate**
- **Network distribution**
  - **Server based network**
    - Server unicasting to one or more clients
    - Server multicasting to several clients
  - **Peer-to-peer(P2P) network**
    - Economical delivery of MVV
    - P2P unicast distribution
    - P2P multicasting



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Conclusion

- Technology for multiview video (MVV) processing chain from capture to display is maturating, enabling the end to end transmission in the near future

- Compression of MVV has been addressed in the MVC standardization activities based on H.264/AVC video coding standard

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Future Directions

- Need to focus more on multiview video coding , depth based coding, point based coding and 3-D mesh coding
- Need to improve the exploitation of inter-view dependencies in MVV compression
- Need to investigate approaches for reconstructing dynamic representations of real world scenes from a set of video streams
- Need best video encoding configuration for each streaming strategy with better error cover up methods at the receiver end
- Need best P2P multicasting design methods