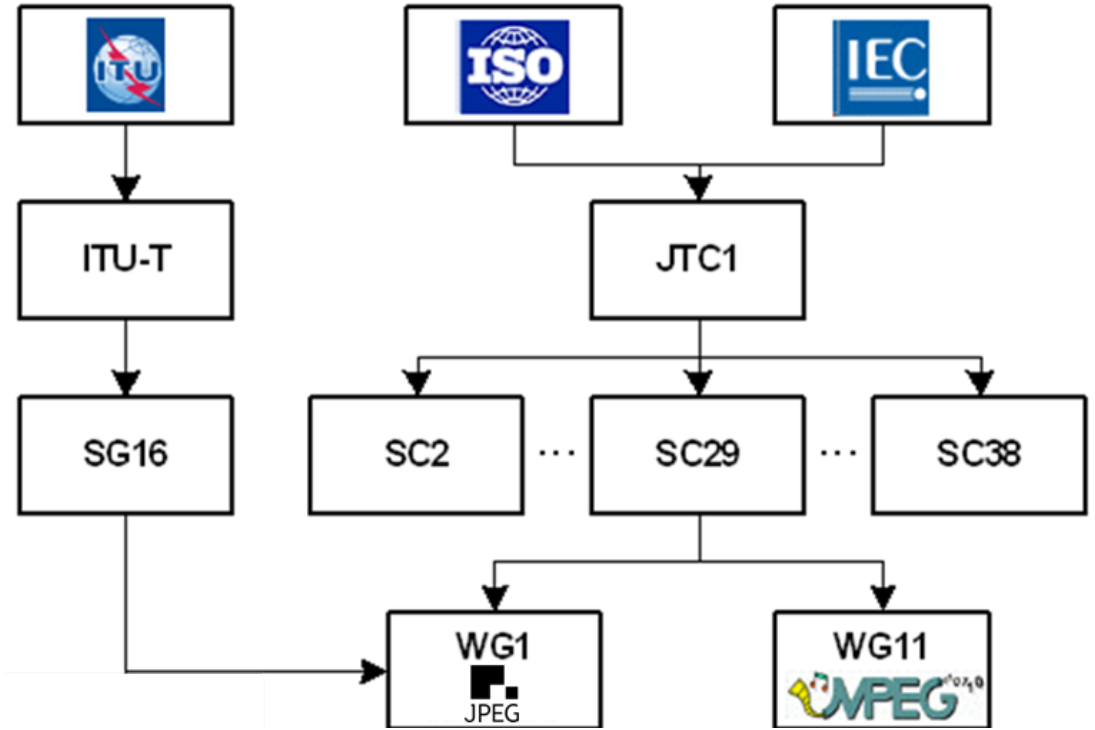
JPEG Pleno

Reinventing the world of imaging

Walt Husak
Dolby Labs

What is JPEG?

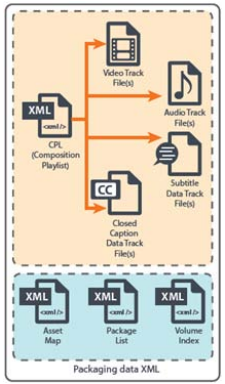


- Joint Photographic Experts Group
  - ISO/IEC
  - ITU-T
- Informally known as JPEG
  - WG1 in official communications

JPEG and Hollywood

- 2004 – DCI selects JPEG2000 as the D-Cinema Image Codec
- 2005 – ISO/IEC 15444-1 AMD1 published
- 2008 – Studios requests Broadcast Profiles
- 2010 – ISO/IEC 15444-1 AMD3 published
- 2012 – SMPTE requests IMF Profiles
- 2014 – ISO/IEC 15444-1 AMD7 published
- 2015 – Newest revision published with comprehensive support for Hollywood-centric applications

MXF and IMF



- Common Format for Media Exchange
- B2B media delivery

D-Cinema

- D-Cinema Release Packages
  - 2K and 4K images
  - Stereoscopic Pairs
  - High Frame Rate

Broadcast

Broadcast Network

Local Station

Common themes

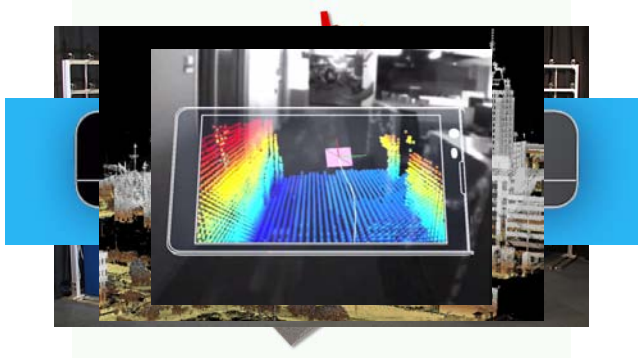
- Still image formats are invaluable for production, post-production and distribution communities
  - Allows editing
  - Robust to concatenation cycles
  - Simpler interchange between facilities
  - Allows multiple versions to be distributed with downstream edit lists

Should pictures be flat?

- Image capture, exchange and display has largely been planar since man began drawing in caves
- Is it time to move on?
- What does it take?

Capturing reality

- Large number of capture devices
  - Ranging
  - Stereographic
  - Plenoptic
  - Multi-array
- Professional and consumer
- Military and Commercial
- Microscopic to city satellite
- No Common Exchange Format

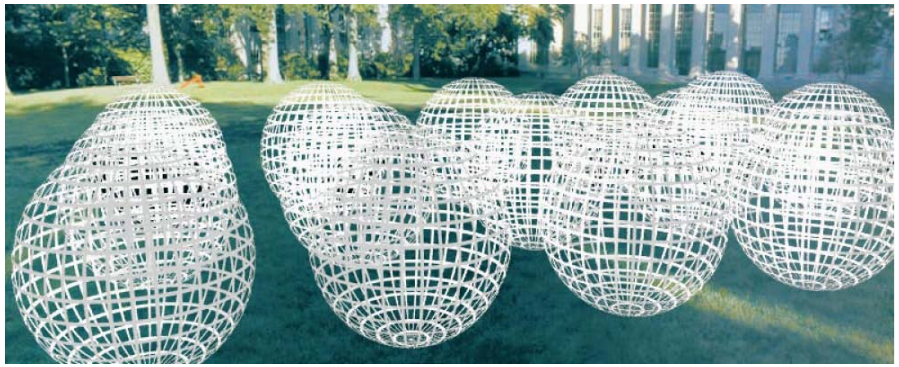


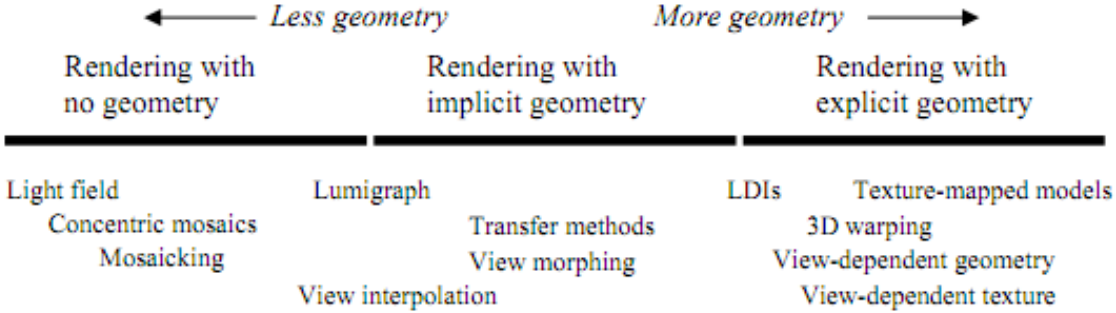
Rendering/viewing reality

- Large number of display devices
  - Planar
  - HUD
  - Stereoscopic
  - Multiview
  - Holographic
- Professional and consumer
- Military and Commercial
- No Common Exchange Format

Plenoptic representation

- 7D function $P_f(x,y,z,\theta,\phi,\lambda,t)$
  - spatial position *(x,y,z)*
  - viewing direction (θ,ϕ)
  - wavelength (λ)
  - time *(t)*

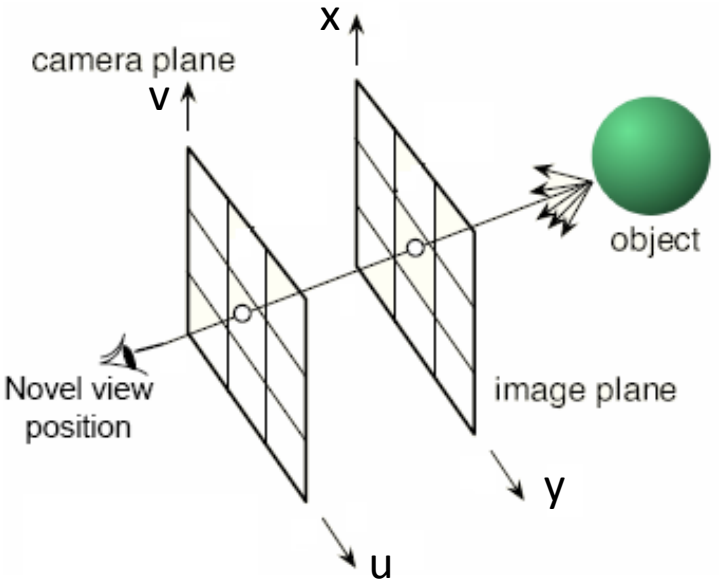




Simplification of plenoptic function

4D light field

- λ represented by R, G, and B components
- Static scene (no t)
- Assume intensity constant along a ray of light



Elements of an ecosystem

Generation

Consumption

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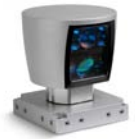
Post production
Preparation
Archiving

Distribution

Rendering
Display
Remuneration

What is missing?



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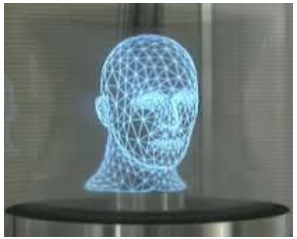


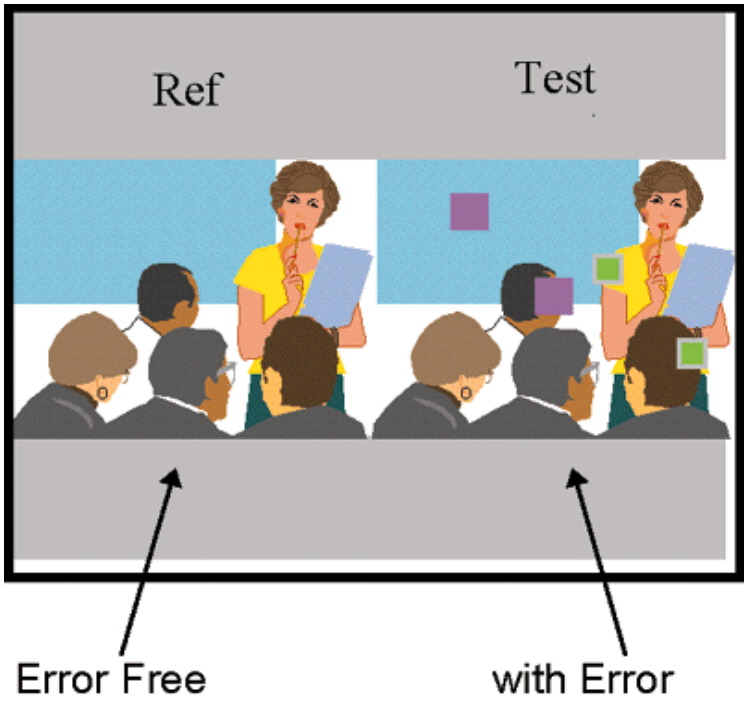
What else do we need?

- How good is one method or proposal over another?

Testing Experts

- Subjective tests are vital for validation
  - Test methods
  - Test facilities
  - Peer review

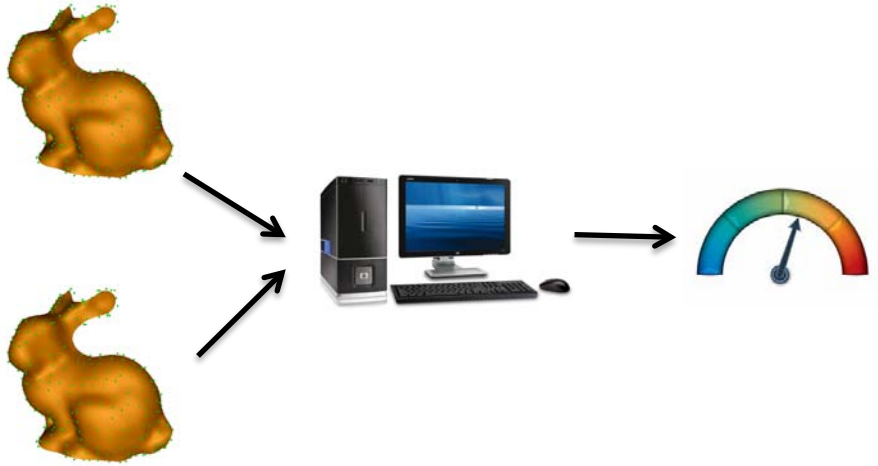
- New modalities
  - Point clouds
  - Light fields
  - Volumetric



Testing Experts

- Objective tests are vital for development
  - Subjective tests are resource intensive
  - Difficult to use for technology development

- Correlation needed between subjective and objective tests



JPEG has some of the world's leading experts in subjective and objective testing

JPEG Pleno scope

JPEG Pleno
targets a standard framework for the representation and exchange of new imaging modalities such as light-field, point-cloud and holographic imaging.

JPEG Pleno design principles

- One or limited number of representation models
- A framework with a system architecture
- Specific coding tools for specific modalities
- Well defined, specific and useful milestones
- Where needed, backward compatible with legacy JPEG

JPEG Pleno Workshop

Warsaw, Poland – June 23rd, 2015

14:00 Touradj Ebrahimi (JPEG Convenor - EPFL): *"JPEG PLENO - Introduction and Scope"*

Light-fields

14:15 Christian Perwaß (Raytrix GmbH, Germany): *"Metrically Calibrated Multi-focus Plenoptic Camera and its Applications"*

14:40 Joachim Keinert (Fraunhofer IIS, Germany): *"Lightfield media production using camera arrays - use cases and requirements"*

14:55 Peter Kovacs (Holografika, Hungary): *"Light Field Displays"*

15:20 Atanas Gotchev (Tampere University of Technology): *"Content creation for light-field displays"*

15:35 Roger Olsson (Mid Sweden University): *"Objective evaluation and SotA compression solutions for plenoptic image content"*

15:50 Discussion on compression of light field data (Requirements, use cases, technologies)

Point-clouds

16:30 Rufael Mekuria (CWI Netherlands): *"Point Cloud Compression"*

16:45 Discussion on compression of point cloud data (Requirements, use cases, technologies)

Holography

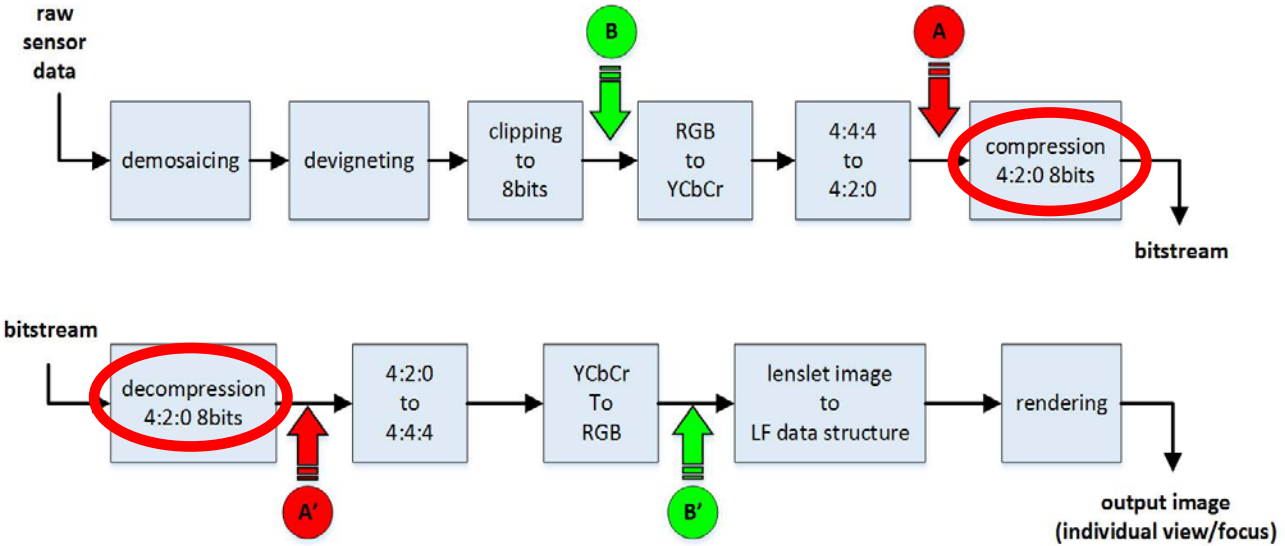
16:55 Małgorzata Kujawinska (Warsaw University of technology): *"Holographic capturing and rendering systems, suitable data representations for phase and amplitude"*

17:10 Frederic Dufaux (TELECOM ParisTech, France): *"Digital Holography Compression"*

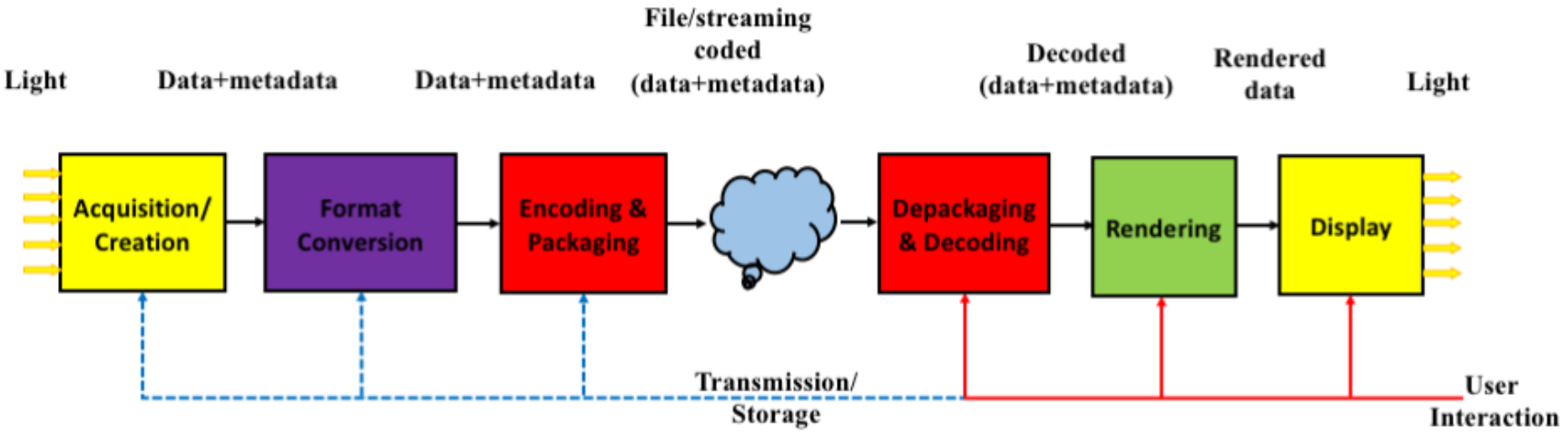
17:35 Discussion on compression of holographic data (Requirements, use cases, technologies)

17:50 Conclusions

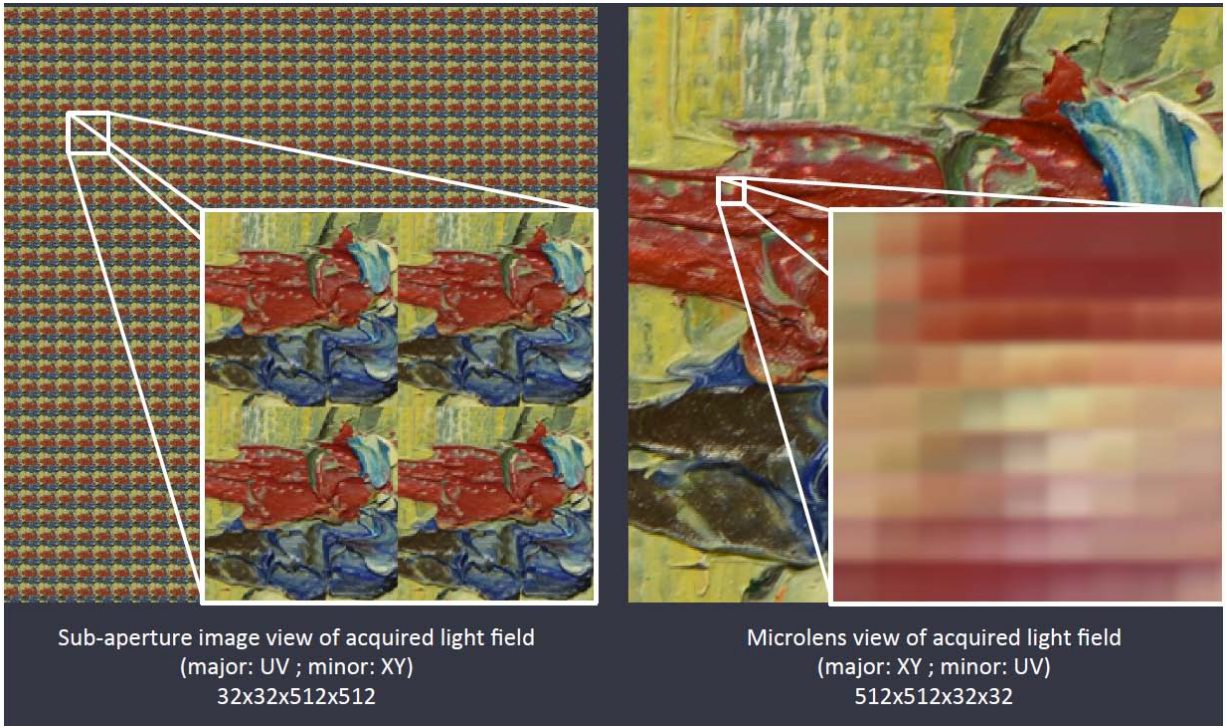
ICME 2016 Light-field image compression Grand Challenge



Plenoptic imaging work flow



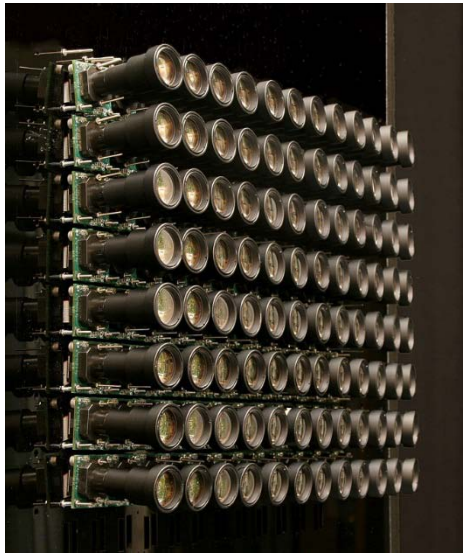
4D light field capture

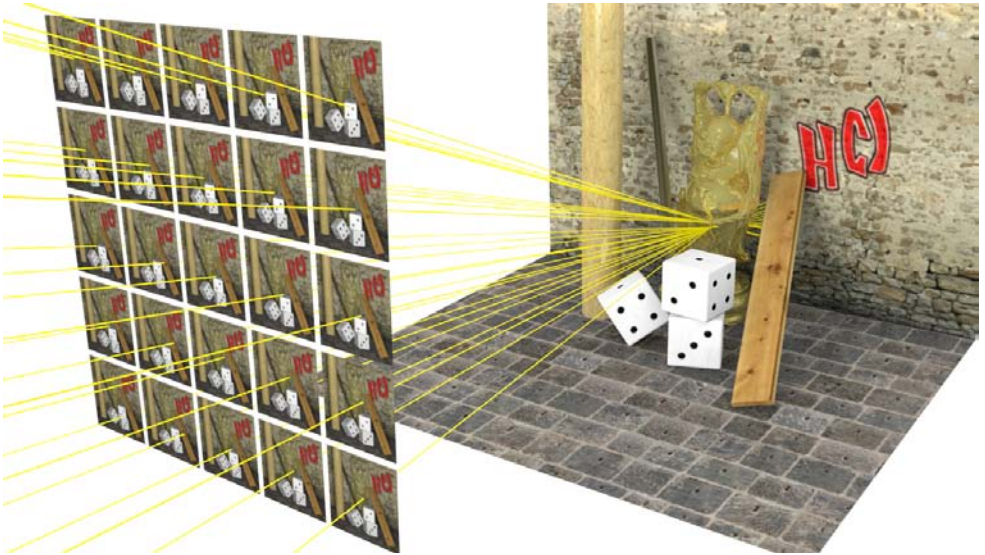


Sub-aperture image view of acquired light field
(major: UV ; minor: XY)
32x32x512x512

Microlens view of acquired light field
(major: XY ; minor: UV)
512x512x32x32

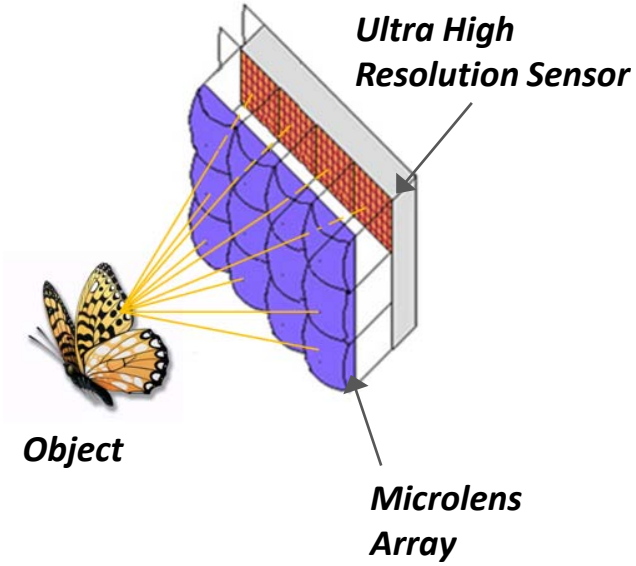
4D light field from multiple cameras

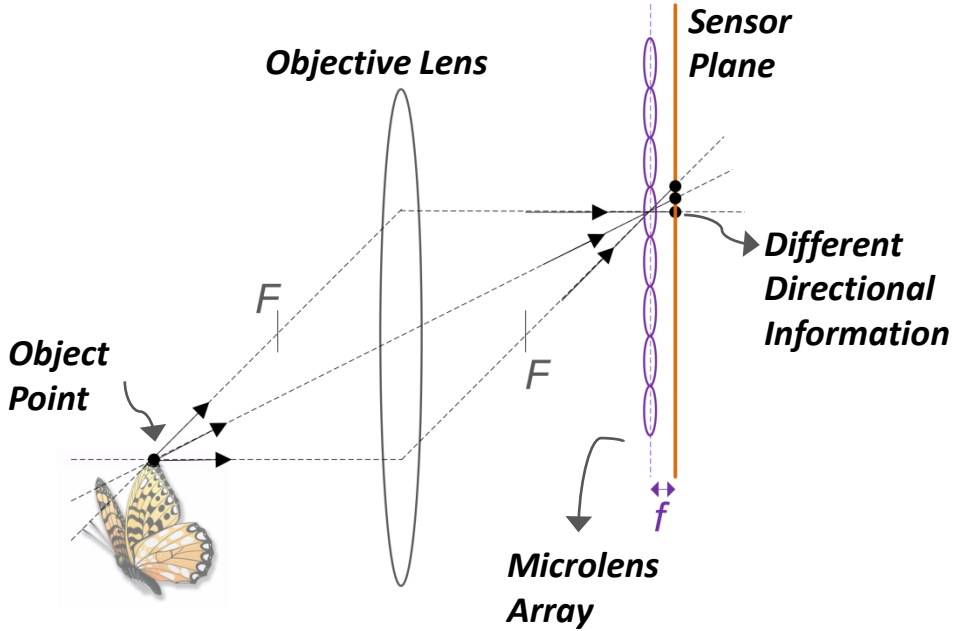




Dense camera array

4D light field with Microlens Array





Lenslet light field

from C. Conti

JPEG Pleno timeline

Date	Stage
06/16	First version of the Call for Proposals
10/16	Second version of the Call for Proposals on Light Field Coding Technologies
01/17	Final version of the Call for Proposals on Light Field Coding Technologies
04/17	Anchor Evaluation Results
05/17	Submission deadline for responses to CfP
07/17	Responses evaluation results available
10/17	Working draft 1 (WD) and core experiments
01/18	Working draft 2 (WD) and core experiments
04/18	Committee Draft (CD) and validations
10/18	DIS
01/19	IS

First version of CfP

- Broad in scope
  - Omnidirectional imaging
  - Depth enhanced imaging
  - Light field (lenslet) imaging
  - Light field (camera array) imaging
  - Point cloud imaging
  - Holographic imaging
- Served to:
  - Prioritize applications
  - Prioritize modalities for consecutive calls
  - Collect data
  - Anchors
  - Evaluation methodologies

Second version of CfP

- Narrow the scope of the first call
  - Focus on light field imaging (lenslet)
  - Focus on light field imaging (dense camera array)
  - Focus on applications
  - Call and complete requirements
  - Collect dataset
  - Call anchor technologies
  - Call for evaluation methodology
  - Learn lessons from prior Grand Challenge (ICME2016)

Final version of CfP

- Finalize all the details
  - Final selection of light field imaging (lenslet) datasets
  - Final selection of light field imaging (dense camera array) dataset
  - Finalize applications under scope
  - Finalize requirements
  - Select anchor technologies
  - Finalize evaluation methodology
  - Evaluation results for anchors
  - Evaluation results for proposals

Summary

- JPEG and Hollywood has a history of joint standards development
  - Cinema
  - Post-production
  - Broadcast
- JPEG PLENO is a new and exciting field
  - Point Clouds
  - Light Fields
  - Depth based imagery
  - Holography
- Foundational standards are needed
  - Exchange formats
  - Objective metrics and subjective test methodologies

Conclusions

- JPEG stands ready to work with the creative community on development of key interchange standards

- JPEG is soliciting input for effective criteria for subjective test methods
  - Viewing subjects from the community are always welcome

- JPEG is prepared to hold Ad Hoc Group meetings in convenient locations to the creative community

Participation in JPEG PLENO

- Joining JPEG
  - US National Body (USNB)
  - Email to wjh@dolby.com
- Participate through SMPTE
  - Follow through liaisons
- Face-to-Face AHG meetings

JPEG Pleno

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