Towards display independent Light Field file formats

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1. Light Field, Displays, Use cases

2. Various existing formats

3. Display independent format

4. Summary
Light Field, Displays, Use cases
What is the light field?

“**The light field** is a vector function that describes the amount of light flowing in every direction through every point in space.”

- 4D function (simplified case)
- Describes a "window" of light
- Enables perfect 3D experience
What is a light field display?

- Shows this "window" of light
- Not multiview or stereo
- Has continuous motion parallax
- Has specific LF ray distribution
## Use cases of light field displays

<table>
<thead>
<tr>
<th>LF display</th>
<th>LF capture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offline</td>
<td>Offline</td>
</tr>
<tr>
<td></td>
<td>3D cinema</td>
</tr>
<tr>
<td>Live</td>
<td>Video-on-demand</td>
</tr>
<tr>
<td></td>
<td>3D maps</td>
</tr>
</tbody>
</table>
Various existing formats
Inherently 3D data and formats

3D geometry: textured mesh
- Easy view rendering
- No efficient compression
- Cache-able models

Volumetric (medical)
- Easy view rendering
- No efficient compression
- Offline transmission

http://metalbyexample.com/textures-and-samplers/
Camera arrays
- Image stream from all cameras
- Parameters as metadata
- Specific LF ray distribution
- **Bad sampling of LF**

Calibrated parameters
- Positions
- Directions
- Field-of-view
- Distortions
- Color
Compressibility of video streams

Efficient combined compression is a challenge.
Delay, computational resource and bitrate trade-off.

Streaming: MPEG-DASH
Importance of depth information

Depth resolves ambiguities

Issues:
- Display or capture ray?
- Disparity enough?
- Accuracy?
- Computational time?
### Importance of depth information

<table>
<thead>
<tr>
<th></th>
<th>View interpolation</th>
<th>Angular color</th>
<th>Time consistency</th>
<th>Display independent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera ray disparity</td>
<td>Yes</td>
<td></td>
<td></td>
<td>Yes</td>
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<tr>
<td>Camera ray depth</td>
<td></td>
<td>Yes</td>
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Display independent format
4D Light Field parametrization

Assumptions: near-flat display

Full parallax: $s, t, \varphi, \theta$

Horizontal parallax: $s, t, \varphi$
Advantages
- Display independence
- Fast processing
- 2D-like image parameters
- Easy interpolation
- Sparse / dense storage
- Easy QoE integration

Disadvantages
- Fixed "window"
- Computation on both sides
- No editing
- Compressibility?
- Information loss
Summary
Format recommendations

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<td>Telehealth</td>
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<td>Livestream</td>
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<td></td>
<td>3D maps</td>
<td>Teleconference</td>
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</tbody>
</table>

3D cinema: custom conversion, display specific
Video-on-demand: angularly continuous, display specific
3D maps: textured mesh
Medical: angularly continuous, volumetric
Telehealth: angularly continuous, MPEG-HEVC
Livestream: angularly continuous, MPEG-HEVC
Teleconference: MPEG-HEVC
Current LF formats lack focus for LF displays.

3D/LF cameras and displays need to develop together.

The proposed angularly continuous display independent format has compelling features for important use-cases.
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