SMART: a Light Field image quality dataset

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Outline

Introduction

Dataset Design, Description, and Analysis

Conclusion

Ongoing works
Introduction (I)

Light Field (LF) imaging

Perceptual quality evaluation
- LF images are subject to several distortions during acquisition, processing, encoding, storage, transmission, and reproduction phases

LF image quality dataset
- The dataset is needed to train, test, and benchmark the image processing algorithms
Table 1: Most relevant datasets with corresponding features.

<table>
<thead>
<tr>
<th>Datasets</th>
<th>Year</th>
<th>Purposes</th>
<th>Features</th>
<th>Acquisition Devices</th>
<th>DM</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synthetic Light Field Archive [32]</td>
<td>2013</td>
<td>Compression</td>
<td>more than 17 light field images, includes transparencies, occlusions and reflections, etc.</td>
<td>Camera (Artificial LF)</td>
<td>No</td>
<td>non-natural</td>
</tr>
<tr>
<td>Light Field Analysis [31]</td>
<td>2013</td>
<td>Depth Map</td>
<td>7 Blender and 6 Gantry images, does not cover the wide range of natural scenes.</td>
<td>Blender Software and Gantry</td>
<td>Yes</td>
<td>Specific purpose</td>
</tr>
<tr>
<td>EPFL Light-Field Image Dataset [29]</td>
<td>2015</td>
<td>General</td>
<td>More than 117 images with different categories: buildings, landscapes, etc.</td>
<td>Lytro Illum</td>
<td>No</td>
<td>Wide Range</td>
</tr>
<tr>
<td>Lytro dataset [20]</td>
<td>2015</td>
<td>LF Reconstruction</td>
<td>30 images with indoor, outdoor, motion blur, etc.</td>
<td>Lytro</td>
<td>No</td>
<td>Specific Purpose</td>
</tr>
<tr>
<td>Light Field Salience Dataset (LFS) [17]</td>
<td>2014</td>
<td>saliency map estimation</td>
<td>more than 100 LF images</td>
<td>Lytro</td>
<td>Yes</td>
<td>Particular for saliency</td>
</tr>
<tr>
<td>GUC Light Field Face and Iris Dataset [26]</td>
<td>2016</td>
<td>face and iris Recognition</td>
<td>112 subjects for faces and 55 subjects for eye pattern</td>
<td>Lytro</td>
<td>NO</td>
<td>Particular for biometric</td>
</tr>
</tbody>
</table>
Introduction (III)

The motivations behind this work are:

- The need of a comprehensive and well defined LF image dataset
- The selected Source Sequences (SRCs) should cover a wide range of content variation
- During pilot-test phases, it is desirable to have a reduced set of SRCs, especially if considering the computational cost of processing LF data
Introduction (IV)

The major contribution of this work are:

- Definition of SRCs image content selection criteria
- The design of a comprehensive LF image quality dataset; the dataset is made freely available to the research community
- An analysis of the features of the proposed dataset
Dataset Design (I)

Image content selection based on key Quality Attributes (QAs):

- General attributes
  - Colorfulness (CF)
  - Spatial Information (SI)
  - Texture: key features, contrast, correlation, energy, and homogeneity

- LF specific capabilities
  - Depth of Field (DOF) variation
  - Transparency
  - Reflection
Dataset Design (II)

Dataset cardinality
- Number of Images = key quality attributes (QAs) × 3

Assumptions:
- one principal feature per image
- the relative quality score in Just Noticeable Differences (JNDs) is based upon data from a minimum of ten observers and three scenes.
Dataset Description (I)

Figure: All focused 2D view of the LF images from the database
Dataset Description (II)

SMART Dataset

- Raw LF image content
- Camera specific calibration data
- Depth map information
Dataset Analysis (I)

Key image quality attributes

- **Spatial Information (SI):**
  
  \[ M_{SI} = \sigma_{space}[Y_{Sobel}] \]
  
  where \( \sigma \) is the standard deviation over the pixels of Sobel filtered luminance plane of the image.

- **Colorfulness (CF):**
  
  \[ M_{CF} = \sqrt{\sigma_{rg}^2 + \sigma_{yb}^2} + 0.3\sqrt{\mu_{rg}^2 + \mu_{yb}^2}; \]
  
  \( rg = R - G; yb = 0.5(R + G) - B; \)
  
  where \( \sigma \) is the standard deviation, \( \mu \) is the mean value and \( R, G, \) and \( B \) are red, green, and blue color channel of the image.

- **Texture:** contrast, homogeneity, energy, and correlation
  
  Gray Level Co-occurrence Matrix (GLCM)
Dataset Analysis (II)

Figure: SI and CF distribution
Dataset Analysis (III)

(a) CF
(b) SI
(b) Contrast
(d) Homogeneity
(e) Energy
(f) Correlation
Conclusion

Analysis of existing LF image datasets
◦ Need of new well defined database

Proposed LF image dataset
◦ A dataset is created and available in http://www.comlab.uniroma3.it/SMART.html
Ongoing work

Perceptual quality assessment of LF images

- SRCs Selection (SMART LF image dataset)
- HRCs (encoding methods: JPEG, JPEG2000, HEVC Intra, etc. and basic rendering)
- Content Visualization: center focused image
- Assessment method: pair comparison

Processed LF images and annotated subjective quality ratings are coming soon!!!
Thank you