SMART: a Light Field image quality dataset

PRADIP PAUDYAL[1], ROGER OLSSON[2], MÅRTEN SJÖSTRÖM[2], FEDERICA BATTISTI[1], AND MARCO CARLI[1]

[1]UNIVERSITY OF ROMA TRE, ROME, ITALY

[2]MID SWEDEN UNIVERSITY, SUNDSVALL, SWEDEN

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

Introduction (II): Literature Survey

Table 1: Most relevant datasets with corresponding features.

Datasets	Year	Purposes	Features	Acquisition Devices	DM	Remarks
Stanford Light Field Archive [30]	2008	General	More than 20 images	Gantry, LF Microscope, and Camera Array	No	Old
Synthetic Light Field Archive [32]	2013	Compression	more than 17 light field images, includes transparencies, occlusions and reflections, etc.	Camera (Artificial LF)	No	non-natural
Light Field Analysis [31]	2013	Depth Map	7 Blender and 6 Gantry images, does not cover the wide range of natural scenes.	Blender Software and Gantry	Yes	Specific purpose
EPFL Light-Field Image Dataset [29]	2015	General	More than 117 images with different categories: buildings, landscapes, etc.	Lytro Illum	No	Wide Range
LCAV-31 [9]	2014	Object Recognition	More than 31 images	Lytro	No	Specific purpose
Lytro dataset [20]	2015	LF Recons-truction	30 images with indoor, outdoor, motion blur, etc.	Lytro	No	Specific Purpose
Light Field Saliency Dataset (LFSD) [17]	2014	saliency map estimation	more than 100 LF images	Lytro	Yes	Particular for saliency
GUC Light Field Face and Iris Dataset [26]	2016	face and iris Recognition	112 subjects for faces and 55 subjects for eye pattern	Lytro	NO	Particular for biometric

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

S. No.	Name	Key Features
(a)	Tile	Energy, Textures
(b)	Table	Colorfulness, Correlation
(c)	Chair	Colorfulness, DOF
(d)	Flower	SI, texture
(e)	Sky	Homogeneous, correlation
(f)	Grid	Depth distribution, grid
(g)	River	Contrast, DoF
(h)	Building	SI, contrast, reflection
(i)	Car	Homogeneity, DoF
(j)	Stone	SI, contrast
(k)	Window	Energy, Transparency, DoF
(l)	Pilers	Colorfulness, DoF
(m)	Book	Homogeneous, Transparency
(n)	Person	Reflection, contrast
(o)	White Sky	Energy, correlation

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):

  $M_{SI} = \sigma_{space}\left[Y_{Sobel}\right],$

  where σ 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 σ is the standard deviation, μ 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)

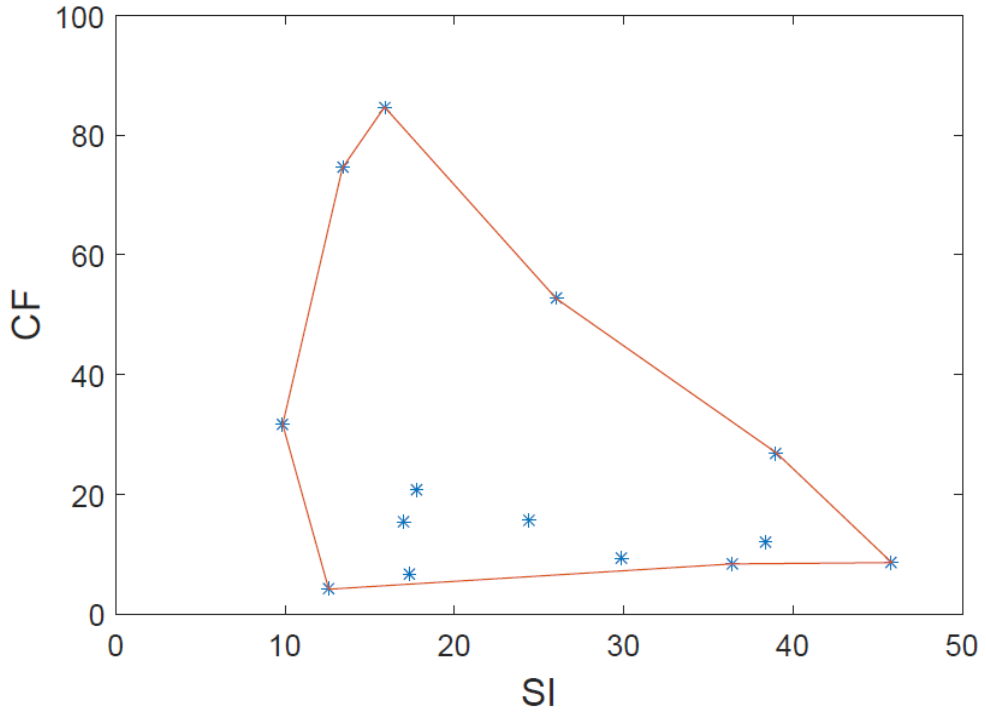
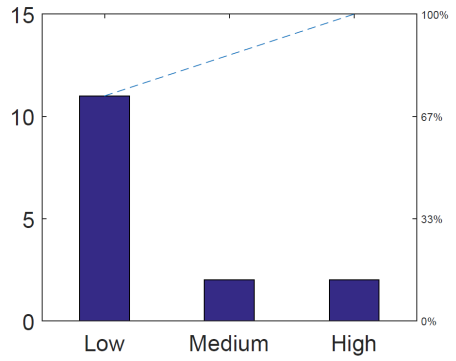
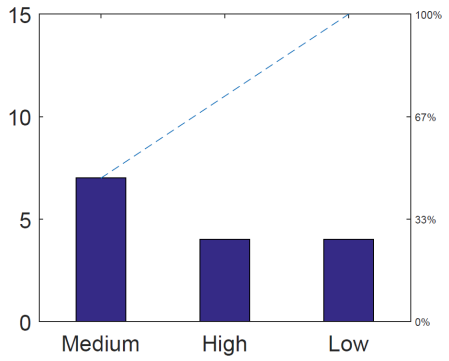


Figure: SI and CF distribution

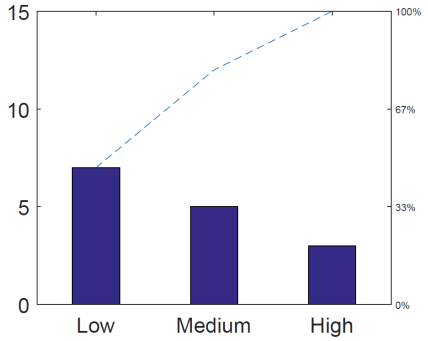
Dataset Analysis (III)



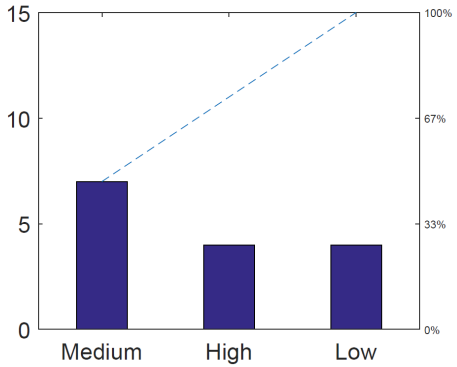
(a) CF



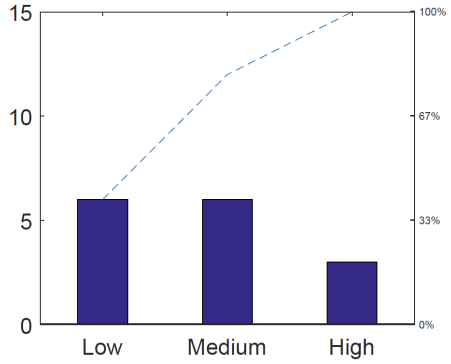
(b) SI



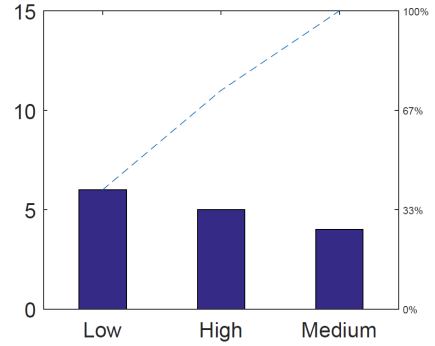
(b) Contrast



(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