New Light Field Image Dataset

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***Abstract*—Recently, an emerging light field imaging technology, which enables capturing full light information in a scene, has gained a lot of interest. To design, develop, implement, and test novel algorithms in light field image processing and compression, the availability of suitable light field image datasets is essential. In this paper, a publicly available light field image dataset is introduced and described in details. The proposed dataset contains 118 light field images captured by using a Lytro Illum light field camera. Based on their content, acquired light field images were classified into ten different categories with various features covering wide range of potential usage, such as image compression and quality evaluation.**

Keywords—Light Field Imaging, Light Field Dataset, Plenoptics

I. Introduction

Technology of Light Field (LF) photography represents one of the new generation of imaging methods enabling in many ways rich features allowing more realistic, interactive, and immersive user experience. The basic idea of capturing LF data originates from the concept of integral photography introduced by Lippmann [1] in the beginning of twentieth century. LF image acquisition process is based on capturing not only the light intensity in the image plane but also the information about the direction of light rays. In general, LF images can be recorded by using either multi-camera arrays or by more recent single camera solutions. The latter acquisition systems exploit additional optical elements consisting in the microlens array placed in front of regular, commercially available image sensors. Capability to record the intensity and direction of incident light brings whole range of new possibilities for LF image postprocessing. More specifically, manipulating and changing the focus, depth of field, exposure, as well as perspective of already captured images are among the main features enabled by LF photography. These advanced features of LF imaging are likely to be exploited in many branches of research and industry, such as microscopy, computer vision, medicine, etc., in near future.

Currently, there exist several commercially available LF single sensor cameras, all of them provided by one of two main manufacturers, namely Raytrix [2] and Lytro [3]. Raytrix has several models of so called focused plenoptic cameras for industrial and scientific applications with effective resolutions ranging from 1 to 7.25 megapixels. Lytro realized and commercialized the LF plenoptic cameras mainly for consumer and semi-professional market. In 2011, Lytro introduced its first-generation pocket-sized LF camera capable of refocusing images after being captured. Later, in 2014, Lytro released a second-generation LF camera, called Lytro Illum, which is designed for commercial and advanced photographers and resembles a traditional Digital Single-Lens Reflex (DSLR) camera. Among other advanced functionalities, Lytro Illum camera offers mainly increased resolution and processing power, when compared to earlier Lytro LF camera.

Despite many advantages, there are challenging requirements to LF imaging systems especially in terms of their computational power. Furthermore, currently available single sensor LF imaging systems do not offer sufficient resolution and thus very good image quality. Additionally, it is known that visual quality of rendered LF image content suffers from degradations arising from various distortions at different stages of the complete LF image processing and transmission chain. Therefore, an extensive evaluation of visual quality of the LF content as well as an investigation of quality of experience becomes necessary.

For purposes enabling the evaluation of different aspects influencing the perceived image quality of rendered LF content, the availability of suitable LF image dataset is essential. In general, there is a lack of LF image datasets, even though several LF image datasets have been designed and introduced in the previous works, for example in [4]–[8]. Moreover, majority of the proposed datasets were acquired with legacy or prototyped devices not taking into account the progress in LF imaging technology. This paper introduces a new publicly available LF image dataset, which was acquired by Lytro Illum camera. Proposed dataset significantly enhances the possibilities to cope with arising challenges of LF imaging technology, such as evaluation of the processing algorithms performance, as well as an assessment of quality of experience in LF imaging.

II. Light-Field Image Dataset Description

The proposed LF image dataset contains images in LFR (Light Field Raw) file format as provided by the Lytro Illum camera. LFR file stores the image information in raw, uncompressed lenslet image before demosaicing process with 10 bits per pixel precision in little-endian format. The resolution of an image in each LFR file containing the information about captured field of light is 5368×7728 pixels. This leads to an overall approximate size of 53 MB for each LFR file. The dataset also provides LF image relevant data extracted by using Lytro Desktop Application [3] including image thumbnails, depth maps, and relative depth of field coordinates (lambdamin and lambdamax), as well as the calibration data specific for Lytro Illum camera used for LF image acquisition. It is worth noting that each camera has different calibration data and one shall always process LFR files with their corresponding calibration data. Furthermore, our datset also contains 4D LF images, which were extracted from LFR files by using Light

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(a) *Buildings* (b) *Grids* (c) *Mirrors and transparency* (d) *Landscapes* (e) *Nature*

(f) *ISO and Color charts* (g) *People* (h) *Studio* (i) *Urban* (j) *Lights*

Figure 1: All-in-focus thumbnails of 2D representation of LF images for each category from proposed LF dataset.

Table I: Description of LF image dataset categories.

Category Name	Description	No. of Images
Buildings	Images of building(s) or parts of building(s) with various level of spatial information, depth of field, and zoom.	5
Grids	Shots of various scenes containing different grid patterns. Close details with wide depth of field range.	9
Mirrors and Transparency	Images with reflection and refraction of light caused by water surface or mirrors. Various scenarios with moderate depth of field.	11
Landscapes	Wide zoom scenes of landscapes. Some contains objects in foreground increasing depth of field.	3
Nature	Close details of particular natural scenes, such as flowers, animals, and other objects in various depth.	12
ISO and Color Charts	Images of Danes-Picta color rendition chart BST4D and ISO 12233 Resolution chart for electronic still cameras. Various zoom, flat depth of field.	26
People	Images containing one to seven persons located in various depth. Portrait shots.	18
Studio	Studio indoor shots with several artificial objects in various depth. Monotonous (white/gray) background.	7
Urban	Particularly detailed shots of city environment with high level of spatial information and moderate depth of field.	17
Lights	Specific shots containing various lighting conditions (natural and artificial light) with extended dynamic range.	10

Field Matlab Toolbox [9]–[11]. Provided 4D LF images are represented as a stack of 2D low-resolution RGB images in addition to a weighting images. The resulting dimensions of the 4D LF images are $15 \times 15 \times 434 \times 625 \times 4$, where 15×15 represents the number of views, 434×625 represents the resolution of each view and 4 corresponds to the RGB channels including additional weighting image component.

The LF image dataset consists of 118 LF images, which were classified into various categories based on their contents. More specifically, ten different categories, namely: Buildings, Grids, Mirrors and Transparency, Landscapes, Nature, ISO and Color charts, People, Studio, Urban, and Light, were identified and created. All-in-focus image thumbnails as an example of images from each category are illustrated in 1. Each category contains images illustrating specific aspects of LF imaging. For instance, the People category offers a large number of images that can be used for face recognition or privacy protection applications. The detailed description of each category as well as a number of acquired LF images in each category is presented in Table I.

III. Conclusion

This paper describes a new and publicly available light field image dataset. The proposed dataset consists of 118 light field images acquired by using Lytro Illum light field camera. Based on the visual content, the captured images are divided into ten different categories. More particularly, the dataset contains light field images in LFR format as captured by the camera accompanied by their thumbnails, corresponding depth maps, relative depth of fields coordinates, and camera calibrating data. All detailed information about the proposed dataset can be found at http://mmspg.epfl.ch/EPFL-light-field-image-dataset.

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