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1 Introduction

During 109th MPEG meeting in Sapporo, ad-hoc group on FTV (Free-viewpoint TeleVision) has identified an urgent need for light-field test materials [1, 2]. This document presents a test light-field sequence provided in response to that need.

The idea of production of the presented "Poznan Laboratory" sequence was to produce a natural content with large number of views (as much as 45×45) and very dense spacing between them. Due to practical reasons, we have decided to capture such scene by employing a single camera, capturing images of a still scene. For that, we have constructed a motorized rig similar to those that are used in plotting or 3D printing.

2 Light-field acquisition system

The construction of the motorized rig (Fig. 1) consists in plastic joints (printed with a rapid prototyping 3D printer), metal frame and two stepper motors, which allow for precise movement of a trolley, to which a camera is mounted. The motion of the trolley (and therefore of the camera) is limited to a flat surface of about 45cm × 45cm.

As camera we used the Canon EOS 550D DSLR with 18.7 Mpix sensor. The sensor is in APS-C (22mm×14.8mm) format. The camera is equipped with standard 18÷55 mm lens. The focal length (and thus zoom) of the camera has been set manually (the same for all views) in order to capture the whole scene. The precise value of focal length can be derived from the estimated intrinsic parameters and the camera sensor size. The shutter time was set to 1/8th second and the aperture was set to F5.0. Those two settings prevented under/over expositions from occurring while still maintaining satisfactory depth-of-field. Each image was captured with the maximum camera resolution of 5184×3456.

Table 1. Parameters of the acquisition system.

Camera type	Canon EOS 550D DSLR
Sensor pixel count	18.7 Mpix
Sensor format	APS-C (22 mm × 14.8 mm)
Lens	18 ÷ 55 mm
Shutter time	1/8 s
Aperture	F5.0
Resolution	5184 × 3456

The camera that captures the photographs is attached to a trolley by a standard mount. The shutter of the camera is activated remotely by software controlling the rig. The consecutive shots are stored on the memory card in the camera.

The X axis motion in horizontal direction (left – right) is performed by means of a trapezoidal screw and nut attached to a trolley. The trolley travels along two rods. This set of rods is attached at two ends to other nuts that are screwed onto two trapezoidal screws that provide motion in Z axis – vertical direction (up – down).

The rig is controlled by a repurposed "Arduino Mega" board with RAMPS 1.4 (RepRap Arduino Mega Pololu Shield). This board is used to control self-made 3D printers, but is flexible enough to drive our light field rig. The Arduino is connected to a control computer by USB cable. No further data connections are needed. The X and Z axes are connected to motor drivers on RAMPS and the camera shutter is controlled by a universal I/O pins on RAMPS.

The control software at the computer side is a simple python script. It controls the motion of the trolley and activates shutter. Photo is taken after the trolley is moved to the desired position and after waiting for a certain period of time to allow for the oscillations to dampen.

The distance between the farthest possible camera positions is approximately 45 cm. The positions repeatability was found to be satisfactory. The differences between images taken from nominally the same point are limited to 1 or 2 pixel shift.

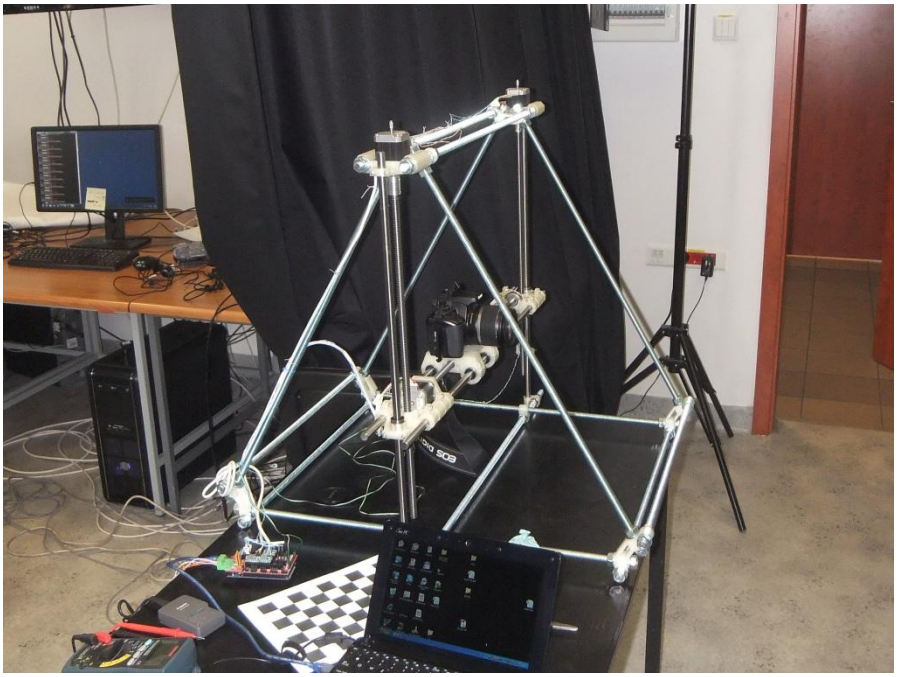

Fig 1. Camera rig used for light-field acquisition.

3 Post-processing

The lens of the cameras suffer from a certain amount of radial distortion. In order to correct such distortions, the individual pictures are corrected. In order to correct radial distortions the following steps have been performed:

1. Calibration of the camera in all positions (using a checker-board – see Fig. 2).
2. Actual correction of radial distortions [3,4]. The corrections are calculated as::

$$\Delta x = k_1 \cdot x \cdot (x^2 + y^2)$$
$$\Delta y = k_2 \cdot y \cdot (x^2 + y^2)$$

where Δx and Δy are distortion corrections for pixel with coordinates x and y, and k_1 and k_2 are distortion parameters.

Additionally, the acquired pictures (Fig. 3) are also cropped to 16:9 aspect ratio and down-scaled to Full HD resolution of 1920×1080 pixels. The obtained corrected sequence (Fig. 4) is recommended as a base version of the proposed test sequence for experimentation.

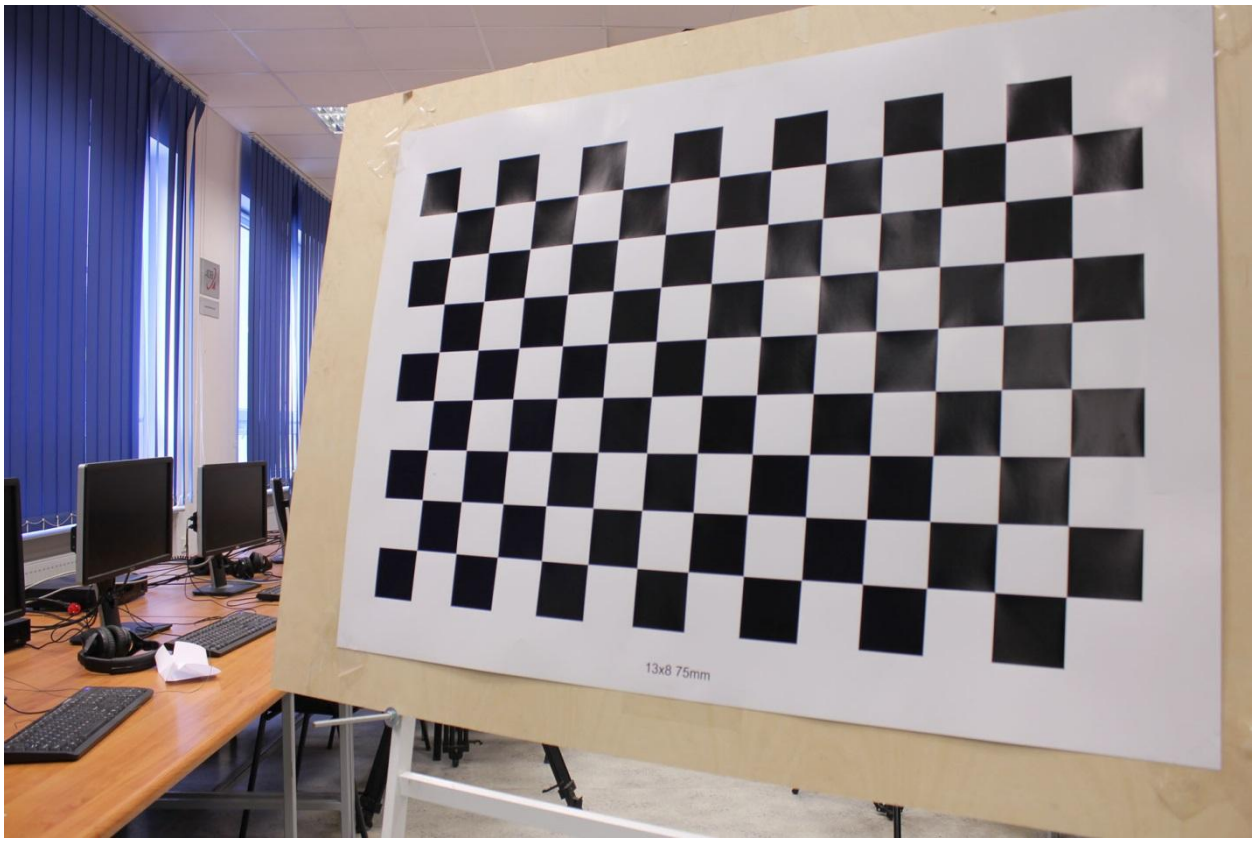

Fig. 2. Checkerboard pattern used for calibration of the camera.

4 Sequence specification

Figures 3 and 4 present an exemplary images of the uncorrected and corrected version of the sequence, respectively. The sequence contains 45×45=2025 views in total, from which exemplary 4×4=16 has been shown in Fig. 5. A plenoptic image of the proposed sequence, composed as 2-dimensional interleave of the whole set of views, is presented in Fig. 6.

The parameters of the corrected version of sequence can be found in Table 2.

Fig 3. Exemplary, uncorrected view from the Poznan Laboratory sequence.

Fig 4. Exemplary, corrected view from the Poznan Laboratory sequence.

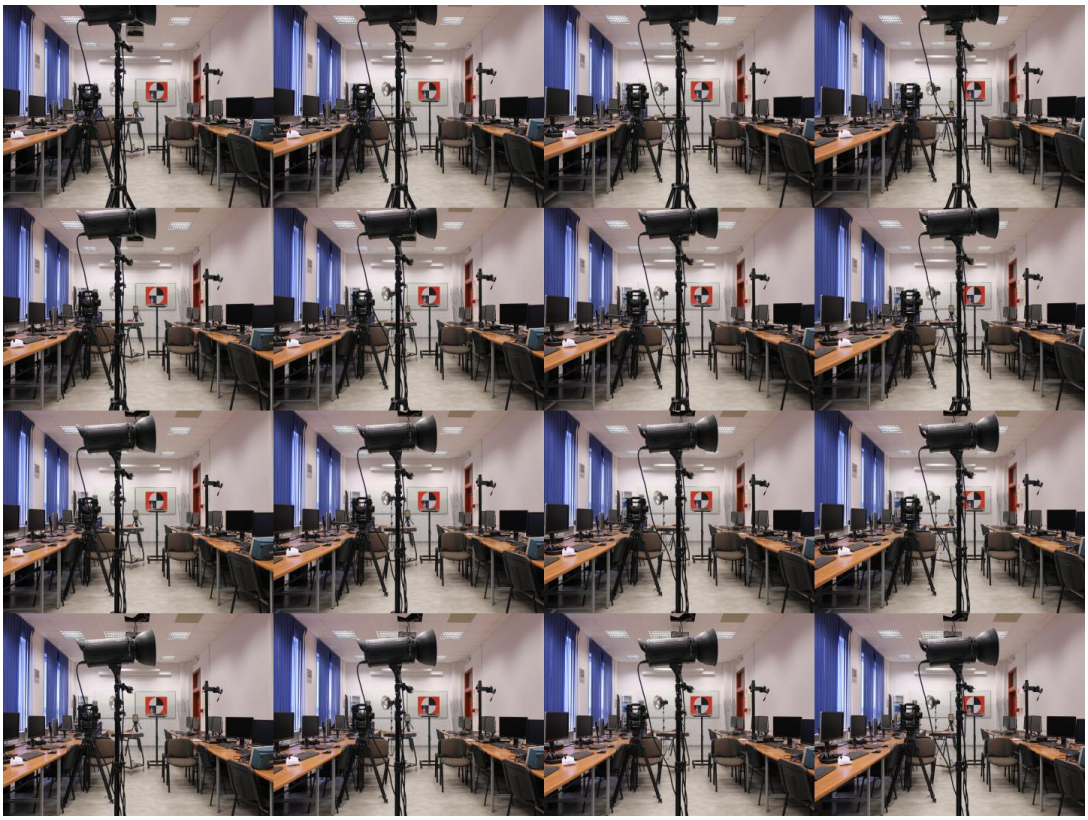

Fig 5. Selected views from the Poznan Laboratory sequence.

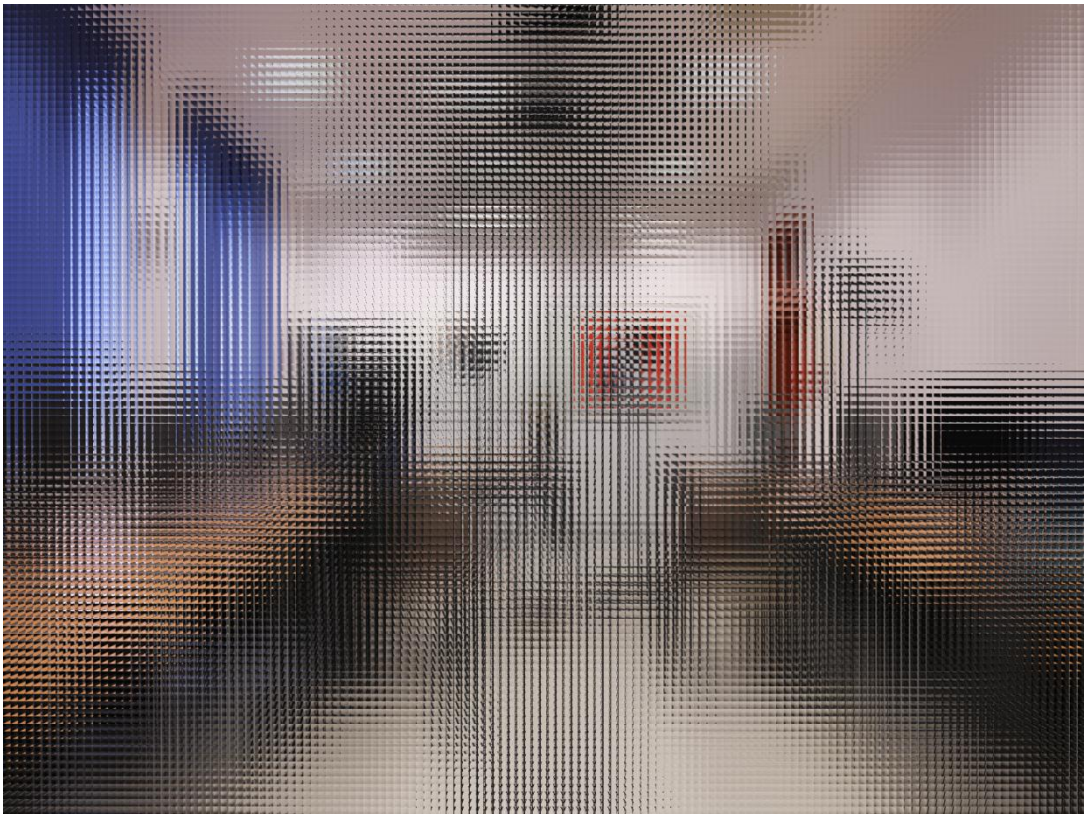

Fig. 6. A plenoptic image (composed as two-dimensional interleave of all views) of Poznan Laboratory sequence.

Table 2. Parameters of the calibrated sequence.

View resolution	1920 × 1080 (Full HD)
View aspect ratio	16:9
Number of views	45 × 45 = 2025 views
Views arrangement	2D array 0.5 cm spacing in both horizontal and vertical direction
Length	1 frame (still image)
Description	Interior of a laboratory at Poznan University of Technology

5 Copyright conditions

The test material is provided to MPEG and the scientific community in general for research and standards development purposes only. Of course, some words of acknowledgement are **appreciated** if the material is to be used in research and are **required** if the material is to be used in publications. In particular, reference to the following document must be listed in all documents that report any usage of the materials.

> Marek Domański, Krzysztof Klimaszewski, Maciej Kurc, Adam Łuczak, Olgierd Stankiewicz, Krzysztof Wegner, *"FTV: Poznan Laboratory – a test light-field sequence from Poznan University of Technology"*, ISO/IEC JTC1/SC29/WG11 Doc. MPEG2014/m35071, Strasbourg, France, October 2014.

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6 Sequence repository

The proposed light-field test sequence is available at **ftp://multimedia.edu.pl/ftv** ftp server. User credential will be provided upon request.

7 Conclusions

In this document a novel light-fields sequence for test purposes has been shown. The sequence presents natural content and has been captured with a high-quality modern camera and therefore the quality of image is high. The main characteristics of the proposed material are:

- natural content (laboratory class at Poznan University of Technology),
- still scene captured by moving camera,
- high quality sensor yielding in good image and low noise,
- 45 × 45 = 2025 views, spaced every 0.5cm in each direction,
- the sequence can be used for experimentation on light-field in MPEG.

Acknowledgement

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References

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