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Title **Omnidirectional lightfield test image "Poznan_Lab_360"**
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Abstract

Recently MPEG have started new exploration aiming for Omnidirectional 6-DoF (Degrees of Freedom). Also, some models for processing omnidirectional light field data [1] have been proposed. Omnidirectional lightfield is one of the possible technical solution for Omnidirectional 6-DoF immersive experience. Unfortunately, currently there is no test data to experiment with. In this paper we propose a hardware platform and the test data for Omnidirectiona lightfield experimentation.

1 Stereoscopic omnidirectional camera model

Recently [2][3] it has been presented that a stereo omnidirectional camera can be modelled as two rotating slit cameras. At each angle (direction of the observation) the pair of cameras acquire a single column of pixels of the final stereoscopic omnidirectional image.

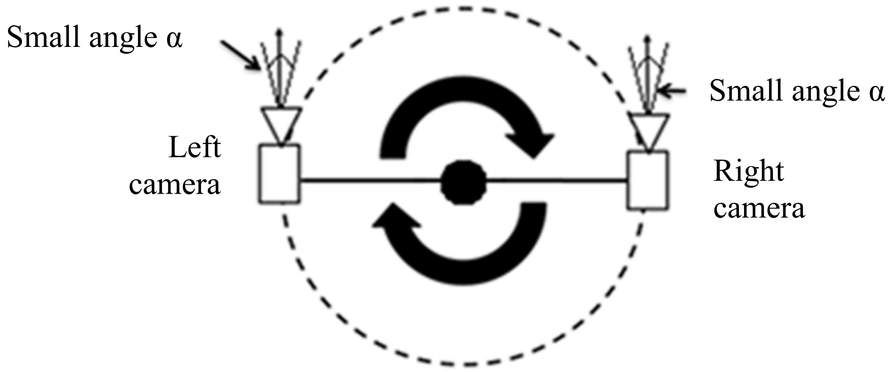


Fig. 1. Pair of cameras rotating around common center at distance r.

2 Omnidirectional lightfield camera model

Omnidirectional lightfield is composed of all rays passing through a sphere surrounding a center of the acquisition. Each ray can be described in 4D lightray-space by position (angular φ, θ) on a sphere where in pass through a predefined sphere, and by direction (angle α, β) of a ray relative to the perpendicular (normal vector) direction to surface of the sphere in pass-through position.

We can imagine that all light rays are captured by a single wide angle camera moving around a center of acquisition.

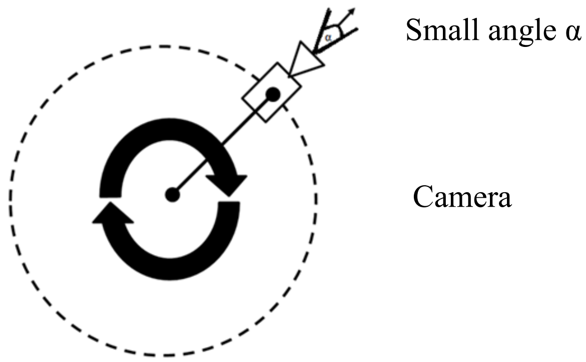


Fig. 2. Usage of omnidirectional rotating camera as an omnidirectional lightfield camera.

3 Experimental capturing hardware platform

Both of the above mentioned models are based a moving camera platform. In order to be as close as possible to the acquisition model we have decide to construct an experimental hardware platform which allow rotating the camera with very high precision.

Our experimental platform is composed of stand allowing placement on the tripod, rotating platform and the three identical Full HD web cameras.

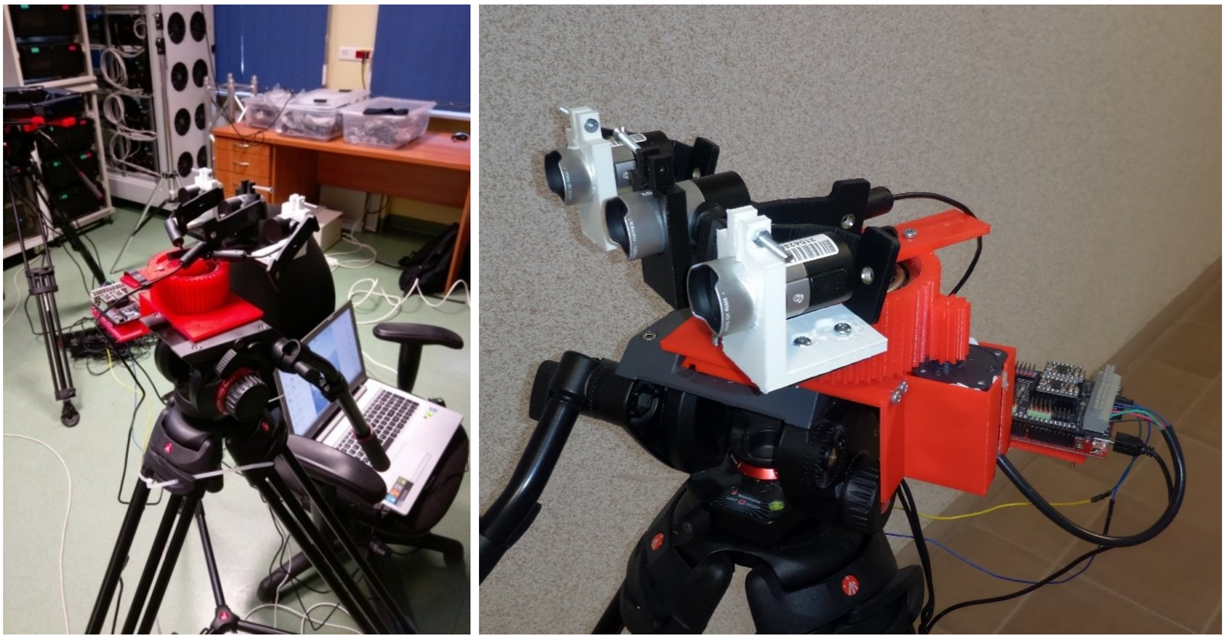


Fig. 3. Capturing hardware platform

We have design rotation platform to assure angular resolution to be better that 0.01°. The stepper motor used for complete turnover needs 7200 steps, without using micro-steps. This means that one step of the stepper motor translates into a rotation of 0.05°. To increase angular resolution we have design 1:5 gearbox with low slip/looseness.

All parts have been printed on 3D printer. The design of the rotating platform was done in the OpenScad environment [4]. To design the transmission, the "publicDomainGear" library [5] was used. The first wheel has 10 teeth and has been applied to the stepper motor shaft. The second gear has 50 teeth and its center coincides with the axis of rotation of the entire platform. In order to reduce vibrations and to improve the accuracy of the rotary system, the large toothed wheel was placed on two cone bearings positioned opposite to each other. The use of the gear and the properties of the stepper motor used allow the platform to perform full rotation with precision up to 0.01° using 36 000 full steps of the engine.

The program for recording the LF images initiates the connection with the stepper motor controller and the cameras. Operator can provide a step size, how densely images need to be captured and program automatically begins acquisition cycle. It alternatively rotates the cameras and capture the images.

4 Captured lightfield test image

Using our experimental platform we have acquired lightfield test image called "Poznan_Lab_360". It is composed of 3600 images of size 1080×1920 captured with 0.1 degree step at circle of 5 centimeter radius. Exemplary images captured every 10 degrees have been shown in Table 1a and Table 1b.

Table. 1a. Preview of the views captured every 10 degrees.

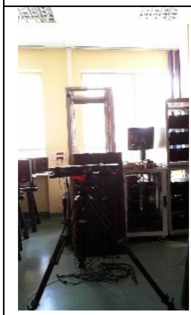
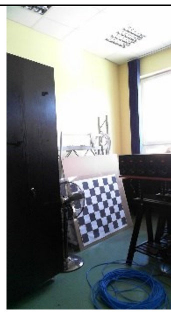
					
0	10	20	30	40	50
					
60	70	80	90	100	110
					
120	130	140	150	160	170
					
180	190	200	210	220	230

Table. 1b. Preview of the views captured every 10 degrees.

					
240	250	260	270	280	290
					
300	310	320	330	340	350

Camera parameters of each view are provided.

```
param_cam0
1441.9042200000000      0.0000000000000000      916.054
0.0000000000000000      1436.7974300000000      554.937
0.0000000000000000      0.0000000000000000      1.0000000000000000
0
0
1.0000000000000000      0.0000000000000000      0.0000000000000000      0.0000000000000000
0.0000000000000000      1.0000000000000000      0.0000000000000000      0.0000000000000000
0.0000000000000000      0.0000000000000000      1.0000000000000000      0.0000000000000000
0.0000000000000000      0.0000000000000000      0.0000000000000000      1.0000000000000000

param_cam1
1449.6184700000000      0.0000000000000000      932.009
0.0000000000000000      1446.0367900000000      555.28
0.0000000000000000      0.0000000000000000      1.0000000000000000
0
0
0.9995000000000000      0.0323000000000000      -0.002000000000000      -0.004786000000000
-0.032300000000000      0.9993000000000000      0.0165000000000000      0.1550000000000000
0.0025000000000000      -0.016400000000000      0.9999000000000000      -0.001870000000000
0.0000000000000000      0.0000000000000000      0.0000000000000000      1.0000000000000000
```

Fig 4. Fragment of camera parameters file for “Poznan_Lab_360”.

5 Omnidirectional image rendering

From the acquired data omnidirectional image can be created. From every view at each angle single middle column of pixels is extracted and all extracted columns are merged together (Fig. 5) to create ideal omnidirectional image according to omnidirectional image acquisition model presented in section 1.

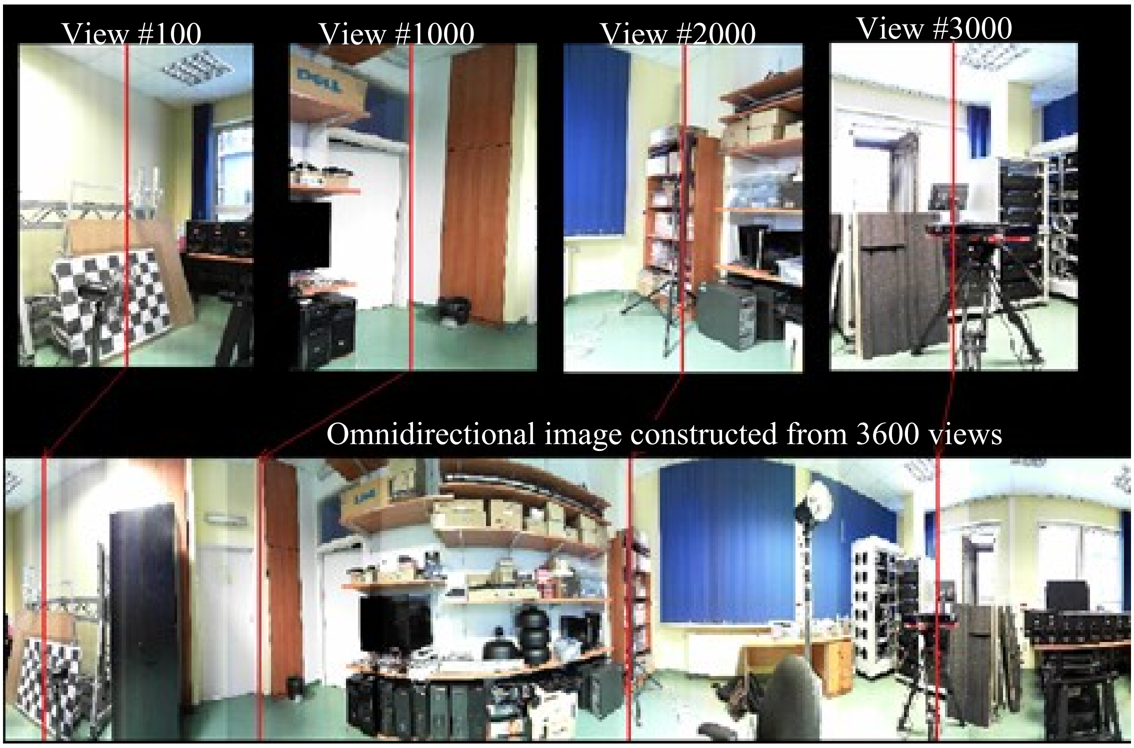


Fig. 5. The process of panoramic image construction by folding.

Fig 6. Created omnidirectional image from acquired LF data.

6 Availability

The sequences remain the property of Poznan University of Technology but they are licensed for free use within ISO/IEC JTC1/SC29/WG11 (MPEG) for the purposes of research and development of standards. These sequences can be also freely used for research purposes outside MPEG as well. Any other use is prohibited unless an explicit permission is given by Poznań University of Technology, Chair of Multimedia Telecommunications and Microelectronics.

Acknowledgements are appreciated if the material was used in research and are required **if the material is to be used in publications**. The acknowledgement should use the reference to this document.

The abovementioned video sequences are available at **ftp://multimedia.edu.pl/ftv** ftp server. User credential will be provided upon request (see email to the authors).

7 Conclusions

We have presented a sequence “Poznan_Lab_360” which can be used as a test data for experimentation with omnidirectional lightfield.

Acknowledgement

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References

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