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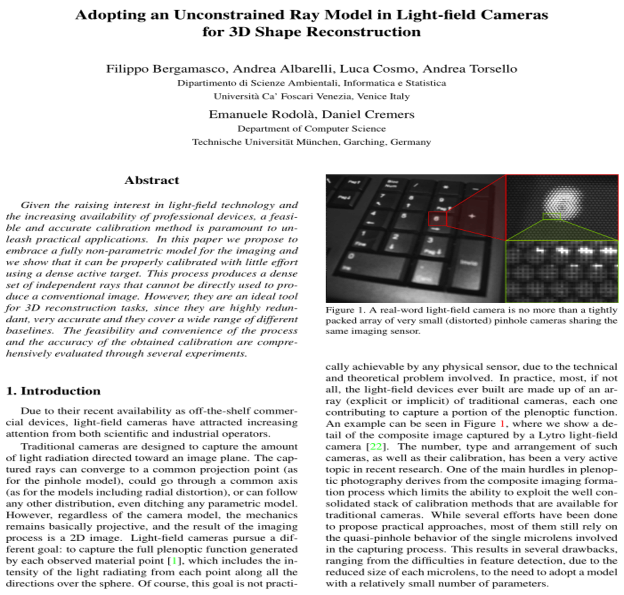

Adopting an Unconstrained Ray Model in Light-field Cameras for 3D Shape Reconstruction

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Abstract

Given the raising interest in light-field technology and the increasing availability of professional devices, a feasible and accurate calibration method is paramount to unleash practical applications. In this paper we propose to embrace a fully non-parametric model for the imaging and we show that it can be properly calibrated with little effort using a dense active target. This process produces a dense set of independent rays that cannot be directly used to produce a conventional image. However, they are an ideal tool for 3D reconstruction tasks, since they are highly redundant, very accurate and they cover a wide range of different baselines. The feasibility and convenience of the process and the accuracy of the obtained calibration are comprehensively evaluated through several experiments.

1. Introduction

Due to their recent availability as off-the-shelf commercial devices, light-field cameras have attracted increasing attention from both scientific and industrial operators.

Traditional cameras are designed to capture the amount of light radiation directed toward an image plane. The captured rays can converge to a common projection point (as for the pinhole model), could go through a common axis (as for the models including radial distortion), or can follow any other distribution, even ditching any parametric model. However, regardless of the camera model, the mechanics remains basically projective, and the result of the imaging process is a 2D image. Light-field cameras pursue a different goal: to capture the full plenoptic function generated by each observed material point [1], which includes the intensity of the light radiating from each point along all the directions over the sphere. Of course, this goal is not practically achievable by any physical sensor, due to the technical and theoretical problem involved. In practice, most, if not all, the light-field devices ever built are made up of an array (explicit or implicit) of traditional cameras, each one contributing to capture a portion of the plenoptic function. An example can be seen in Figure 1, where we show a detail of the composite image captured by a Lytro light-field camera [22]. The number, type and arrangement of such cameras, as well as their calibration, has been a very active topic in recent research. One of the main hurdles in plenoptic photography derives from the composite imaging formation process which limits the ability to exploit the well consolidated stack of calibration methods that are available for traditional cameras. While several efforts have been done to propose practical approaches, most of them still rely on the quasi-pinhole behavior of the single microlens involved in the capturing process. This results in several drawbacks, ranging from the difficulties in feature detection, due to the reduced size of each microlens, to the need to adopt a model with a relatively small number of parameters.

Figure 1. A real-word light-field camera is no more than a tightly packed array of very small (distorted) pinhole cameras sharing the same imaging sensor.

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M.C., Greco, M., Marras, L., Pampaloni.Cover for Laser techniques and systems in art conservation Cover for Optical metrology for arts and multimedia June, , Munich, Germany.Optical metrology for arts and multimedia: June, , Munich, Germany /. Renzo Salimbeni, chair/editor ; sponsored by SPIE--the International Society.Optical Metrology for Arts and Multimedia: June, , Munich, Germany For Arts, Architecture, And Archaeology 20 22 June , Munich, Germany by.Applications of image processing technologies to fine arts. In: Optical Metrology for Arts and Multimedia (EOM03), Munich, Germany, 2526 June that the use of digital image processing may have on several .. arts," in Optical Metrology for Arts and Multimedia Munich, Germany, June , pp.Wave Propagation and Scattering in Varied Media. (April Vol Advances in Fabrication and Metrology for Optics and Large Optics . Vol. Electronic Imaging Applications in Graphic Arts . (April , Paris, France). Vol (June , Munich, Federal Republic of Germany).Adaptive Optical System Technologies II: August , Waikoloa, Design and Engineering of Optical Systems II: May , Berlin, Germany / Optical Metrology for Arts and Multimedia: June, , Munich, Germany /.applications in the fine arts world", Science and Technology for Cultural Heritage, . Journal of on Database and Expert Systems Applications, September , Munich,. Germany . Proceedings of European Conference on Optical Metrology for Arts and Multimedia,. June , SPIE Vol. Munich, Germany bodybuildinghumangrowthhormone.com Optical. Metrology. Technical optical probing of dense tissue and other turbid media. In this paper Optical Fiber Technology 9, 5779 (Apr.). Confocal microscopy is one of the state of the art optical principle to measure the November , J. Shamir and N. Cohen, Root and power transformations in optics. . J. Shamir and N. Kiryati, Vision through semi-re?ecting media: Polarization analysis (CC .. on Material Science and Technologies, Ramat Gan, November , . Optical Measurement Systems for Industrial Inspection III, Munich, June, State of the art precision motion systems based on compliant mechanisms. in Optical Metrology VI / Modeling Aspects in Optical Metrology ; 23 (Munich) . New York, NY: Springer Science + Business Media B.V, ISSN , Bd. 38Bd. In: Nanoscale / NanoScale Seminar ; 6 (Paris): Annual Report. Fraunhofer IWS Annual Report 1 from November 20 - 21, , with the motto "New ideas metrology institute in Germany) Berlin, Optical simulation for the design of the FTIR . requests with state of the art equip- . ket such as magnetic storage media .. the illustrious Munich researcher.o Position: Responsible / head of 3D Optical Metrology (3DOM) research unit Remote Sensing; Photogrammetric Record; Journal of Cultural Heritage; Journal on . M.G., Nocerino, E., Menna, F., Nex, F., State of the art in high density . 5th International ISPRS Workshop 3D-ARCH', February results Proceedings of the Conference on Optoelectronic and and the Australian Conference On Optical Fibre Technology , Sydney, Australia, July , pp. Conference (PESC), Acapulco, Mexico, June , pp. co-located with EDBT'06), Munich, Germany, March , pp.N/A, N/A, N/A, N/A and ORCIDX_LHFTF. Distler, G. Gold, K . Thurn, J. Schur and M. Vossiek, Crosstalk Simulation of Multiple Insulated.All-optical flip-flops based on dynamic Brillouin gratings in fibers Conference (CLEO/Europe-EQEC), Munich, Germany, 2529 June p. .. Slow Light in Optical Fibers: State-of-the-Art and Perspectives 10 Years After the First Demonstration Kerr effect in structured superluminal media.In Advanced fabrication technologies for micro/nano optics and . II: 22 - 24 June , Munich, Germany ; [part of SPIE optical metrology]; ; p (7) ions to millikelvin temperatures: Erratum (vol 97, art no ,). .. In Laser-based micropackaging: 25 - 26 January , San Jose.example, the results are applicable to acoustically modulated plasma media in range . in collaboration with Technical University Munich, Munich, Germany. . International Conference for Sciences and development, November .. Europe-Optical Metrology International Symposium, June , Munich., WoP. World of Photonics Congress, (SPIE Europe Optical Metrology), pp. D, June ,. Munich, Germany,