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Tutorial Chairs, 3DTV-Con

Tutorial 3DTV-Con 2016

Light field – models, processing and compression

Motivation

Conventional image and video capture has proved to be powerful components in numerous applications throughout the years, providing information about how objects in a scene are related in space, time, and colour. Such conventional 2D image captured by a digital camera can be described as sampling of the 7-dimensional plenoptic function that theoretically describe all light reflected of a scene. Advancement in computational power, image sensor resolution and optical system miniaturization in recent years have enabled new image capture systems that are able capture both intensity *and* direction. Having such information enables new possibilities of post-processing and image enhancements but also require new formats and methods to compress the extensive amount of data.

This tutorial will present the fundamentals of light field, its representation, and the consequences of capturing it by several cameras or a special plenoptic camera. Models describing the light field will be presented that enables optimized selections and prediction of capabilities for different light field systems. The tutorial will also portray fundamental processing of light field data such as interpolation and reconstruction of images with different depth of field, super-resolution and alike. Finally, the tutorial will demonstrate how the light field data can be efficiently compressed by using the high redundancy of the data. Total time of tutorial 3 hours.

In particularly the tutorial will consider the following.

Light field fundamentals and models

- Multiple Pin-hole cameras and plenoptic camera
- Light ray geometrical optics model
- Ray-phase space and Fourier analysis for cameras and displays
- Optimal sampling and antialiasing filter
- SPC-model description and application to plenoptic cameras

Light field processing

- Light field interpolation and reconstruction
- Re-focusing and super-resolution

- Depth extraction
- Sparsification of light field data

Light field image and video compression

- Basics of compression, hybrid coders
- H.264 and HEVC
- Approaches to compress light field data

About the presenters

Robert Bregović received the Dipl.-Ing. and M.Sc. degrees in electrical engineering from the Faculty of Electrical Engineering and Computing, University of Zagreb, Zagreb, Croatia, in 1994 and 1998, respectively, and the D.Sc.(Tech.) (Hons.) degree in information technology from the Tampere University of Technology, Tampere, Finland, in 2003. He was an Assistant with the Department of Electronic Systems and Information Processing, Faculty of Electrical Engineering and Computing, University of Zagreb, Zagreb, Croatia, from 1994 to 1998. In 1999, he was a Visiting Researcher with the Tampere International Center for Signal Processing, Department of Signal Processing, Tampere University of Technology, where he was a Researcher from 2000 to 2003, and he has been a Post-Doctoral Researcher with the Department of Signal Processing since 2003. He has written more than 60 international journal and conference articles. He taught various courses in the area of digital signal processing (e.g., linear filtering and multirate signal processing) and gave tutorials on topics related to visualization of 3-D content at the International Conference on Multimedia and Expo 2013 and International Conference on Visual Communications and Image Processing 2014. His current research interests include the design and implementation of digital filters and filterbanks and topics related to acquisition, processing/modeling, and visualization of 3-D content.

Atanas Gotchev received the M.Sc. degrees in radio and television engineering and applied mathematics and the Ph.D. degree in telecommunications from the Technical University of Sofia, Sofia, Bulgaria, in 1990, 1992, and 1996, respectively, and the D.Sc.(Tech.) degree in information technologies from the Tampere University of Technology, Tampere, Finland, in 2003. He has held research and teaching positions with the Bulgarian Academy of Sciences, Sofia, and Technical University of Sofia. He is currently an Associate Professor (Tenure Track) with the Department of Signal Processing, Tampere University of Technology. His research interests include sampling and interpolation theory, and spline and spectral methods with applications to multidimensional signal analysis. His recent work concentrates on algorithms for multicamera and multisensor 3-D scene capture, transform-domain light field reconstruction, and Fourier analysis of 3-D displays.

Roger Olsson received the M.Sc. degree in Electrical Engineering and the Ph.D. degree in Telecommunication from Mid Sweden University, Sweden, in 1998 and 2010 respectively. He worked in the video compression and distribution industry 1997-2000. He again joined Mid Sweden University as a junior lecturer 2000-2004 where he taught courses in

telecommunication, signals- and systems, and signal- and image processing. Since 2010 he is employed as a researcher at Mid Sweden University where his research interest includes plenoptic image capture, processing, and compression; plenoptic system modelling; and depth map capture and processing. www.miun.se/en/personnel/rogerolsson

Mårten Sjöström received the M.Sc. degree in electrical engineering and applied physics from Linköping University, Sweden, in 1992, the Licentiate of Technology degree in signal processing from KTH, Stockholm, Sweden, in 1998, and the Ph.D. degree in modeling of nonlinear systems from EPFL, Lausanne, Switzerland, in 2001. He worked as an Electrical Engineer at ABB, Sweden, from 19931994, was a fellow at CERN from 19941996, and a Ph.D.-student at EPFL, Lausanne, Switzerland during 19972001. In 2001, he joined Mid Sweden University and was appointed Associate Professor and Full Professor in Signal Processing in 2008 and 2013, respectively. He is the head of the subject Computer and System Sciences at Mid Sweden University since 2013. He founded the Realistic 3D research group in 2007. His current research interests are within multidimensional signal processing and imaging, as well as system modelling and identification. www.miun.se/en/personnel/martensjostrom