CLIM Workshop

Keynotes

Light field imaging: modelling, parameterization and sparsification
Prof. Atanas Gotchev, Tampere Technical Univ., Finland

In this talk, we relate the basics of plenoptics with modern signal processing concepts such as sparsification and over-complete representations. We build our story on the definition of the plenoptic function and its 4D light field (LF) approximation, where we use the two-plane parameterization as a starting point to define concepts such as ray-space and epipolar plane images (EPI). We specifically look at their Fourier domain appearance in order to discuss issues related with light field sampling, reconstruction and sparsification. We argue that we need to target the reconstruction of what we call densely-sampled light field (DSLF). This is a representation where neighbouring light field slices (i.e. 2D camera views) are with less than 1 pixel maximum disparity. In DSLF, epipolar lines are unambiguously continuous and therefore any desired ray can be easily interpolated. Having such a representation in place, one can accomplish other light field processing tasks such as ray interpolation, rendering, segmentation, spatial super-resolution, etc. We present our approach for DSLF reconstruction by sparsification in shearlet transform domain and discuss its pros and cons in comparison with the state of the art. We then present various applications, such as hogogram generation from non-coherent light fields, continuous refocusing in light field microscopy and generating content for wide field of view LF displays.

Non-Lambertian Light Field Analysis,
Prof. Bastian Goldluecke, Konstanz Univ., Germany.

Recent design in light-field cameras, and related image processing
Benoit Vandame, Technicolor

Light field imaging is becoming increasingly popular thanks to the recent advances in Light Field capture of real scenes. By capturing light rays emitted along different directions, light fields yield a much richer description of the scene, enabling post-capture processing that can be appealing for a variety of applications (e.g., photorealistic rendering, computational photography and computer vision). Many acquisition devices have been designed to capture light fields, ranging from camera arrays, to single cameras mounted on moving gantries, and plenoptic cameras.

These acquisition devices offer different trade-offs between angular and spatial resolution. Plenoptic cameras use an array of micro-lenses placed in front of the sensor to capture multiple low resolution views in one 2D sensor image, hence reduce the spatial resolution by orders of magnitude compared to the raw sensor image. Plenoptic cameras and camera array defines the 2 main families of light-field devices, they are evolving jointly and both approaches are now embedded into smartphone or high-end cameras.

Ongoing improvement in sensor design, leads to a perfect integration of micro-lenses array with the pixels. So-called plenoptic sensor draws a new paradigm which renew the usage of plenoptic cameras like live autofocus, synthetic bokeh, and depth estimation. Plenoptic sensors are nowadays embedded on most of the high-end smartphones or video cameras.

The keynote proposes to review fundamentals in light field imaging, the main capturing devices and the recent evolution of pixel design. Through practical image processing chains, various algorithms will presented for both family of light-field devices.

Immersive activities in MPEG-I: current status and upcoming challenges

Joêl Jung, Orang Lab.

2017 has seen the emergence of omni-directional capture devices intended to provide a new way of consuming videos. Those "360 cameras" are made of several 2D video cameras, gathered on a circular or spherical rig. The availability of such new panoramic content has created a "buzz" around 360 immersive videos. Announcements of new technologies, new devices, new services are made weekly, with keywords such as "virtual reality", "light-field", "degrees of freedom", etc. All of them target the same goal: provide a perfect representation of the real world in a virtual environment, with high immersion and quality of experience.

Unfortunately, when watching natural (not computer generated) 360 content, the quality is far from acceptable. For instance, the recent OMAF v1 standard, which addresses storage and transmission of omni-directional audio and video content, does not deal at all with motion parallax. There are obviously limitations of the display side, such as the resolution, expected to be solved rapidly. There are however other challenges, where new algorithmic designs are mandatory, to achieve a real immersive experience, and most importantly to reduce sickness issues.

MPEG has created in 2018 a new project call MPEG-I, addressing the "Coded representation of immersive media". This plenary talk will start with a short summary of the main recent capturing devices and associated representation formats. A generic and practical definition of the light-field will be given. Then, the current status of MPEG-I will be reported, with a particular focus on 3DoF+, handled in the MPEG-I Visual subgroup, that will yield to the very first immersive coding standard, in 2020. Then, the upcoming challenges related to 6DoF will be discussed.

Point Cloud Compression in MPEG

Sébastien LASSERRE (BlackBerry), slasserre@blackberry.com

MPEG will issue two specifications on Point Cloud Compression (PCC) in the standard MPEG-I (ISO/IEC 23090) on the Coded Representation of Immersive Media. A first specification (MPEG-I part 5, so-called VPCC), based on videos to represent the data of point clouds, is expected to be finalized first, and a second specification (MPEG-I part 9, so-called GPCC) will be issued later and uses specific techniques to code the geometry and attributes of point clouds. An all-intra first version of GPCC should converge soon to a stable specification, however a second version including inter prediction tools will probably not be able available before a few years.

This presentation will give an overview of the complete MPEG process that has led to the foreseen VPCC and GPCC. Beyond point cloud compression, the presentation will also provide the keys of a more general process systematically followed to create an activity in MPEG. This goes from requirements to the final issue of an International Standard (IS), jumping the hurdles of issuing and responding to a Call for Evidence and a Call for Proposal, performing visual testing, and creating a Test Model that will become the specification it-self.

Particular to PCC, it will be explained how requirements, market needs and non-combinable proposed tools have led to two PCC tracks (VPCC and GPCC) that address different use-cases like

Virtual/Augmented Reality on one hand, and autonomous driving, 3D maps, culture heritage on the other hand.

Finally, a quick description of the various compression tools proposed in the two test models will be provided.

"JPEG Pleno, a framework to represent plenoptic imaging modalities"
Peter Schelkens, Vrije Universitat Brussels, Belgium

JPEG Pleno aims to provide a standard framework for representing plenoptic imaging modalities, such as light field, point cloud, and holographic imaging. The JPEG Pleno standard tools are being designed together accounting for their synergies and dependencies. To fully exploit this holistic approach, JPEG Pleno is not just a set of efficient coding tools addressing compression efficiency. It is a representation framework understood as a fully integrated system for providing advanced functionality support for image manipulation, metadata, random access and interaction, and various file formats. In addition, it offers privacy protection, ownership rights, and security.