1. **Shwetadwip Chowdhury, University of California (UC) Berkeley: Computational microscopy for biological imaging**

Abstract:

Computational imaging has become a powerful tool with which to enable robust, cost-effective, and versatile imaging solutions. In this talk, we explore some specific developments of computational imaging in biological microscopy. Emphasis is placed on biological imaging applications where novel computational techniques can replace or even supersede traditional microscopy techniques that rely on laborious optical design, expensive illumination sources, intensive acquisition requirements, etc. We specifically describe our computational imaging solutions to two main challenges in biological microscopy: 1) imaging with high-resolution across large fields of view and 2) imaging optically scattering biological samples. Our solutions to these challenges synergistically combine optical hardware with advanced computational algorithms to offer a streamlined imaging pipeline for advanced imaging capabilities in cost-effective and robust imaging platforms.

2. **Evan Yifan Peng, Stanford University: Co-designing Optics and Algorithms: Computational Imaging with Diffractive Optics**

Abstract:

Despite the benefits of facilitating compact form factors, diffractive optical elements (DOEs) have sufficient degrees of freedom that one can manipulate to encode the desirable light modulation functionality. We theoretically and experimentally investigate the practicability of introducing numerical optimization into the co-design procedure of ultrathin diffractive optics and image processing algorithms. We anticipate enabling more powerful computational camera properties (e.g. extended depth of field, wide field of view, high dynamic range, focus tunable, full spectrum imaging, etc.) with more compact form factors. This imaging modality can be very promising in the consumer-level camera market as well as many scientific imaging scenarios. Computational imaging with diffractive optics provides new insights on incorporating optics and computation algorithms to better record, understand and deliver desirable visual information under the constraint of current data bandwidth of hardware.

3. **Valentin Volchkov, MPI Tübingen: MTF estimation with deep learning**

Abstract:

The modulation transfer function (MTF) is widely used to characterise the performance of optical systems. Measuring it is costly and it is thus rarely available for a given lens specimen. Fortunately, images recorded through an optical system contain ample information about its MTF, only that it is confounded with the statistics of the images. I will present a method to estimate the MTF of camera lens systems directly from photographs, without the need for expensive equipment. The accurately measured point response of lenses serves as ground truth training data. We then use the same lenses to record natural images and employ a supervised learning approach using a convolutional neural network to estimate the MTF on small image patches, aggregating the information into MTF charts over the entire field of view. It generalises to unseen lenses and can be applied for single photographs, with the performance improving if multiple photographs are available.

4. **Prof. Hullin, Universität Bonn: 4D Imaging through Spray-On Optics**

Abstract:

Light fields are a powerful concept in computational imaging and a mainstay in image-based rendering; however, so far their acquisition required either carefully designed and calibrated optical systems (micro-lens arrays), or multi-camera/multi-shot settings. In this talk, we demonstrate the reconstruction of fully calibrated light field data from a single ordinary photograph taken through a partially wetted window. Each drop of water produces a distorted view on the scene, and the challenge of recovering the unknown mapping from pixel coordinates to refracted rays in space is a severely underconstrained problem. Our solution combines ray tracing and low-level image analysis techniques with state-of-the-art drop shape simulation and an iterative refinement scheme to enforce photo-consistency across features that are seen in multiple views. This novel approach not only recovers a dense pixel-to-ray mapping, but also the refractive geometry through which the scene is observed, to high accuracy.

5. **Robert-Alexander Windberger, IDS Obersulm: From Image to Information with on-Camera Neural Networks for IDS NXT**

Abstract:

Next generation industry builds on interconnected intelligent devices. With our IDS NXT product line, we provide an industrial-grade camera platform capable of performing pioneering image processing on board. A dedicated FPGA-based accelerator enables users to harness the accuracy, convenience, and versatility of deep learning algorithms. Renowned neural network models can be implemented using popular frameworks such as Keras and translated for the IDS NXT accelerator. Once loaded onto the camera, the accelerator switches between models within milliseconds and thus quickly adjusts to tasks of varying complexity. While neural networks are powerful, the machine vision toolbox has more to offer: by combining neural networks with other machine learning methods, they can be deployed as anomaly detectors to give just one example. Quick and easy integration is achieved by a library of executable vision apps, however, customized apps can be developed with access to accelerator resources if further specialization is desired. During this presentation, the workflow of bringing neural networks to IDS NXT industrial cameras is outlined alongside example applications.

6. **Jeremy Huard, Mathworks München: Deep Learning for Computer Vision with MATLAB**

Abstract:

Semantic segmentation, object detection, and image recognition. Computer vision applications integrated with deep learning provide advanced algorithms with high accuracy. MATLAB® provides an environment to design, create, and integrate deep learning models with computer vision applications. In this talk, we will present how MATLAB can help with deep learning applications at various stages, including:

- importing and labeling images and videos
- creating deep network from scratch using the Deep Network Designer App
- importing pretrained models for transfer learning
- training models with GPUs
- tuning hyperparameters using Bayesian optimization
- debugging deep learning results

- interoperate with other deep learning frameworks
- and deploying deep learning models to hardware including embedded GPUs.

7. **Paolo Favoro, University Bern: Blind Deconvolution- A Journey from Model-Based to Deep Learning Methods**

Abstract:
Blind deconvolution has enjoyed quite a remarkable progress in the last few decades thanks to developments in optimization and machine learning. To a large extent today several algorithms allow to recover a sharp image from a blurry one without additional knowledge about the blur. This is a remarkable achievement given the extreme ill-posedness of this mathematical problem. Very interesting steps forward have been made in the last decade, when fundamental inconsistencies in the formulation, such as priors favoring the blurry solution, were exposed. This has led to the study of novel formulations that favor sharp over blurry images and result in state of the art performance with robustness to noise in real images.

More recently, developments in deep learning have led to a fundamentally different approach to this problem, where enough data can adequately represent a realistic blur model and allow a neural network to learn how to remove blur from images. Approaches in deep learning have led to surprising results, where rather complex blur artifacts are removed effectively and efficiently. We give an account of the latest developments and show their strengths and weaknesses.

8. **Prof. Daniele Faccio (Univ. Edinburgh): Time-of-flight Computational Imaging**

Abstract:
We will overview some recent applications of time-of-flight computational imaging, i.e. applications where time-of-flight information from a scene is computationally processed to provide access to information that otherwise is not directly accessible. Examples are new forms of LIDAR imaging, including non-line-of-sight, and new-generation diffuse optical tomography for imaging deep inside scattering media such as the human body.

9. **Prof. Stefan Roth, TU Darmstadt: Deep Learning meets non-local methods for Image Restoration.**

Abstract:
Deep learning approaches define the current state of the art in many areas of image restoration. Yet, the spatial locality of their convolutional layers stands in contrast to non-local approaches, which had previously been a dominating paradigm in this area. In the first part of my talk, I will discuss how we can bridge these two areas and define powerful non-local layers in deep networks. In the second part of my talk, I will explore their application to image restoration and illuminate the issue of benchmarking such deep networks for image denoising in realistic settings.

10. **Prof. Y. Altmann, Heriot University Edinburgh: Bayesian methods for scalable and robust 3D imaging and sensing in the photon-starved regime**

Abstract:

Abstract: The recent advances in sensitive photon detectors have enabled unprecedented capabilities in quantifying light flux at a photonics level. This hardware improvement has paved the way to new 3D imaging and sensing strategies, with a growing number of applications in defence, automotive and underwater monitoring. It also induced a series of new computational challenges in terms of data acquisition, storage, modelling and processing. In particular, new computational methods are required to handle efficiently high-dimensional and highly uncertain measurements, within a reasonable amount of time. In this talk, we will discuss how advanced Bayesian methods can be used to extract information and associated measures of uncertainty about complex 3D scenes (long-range imaging, imaging through scattering media). We will also discuss how recent scalable methodologies can yield significantly faster analysis, enabling real-time 3D reconstruction of complex scenes.

11. **Jürgen Kaminski, Leica Camera Wetzlar: The Elephant in the Room - Physical Limits of Computational Imaging**

Abstract:

Computational Imaging makes a big promise: Being able to replace bulky and expensive cameras and lenses with small and cheap modules while retaining or even enhancing image quality. In the last few years, impressive progress has been made in this field that may lead to the expectation that "everything is possible". However, we shall not forget that all those sophisticated algorithms depend on the input of reliable data that has to be acquired by physical means. In this talk, we will explore the theoretical and practical limits of optical image acquisition and how they can provide guidelines for the design and layout of Computational Imaging systems.

12. **S. Tille, Leica Microsystems: Fusion of Optics & Digital Imaging**

Abstract:

will follow

13. **H. Kreipe, Continental: Autonome Driving Cars**

Abstract:

will follow