Ultrafast Computational Imaging

Abstract: An imaging system with sufficient illumination and detection speed can capture the propagation of light through a scene. This allows for several unique imaging capabilities, adding information about the transient response of materials, as well as the ability to see around corners. Time of Flight Non-Line-of-Sight (NLOS) imaging has been used to reconstruct scenes that are blocked from direct view via non-specular reflections in the scene. This allows an imaging system to see around corners. Current methods image scenes of few meter diameter at centimeter resolution. There are currently several challenges in this area. In this talk, I will review the current state of our research and the field and point out some of the challenges and opportunities of this method. Including these challenges are speed and efficiency of the reconstruction; scene features like occlusions and multiple reflections that cannot be handled by current reconstruction methods; and the development of hardware systems that can capture relevant information at reasonable speed and resolution while maintaining acceptable requirements to size, weight, power, and cost. We will highlight several recent developments that seek to address these problems, talk about fundamental limitations and requirements of NLOS imaging, and speculate on application areas and scenarios where this method addresses problems that cannot be better addressed by other competing options, such as non-line-of-sight sonar and RADAR imaging through walls. Besides the reconstruction of NLOS geometry, ultrafast imaging systems can capture fast transient material responses such as fluorescence lifetime, that allow for improved material identification and analysis. Fluorescence lifetime has been shown to improve the ability to detect cancerous tissue, assess plant health, analyse gunpowder residue, to give a few examples.

Biography: Andreas Velten obtained his PhD in Physics at the University of New Mexico designing lasers for precise phase measurements using intracavity phase interferometry. After graduation worked as a Postdoctoral Associate in the group of Ramesh Raskar at the MIT Media Lab followed by positions as Research Associate and Associate Scientist at the Morgridge Institute for Research and the Laboratory for Optical and Computational Instrumentation (LOCI) at the University of Wisconsin-Madison. In 2016 he joined the Department of Biostatistics and Medical Informatics and the Department of Electrical and Computer Engineering at the University of Wisconsin-Madison as Assistant Professor. Professor Velten has received multiple international awards for his work, including inclusion in the MIT TR35 and the Image Engineering Innovation Award of the Society for Imaging Science and Technology. He is co-founder of multiple start-up companies including OnLume which develops Surgical Imaging Systems.

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