3D Imaging with Time of Flight Cameras: Theory, Algorithms and Applications

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Figure 1: This course offers a self-contained tutorial to building, understanding, and exploiting Time of Flight 3D sensors. We will begin the course by introducing attendees to the landscape of 3D cameras (upper-left) that can obtain depth maps of a scene (upper-right). In the (bottom row) we show different hardware systems, which will be discussed in the course as well.

Abstract

Time-of-flight (ToF) cameras provide access to depth/3D information of a scene. They find applications in imaging, computer vision and computer graphics. This course introduces our audience to recent advances in this area. We discuss 3D imaging applications like gestural interactions, industrial vision, transient imaging, bio-imaging and illumination multiplexing. We constrain our discussion to low cost and off-the-shelf imaging systems, to encourage reproducibility. Attendees will receive an overview of the benefits and limitations of different types of 3D cameras. Deep emphasis will be placed on Time of Flight 3D technology as it forms the basis for the new Microsoft Kinect One. Instructors will present recent papers in graphics and computational photography that exploit such sensors. Finally, attendees are provided a primer on constructing their own prototype ToF camera on a DIY budget to reproduce the results shown.¹

Module I: Introduction and Comparisons of 3D Cameras

In this module we will begin by discussing industrial and research applications of 3D cameras, which include 3D scanning, robotic navigation, ultrafast imaging and more. Motivated by industry trends, we will place a significant emphasis on comparing structured light, stereo, and time of flight based 3D solutions.

Module II: Computational Photography with ToF

Time of flight sensors, which are ordinarily used for depth, also offer a new dimension of coding in computational photography. For example, we will discuss recent work that uses low cost time of flight sensors to perform ultrafast imaging.

Module III: ToF Imaging in Human Computer Interaction and Computer Vision

Time of Flight sensors have been used for 3D navigation, gesture recognition, and high quality, low cost 3D scanning. We will discuss an industrial perspective on such applications.

Module IV: Reproducibility: DIY ToF Camera

A key takeaway from this course is the ability to learn more about the hardware that vision software sits on top of. We will walk attendees through building their own 3D time of flight sensor on a DIY budget (sub 500 dollars). This module is self-contained.

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¹ Relevant Papers attached in the Course Notes