Computational Photography Tutorial
Module I: Introduction

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Jean-François Lalonde is an assistant professor in ECE at Laval University, Quebec City. Previously, he was a Post-Doctoral Associate at Disney Research, Pittsburgh. He received a B.Eng. degree in Computer Engineering with honors from Laval University, Canada, in 2004. He earned his M.S at the Robotics Institute at Carnegie Mellon University in 2006 and received his Ph.D., also from Carnegie Mellon, in 2011. After graduation, he became a Computer Vision Scientist at Tandent, where he helped develop LightBrush™, the first commercial intrinsic imaging application. His work focuses on lighting-aware image understanding and synthesis by leveraging large amounts of data.

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Mohit Gupta is an assistant professor in the CS department at the University of Wisconsin-Madison. Earlier, he was a research scientist in the CAVE lab at Columbia University. He received a B.Tech. in computer science from Indian Institute of Technology Delhi, and a Ph.D. from the Robotics Institute, Carnegie Mellon University. His research interests are broadly in computer vision and computational imaging. His focus is on designing computational cameras that enable computer vision systems to perform robustly in extreme real-world scenarios, as well as capture novel kinds of information about the physical world that is not possible with conventional cameras.

All materials
(including slides & list of references)
available at
jflalonde.ca/icip16
From camera obscura to the computational camera

With inspiration from Brian Barsky’s talk, “Computational photography: going forward from an historical perspective”, presented at ICCP 2015
Camera obscura

Unknown, 17th century, public domain
Camera obscura (18th century)

Canaletto, 18th century, public domain
Vermeer and realism

Johannes Vermeer, La leçon de musique (1662–1665)
Short detour: Tim’s Vermeer

Preview available here: https://www.youtube.com/watch?v=CS_HUWs9c8c

Movie available on Netflix
Earliest surviving photograph (c.1826)

First photograph (c.1826)

Joseph Nicéphore Niépce. Source: public domain

Photo courtesy Musée Niécephore Niépce/Chalon-sur-Saône, from petapixel
First daguerrotype

Louis Jaques Mande Daguerre, “L'atelier de l'artiste”, 1837, public domain
First photo of a human being (1838)

Louis Daguerre, "Le boulevard du Temple", 1838, from petapixel
First selfie (1839)

Robert Cornelius, “The first light picture ever taken”, 1839, from petapixel
"The 1821 derby at Epsom", Jean Louis Théodore Géricault, 1821, public domain
"The horse in motion", Eadweard Muybridge, 1878, public domain
What is photography?

5 separate negatives combined

Single shot, no retouching

Henry Peach Robinson, “Fading away”, 1858, public domain

Peter Henry Emerson, “At Plough, The End of the Furrow”, 1887, public domain
Eastman Kodak (1888)
Street photography

“Knowing when to shoot… the decisive moment”
Henri Cartier-Bresson
First digital photograph (1957)

Resolution: 176x176
First digital camera (1975)
Modern digital cameras
Traditional, “film-like” photography

Mimics human eye for a single snapshot
single view, single instant, fixed dynamic range and depth of field for given illumination in a static world
Computational photography

Detector

Pixels

Programmable optics

Scene

Light source

Image
Computational photography

Diagram:
- Scene
  → Detector
  → Programmable optics
  ↓ Computation
  ↓ Image
- Light source
Computational photography

Diagram:
- **Scene** → **Programmable illumination**
- **Programmable optics** → **Detector**
- **Computation** → **Image**

Key terms:
- Detector
- Scene
- Programmable optics
- Computation
- Image
Computational photography

- Detector
- Programmable optics
- Scene
- Programmable illumination

Image

Computation

Programmable illumination
Computational photography

“Coded” photography [M. Gupta]
Novel camera designs for improved functionalities

“Augmented” photography [J-F Lalonde]
Algorithmic tools to augment regular cameras

Detector
Scene
Programmable optics
Programmable illumination
Schedule

14:00-14:20  Opening remarks & brief history of photography  [J.-F. Lalonde]
14:20-15:30  Coded photography  [M. Gupta]
15:30-15:40  Break
15:40-16:50  Augmented photography  [J.-F. Lalonde]
16:50-17:10  Future and impact of photography  [M. Gupta]
17:10-17:30  Q&A