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.
Mohit Gupta will start as an assistant professor in the CS department at the University of Wisconsin-Madison in January ’16. He is currently a research scientist in the CAVE lab at Columbia University. He received a B.Tech. in computer science from Indian Institute of Technology Delhi in 2003, an M.S. from Stony Brook University in 2005 and a Ph.D. from the Robotics Institute, Carnegie Mellon University in 2011. His research interests are in computer vision and computational imaging. His focus is on designing computational cameras that enable computer vision systems to perform robustly in demanding real-world scenarios, as well as capture novel kinds of information about the physical world.
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)
Earliest surviving photograph (c.1826)

Joseph Nicéphore Niépce. “Le point de vue de la fenêtre” c.1826.
Enhanced by Helmut Gersheim, c. 1952

Photo by J. Paul Getty Museum, from petapixel

public domain
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)
First selfie (1839)
"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)

U.S. patent no. 388,850, issued to George Eastman, September 4, 1888
Street photography

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

Resolution: 176x176
First digital camera (1975)

Steve Sasson, Eastman Kodak. Photo credit: Eastman Kodak
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

Detector

Programmable optics

Scene

Light source

Computation

Picture
Computational photography

- Detector
- Scene
- Programmable optics
- Programmable illumination
- Computation
- Picture
Computational photography

- Image
- Computation
- Picture
- Detector
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Computational photography

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

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

13:50-15:00  Coded photography  [M. Gupta]
15:00-15:10  Break
15:10-16:20  Augmented photography  [J.-F. Lalonde]
16:20-16:40  Future and impact of photography  [M. Gupta]
16:40-17:00  Q&A