Augmented Reality

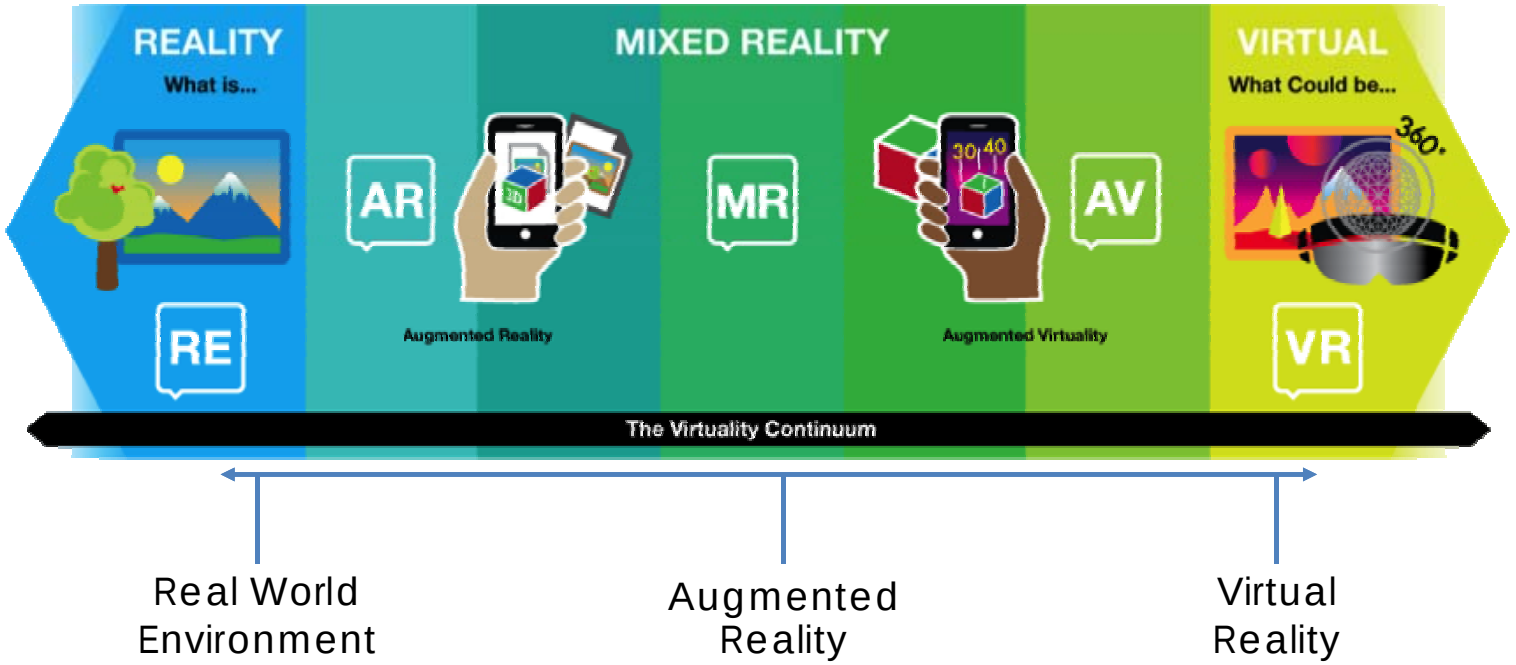
Sung-eui Yoon

Goals for Today

Goals

- Getting acquainted with AR
- Making your own Augmented Reality
- Some of recent techniques

What is Augmented Reality?



Milgram, Paul, et al. "Augmented reality: A class of displays on the reality-virtuality continuum." *Photonics for industrial applications*. International Society for Optics and Photonics, 1995.

Photo Source: http://smartideasblog.trekk.com/augmented-or-virtual-how-do-you-like-your-reality

Brief History

- 1968 Ivan Sutherland invents first head-mounted display “Sword-of-Damocles” at University of Utah.
- 2010 Vuforia for AR Mobile Apps was released by Qualcomm.
- 2013 Google announces Google Glass.
- 2015 Microsoft announces the HoloLens.
- 2016 Niantic released Pokémon Go.

Original slides are from Frend, Chauncey. ”Augmented Reality & the UITS Advanced Visualization Lab."

AR today – Industry Examples

AR Coloring Book

(0:00-0:30)

Live Texturing of Augmented Reality Characters from Colored Drawings
IEEE International Symposium on Mixed and Augmented Reality (ISMAR) 2015

HoloLens

Augmented Climbing Wall

(0:00-0:33)

dedicated workshops on Mar. 24th & 31st

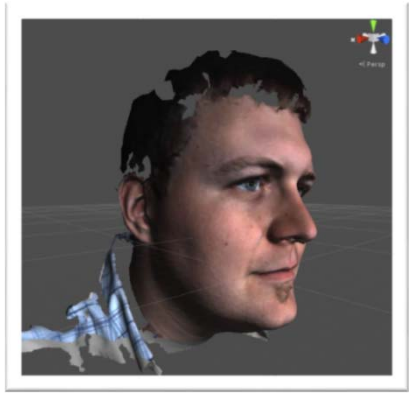
Building Experiences

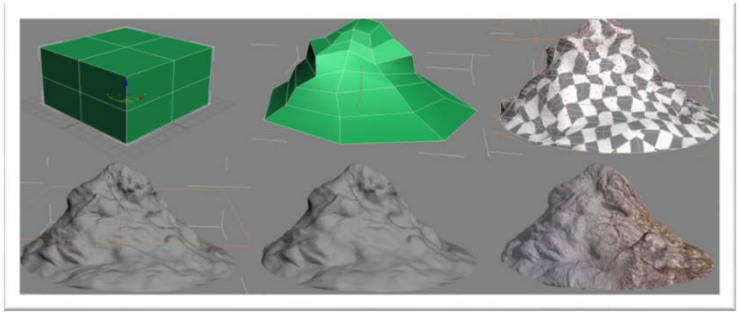
Assets + Display + Interface

Sourcing or Building Data

- 3D Scanning
  - 3D Scanning
  - Photogrammetry
- 3D Authoring
  - Autodesk Maya or Max
  - Sketchup
  - TinkerCAD
- 3D Repositories
  - Sketchup 3D Warehouse
  - Smithsonian X 3D https://3d.si.edu/browser
  - Sketchfab*
  - Thingiverse*

- You can also augment with media
  - Audio
  - 2D media (Image & video)
  - Text





Building Experiences

Assets + **Display** + Interface

Mobile Devices

PC or Mac with Webcam

HoloLens Headset

Building Experiences

Assets + Display + **Interface**

Onboarding AR – Prototyping Tools

No programming required

wikitude

See more.

Building Experiences

Assets + Display + **Interface**

Development Tools

Base Package → **AR Plugins**

AR Technology

- Mobile Device Apps
- Image or Object Markers

- Desktop or Laptop Apps
- Fiducial or Image Markers

- HoloLens device Apps
- Area Learning or Image Markers

What the future may hold

Web Hosted AR Applications

HTML

WebGL

WebRTC

Consumer-grade headsets

magic leap

Cyber Physical AR Applications

(2:16-3:04)

Resources for you!

Base Package

Tutorials https://unity3d.com/learn

AR Plugins

Vuforia Basics Tutorial By: Chauncey
https://www.youtube.com/watch?v=qbI9PrSUo5w

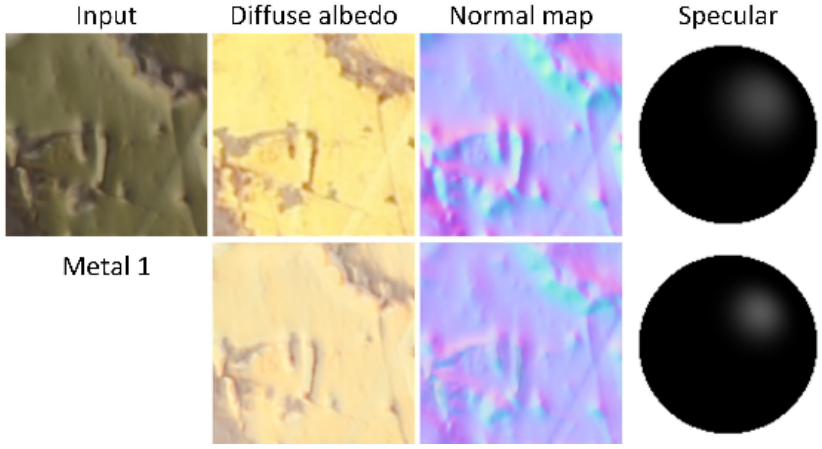
AR YouTube Playlist

Technical Components

- AR spans various fields
- Robotics parts
  - Simultaneous localization and mapping (SLAM)
- Computer vision parts
  - Geometry, light, and materials estimation
- Graphics parts
  - Rendering virtual objects
- Machine learning
  - Understand various things

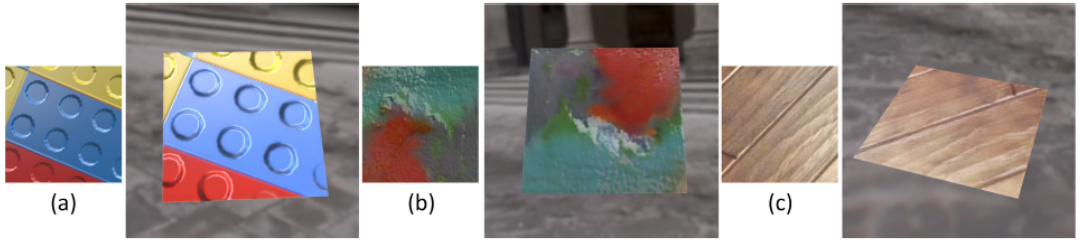
Modeling Surface Appearance from a Single Photography using Self-Augmentation [Li et al.]

- **Assume the anisotropic Ward BRDF model**
  - **Diffuse albedo and normal map per each pixel**
  - **Specular parameters for each image**



Ground truth

Reconstructed ones



Original images with relighted images

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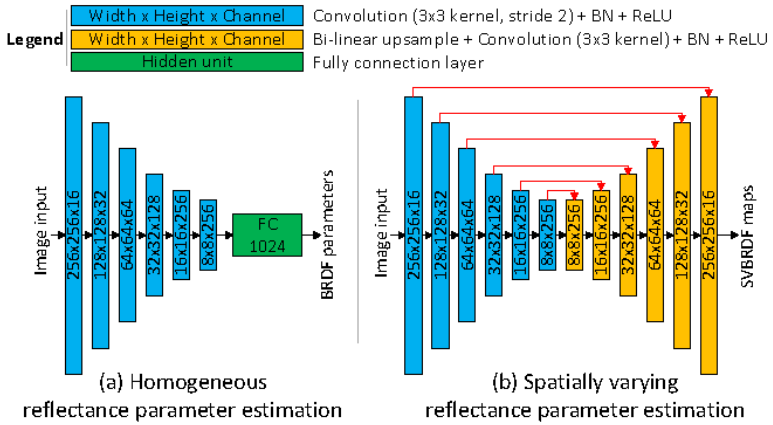
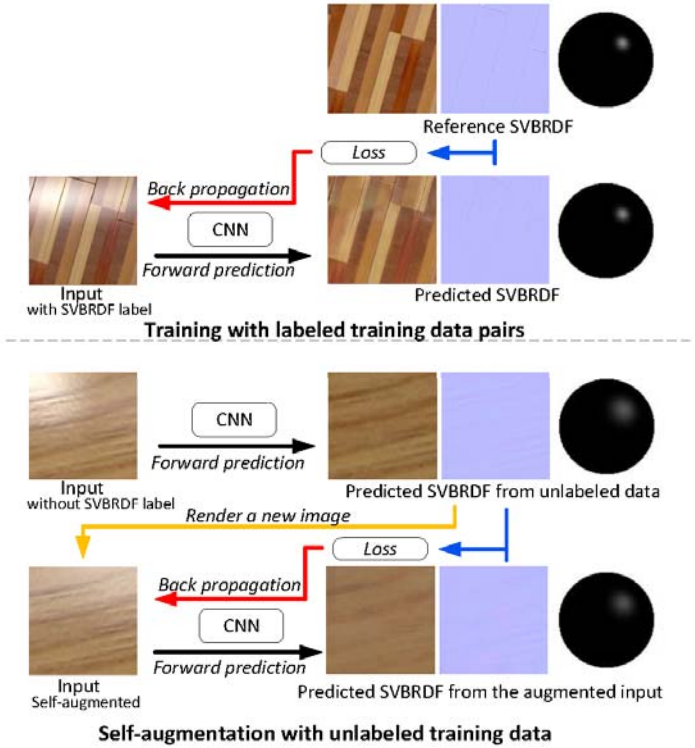
Network Architectures

- **Two separate architectures**





- **Self-augmentation**
  - **Use unlabeled image and reconstruct parameters**
  - **Generate its corresponding image**
  - **Use them as training pairs with labeled ones**

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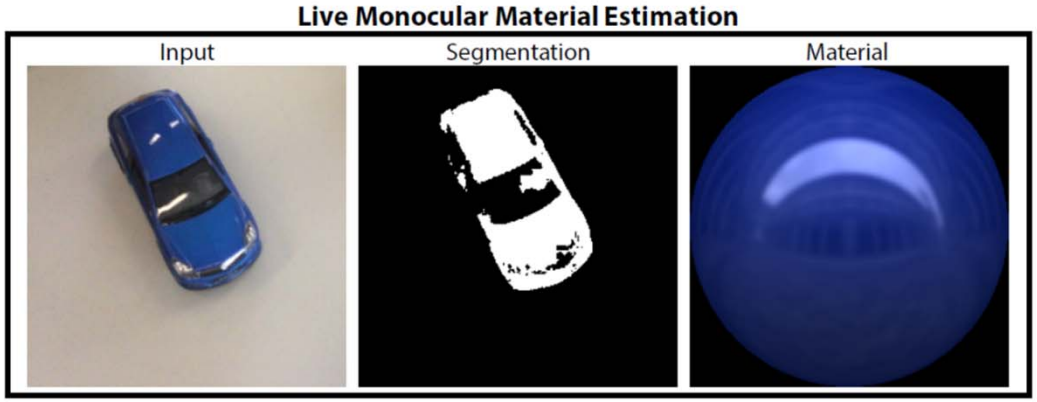
LIME: Live Intrinsic Material Estimation [Meka et al. CVPR 18]

- **Estimate specular information of an object in the RGB image**
  - **Starts with the rendering equation, but ends up with assuming the Phong illumination: diffuse and specular terms**

$$\mathrm{BP}(\mathbf{x},\mathbf{n},\boldsymbol{\omega}_i,\boldsymbol{\omega}_o) = \underbrace{\mathbf{m}_d(\boldsymbol{\omega}_i \cdot \mathbf{n})}_{\text{diffuse}} + \underbrace{\mathbf{m}_s(\mathbf{h}\cdot\mathbf{n})^s}_{\text{specular}}. \qquad (3)$$



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Real-Time Geometry, Albedo, and Motion Reconstruction Using a Single RGB-D Camera

Kaiwen Guo[1], Feng Xu[1], Tao Yu[1,2], Xiaoyang Liu[1], Qionghai Dai[1], Yebin Liu[1]

Tsinghua University[1] Beihang University[2]

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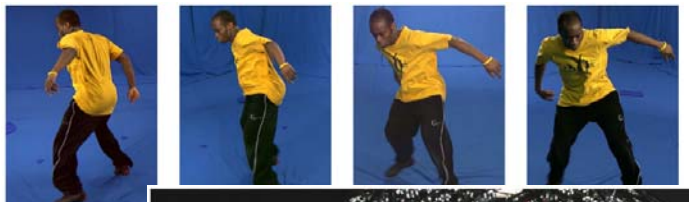
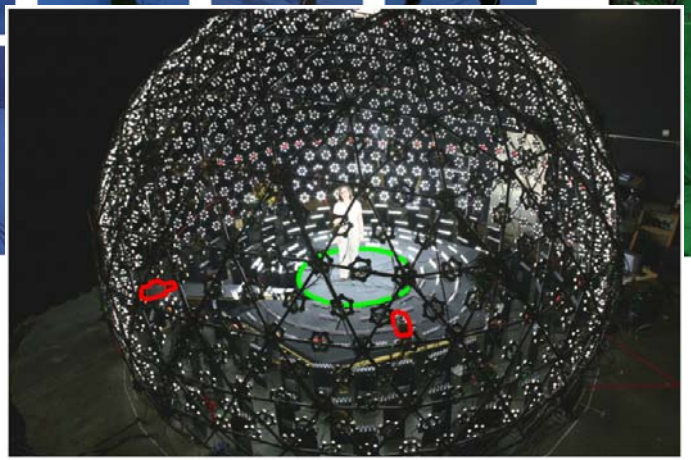
Offline Volumetric Performance Capture





[Starck and Hilton, 2007], [Liu et al., 2009]

[Vlasic et al. 2009], [Debevec, Light Stage], [Collet et al. 2015]

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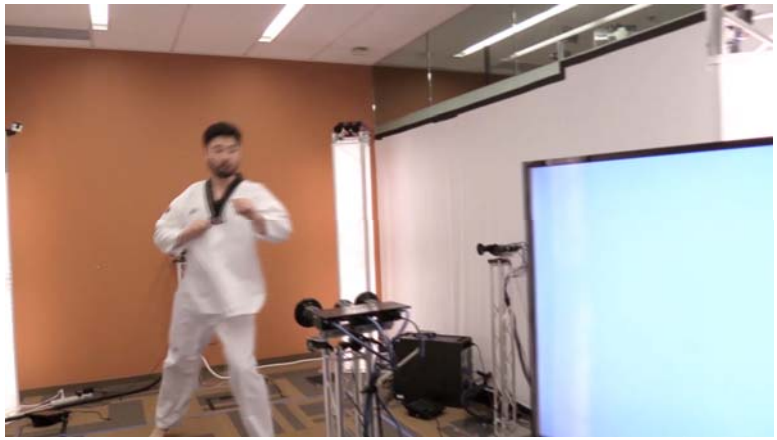
Real-time Volumetric Performance Capture



[Fusion4D, Dou et al. 2016], [Holoportation, Orts-Escolano et al. 2016]

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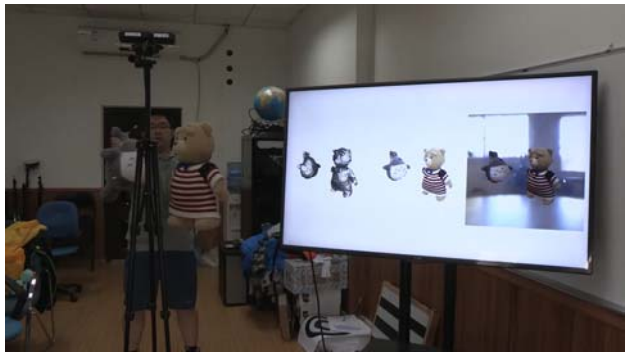
Real-time Single-view Volumetric Capture



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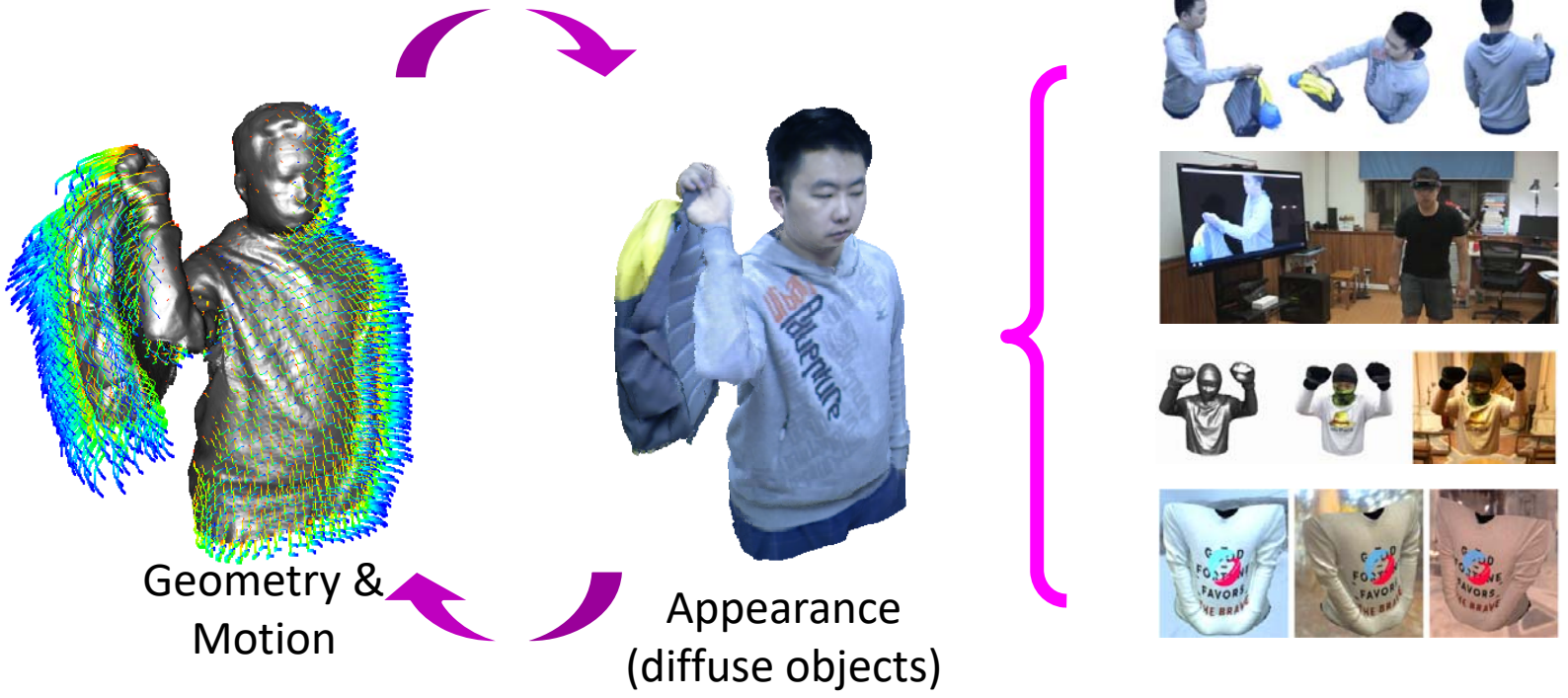
Key Idea: Joint Optimization considering Shading



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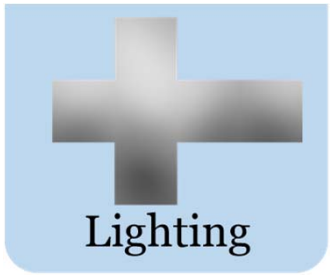
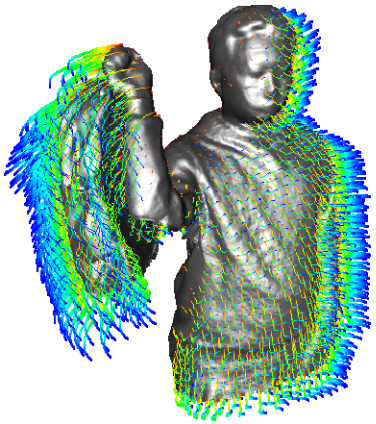
Overview



Color

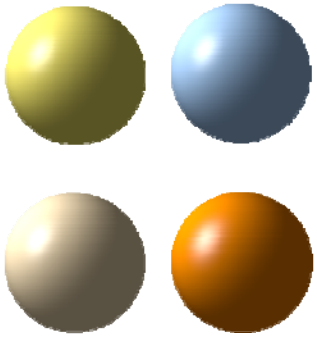
Depth

Input



Motion

Geometry



Albedo (color)

Output

Assume diffuse objects

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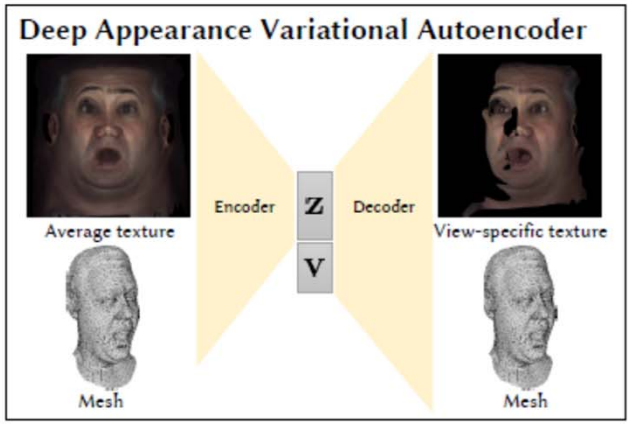
Deep Appearance Models for Face Rendering [SIG 18]

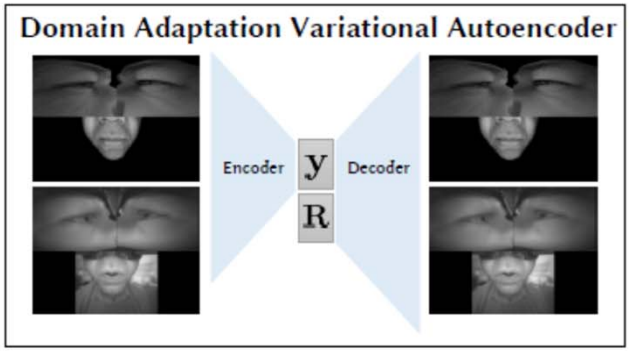
- **Data-driven rendering method that do not require complex geometry and materials**

Multi-camera Capture Images

Synthetic HMD Images

Images from Camera Mounted on HMD





Ground Truth (novel view)

Rendered Avatar (novel view)

Input

Animated Avatar

Learning to Predict Indoor Illumination from a Single Image

Marc-André Gardner, Kalyan Sunkavalli, Ersin Yumer, Xiaohui Shen,
Emiliano Gambaretto, Christian Gagné, Jean-François Lalonde

Université Laval, Québec, Canada
Adobe Systems Inc., San Jose, USA

Illumination is key

Current approaches and limitations

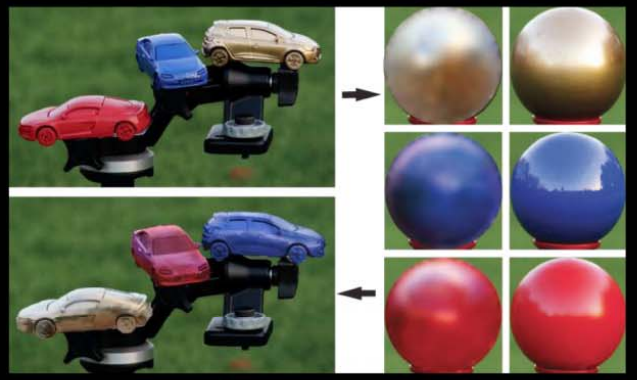
Calibration objects

[Debevec, 1998]

Specialized hardware

[Tocci, 2011], [Manakov, 2013]

Scene knowledge



[Rematas, 2015]

Our approach

No calibration

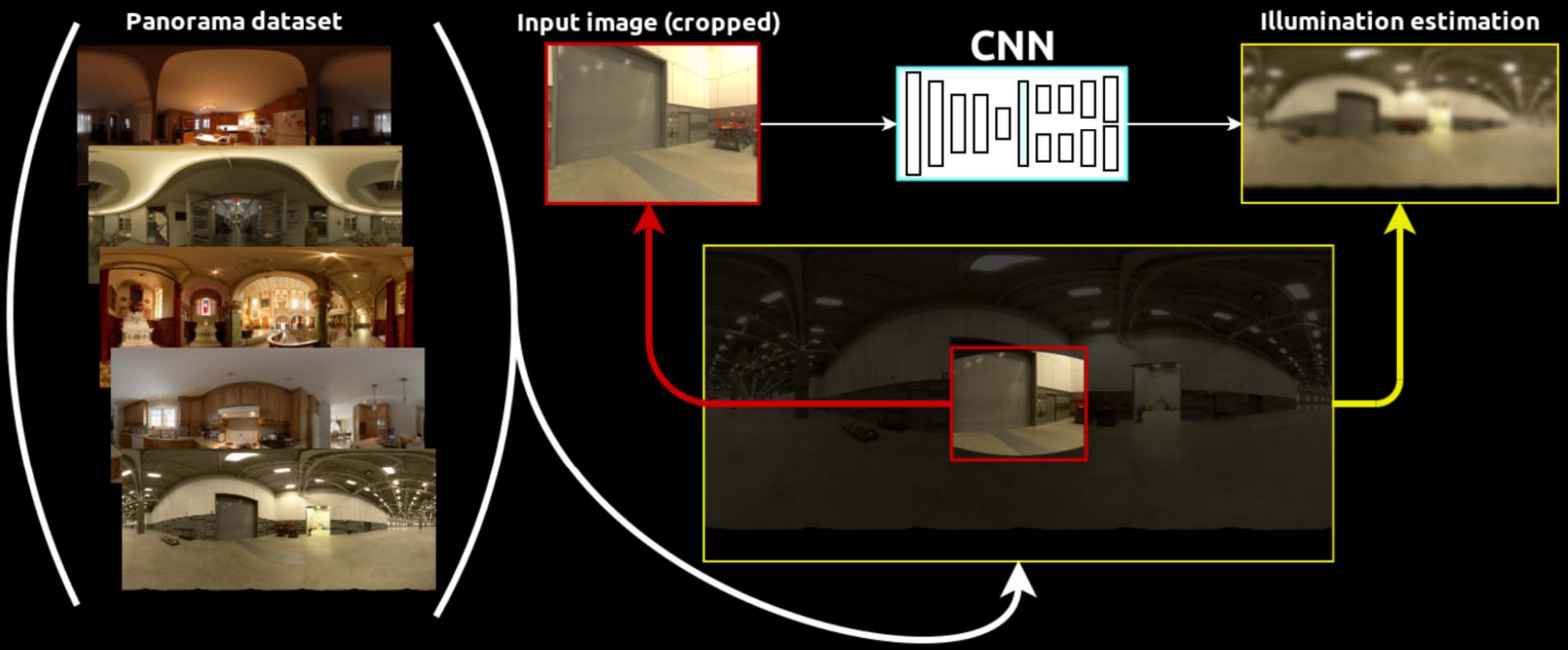
Any camera

No prior knowledge

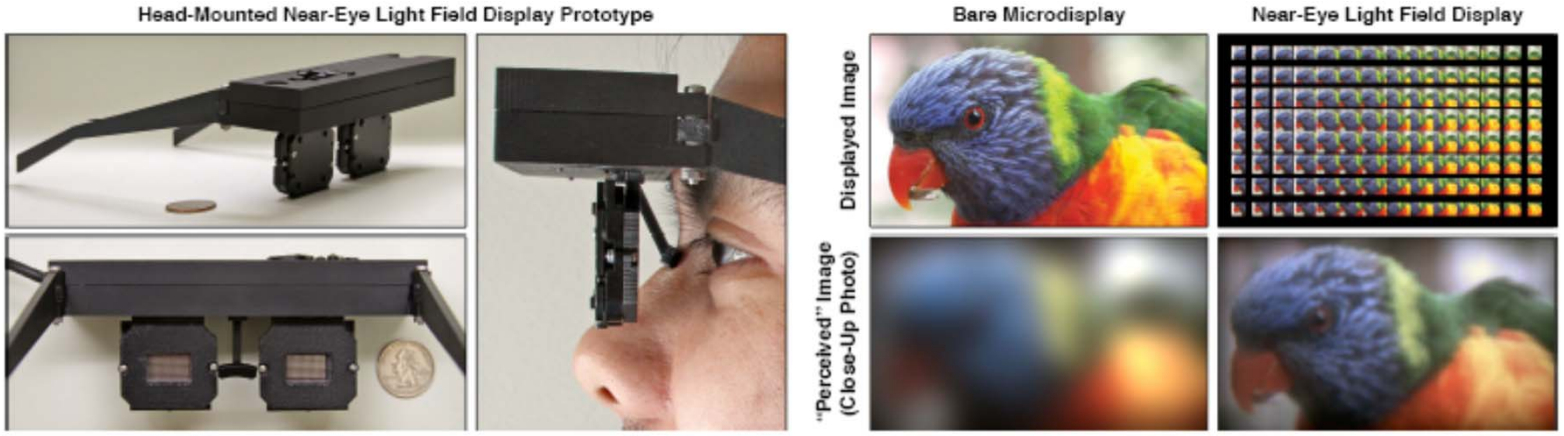
Our goal

Given a single indoor LDR image, recover a whole HDR environment map

End-to-end learning approach



Near-Eye Light Field Display [ToG 13]



- **Use a microlens array for supporting the light field**

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Goals for Today were:

- **Getting acquainted with AR**
- **Making your own Augmented Reality**
- **Some of recent techniques**