

# The Past and the Future of Light Field Imaging

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08.11.2018



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## **What is Light Field Imaging**

### **I. The Past**

History and Applications  
Commercialization

### **II. The Present**

Light Fields are for Industry

### **III. A Glimpse in the Future**

VR and Deep Learning

## Theoretical Foundations

**1846** Faraday: “Thoughts on Ray Vibrations”

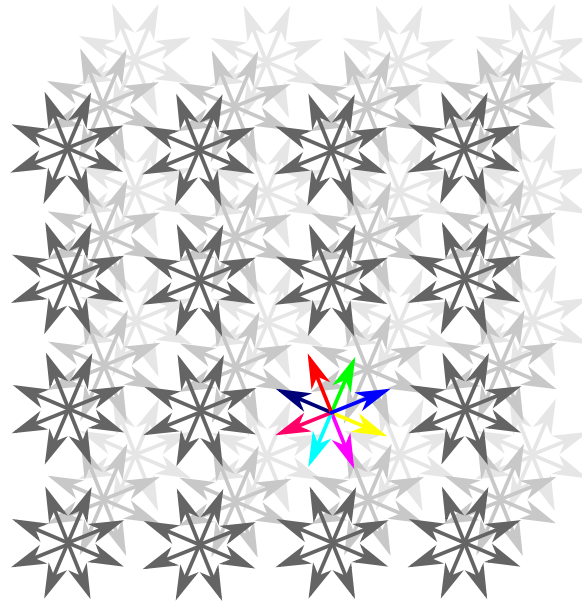
**1936** Gershung: “The Light Field”

**1991** Adelson: “The Plenoptic Function”

# What is Light Field Imaging

## The Plenoptic Function

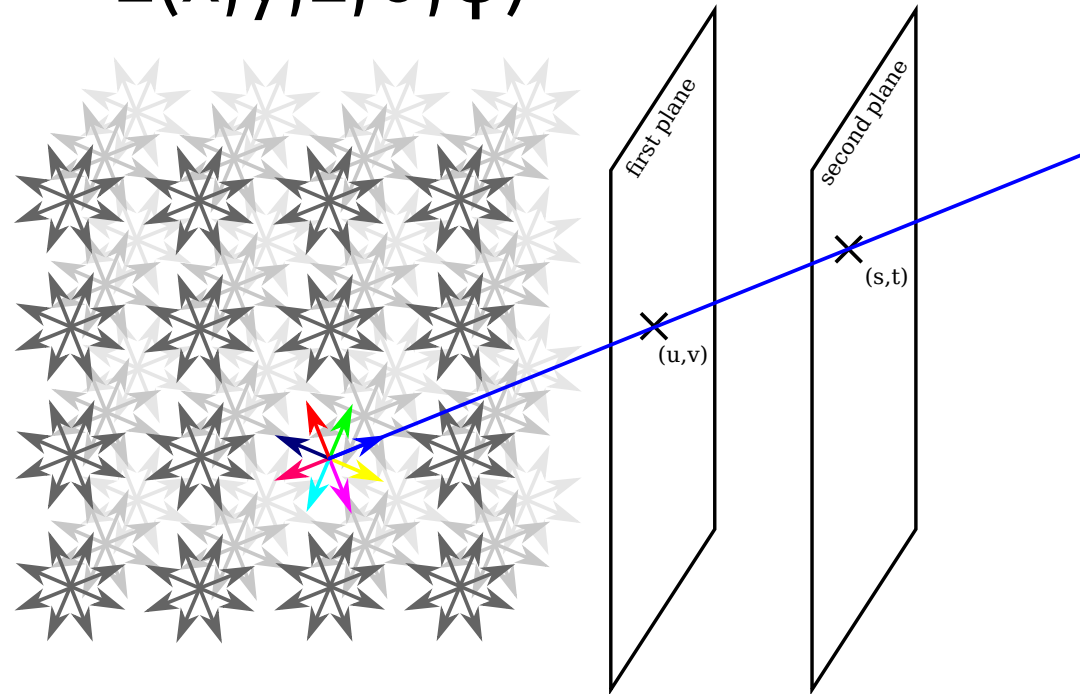
$$L(x, y, z, \theta, \phi)$$



# What is Light Field Imaging

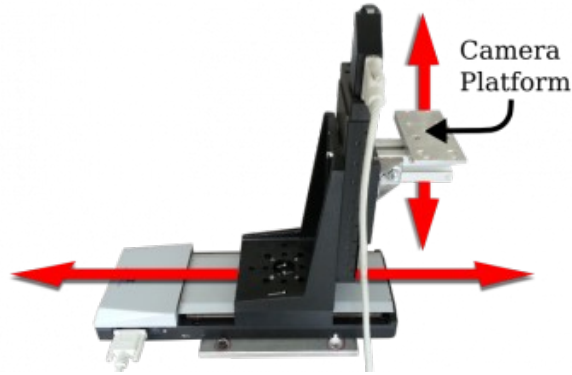
## The Plenoptic Function

$$L(x, y, z, \theta, \phi)$$

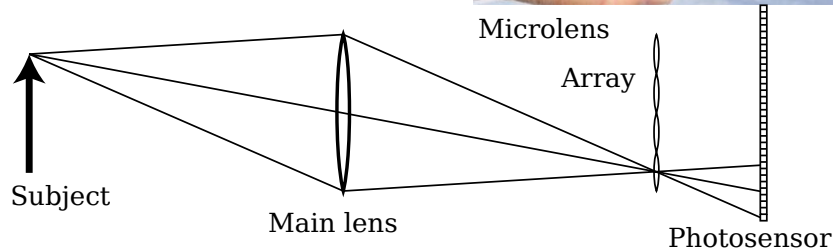


# What is Light Field Imaging

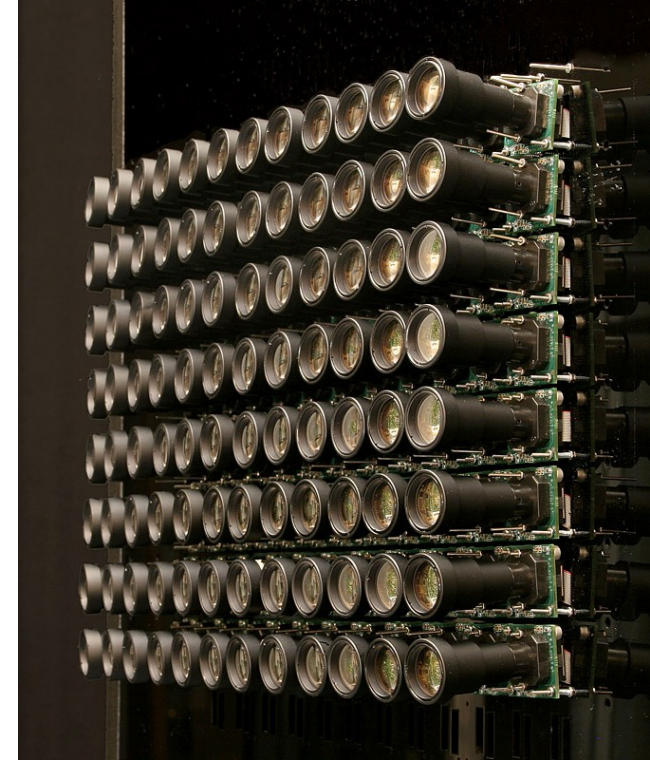
## Recording Light Field Data



Translation Stage



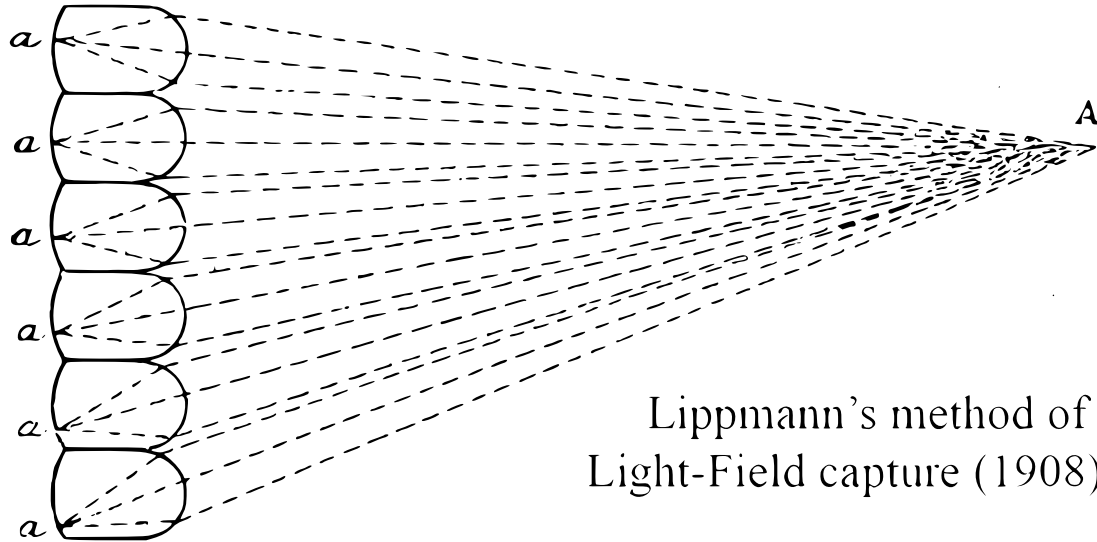
Plenoptic Camera



Camera Array

## The First Application: Display and Recorder

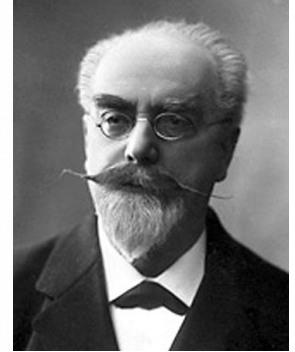
Lippmann 1908:



Lippmann's method of  
Light-Field capture (1908)



Prof. Lippmann's camera, showing the  
front with its twelve lenses.

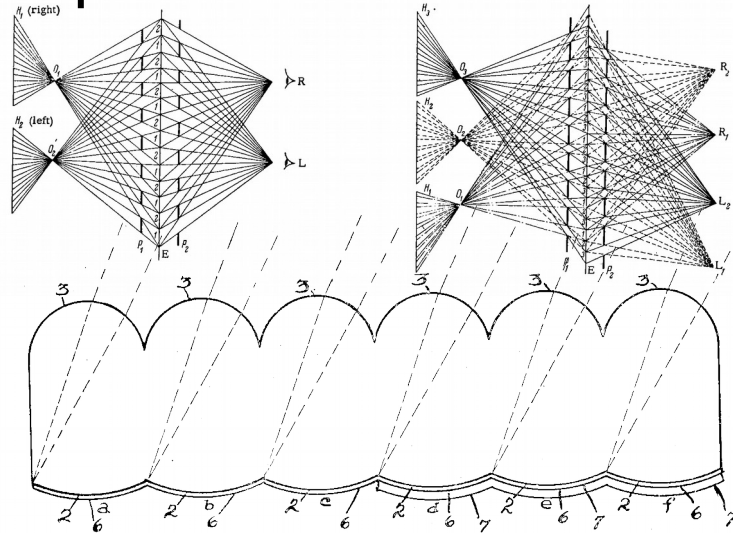


... not quite ready for the market

## The First Application: Display and Recorder

### Further Developements:

**1911** Sokolev:



**1930** Ives:

Further works by Coffey 1935, Ivanov 1948, Gruetzner 1952, Chutjian 1968, Dudnikov 1970, Ivars 1988



## The Beginning of an Era

**1996** Levoy and Hanrahan: "Light Field Rendering"

**1996** Gortler et al.: "The Lumigraph"

**Generation of new viewpoints  
from a recorded light field**

## Light Field Applications

### Synthetic Aperture Imaging



## Light Field Applications Synthetic Aperture Imaging



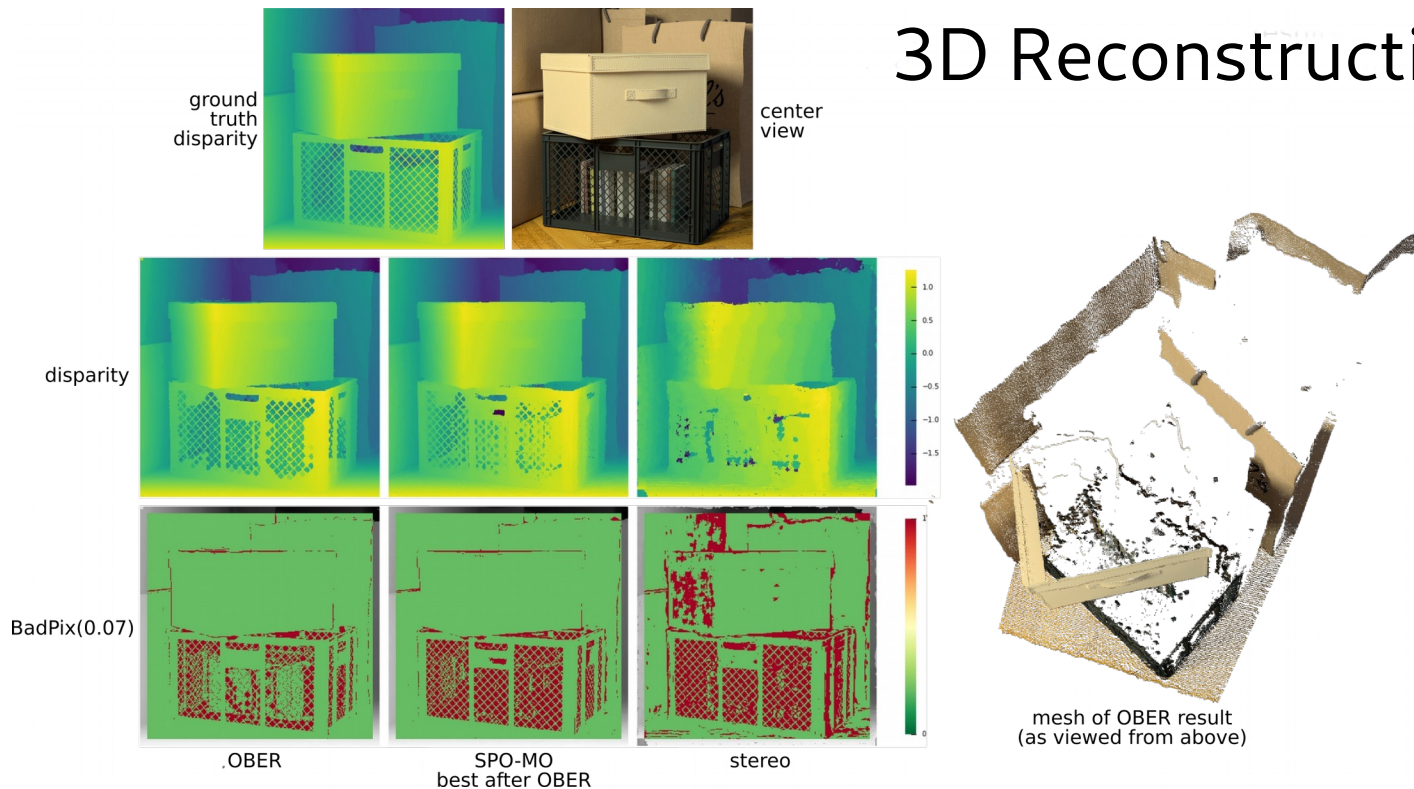
## Light Field Applications Superresolution





## Light Field Applications

### 3D Reconstruction



## Light Field Applications

### Surface Properties



Input



Diffuse



Specular

## Commercial Use **Lytro (2006-2018)**

- Application: Refocusing



- first commercial Plenoptic Camera
- researches were very happy!
- consumers not so much...

## Never Released

- **Pelican Imaging (2006-2016)**

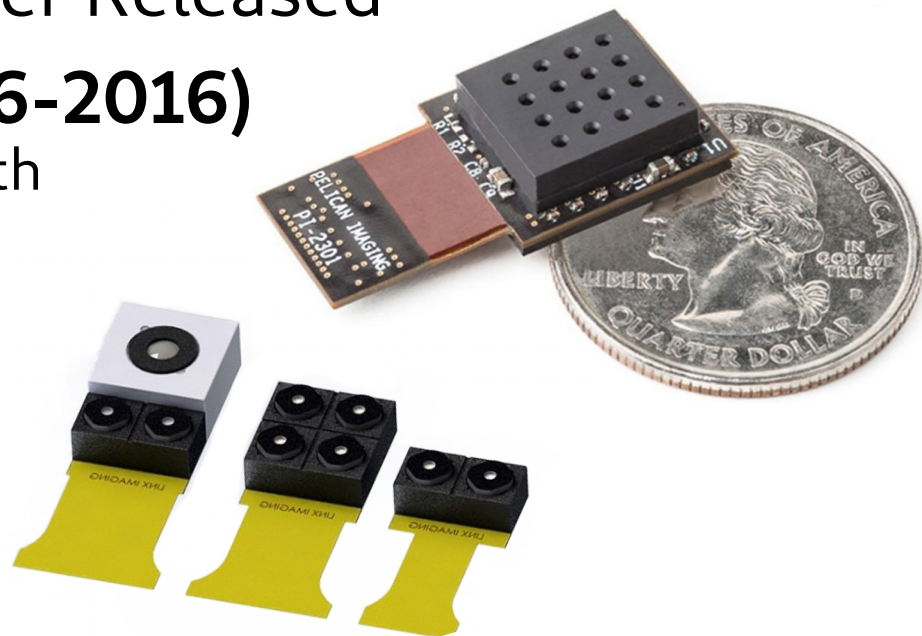
refocusing, close range depth

Acquired by Tessera

- **LinX (2006-2016)**

refocusing

Acquired by Apple





# The Present

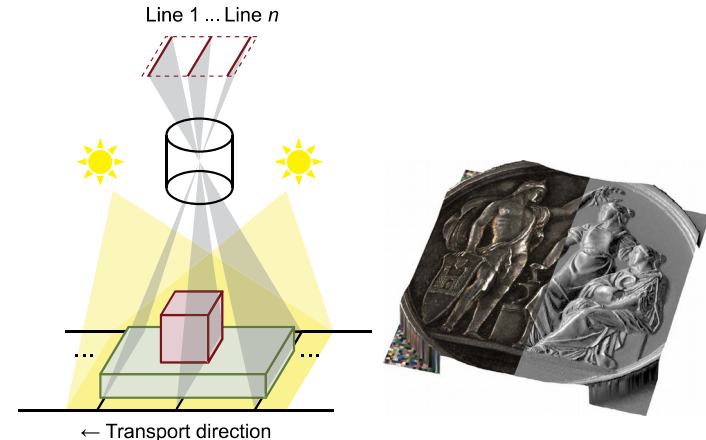
Current Light Field products are for industry!

- **Raytrix** (since 2009)  
optical inspection



- **HD Vision Systems** (since 2017)  
robotics, optical inspection

- **AIT**  
very high speed inline inspection



We are just starting...

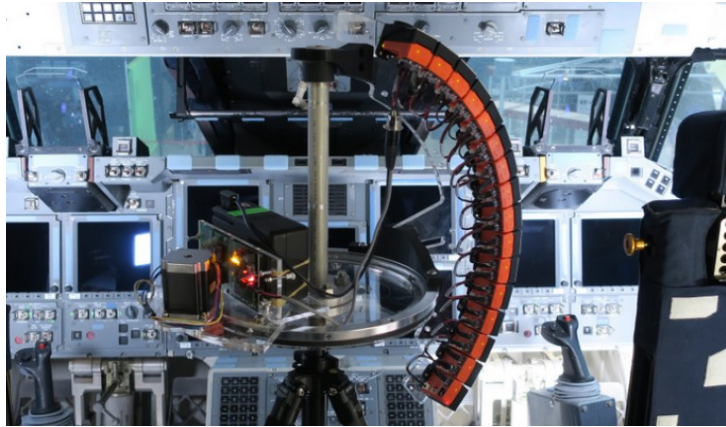
**... and will see many more applications based on  
Light Field Imaging**

- depth estimation (already available!)
- image synthesis (coming next...)
- material properties (just wait and see...)

# A Glimpse in the Future

... future applications:

Light Fields for VR

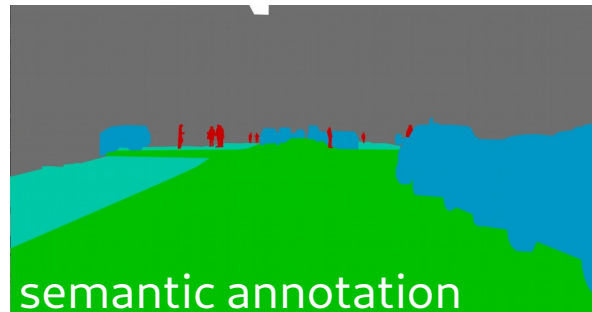
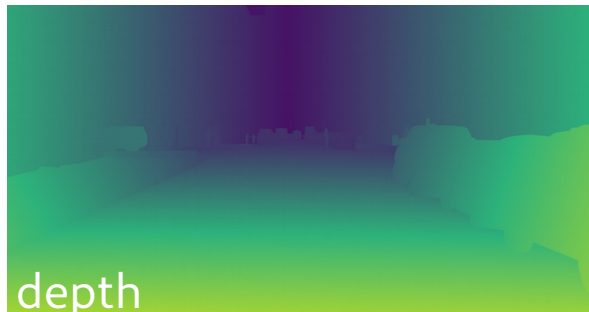
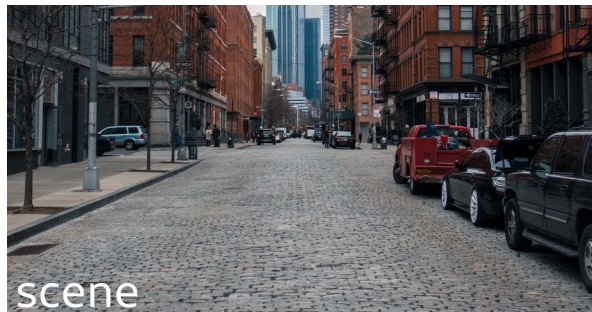


Google

# A Glimpse in the Future

...future applications:

**training data for Deep Learning**



## TrueLight

startup in founding phase

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