



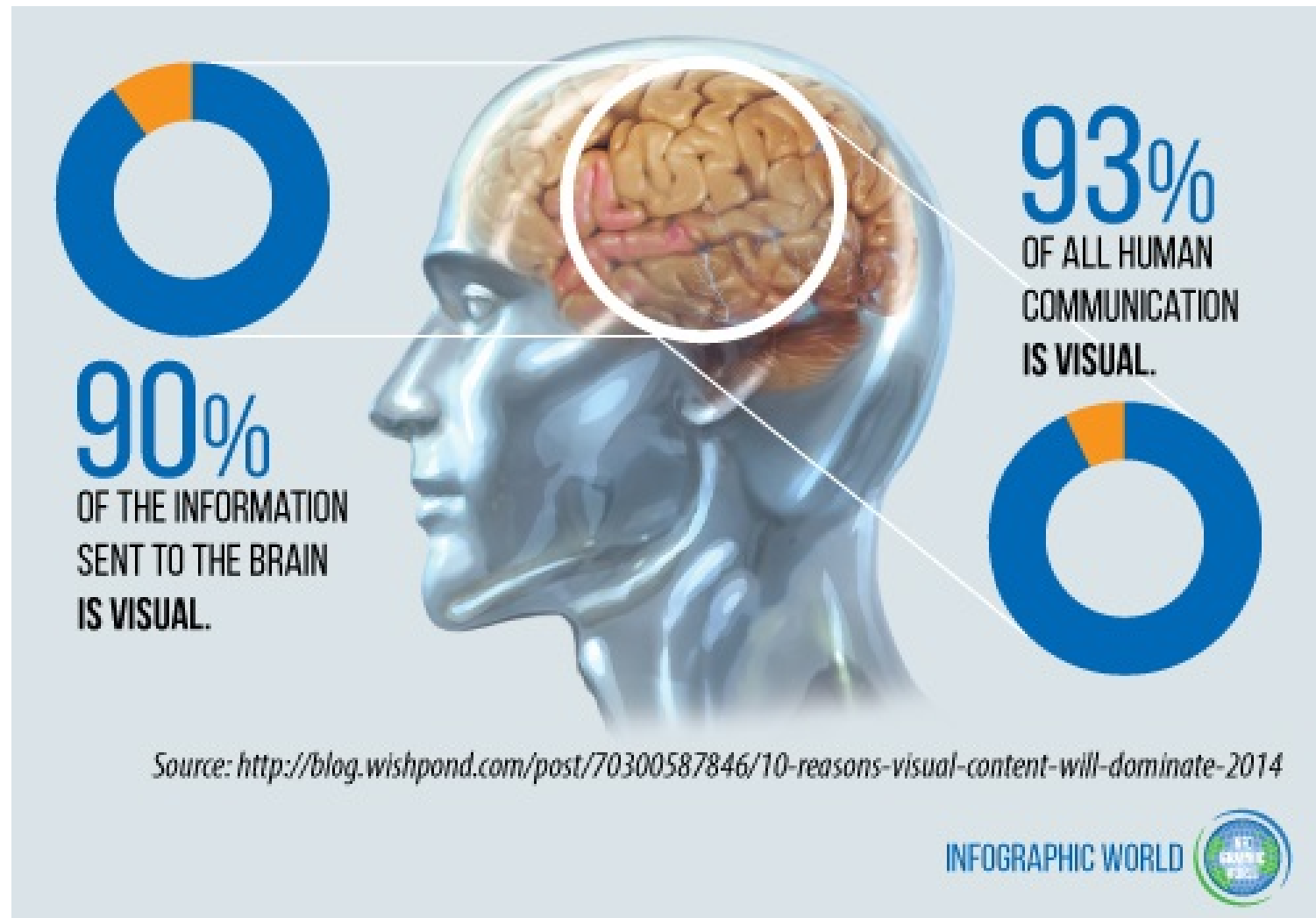
# **Introduction to Computer Vision and Pattern Recognition**

**For AIDA eLearning Presentation**

**PROF. CHANG-WEN CHEN  
SPRING 2022**



# Visual Signal Processing in Human Brain





# What is Computer Vision?



- ◆ Automatically identifying objects in images or video
- ◆ Extracting latent information from visual data
- ◆ Technology that interprets light stimuli
- ◆ Computers seeing/learning things that the programmers who made them didn't tell them
- ◆ Mimicking human perception of sight with computational algorithms
- ◆ Train computers to understand the visual world
- ◆ The study of understanding the world through visual perception



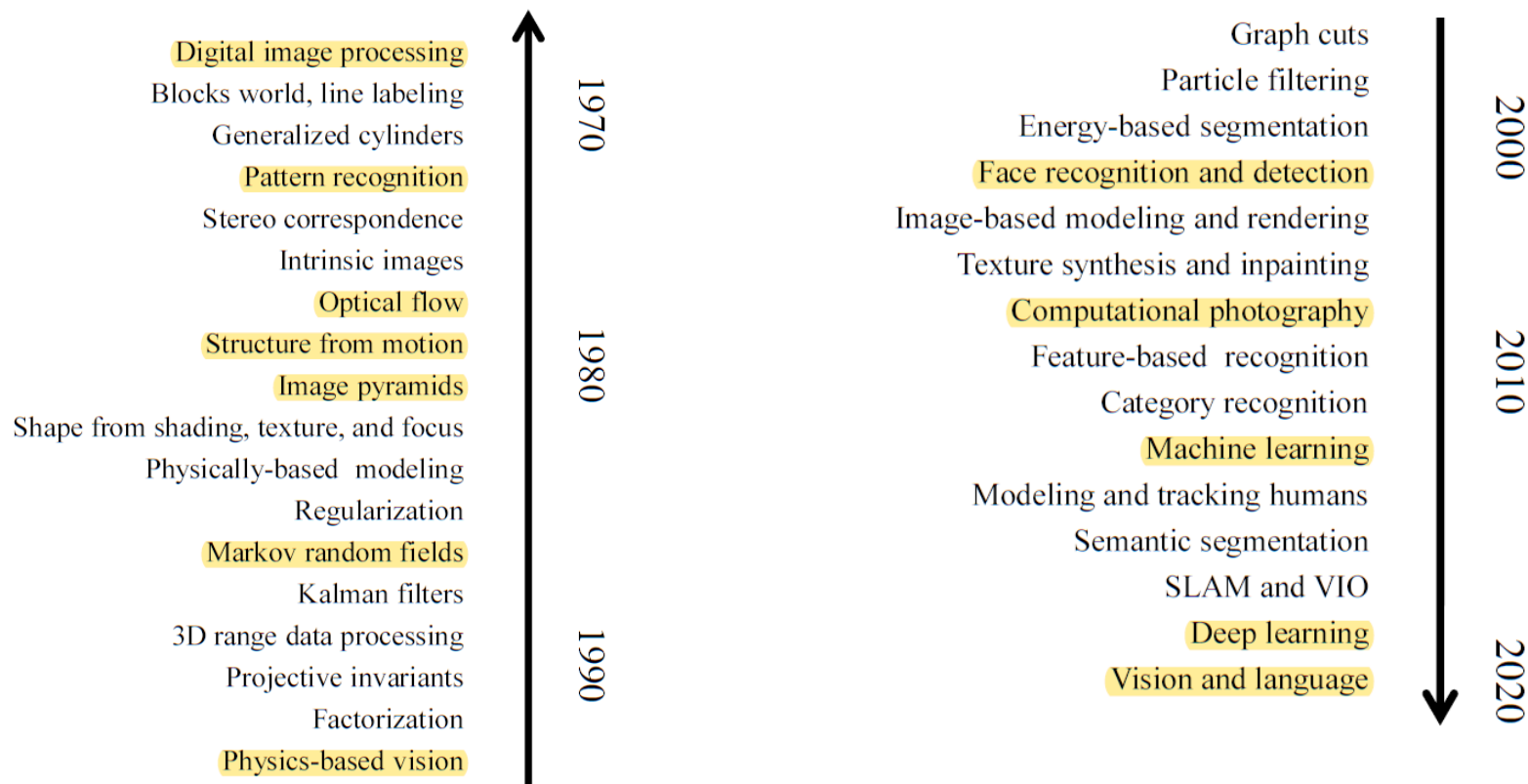
# Computer Vision: A Simulation of Eyes?



- ◆ Converting images to more understandable things like distance, edges, directions etc.
- ◆ Computers getting information out of images/video
- ◆ Giving the computer "eyes" to see and identify as humans would
- ◆ Teaching computer to interpret and understand our world through images



# Brief History of Computer Vision



# Every Picture Tells a Story



- Goal of computer vision is to write computer programs that can interpret images
  - ◆ What is it about?
  - ◆ What are in the picture?
  - ◆ Where are they ?
  - ◆ What are the relationships ?
  - ◆ What are their spatial dependency?
  - ◆ What are the relationships between the object and the scene?



# What Do Computers See?



243	239	240	225	206	185	188	218	211	206	216	225
242	239	218	110	67	31	34	152	213	206	208	221
243	242	123	58	94	82	132	77	108	208	208	215
235	217	115	212	243	236	247	139	91	209	208	211
233	208	131	222	219	226	196	114	74	208	213	214
232	217	131	116	77	150	69	56	52	201	228	223
232	232	182	186	184	179	159	123	93	232	235	235
232	236	201	154	216	133	129	81	175	252	241	240
235	238	230	128	172	138	65	63	234	249	241	245
237	236	247	143	59	78	10	94	255	248	247	251
234	237	245	193	55	33	115	144	213	255	253	251
248	245	161	128	149	109	138	65	47	156	239	255
190	107	39	102	94	73	114	58	17	7	51	137
23	32	33	148	168	203	179	43	27	17	12	8
17	26	12	160	255	255	109	22	26	19	35	24



# Can Computers Match or Beat Human Vision?



■ Yes but mostly no!

- ◆ Humans are much better at “hard” things
- ◆ Computers can be better at “easy” things



La Gare Montparnasse, 1895





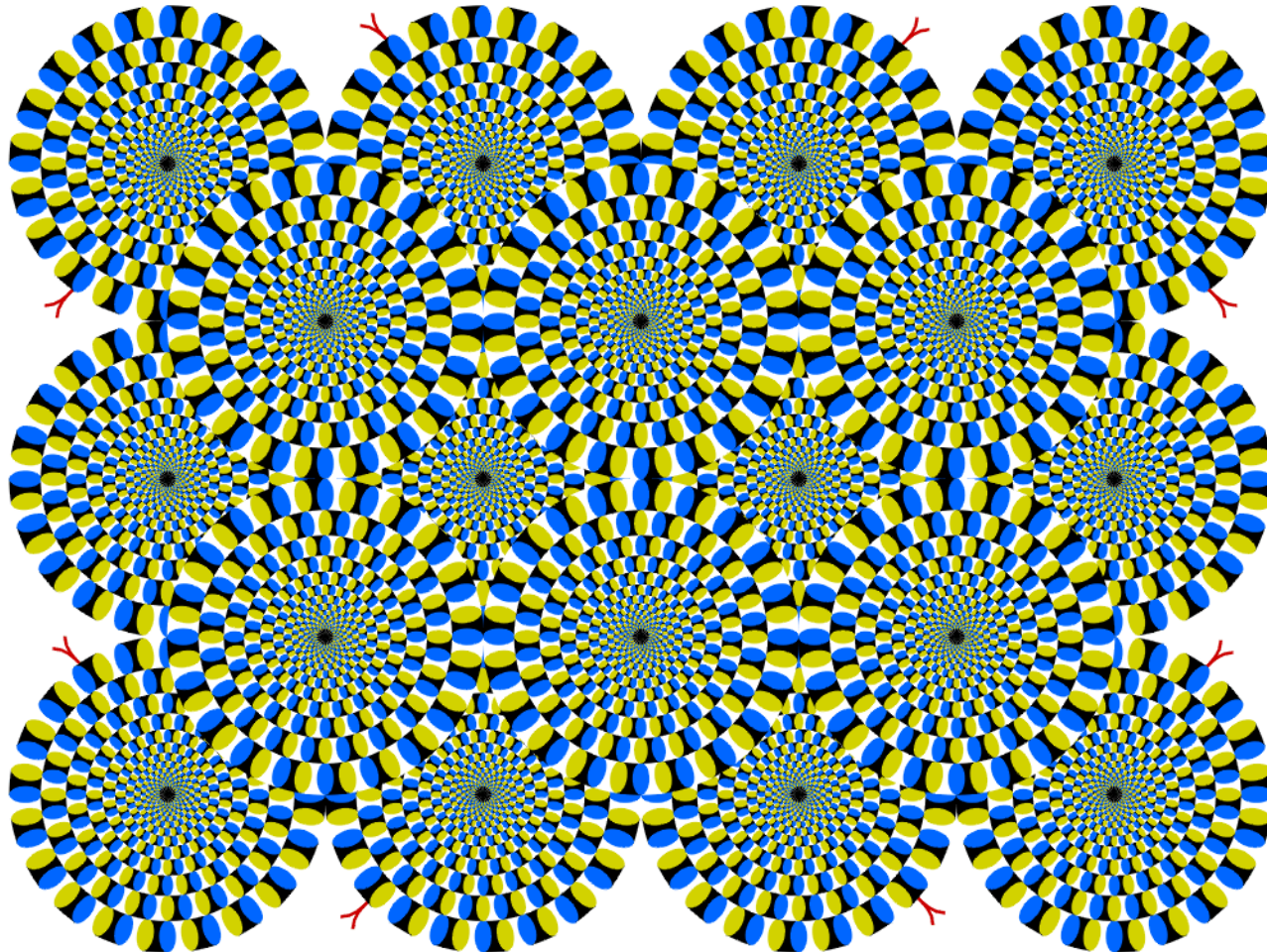
# Human Perception Shortcomings



[Sinha and Poggio, \*Nature\*, 1996](#)



# Visual Illusions



Copyright [A.Kitaoka](#) 2003

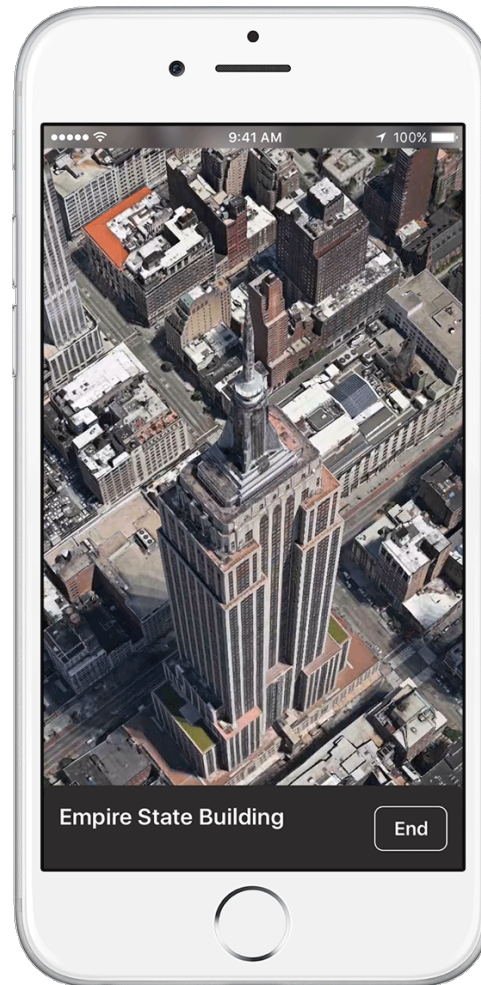


# CURRENT STATE OF THE ART

**EXAMPLES OF WHAT CURRENT COMPUTER VISION SYSTEMS  
CAN DO**



# 3D Maps

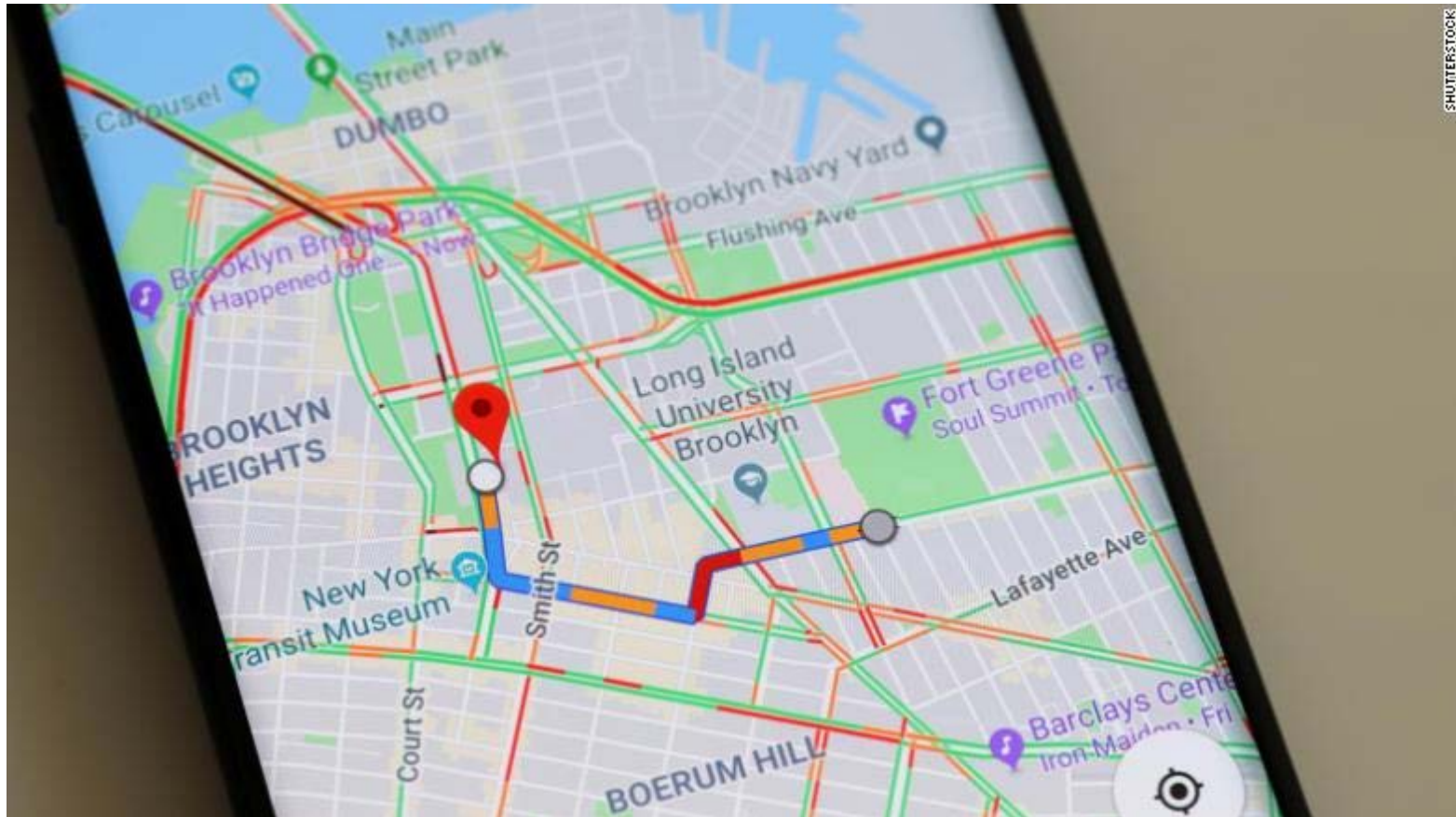


Apple Maps





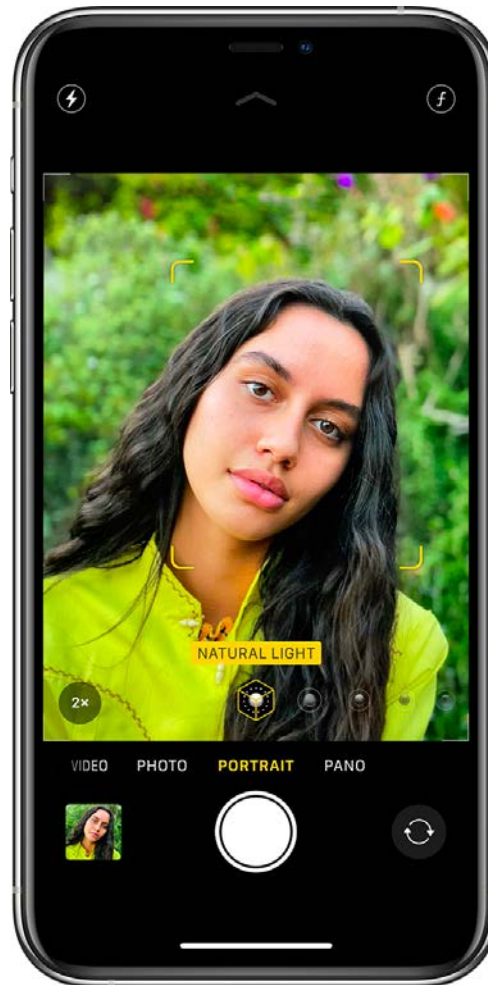
# 2D Maps



Google Maps



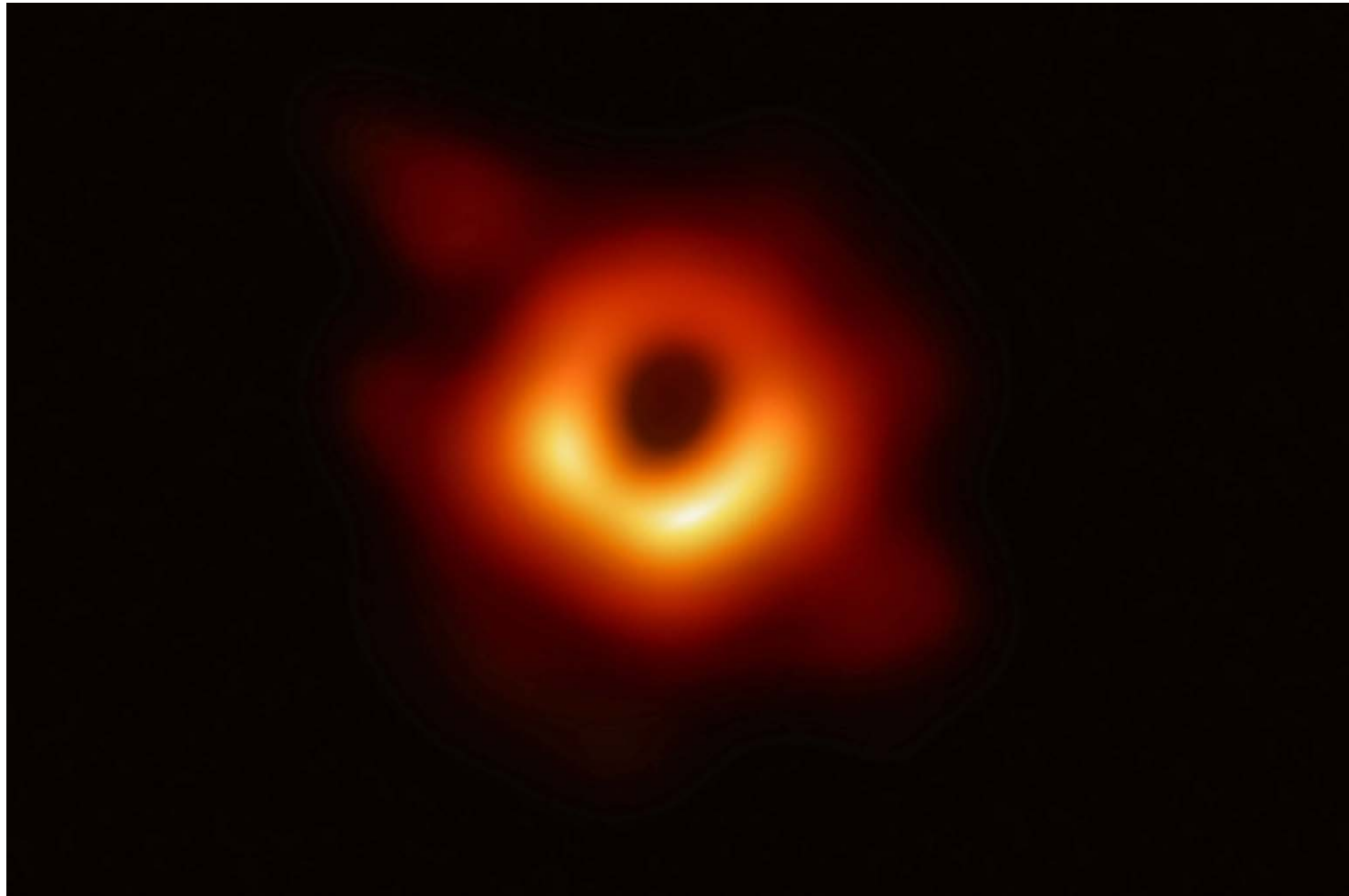
# Computational Photography



Portrait mode – Simulating wider aperture



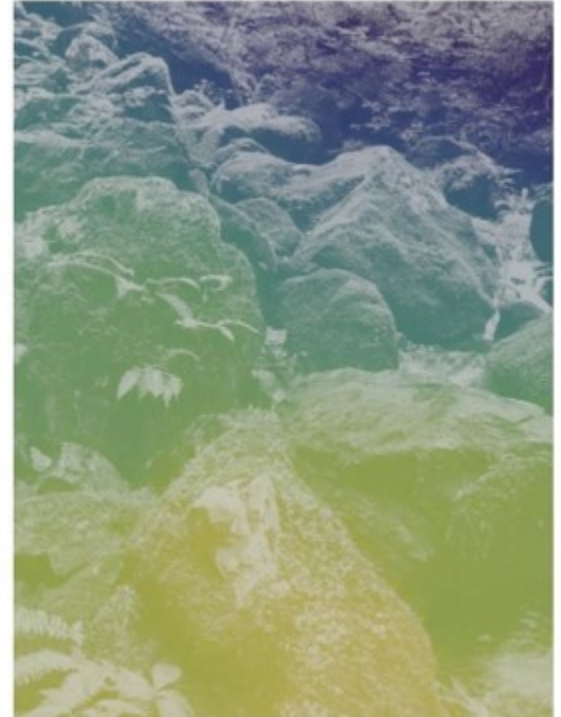
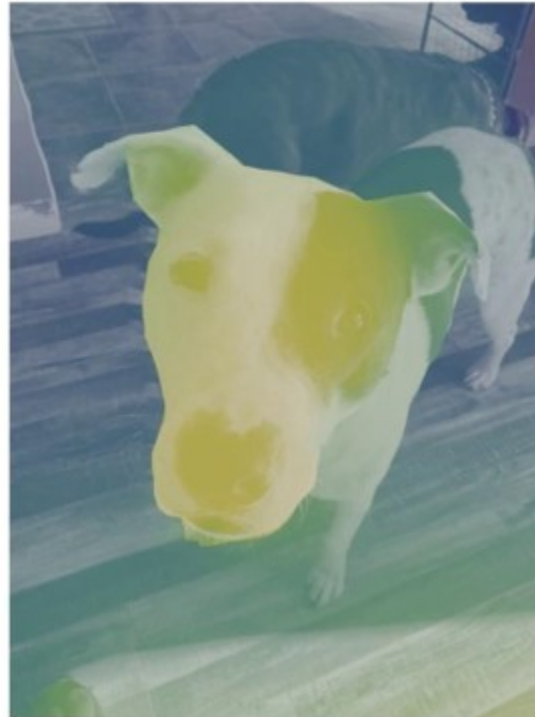
# Even Wider Aperture...



[How scientists captured the first image of a black hole, 2019](#)



# 3D Photos



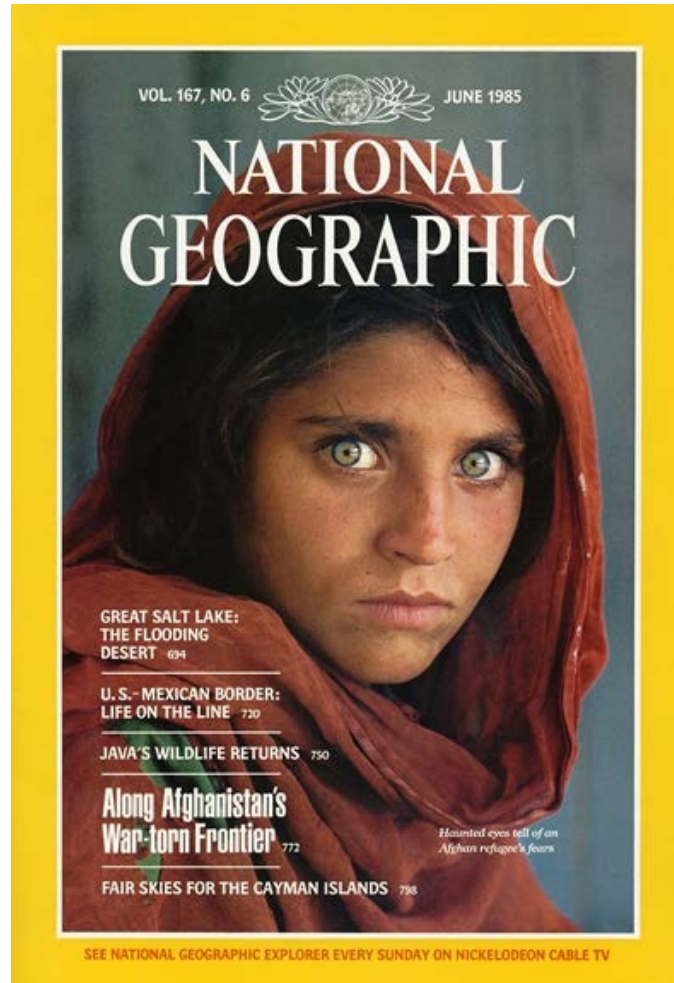
3D Photos on Facebook: Estimate depth from photo to create animation

<https://ai.facebook.com/blog/-powered-by-ai-turning-any-2d-photo-into-3d-using-convolutional-neural-nets/>





# Face Recognition



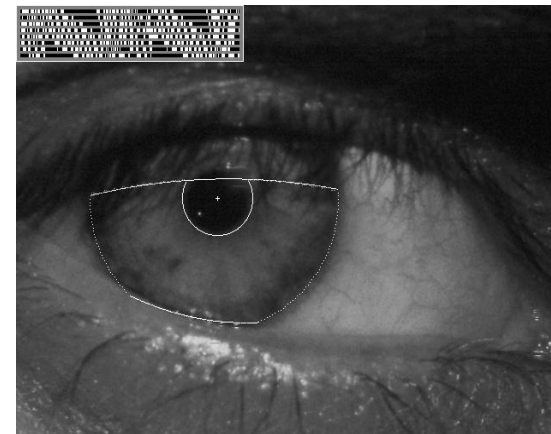
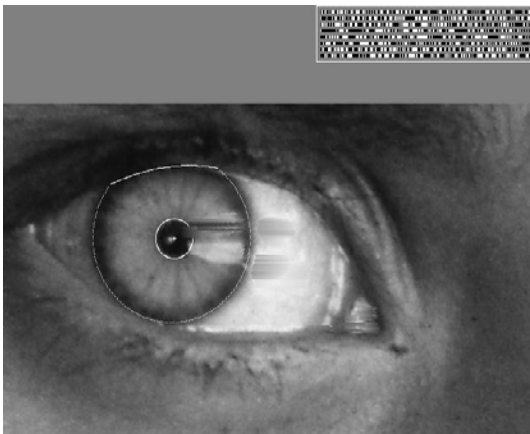
Who is she?



# Vision-based Biometrics



*“How the Afghan Girl was Identified by Her Iris Patterns”* Read the [story](#)





# Object Recognition



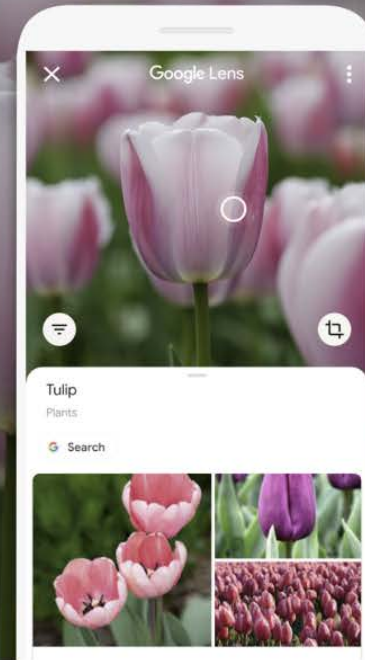
Google Lens

Download



## Search what you see

Explore what's around you in an entirely  
new way.





# Special Effects: Shape Capture



*The Matrix* movies, ESC Entertainment, XYZRGB, NRC





# Sports Applications



*Sportvision* first down line  
Nice [explanation](http://www.howstuffworks.com) on [www.howstuffworks.com](http://www.howstuffworks.com)



# Application in Games



Microsoft's XBox Kinect



# Virtual Reality



Oculus Quest, Beat Saber



# Augmented Reality



Microsoft HoloLens 2





# Sensors in HoloLens2



## HoloLens2 Sensors

8Mpix RGB camera

4 head-tracking cameras  
(stereo + periphery) + IMU

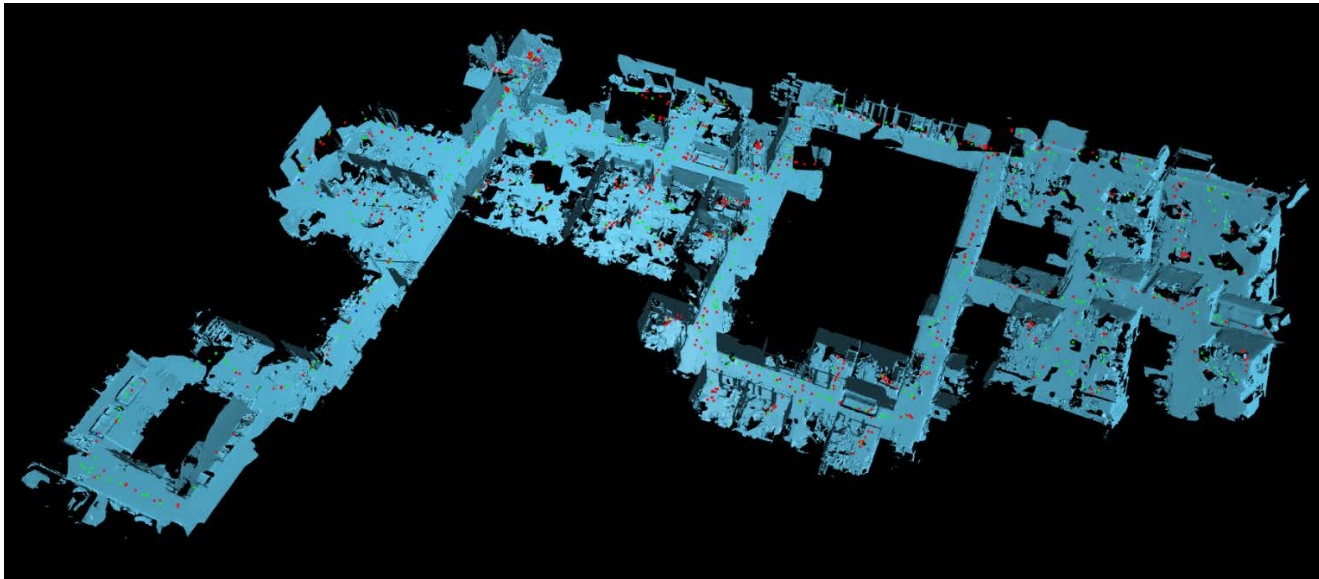
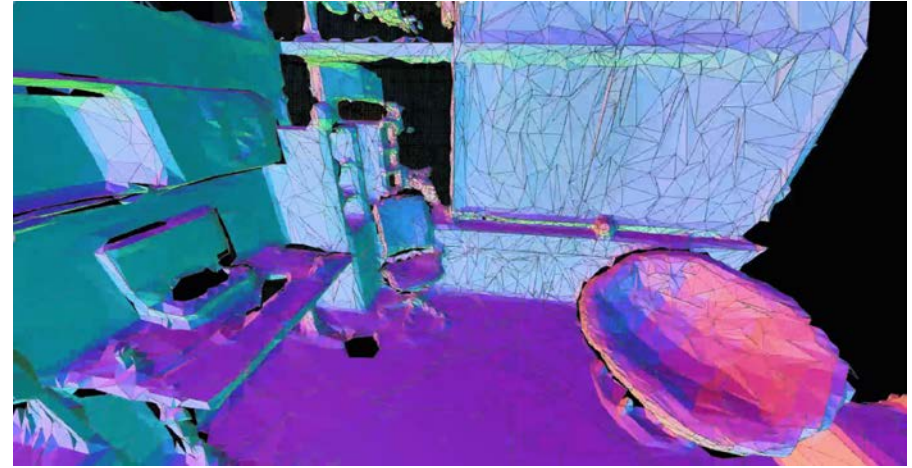
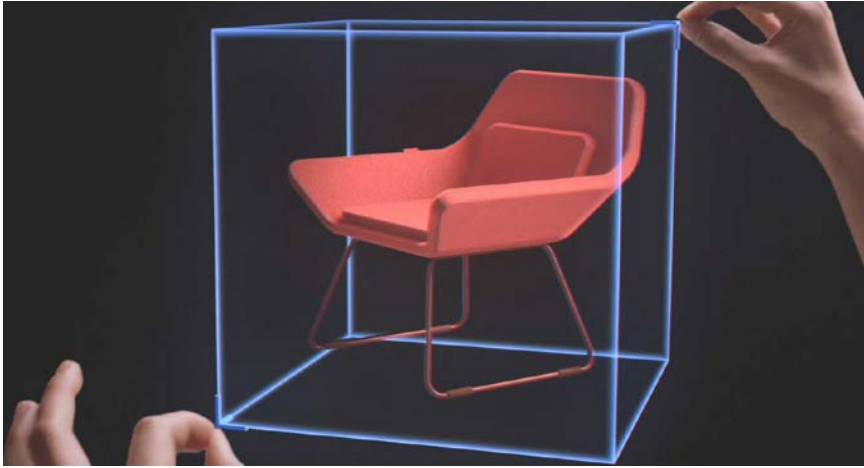
1Mpix depth camera  
(near and far range)

IR eye cameras + IR LEDs

5 microphone array

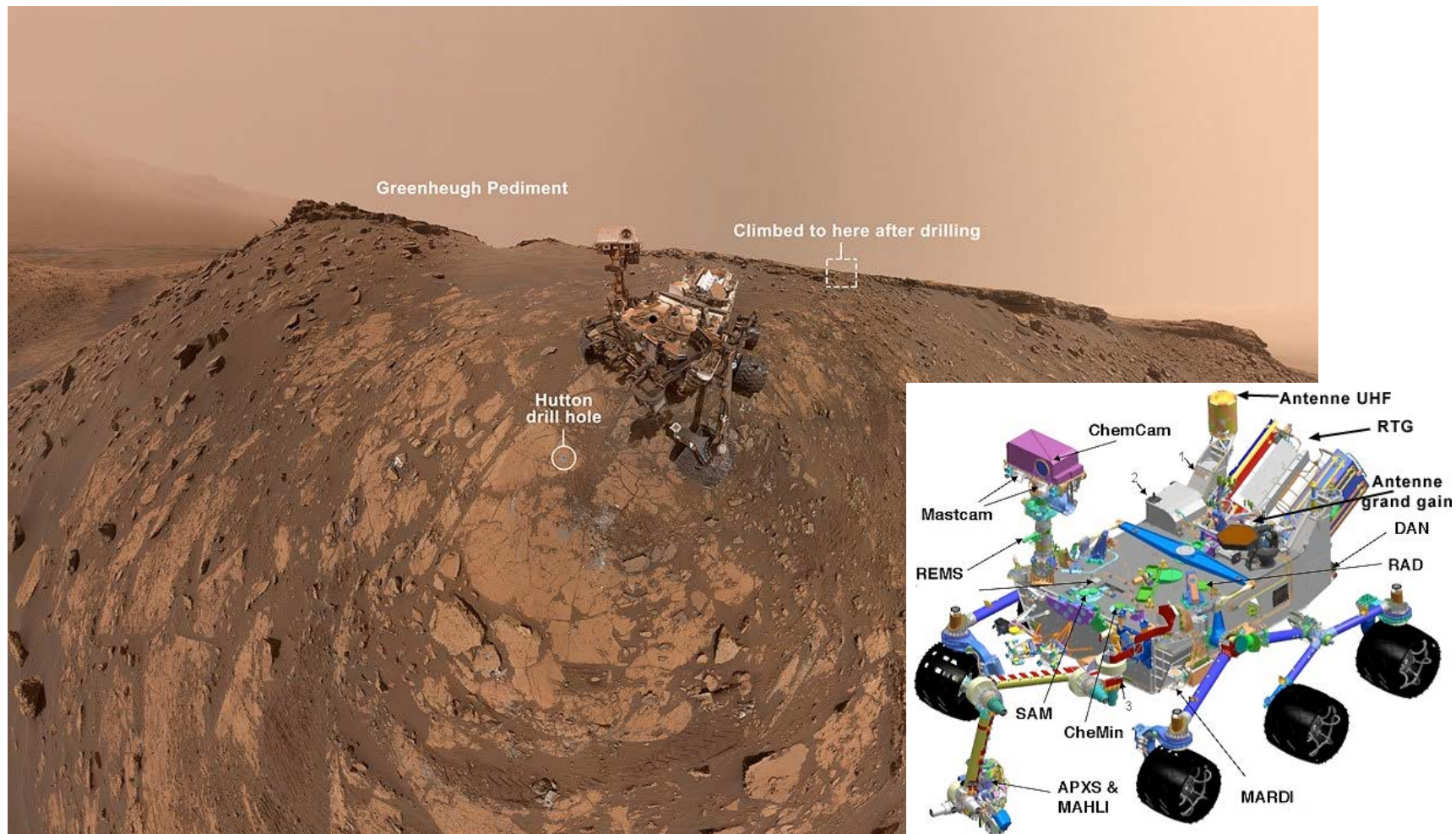


# Augmented Reality





# Advanced Robotics



NASA's Mars Curiosity Rover (self portrait) [https://en.wikipedia.org/wiki/Curiosity\\_\(rover\)](https://en.wikipedia.org/wiki/Curiosity_(rover))





# Smart Cars



[▶▶ manufacturer products](#) [consumer products ◀◀](#)

## Our Vision. Your Safety.

rear looking camera

forward looking camera

side looking camera

### EyeQ Vision on a Chip

[> read more](#)

### Vision Applications

Road, Vehicle, Pedestrian Protection and more

[> read more](#)

### AWS Advance Warning System

[> read more](#)

### News

- > [Mobileye Advanced Technologies Power Volvo Cars World First Collision Warning With Auto Brake System](#)
- > [Volvo: New Collision Warning with Auto Brake Helps Prevent Rear-end](#)

[> all news](#)

### Events

- > [Mobileye at Equip Auto, Paris, France](#)
- > [Mobileye at SEMA, Las Vegas, NV](#)

[> read more](#)

## Mobileye

- Vision systems currently in high-end BMW, GM, Volvo models

Slide content courtesy of Amnon Shashua

# Applications in Drones



## Drone helps rescuers find lost hiker on mountain edge

Location: Kowloon Peak, Hong Kong

People rescued: 1

Date: 2018/10/31

Description: A 52-year-old man became lost on a cliff face while hiking Kowloon Peak. He sent rescuers photos of the location around him but could not describe where he was. A volunteer looked at those pictures, then flew his drone over the area until he spotted a matching landscape and found the man. He later guided rescuers to him.

Links to more coverage

Share: [f](#) [t](#) [in](#)





# Computer Vision vs Pattern Recognition

Computer Vision	Pattern Recognition
It is the study of how machines can be trained to extract meaningful information from images.	It is used to identify patterns and regularities in data for classification purposes.
It works on the visual data, such as digital images or videos.	The data inputs can be images, texts, videos, or audio files.
The purpose is to train a computer or machine to understand recognizable features in an image.	It is used to extract useful information from given samples, such as speech, images or text.
Applications include automated checkout, driverless car testing, medical diagnostics, crops and livestock monitoring, defect detection, etc.	Applications include computer-aided diagnosis, bioinformatics, data compression, image analysis, signal processing, and so on.



# Summary – Take Home Message

- **Computer Vision and Pattern Recognition is an active area that has generated tremendous impact in almost every aspect of personal and social life**
  - ◆ **This is a great subject for almost all majors at PolyU**
- **You just saw examples of current computer vision and pattern recognition systems**
  - ◆ **Many of these are less than 5 years old**
- **This field is rapidly changing and will continue to impact the society at various scales**
  - ◆ **Many new applications are expected in the next 5-10 years**



# THANK YOU!