

電腦視覺

Computer Vision: from Recognition to Geometry

簡韶逸 Shao-Yi Chien

Department of Electrical Engineering
National Taiwan University

Spring 2025

Computer Vision

- Describe the world that the computer see in one or more images and to reconstruct its properties, such as shape, illumination, and color distribution
- Is it hard? An inverse problem

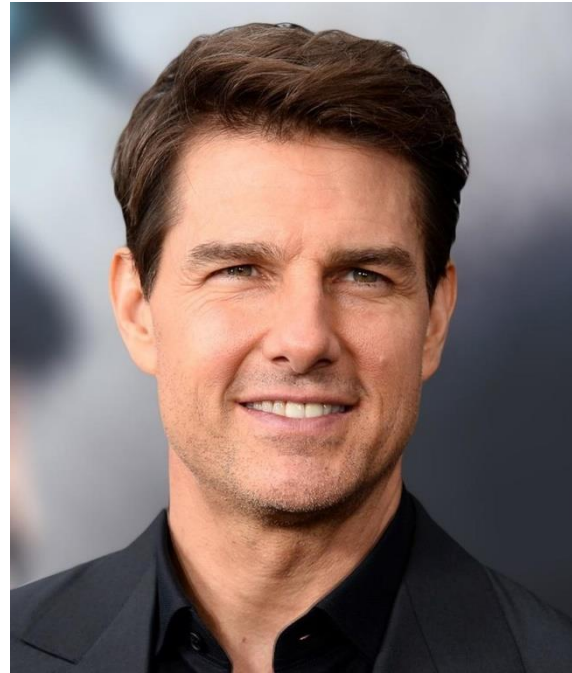
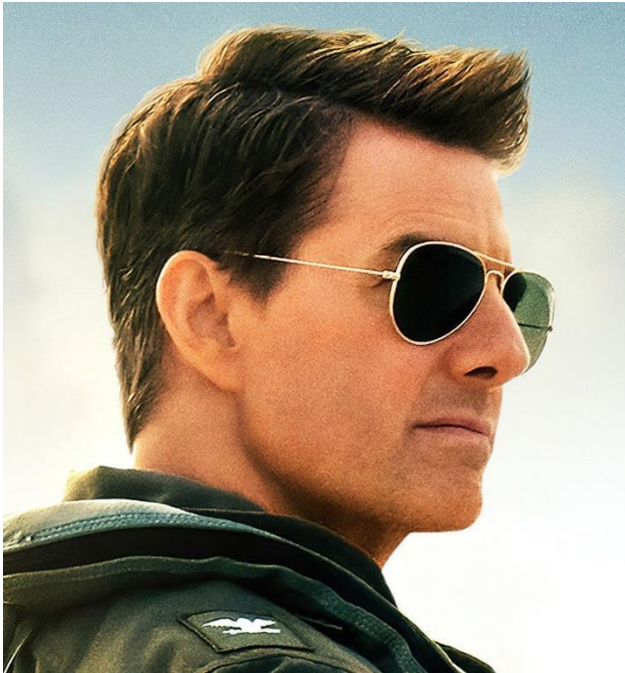


Computer Vision



[R. C. James]

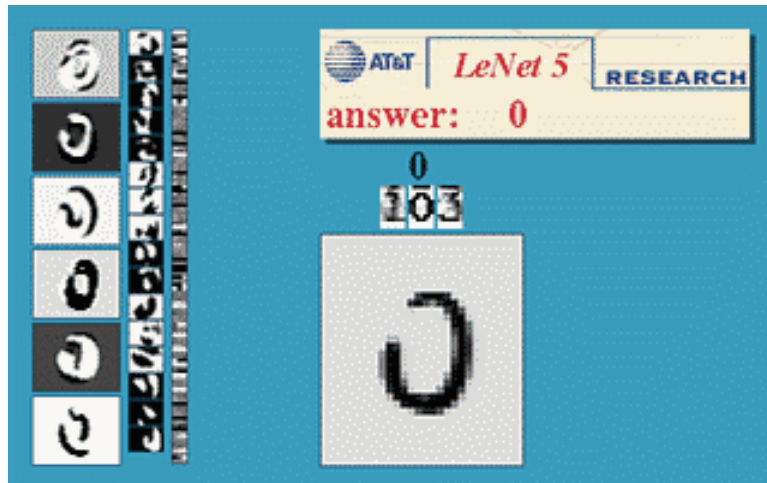
Computer Vision



Same Person?

Wide Applications of Computer Vision

- Optical character recognition (OCR)



Digit recognition, AT&T labs

<http://www.research.att.com/~yann/>

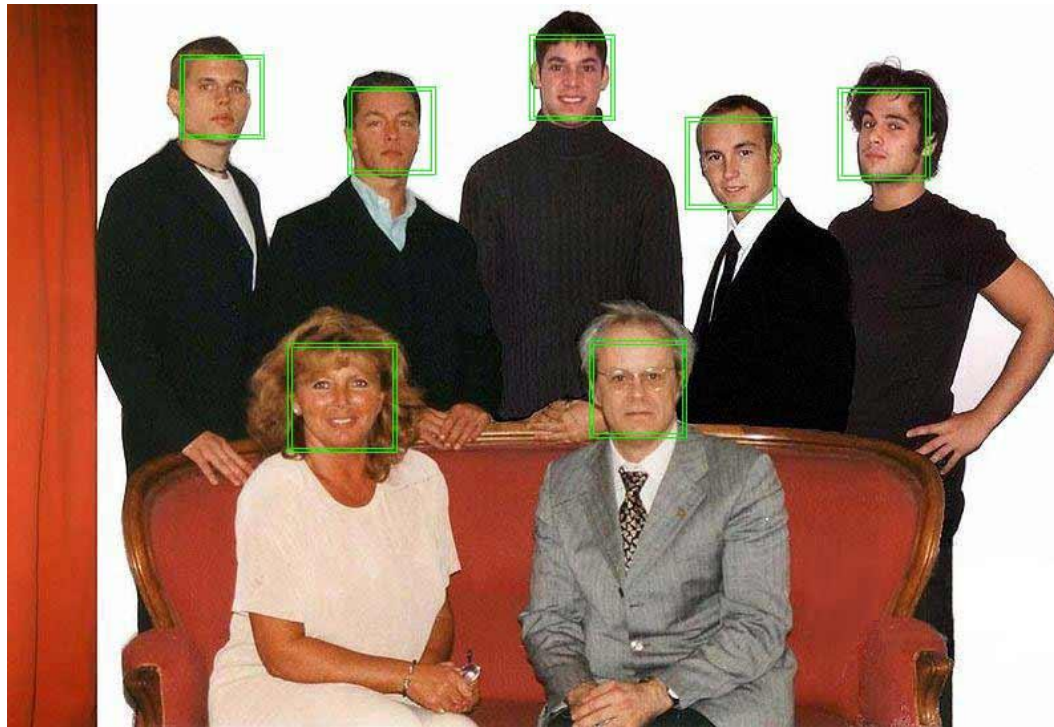


License plate readers

http://en.wikipedia.org/wiki/Automatic_number_plate_recognition

Wide Applications of Computer Vision

- Face detection: in all digital cameras and smart phones

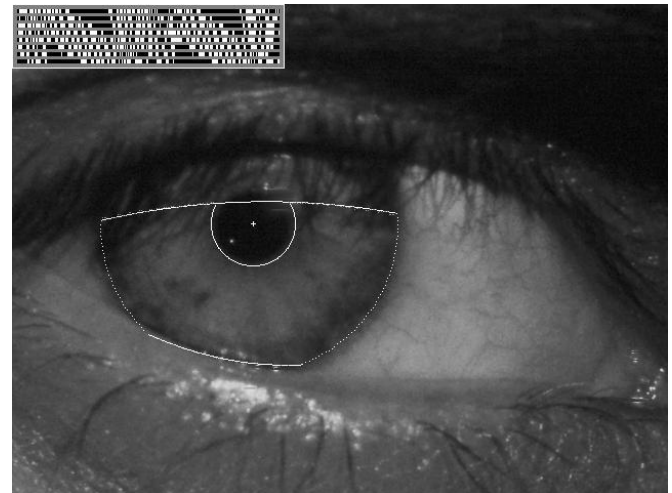
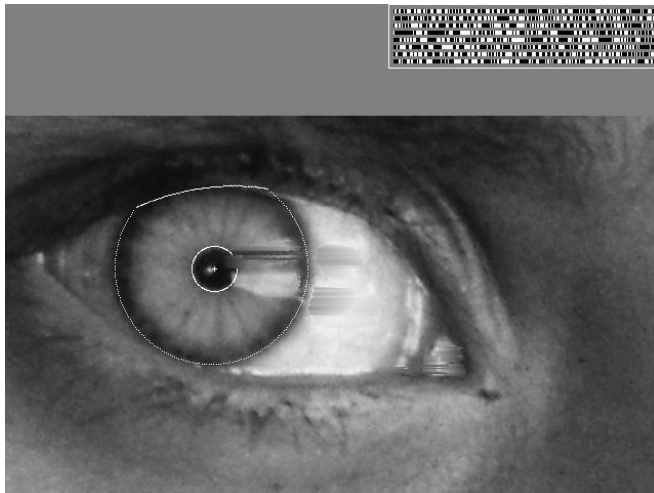


Wide Applications of Computer Vision

- Iris recognition
(Vision-based biometrics)

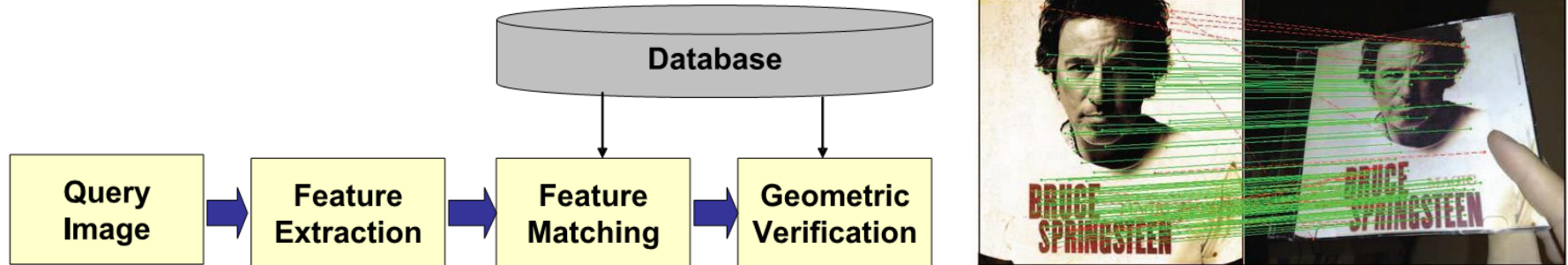


“How the Afghan Girl was Identified by Her Iris Patterns” Read the [story](#)

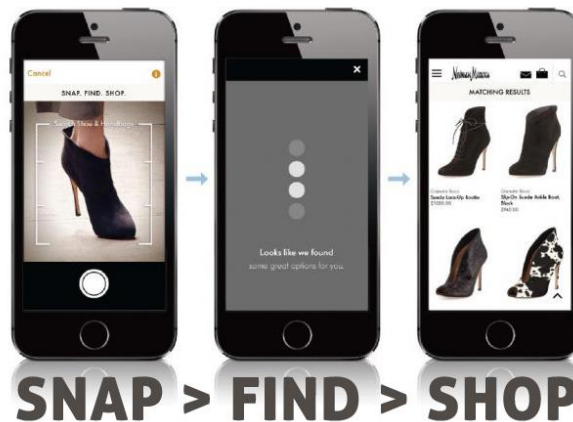


Wide Applications of Computer Vision

- Object recognition



[Girod et al. 2011]



[slyce.it]

Wide Applications of Computer Vision

- Motion capture



Pirates of the Caribbean,
Industrial Light and Magic

Wide Applications of Computer Vision

- Computer vision in sports



Hawk-Eye: helping/improving referee decisions



Intel: [freeD technology](#)

Wide Applications of Computer Vision

- Smart cars: [ADAS](#)

The image is a screenshot of the Intel Mobileye website. At the top, there are two navigation tabs: "manufacturer products" (active) and "consumer products". Below the tabs is the main heading "Our Vision. Your Safety." with a central image of a car from a top-down perspective. Four yellow beams of light emanate from the car, labeled "rear looking camera", "forward looking camera", and "side looking camera". Below this main section are three product/application tiles: "EyeQ Vision on a Chip" with an image of the chip, "Vision Applications" with an image of a pedestrian and text "Road, Vehicle, Pedestrian Protection and more", and "AWS Advance Warning System" with an image of a car icon and the number "0.8". To the right of these tiles is a "News" sidebar with two headlines: "Mobileye Advanced Technologies Power Volvo Cars World First Collision Warning With Auto Brake System" and "Volvo: New Collision Warning with Auto Brake Helps Prevent Rear-end". Below the news is an "Events" section with two headlines: "Mobileye at Equip Auto, Paris, France" and "Mobileye at SEMA, Las Vegas, NV". At the bottom of the sidebar is a "read more" link.

manufacturer products consumer products

Our Vision. Your Safety.

rear looking camera forward looking camera side looking camera

• **EyeQ** Vision on a Chip

• **Vision Applications**
Road, Vehicle, Pedestrian Protection and more

• **AWS** Advance Warning System

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

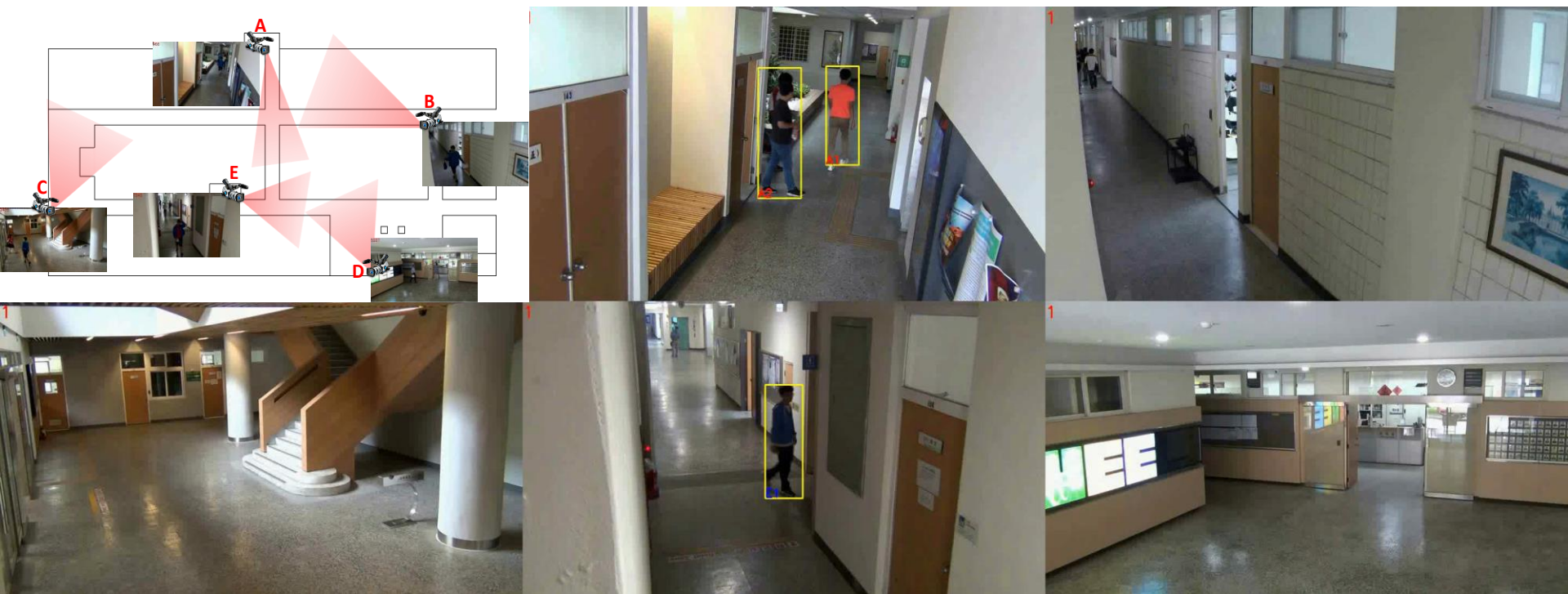
- > Mobileye at Equip Auto, Paris, France
- > Mobileye at SEMA, Las Vegas, NV

read more

[Intel Mobileye]

Wide Applications of Computer Vision

- Surveillance system



Ref: Chih-Wei Wu, Meng-Ting Zhong, Yu Tsao, Shao-Wen Yang, Yen-Kuang Chen, and Shao-Yi Chien, "Track-clustering Error Evaluation for Track-based Multi-camera Tracking System Employing Human Re-identification," *CVPR 2016 Workshop*.

Wide Applications of Computer Vision

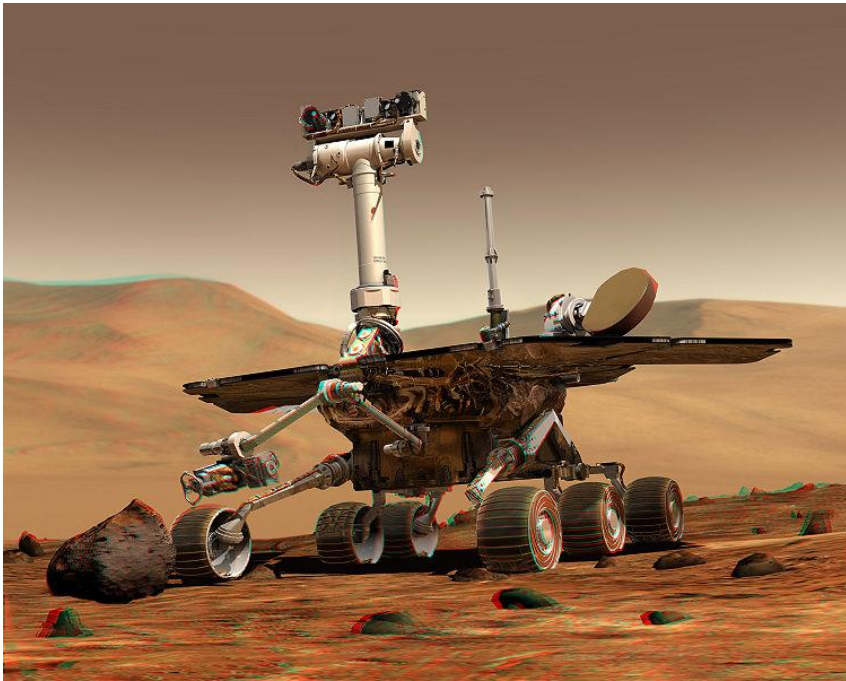
- Vision-based interaction



[Microsoft Xbox]

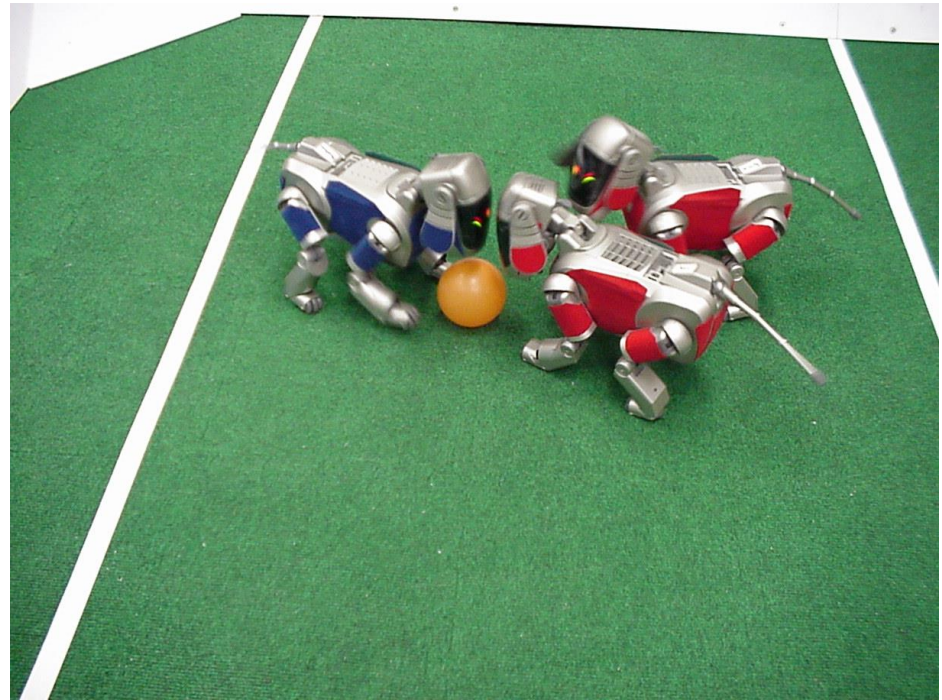
Wide Applications of Computer Vision

- Robotics



NASA's Mars Spirit Rover

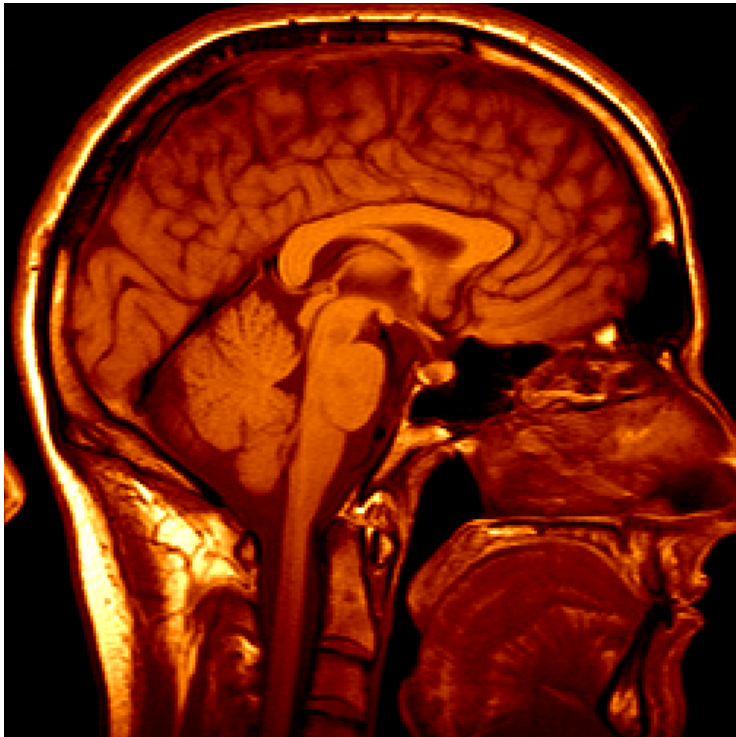
http://en.wikipedia.org/wiki/Spirit_rover



<http://www.robocup.org/>

Wide Applications of Computer Vision

- Medical image



3D imaging
MRI, CT



Image guided surgery
[Grimson et al., MIT](#)

Wide Applications of Computer Vision

[Ganzin]



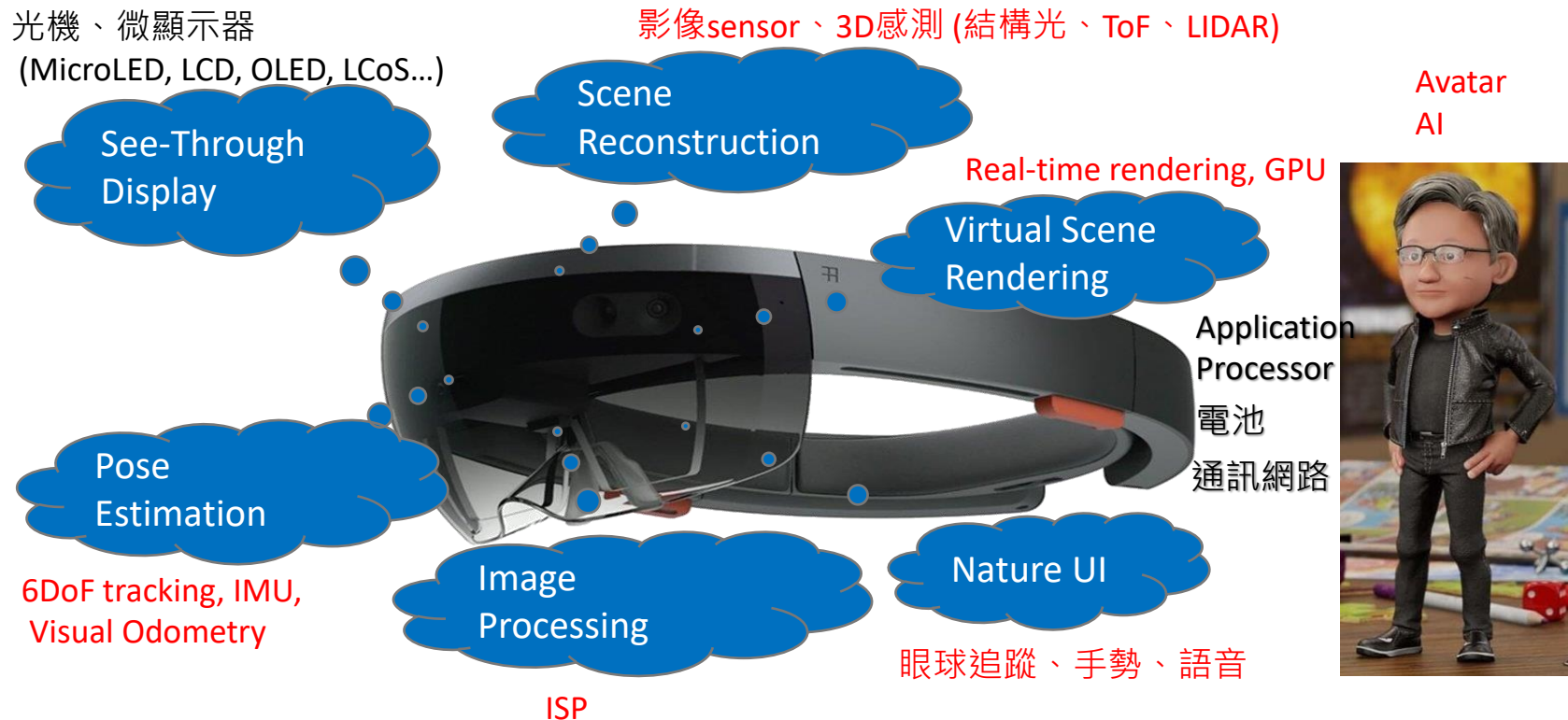
Wide Applications of Computer Vision

[Ganzin]



Wide Applications of Computer Vision

- AR/VR devices for the metaverse



Wide Applications of Computer Vision

[Apple]



Wide Applications of Computer Vision



[DALL·E]

Wide Applications of Computer Vision



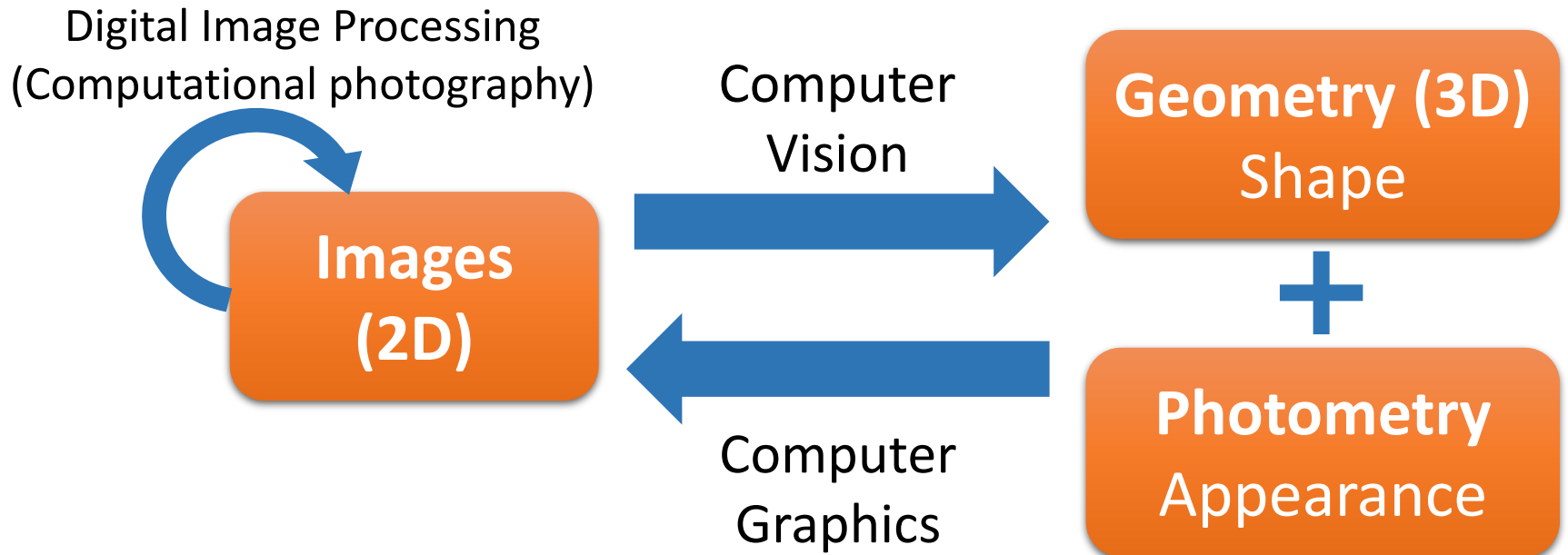
[Sora]

Prompt: A Chinese Lunar New Year celebration video with Chinese Dragon.

Important Near-Future Applications

- AR/VR, Metaverse, spatial computing
- Autonomous vehicle
- Content generation
- Robot
- IoT: AIoT (AI+IoT), IoVT (Internet-of-Video-Things)
- Medical imaging
- Large-scale video analysis
- Computational photography/image synthesis
- Industrial automation
- ...

Related Fields



- The boundaries between digital image processing/computer vision/computer graphics become vague nowadays

About this Course...

- Provide a comprehensive introduction to the field of computer vision (CV)
 - From classical methods to deep learning based methods
 - From recognition to geometry
 - No experiences in CV and image processing are required
- The two courses, **Computer Vision** and **Deep Learning for Computer Vision**, can give you a complete view of modern CV techniques
- Grading
 - Four homeworks: 60%
 - Class/talk participation: 10%
 - Group final project: 30%

Course Website

- Course website
 - <https://cool.ntu.edu.tw/courses/49660>
 - 採線上線下混合教學方式，請密切注意NTU Cool訊息
- TA
 - 范宇清 jackmafan@media.ee.ntu.edu.tw

(Tentative) Schedule: May be Modified...

Week	Date	Topic
1	2/21	Introduction to human vision systems
2	2/28	Camera basic, image formation and basic Image processing
3	3/7	Feature detection and matching
4	3/14	Machine learning basics (I)
5	3/21	Machine learning basics (II)
6	3/28	Deep learning basics
7	4/4	春假
8	4/11	Segmentation
9	4/18	Projective Geometry
10	4/25	Estimation of Transformations
11	5/2	Single Camera Geometry/Camera calibration
12	5/9	Two-View Geometry
13	5/16	Dense motion estimation/stereo
14	5/23	Optical flow + object tracking
15	5/30	3D reconstruction/depth sensing/Structure from motion
16	6/6	Final project presentation

228

端午節

原則上每兩週會有一次實體上課

Homeworks

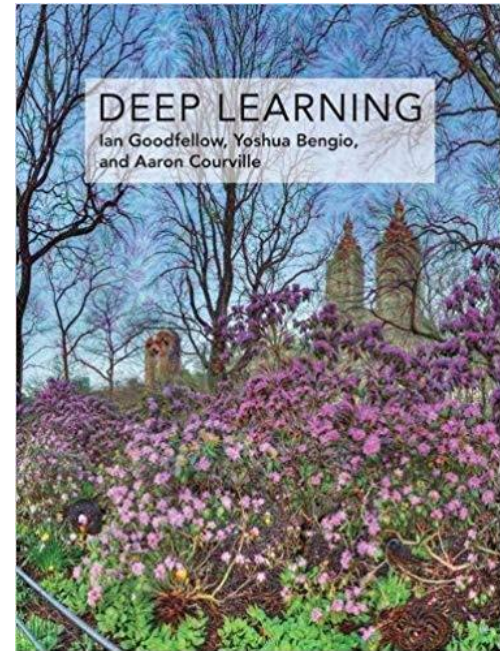
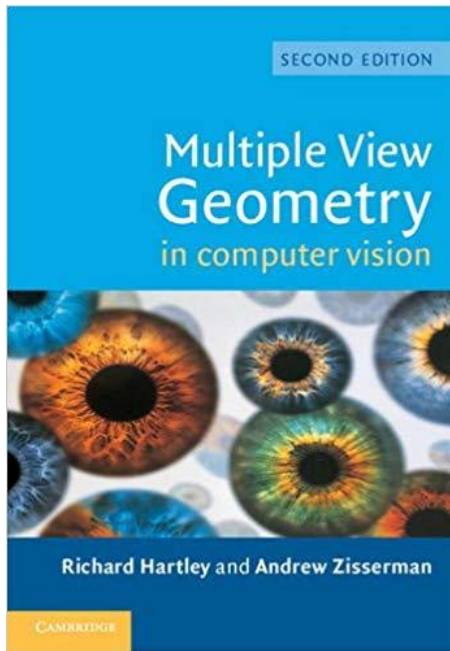
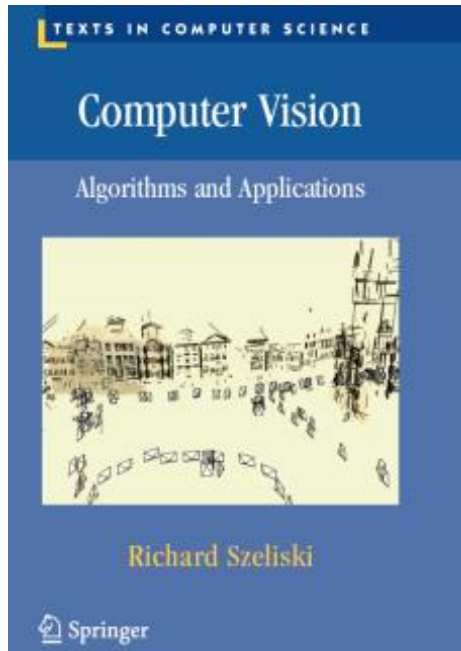
- Four assignments (tentative):
 - HW1: Image filters
 - HW2: Detection or recognition
 - HW3: Pose estimation
 - HW4: Stereo matching
- Official language is Python
- Lab0: Python and basic image processing
 - Will announce later in the next week

Final Project

- Will have one or two problems/challenges
- Each team should have 3—4 members
- Project may be supported by industry with awards
- Evaluated by professor, TAs, guest judges from industry, and you (peer review)!
- The problems/challenges will be announced around the week of mid exam

Reference Materials

- Reference books



<http://szeliski.org/Book/>

- And papers in CVPR, ICCV, ECCV, BMVC, WACV, ACCV,