電腦視覺
Computer Vision: from Recognition to Geometry

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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

Wide Applications of Computer Vision

- Optical character recognition (OCR)
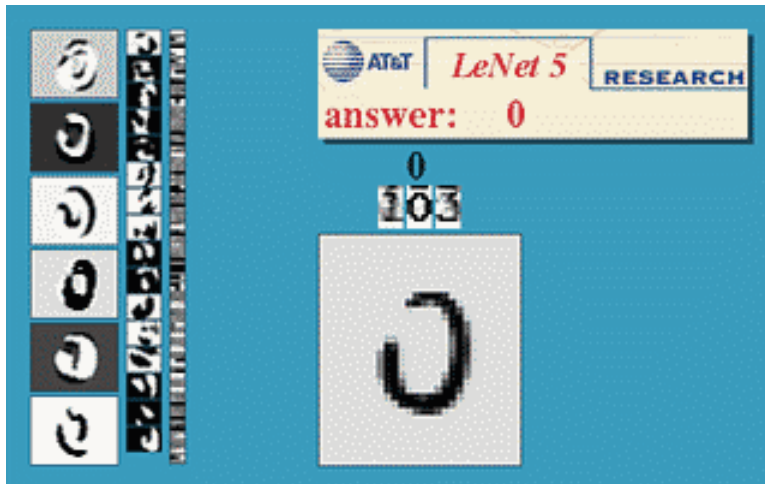
Digit recognition, AT&T labs
http://www.research.att.com/~yann/

License plate readers
http://en.wikipedia.org/wiki/Automatic_number_plate_recognition
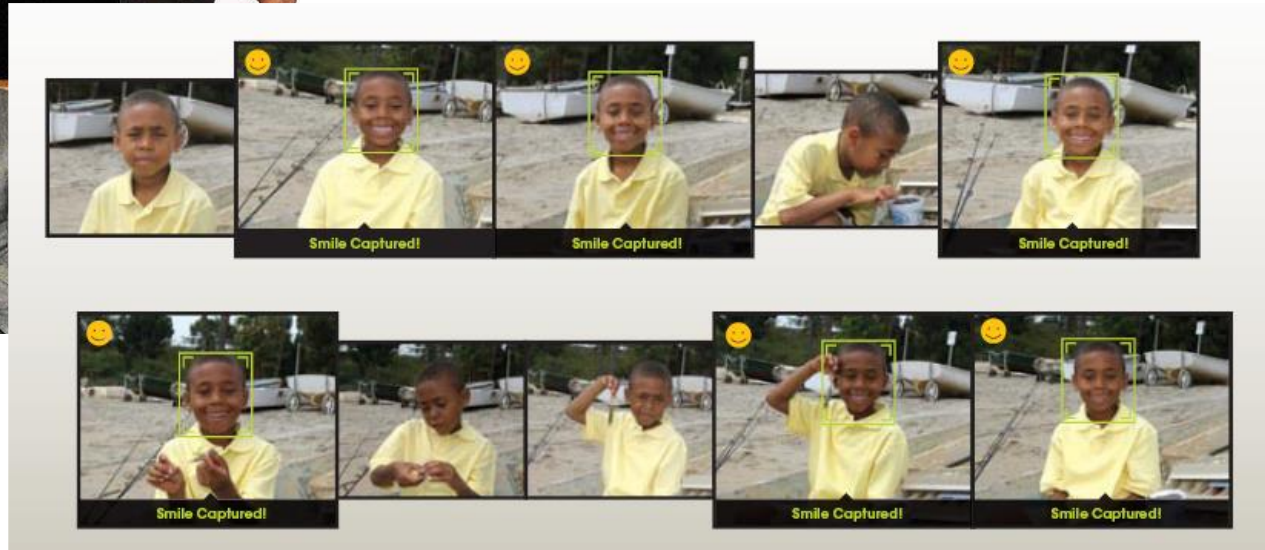
Wide Applications of Computer Vision

- Face detection: in all digital cameras and smart phones
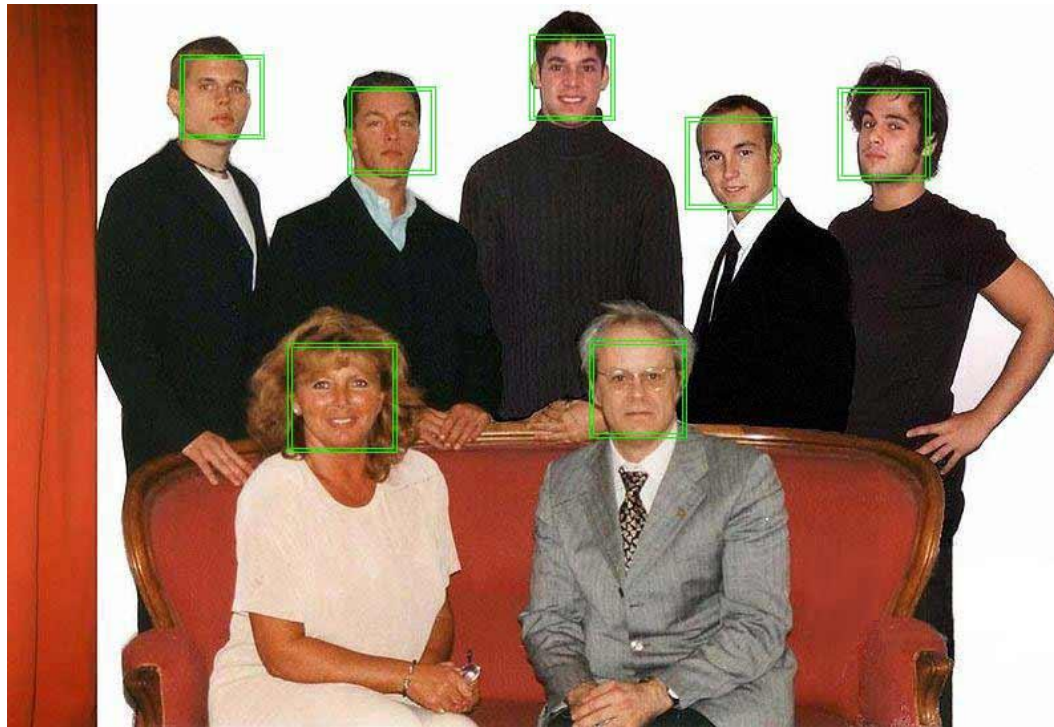
Wide Applications of Computer Vision

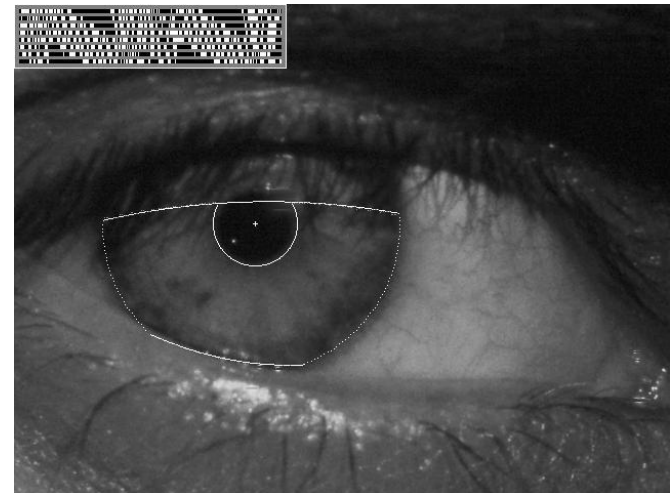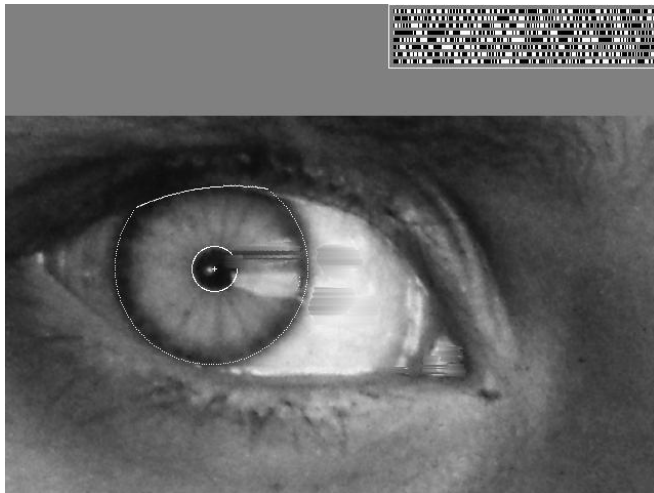- Face detection: in all digital cameras and smart phones

Smile Captured!

[Sony]

Wide Applications of Computer Vision

- Iris recognition
  (Vision-based biometrics)

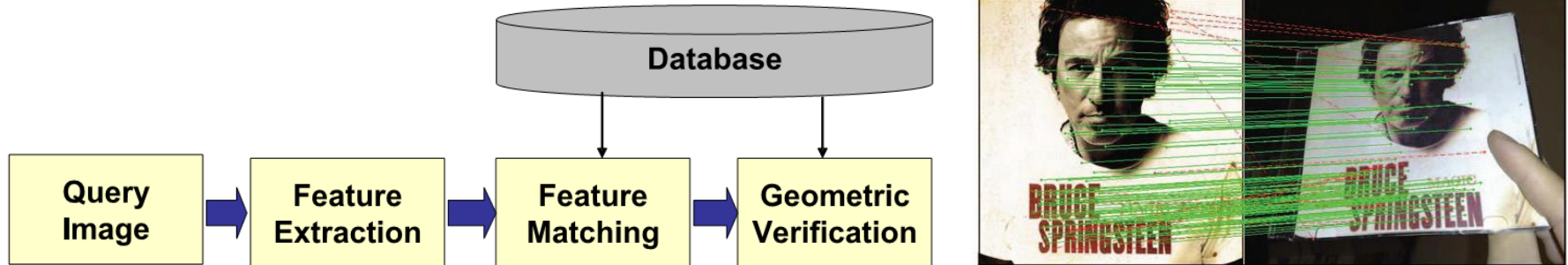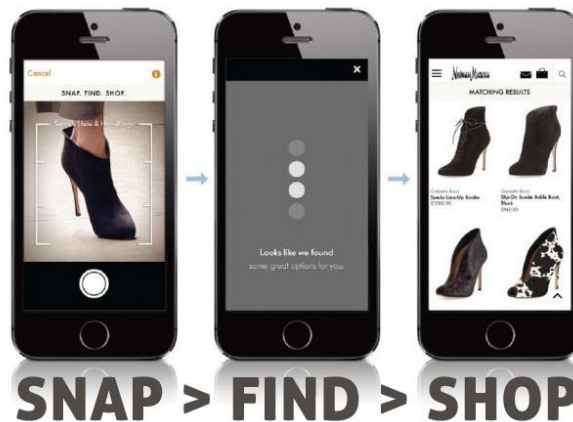"*How the Afghan Girl was Identified by Her Iris Patterns*"   Read the story

Wide Applications of Computer Vision

- Object recognition

Query Image → Feature Extraction → Feature Matching → Geometric Verification

Database

[Girod et al. 2011]

SNAP > FIND > SHOP   [slyce.it]

Wide Applications of Computer Vision

- Shape capture

The Matrix movies, ESC Entertainment, XYZRGB, NRC

Wide Applications of Computer Vision

• Motion capture

Pirates of the Carribean,
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

[Intel Mobileye]

Wide Applications of Computer Vision

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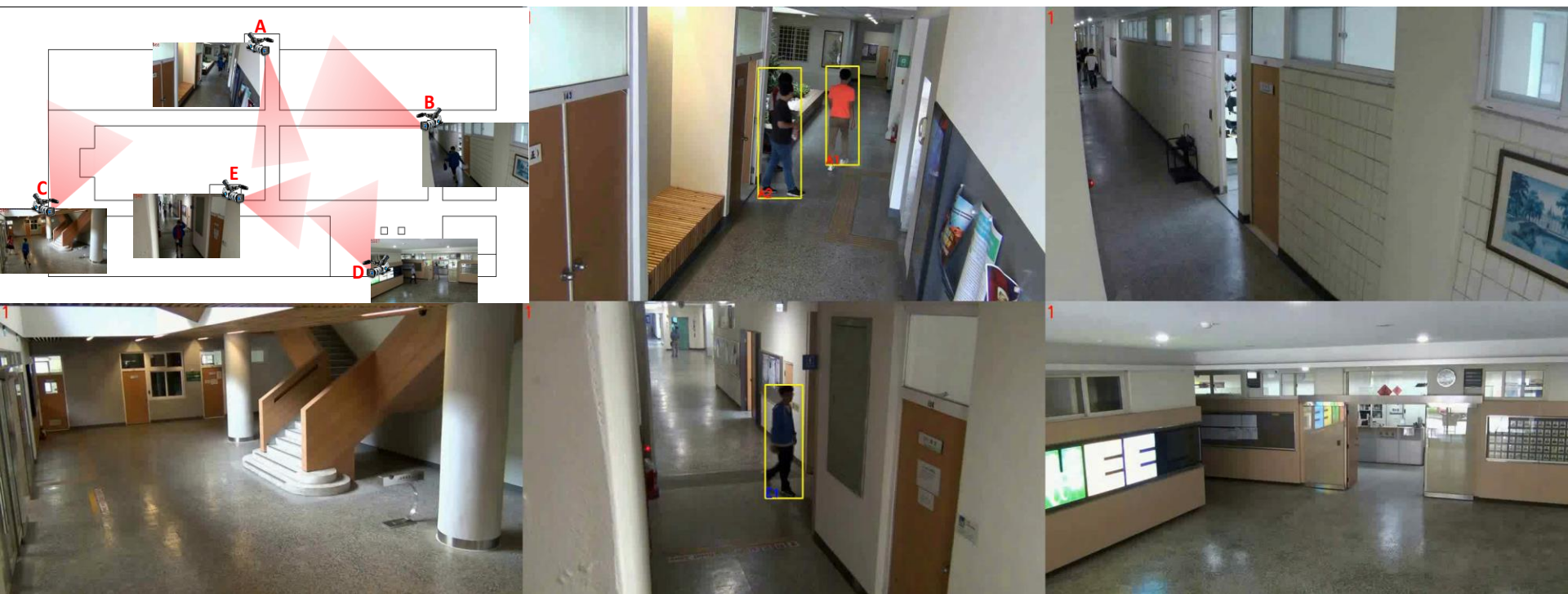
Ref: Chih-Wei Wu, Meng-Ting Zhong, Yu Tsao, Shao-Wen Yang, Yen-Kuang Chen, and Shao-Yi Chien, "Track-clustering Error Evaluation for Track-based Multi-camera Tracking System Employing Human Re-identification," *CVPR 2016 Workshop*.

Wide Applications of Computer Vision

- Vision-based interaction

[Microsoft Xbox]

Wide Applications of Computer Vision
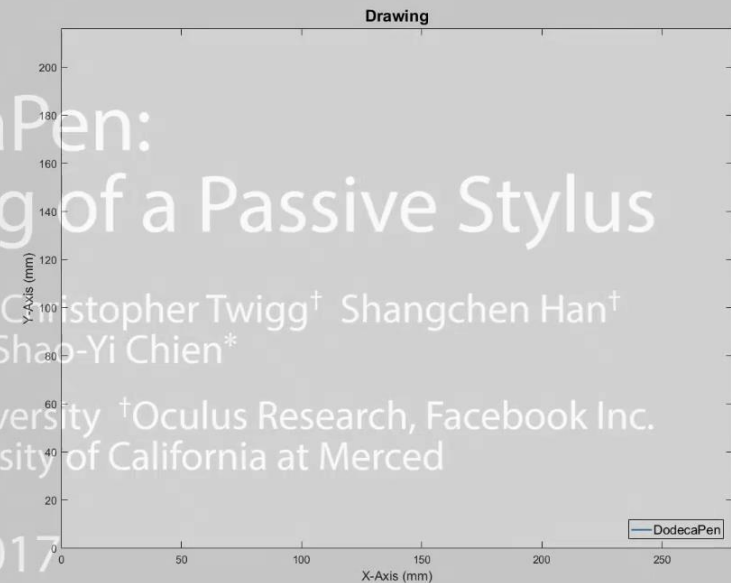
Wide Applications of Computer Vision

- Robotics
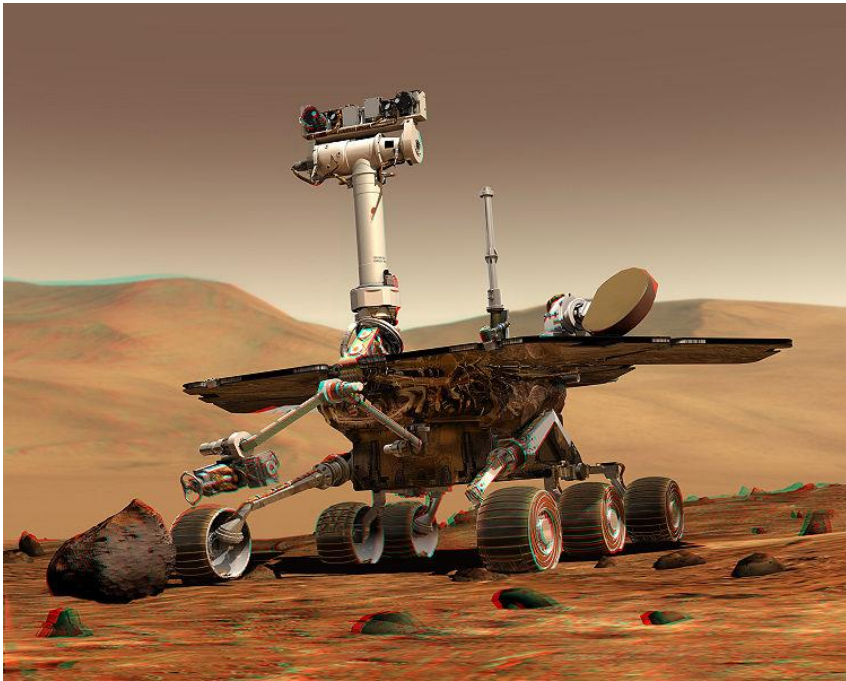
NASA's Mars Spirit Rover
http://en.wikipedia.org/wiki/Spirit_rover

http://www.robocup.org/
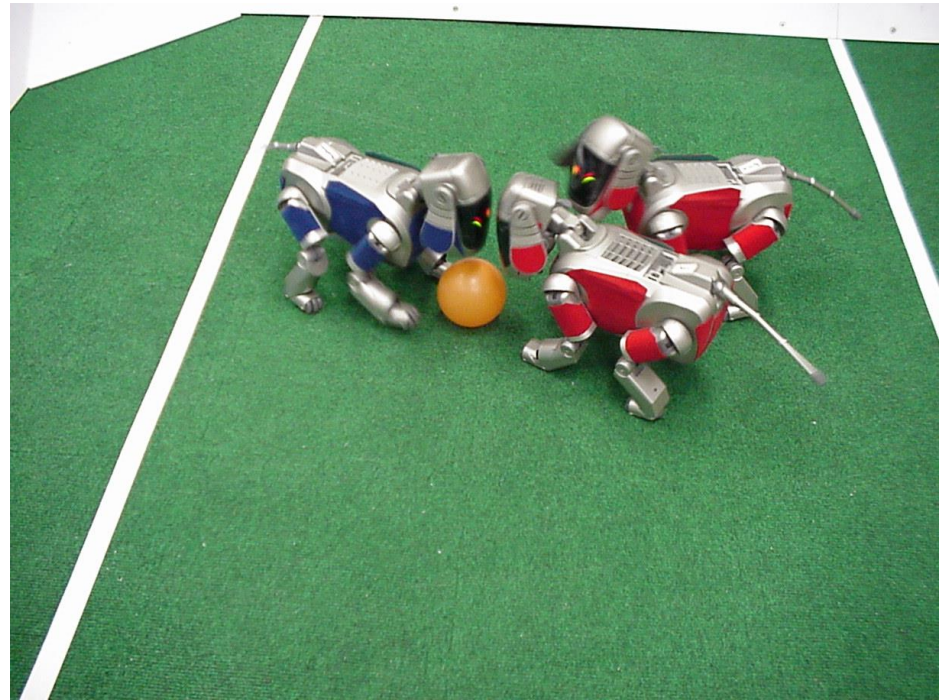
Wide Applications of Computer Vision

- Medical image
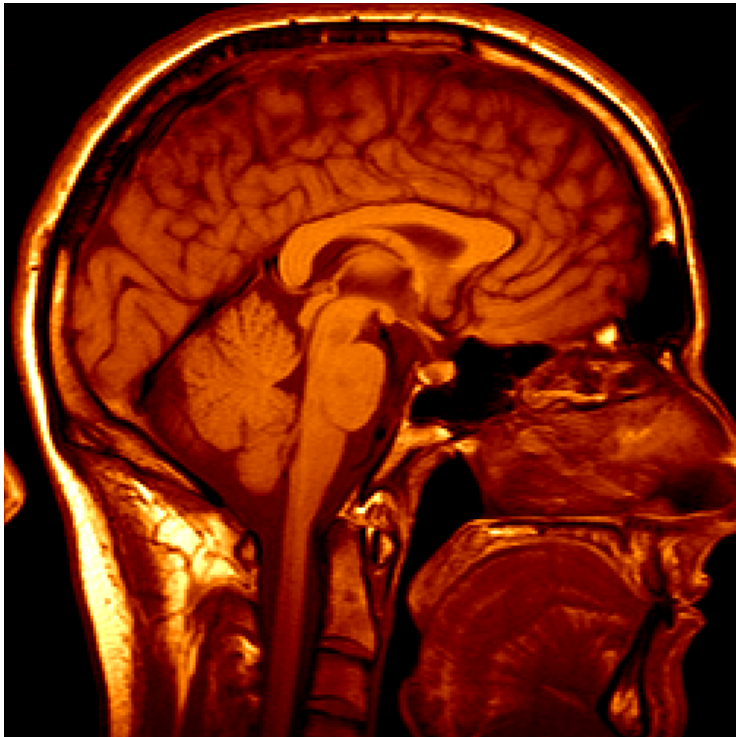
3D imaging
MRI, CT

Image guided surgery
Grimson et al., MIT

Wide Applications of Computer Vision

Wide Applications of Computer Vision

Wide Applications of Computer Vision

- AR/VR devices for the metaverse

光機、微顯示器
(MicroLED, LCD, OLED, LCoS…)

影像sensor、3D感測 (結構光、ToF、LIDAR)

Avatar
AI

Scene Reconstruction

See-Through Display

Real-time rendering, GPU

Virtual Scene Rendering

Application Processor

電池

通訊網路

Pose Estimation

6DoF tracking, IMU, Visual Odometry

Image Processing

Nature UI

眼球追蹤、手勢、語音

ISP
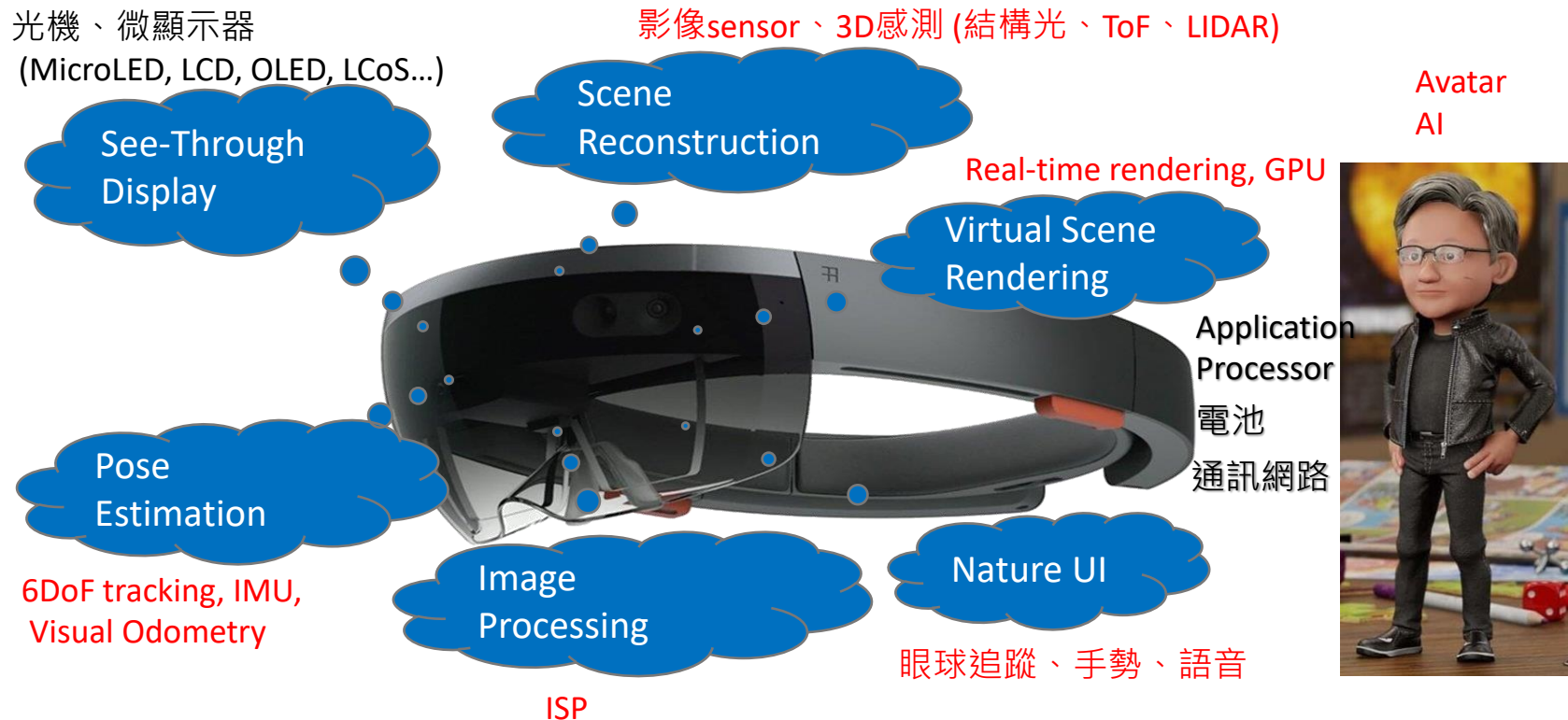
Wide Applications of Computer Vision

[Midjourney]

Important Near-Future Applications

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

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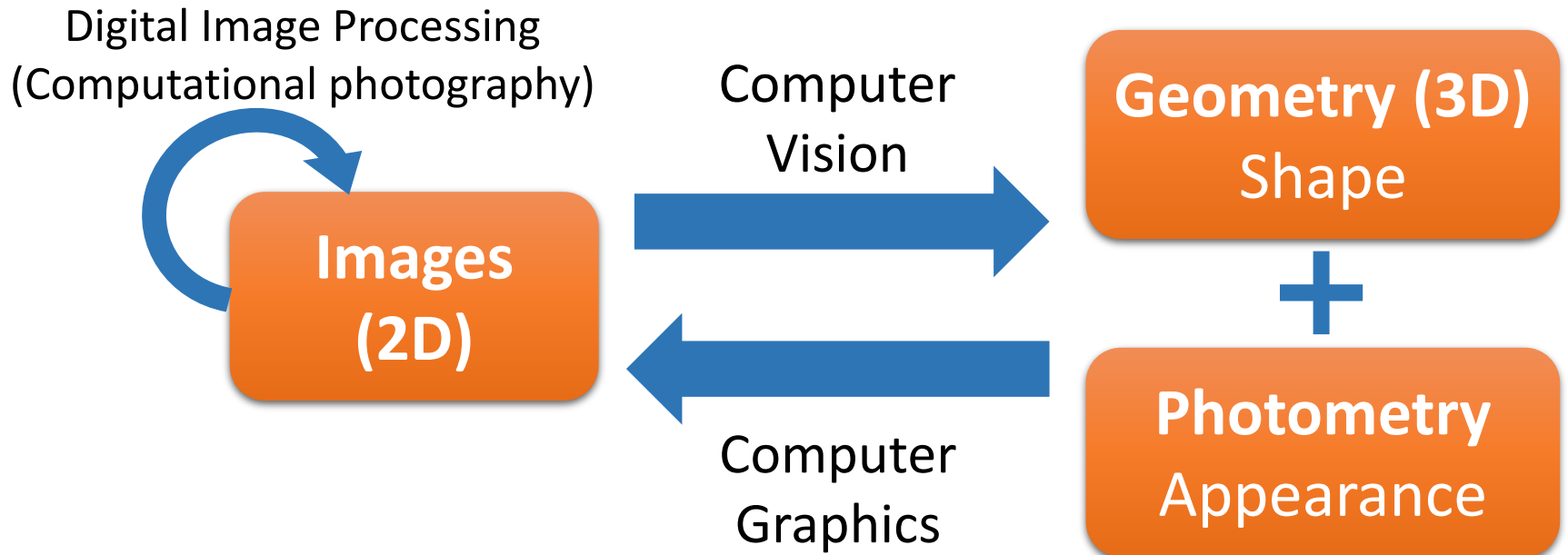
- The boundaries between digital image processing/computer vision/computer graphics become vague nowadays

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/26914
  - http://media.ee.ntu.edu.tw/courses/cv/23S/

- TA
  - Yu-Kai Chen (陳昱愷) chenyukai@media.ee.ntu.edu.tw
  - Tzu-Chieh Liu (劉子傑) tzujliu@media.ee.ntu.edu.tw
  - Yi-Hsun Lee (李奕勳) smilel6g84@media.ee.ntu.edu.tw
  - Yung-Wei Fan (范詠為) ywfan@media.ee.ntu.edu.tw

(Tentative) Schedule: May be Modified…

Week	Date	Topic
1	2/24	Introduction to human vision systems
2	3/3	Camera basic, image formation and basic Image processing
3	3/10	Feature detection and matching
4	3/17	Machine learning basics
5	3/24	Deep learning basics
6	3/31	Recognition
7	4/7	Segmentation
8	4/14	Projective Geometry
9	4/21	Estimation of Transformations
10	4/28	Single Camera Geometry/Camera calibration
11	5/5	Two-View Geometry
12	5/12	Dense motion estimation/stereo
13	5/19	Optical flow + object tracking
14	5/26	3D reconstruction/depth sensing
15	6/2	Structure from motion
16	6/9	Final project presentation

或是延到6/16

Homeworks

- Four assignments:
  - HW1: Image filters
  - HW2: Detection or recognition
  - HW3: Pose estimation
  - HW4: Stereo matching
- Official language is Python
- Lab0: Python and basic image processing
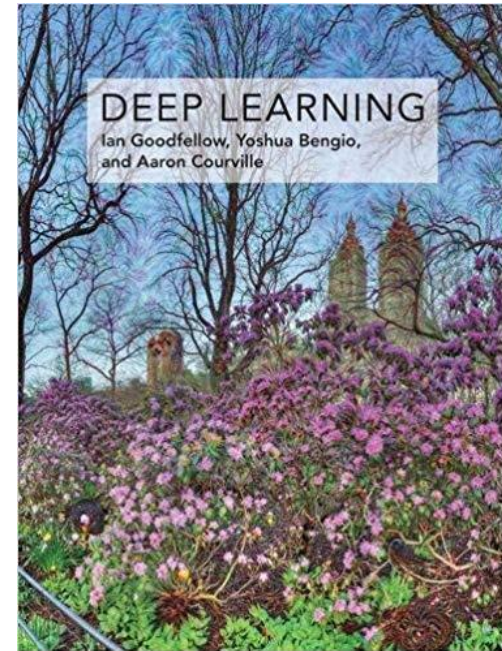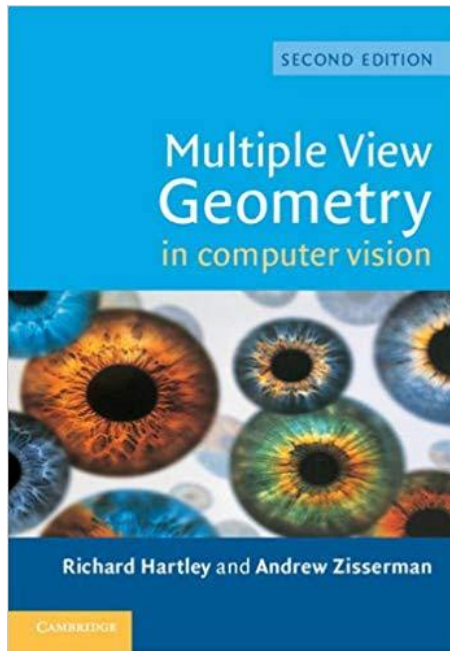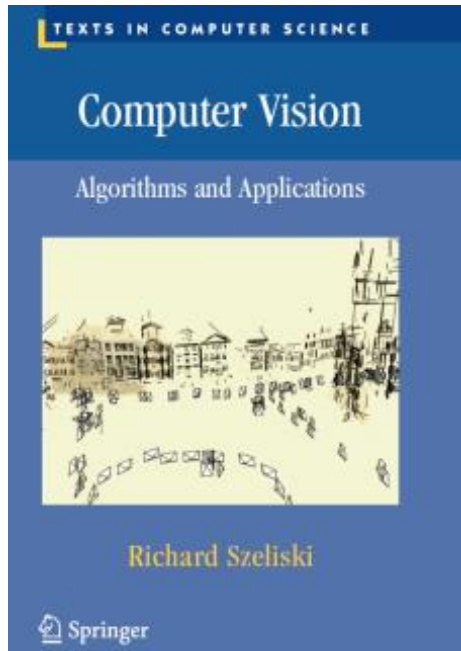 - 3/1 18:30--20:00 @ TBD

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, ….

加簽規則

I'm sorry...

- 請慎重考慮......
- 以教室容量為限，可加簽約40位同學
- 篩選順序
  - 電資學院及重點科技學院(含輔系) > 工學院 > 理學院 > 其他
  - 博班 > 碩二 > 碩一 = 大四 > 大三 > 大二 > 大一
- 想加簽的同學，請於第二節上課之前填寫好下列表單：
  - https://forms.gle/FQTK4rpkRAVhCG4b9
- 有選上的同學將在一週內寄送授權碼