

電腦視覺

Computer Vision: from Recognition to Geometry

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Fall 2018

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



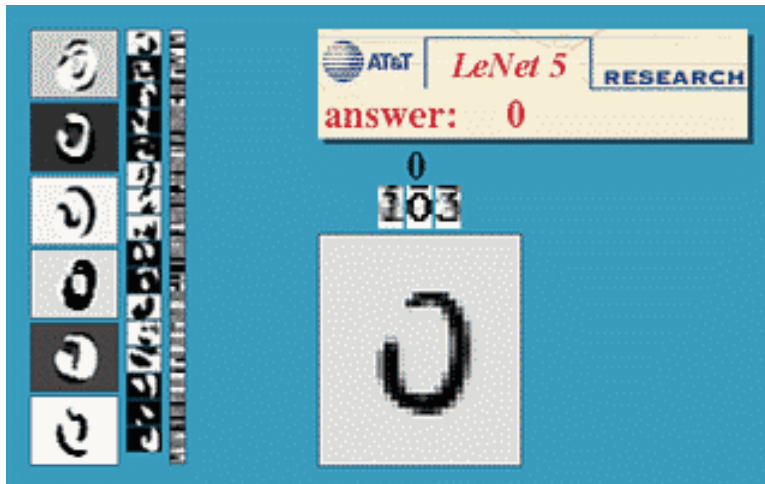
Computer Vision



[R. C. James]

Wide Applications of Computer Vision

- Optical character recognition (OCR)



Digit recognition, AT&T labs

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

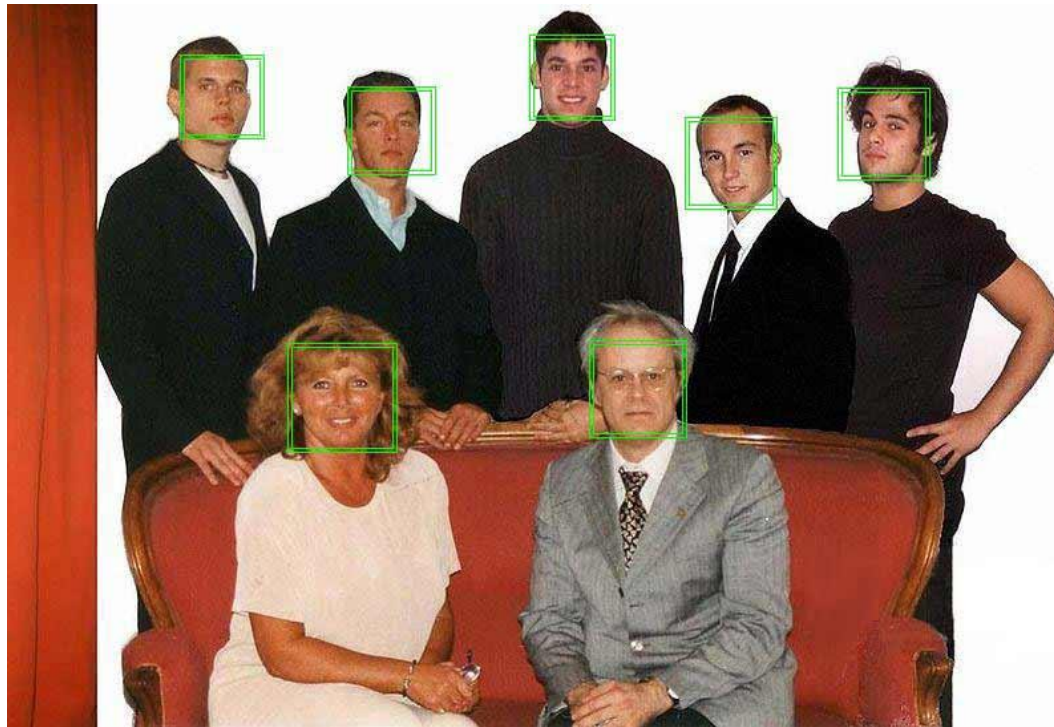


License plate readers

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

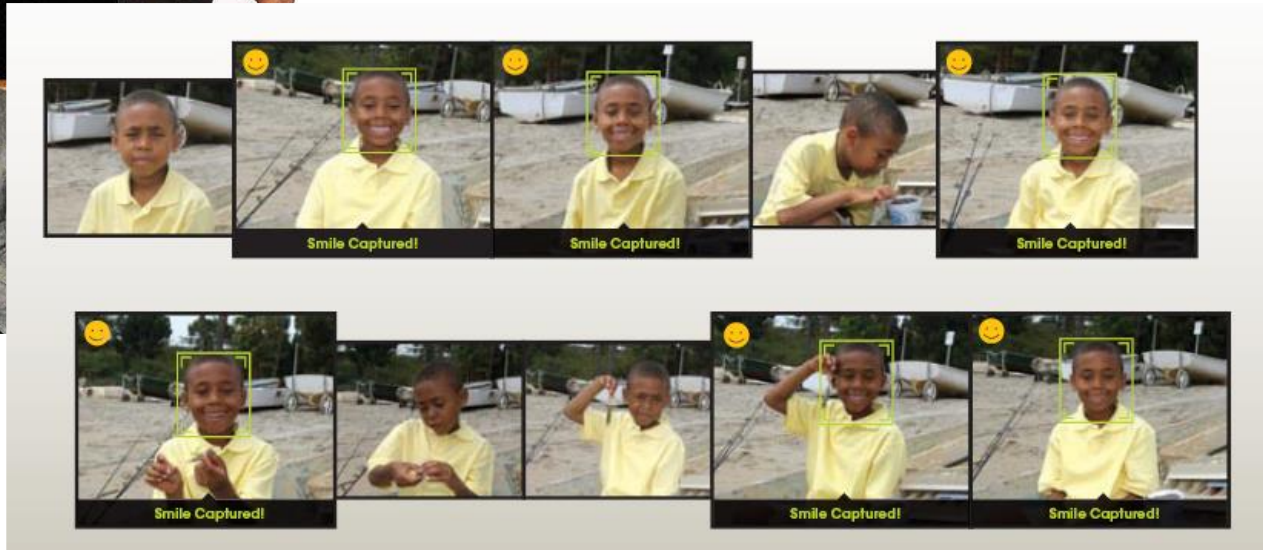
Wide Applications of Computer Vision

- Face detection: in all digital cameras and smart phones



Wide Applications of Computer Vision

- Face detection: in all digital cameras and smart phones



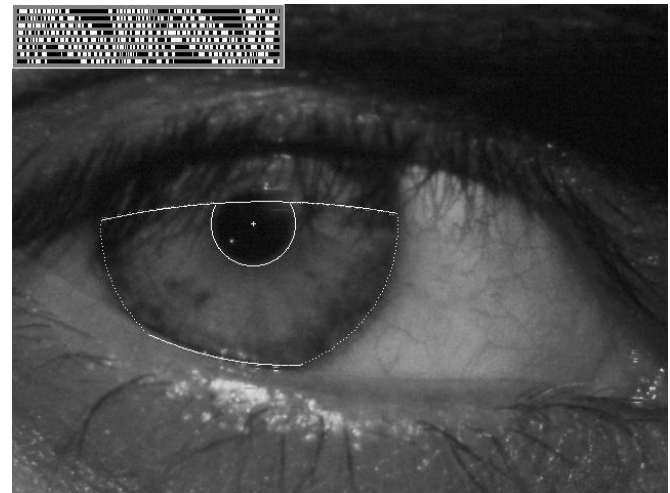
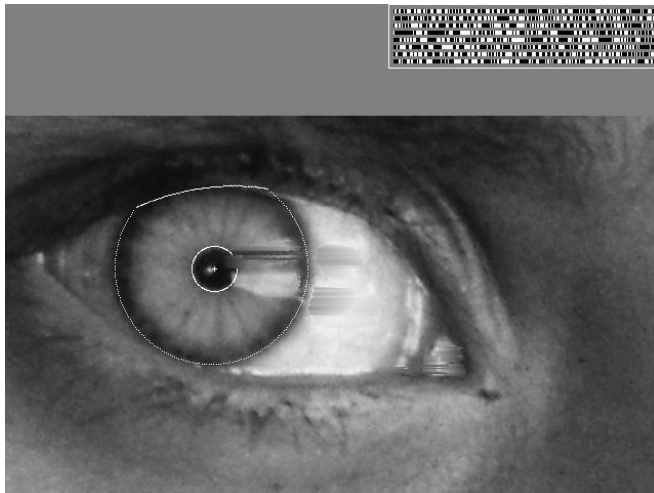
[Sony]

Wide Applications of Computer Vision

- Iris recognition
(Vision-based biometrics)

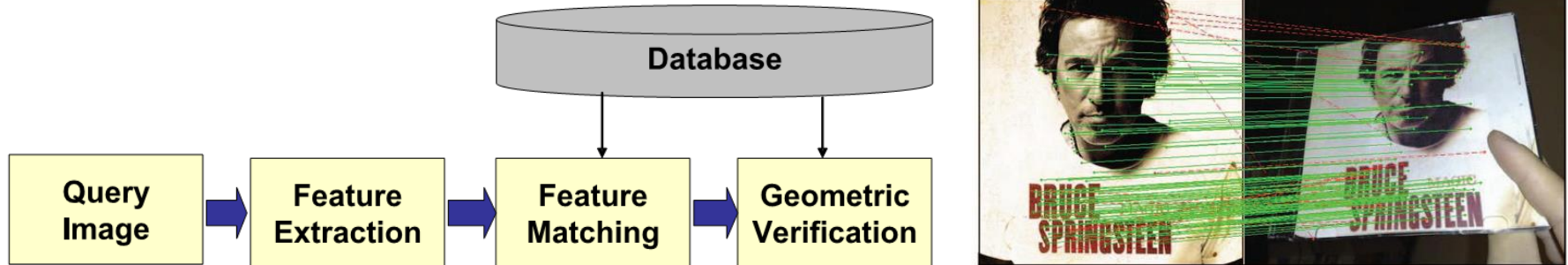


“How the Afghan Girl was Identified by Her Iris Patterns” Read the [story](#)

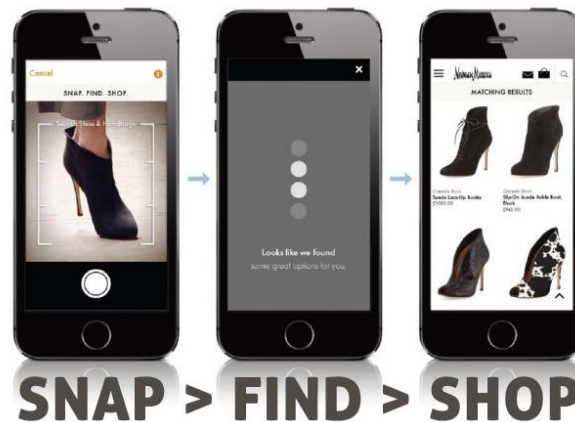


Wide Applications of Computer Vision

- Object recognition



[Girod et al. 2011]



[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](#)

The image is a screenshot of the Intel Mobileye website, showcasing its Advanced Driver Assistance Systems (ADAS). The main banner features a top-down view of a car with four camera fields of view: rear, forward, and two side cameras. The text "Our Vision. Your Safety." is prominently displayed. Navigation tabs for "manufacturer products" and "consumer products" are at the top. To the right, a "News" section lists recent articles about Volvo's first collision warning system and a new collision warning system. Below the main banner, three product/application tiles are shown: "EyeQ Vision on a Chip" with an image of the chip, "Vision Applications" showing a pedestrian detection box, and "AWS Advance Warning System" with a car icon and a distance reading of "0.8". Each tile includes a "read more" link. On the far right, an "Events" section lists upcoming events like "Mobileye at Equip Auto, Paris, France" and "Mobileye at SEMA, Las Vegas, NV", also with a "read more" link.

manufacturer products consumer products

Our Vision. Your Safety.

rear looking camera forward looking camera side looking camera

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

EyeQ Vision on a Chip

> read more

Vision Applications

Road, Vehicle, Pedestrian Protection and more

> read more

AWS Advance Warning System

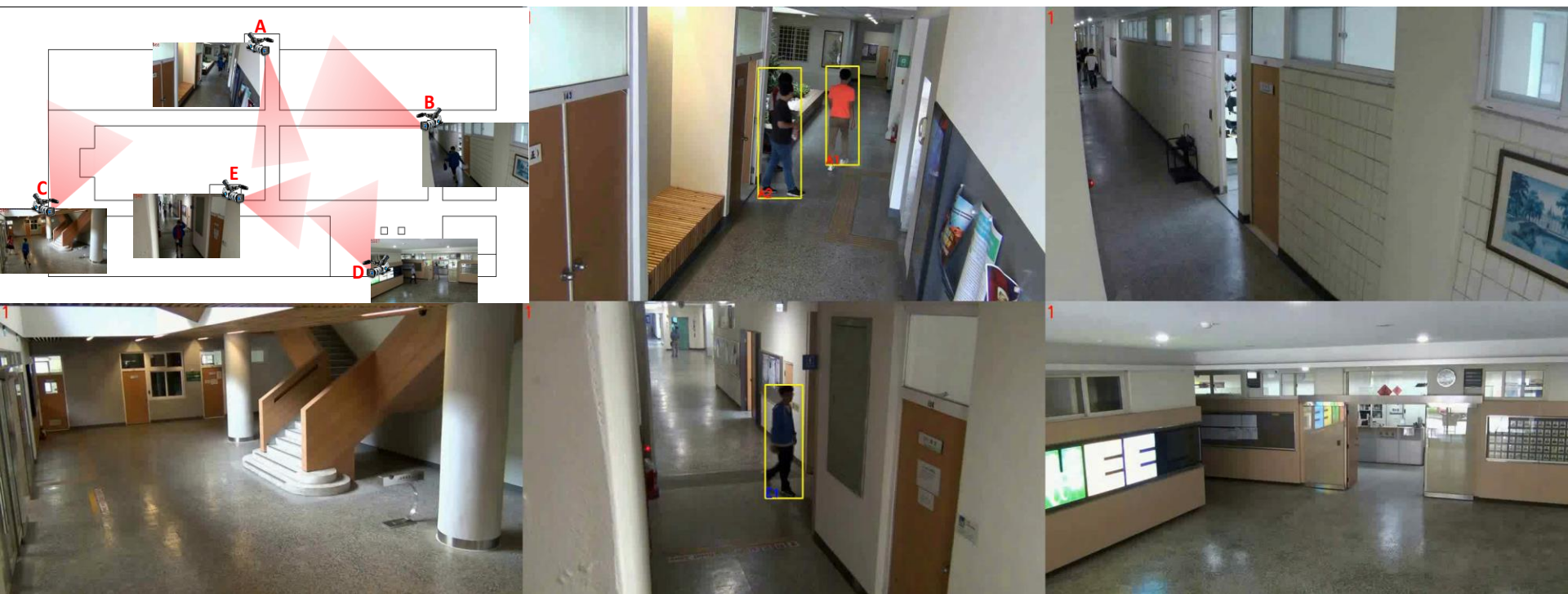
0.8

> 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

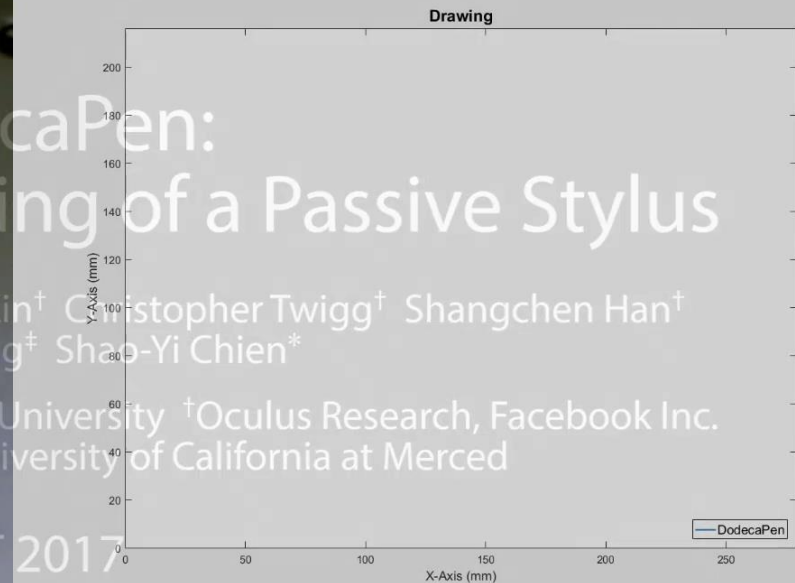
- Vision-based interaction



[Microsoft Xbox]

Wide Applications of Computer Vision

DodecaPen: Puppy



DodecaPen: Accurate 6DoF Tracking of a Passive Stylus

Po-Chen Wu^{*†} Robert Wang[†] Kenrick Kin[†] Christopher Twigg[†] Shangchen Han[†]
Ming-Hsuan Yang[†] Shao-Yi Chien^{*}

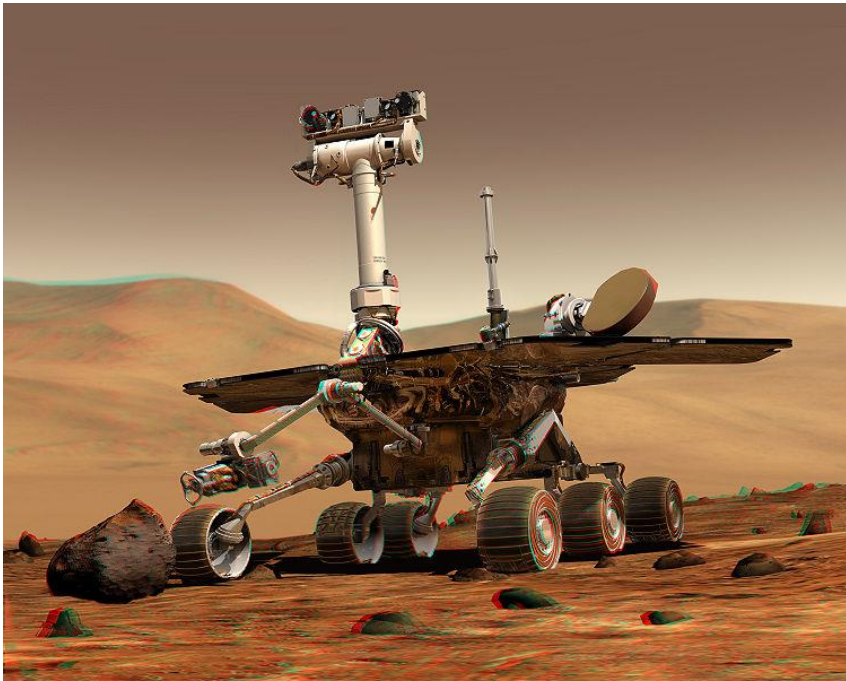
^{*}Media IC & System Lab, National Taiwan University [†]Oculus Research, Facebook Inc.

[†]Vision and Learning Lab, University of California at Merced

UIST 2017

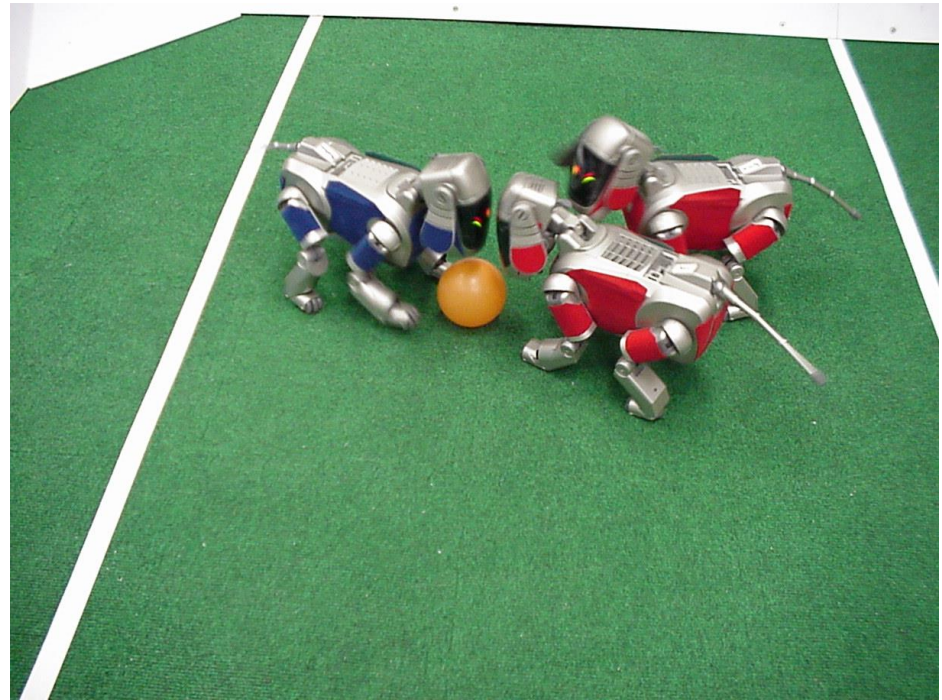
Wide Applications of Computer Vision

- Robotics



NASA's Mars Spirit Rover

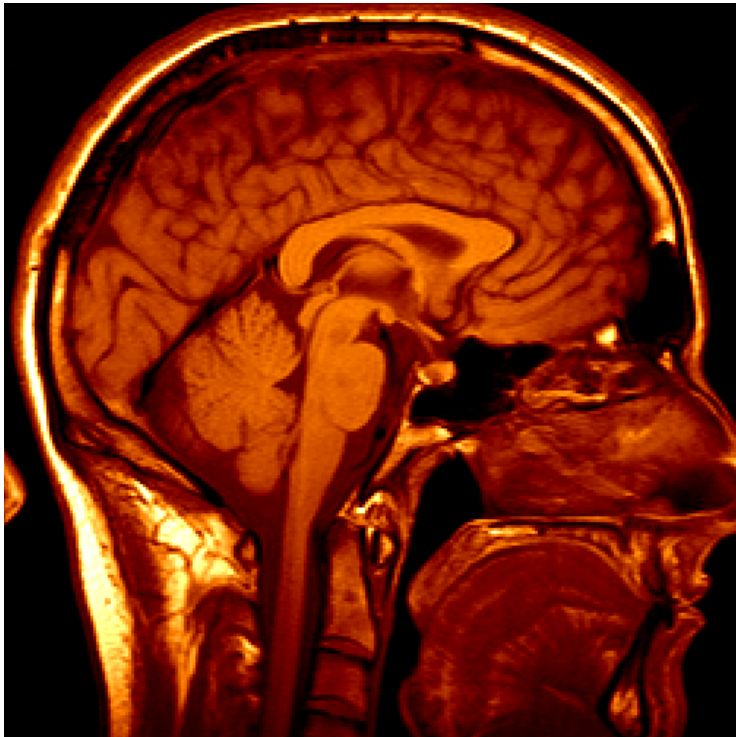
http://en.wikipedia.org/wiki/Spirit_rover



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

Wide Applications of Computer Vision

- Medical image



3D imaging
MRI, CT

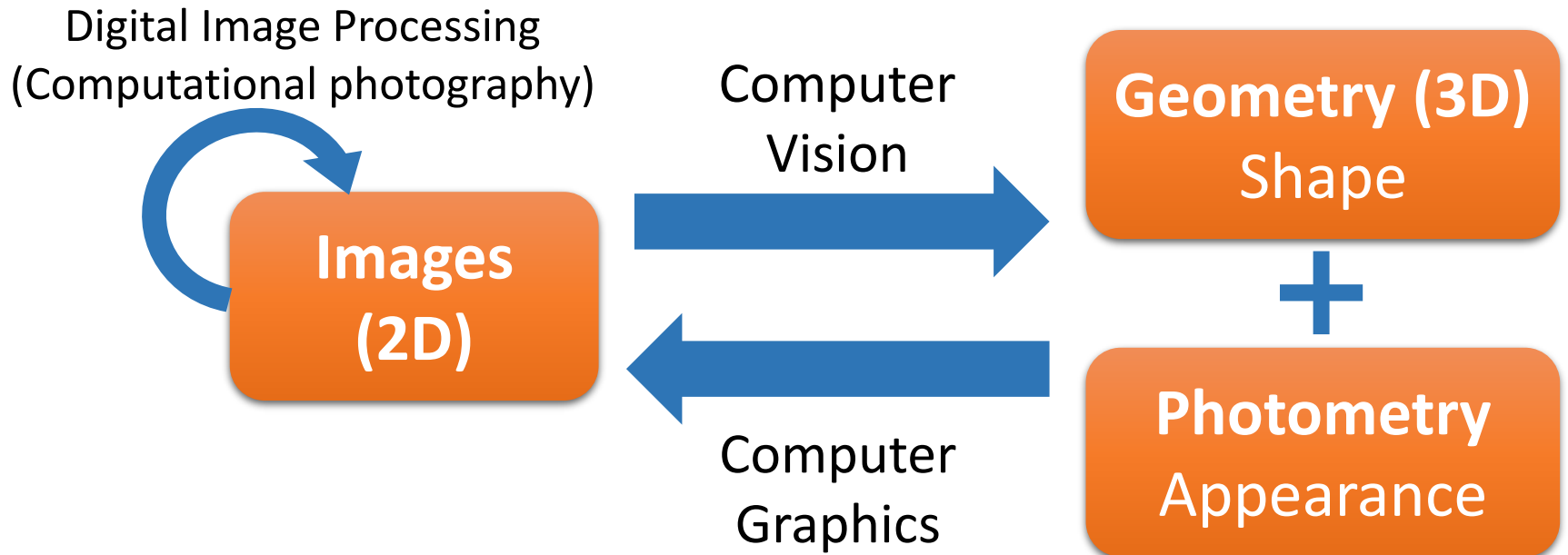


Image guided surgery
[Grimson et al., MIT](#)

Important Near-Future Applications

- AR/VR
- 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 process 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 participation: 5%
 - Group final project: 35%

Course Website

- Course website
 - <http://media.ee.ntu.edu.tw/courses/cv/18F/>
- TA
 - 塗偉志
 - MD-726
 - wctu@media.ee.ntu.edu.tw
 - Will lead TA teams for each homework



Schedule

Week	Date	Topic
1	9/12	Introduction to human vision systems
2	9/19	Camera basic, image formation and basic Image processing
3	9/26	Feature detection and matching
4	10/3	Machine learning basics
5	10/10	國慶日放假
6	10/17	Deep learning basics
7	10/24	Recognition and detection
8	10/31	Segmentation
9	11/7	Projective Geometry, Transformations and Estimation/Camera calibration
10	11/14	Camera Geometry and Single View Geometry
11	11/21	Two-View Geometry
12	11/28	Dense motion estimation/stereo
13	12/5	Structure from motion
14	12/12	3D reconstruction/depth sensing
15	12/19	Computational photography
16	12/26	Object tracking
17	1/2	Advanced topics in CV
18	1/9	CES
19	1/16	Final Project

Homeworks

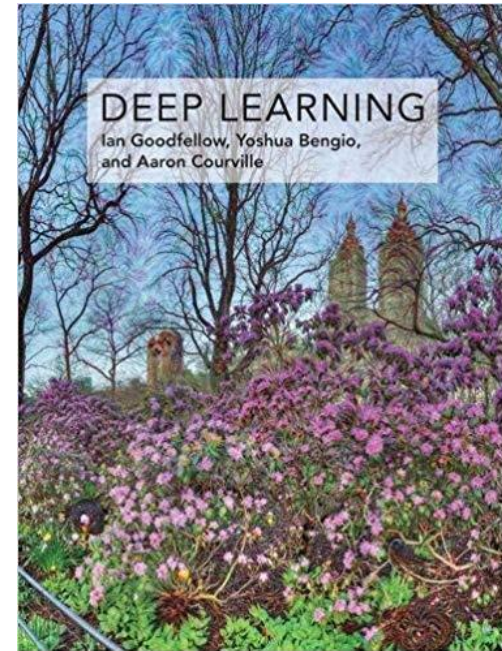
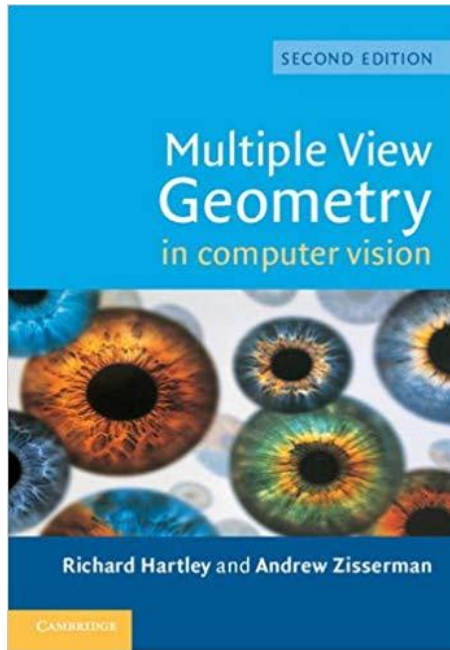
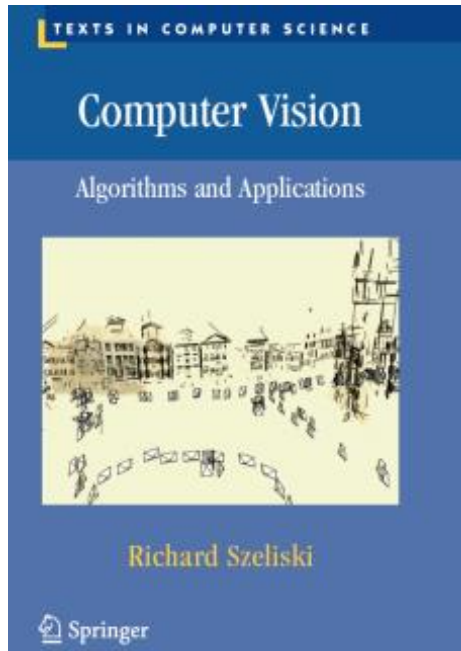
- Four assignments:
 - HW1: Image filters
 - HW2: Detection and recognition
 - HW3: Pose estimation
 - HW4: Stereo matching
- Official language is Python
- Lab0: Python and basic image processing
 - 9/19 18:30--20:00 @ EEII-143

Final Project

- Will have one or two problems/challenges
- Each team should have 3—4 members
- Project will 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

- 第一次開課，請慎重考慮.....
- 以教室容量為限，可加簽50位同學
- 篩選順序
 - 電資學院 (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
- 請於第二節上課之前填寫好下列表單：
 - <https://goo.gl/fxocvg>
- 第三節上課時將公布獲選名單
- 有選上的同學第三節下課後親自拿學生證(或是可證明身份之文件)來領授權碼

