

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



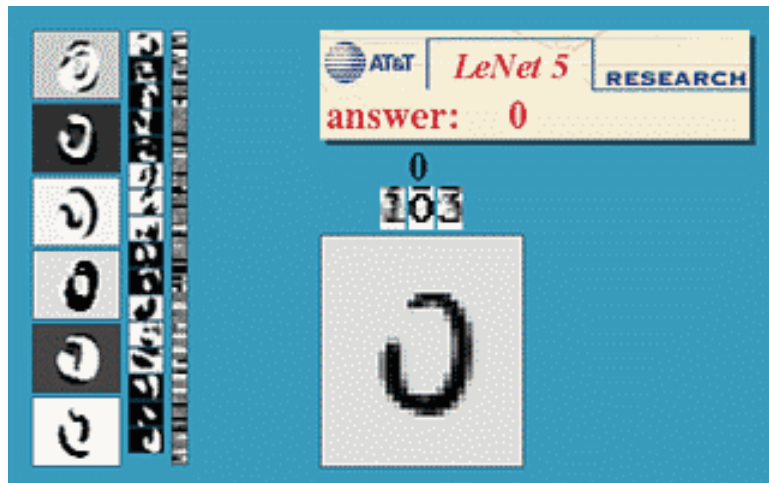
Computer Vision



[R. C. James]

Wide Applications of Computer Vision

- Optical character recognition (OCR)



Digit recognition, AT&T labs

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

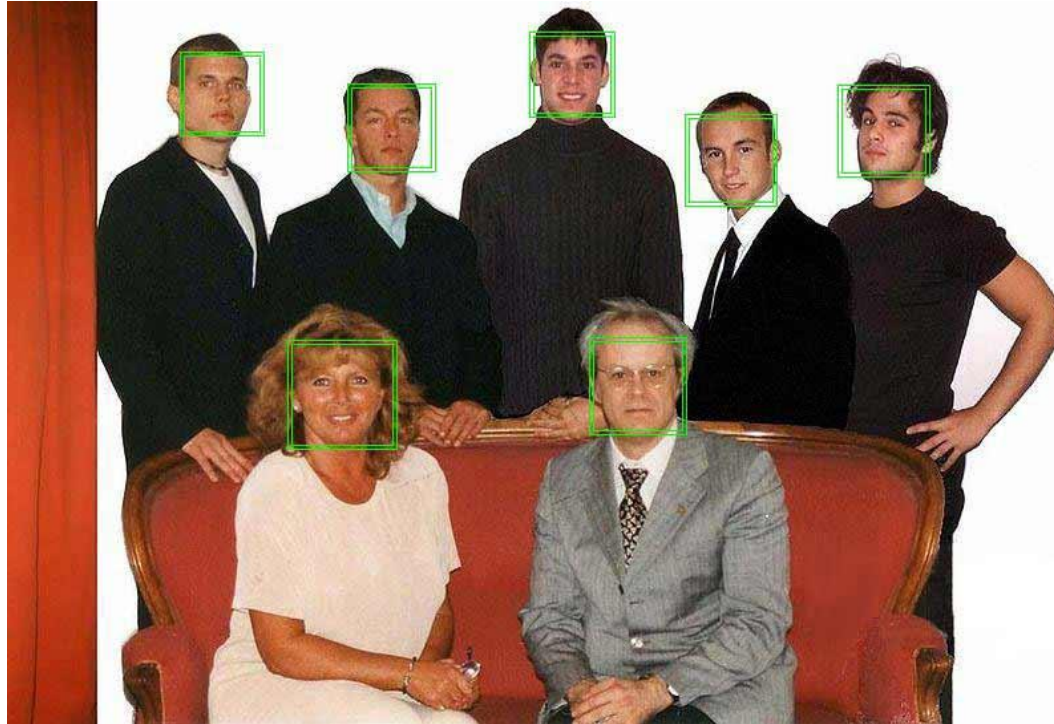


License plate readers

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

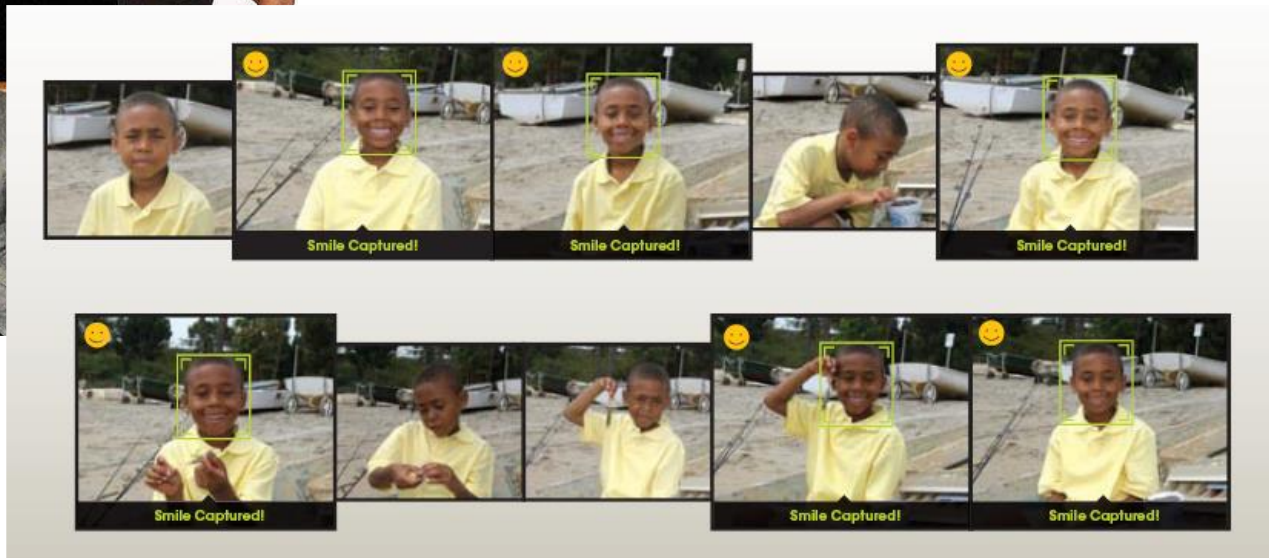
Wide Applications of Computer Vision

- Face detection: in all digital cameras and smart phones



Wide Applications of Computer Vision

- Face detection: in all digital cameras and smart phones



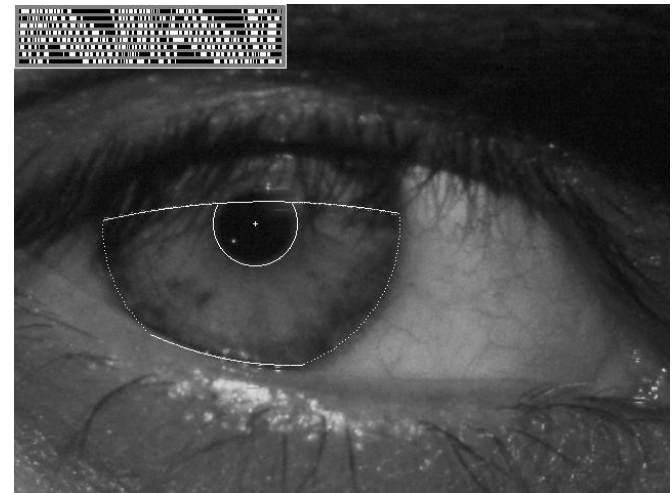
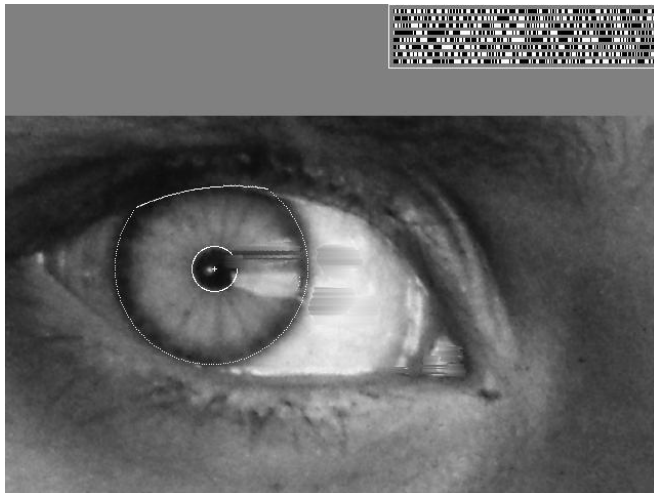
[Sony]

Wide Applications of Computer Vision

- Iris recognition
(Vision-based biometrics)

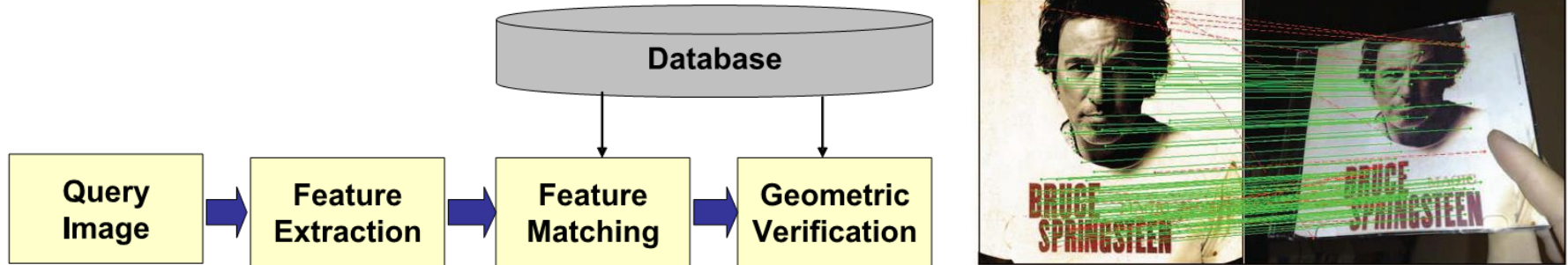


“How the Afghan Girl was Identified by Her Iris Patterns” Read the [story](#)

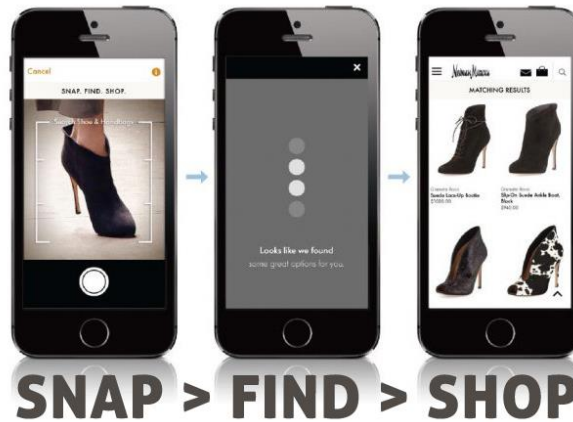


Wide Applications of Computer Vision

- 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



Intel: [freeD technology](#)

[Hawk-Eye](#): helping/improving referee decisions

Wide Applications of Computer Vision

- Smart cars: [ADAS](#)

The screenshot displays the Intel Mobileye website interface. At the top, there are navigation tabs for "manufacturer products" and "consumer products". The main header reads "Our Vision. Your Safety." and features a top-down view of a car with three camera fields of view: "rear looking camera", "forward looking camera", and "side looking camera".

Below the main header, there are three product highlights:

- EyeQ Vision on a Chip**: Accompanied by an image of the EyeQ chip. A "read more" link is present.
- Vision Applications**: Accompanied by an image of a pedestrian on a crosswalk. Text includes "Road, Vehicle, Pedestrian Protection and more". A "read more" link is present.
- AWS Advance Warning System**: Accompanied by an image of a car on a road with a distance warning of "0.8". A "read more" link is present.

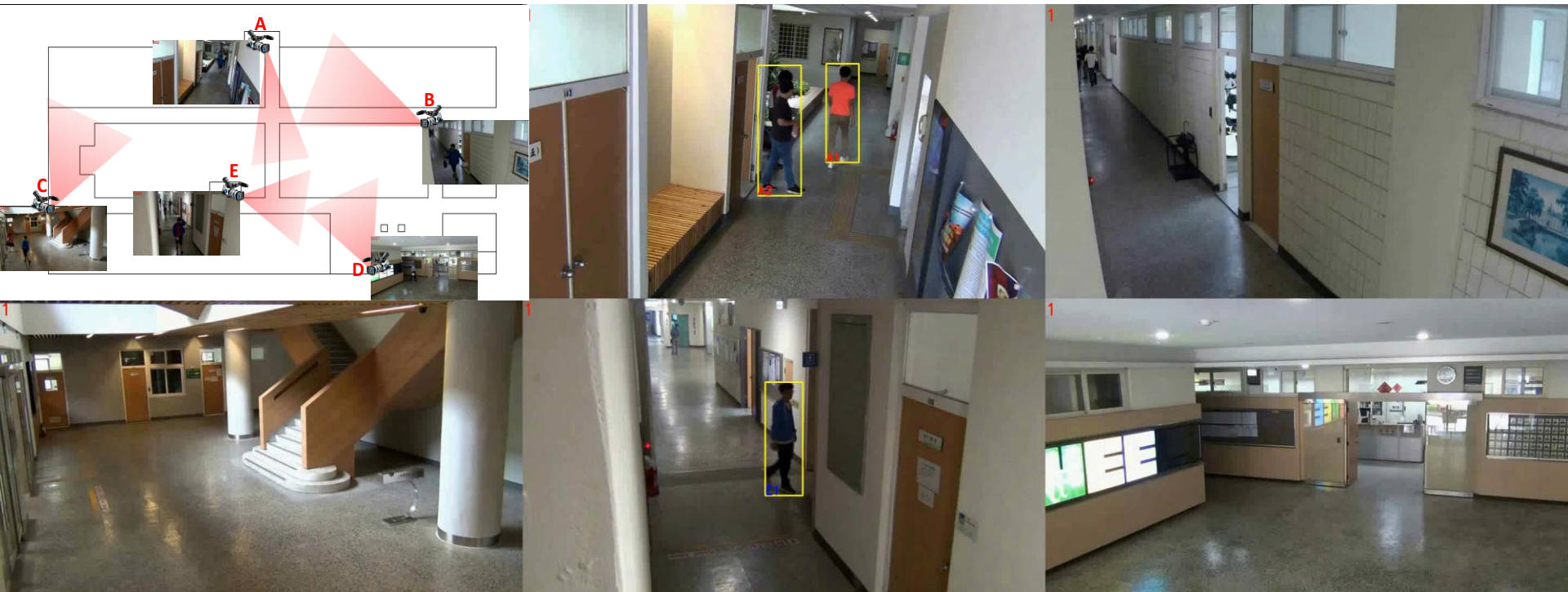
On the right side, there are two vertical sections:

- News**: Contains two news items:
 - > [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](#)A "read more" link is at the bottom.
- Events**: Contains two event items:
 - > [Mobileye at Equip Auto, Paris, France](#)
 - > [Mobileye at SEMA, Las Vegas, NV](#)A "read more" link is at the bottom.

[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

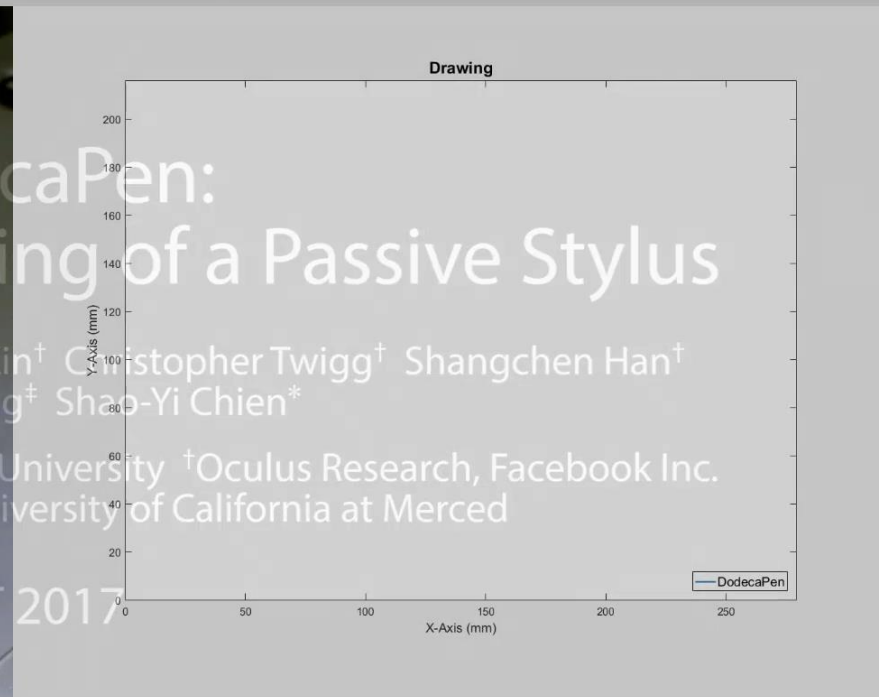
- Vision-based interaction



[Microsoft Xbox]

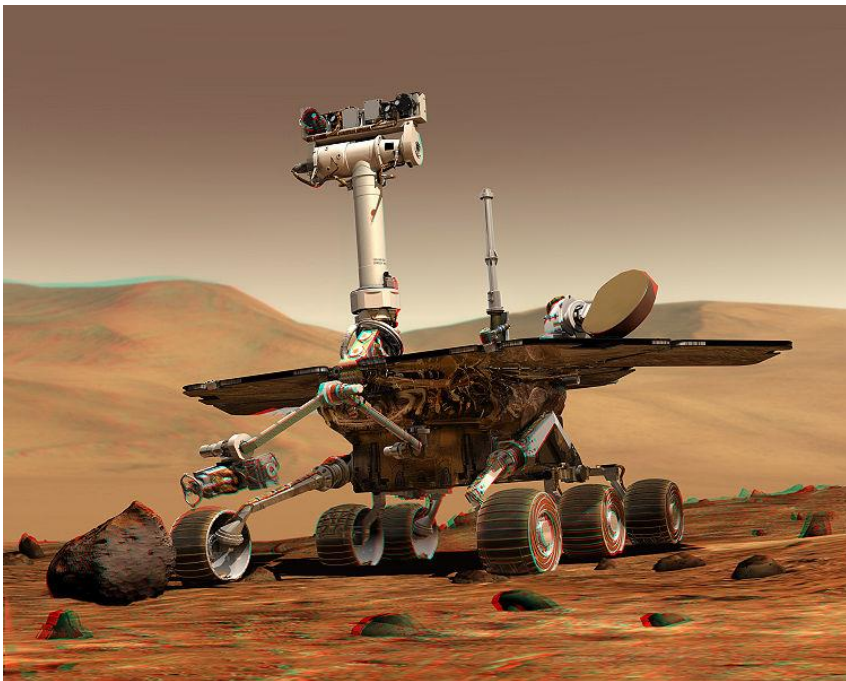
Wide Applications of Computer Vision

DodecaPen: Puppy



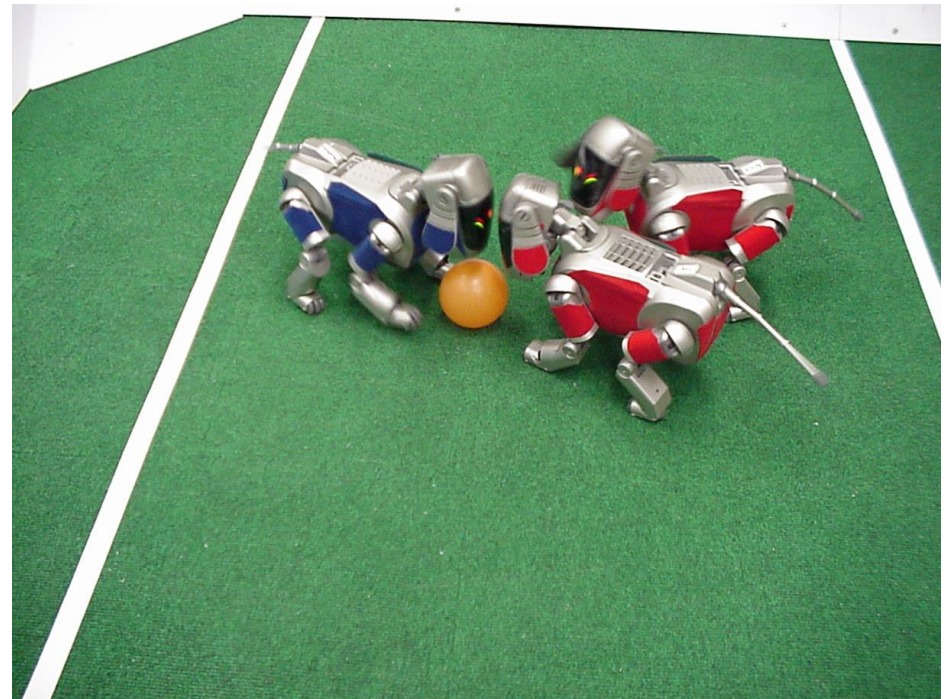
Wide Applications of Computer Vision

- Robotics



NASA's Mars Spirit Rover

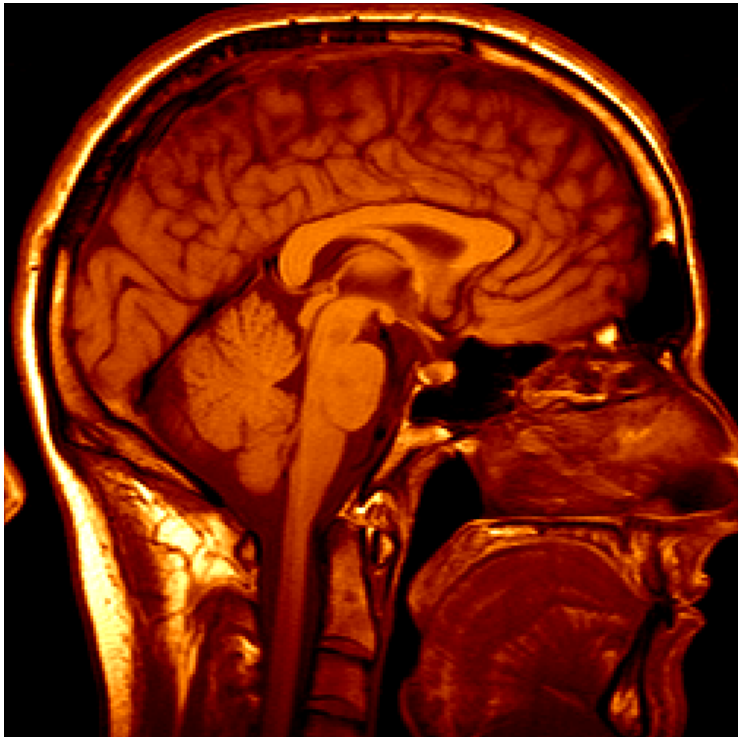
http://en.wikipedia.org/wiki/Spirit_rover



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

Wide Applications of Computer Vision

- Medical image



3D imaging
MRI, CT

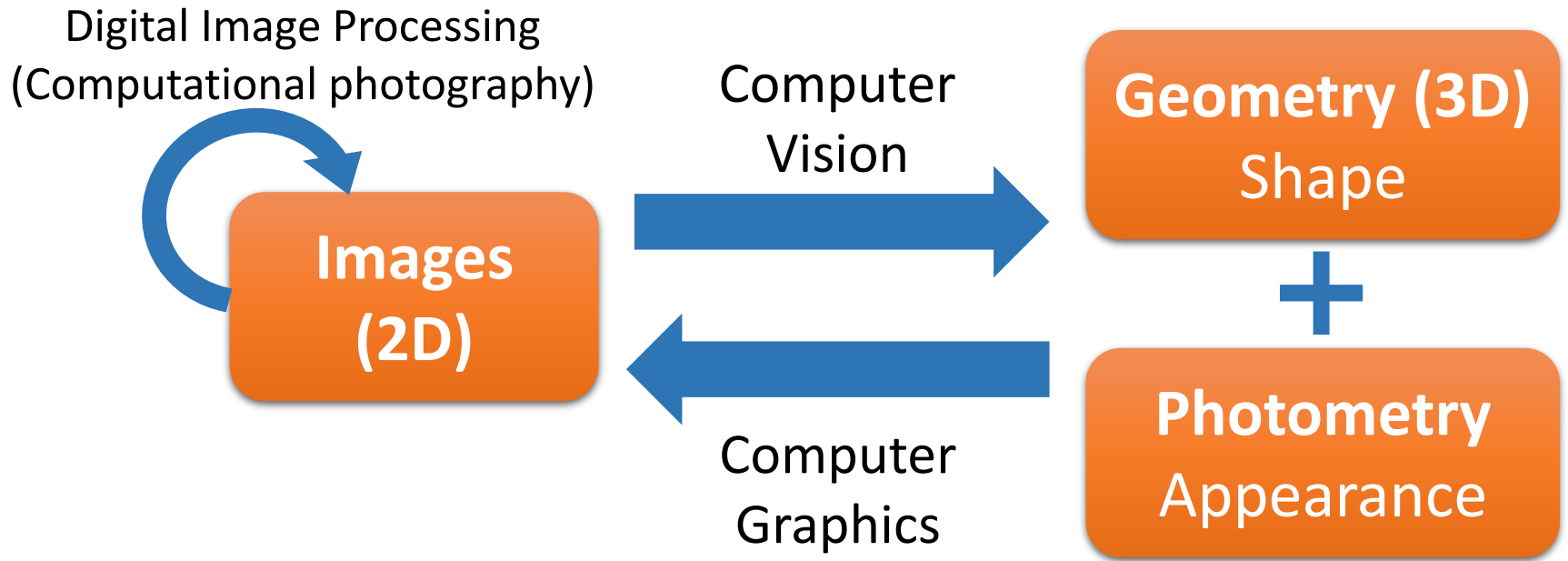


Image guided surgery
[Grimson et al., MIT](#)

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

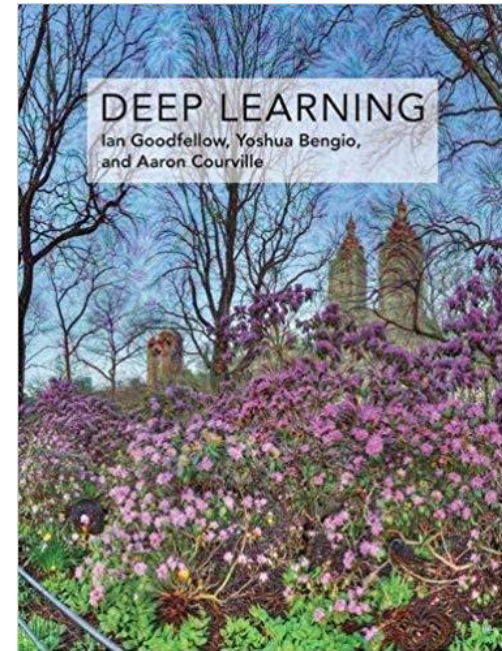
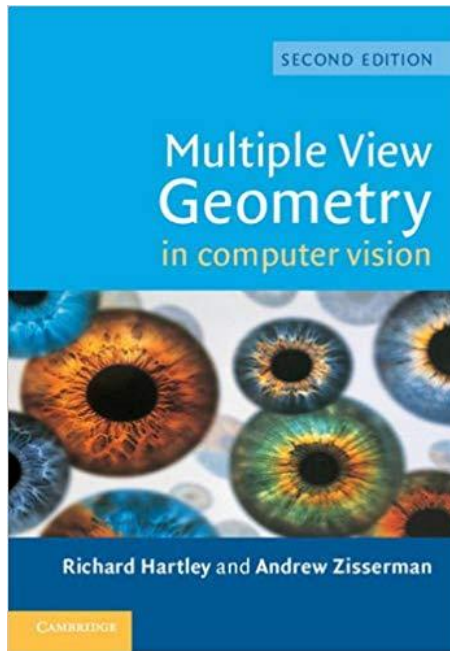
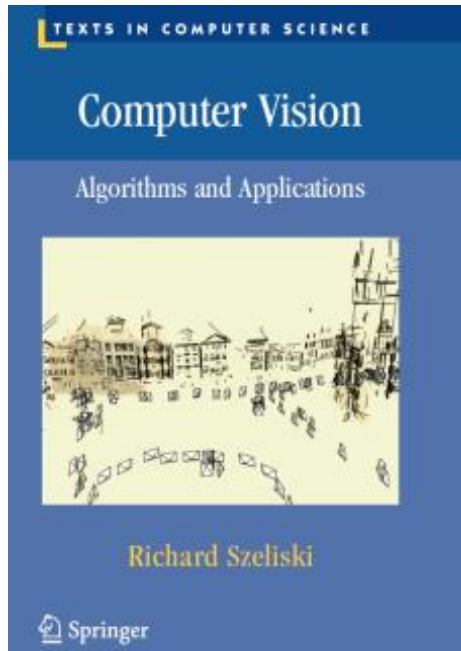
- Four assignments:
 - HW1: Image filters
 - HW2: Detection and recognition
 - HW3: Pose estimation
 - HW4: Stereo matching
- Official language is Python
- Lab0: Python and basic image processing
 - 9/19 18:30--20:00 @ EEII-143

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

