
IMAGE PROCESSING
INSTRUCTOR: CHUNPING LIU
SCHOOL OF COMPUTER SCIENCE AND TECHNOLOGY
SOOCHOW UNIVERSITY

COURSE STAFF

- **Instructor: Dr. Chunping Liu**
  - **Research Topics**
    - **Image Processing and Analysis**
    - **Computer Vision**
    - **Machine Learning**
    - **Image Understanding: Image Captioning and Visual Question Answering**
  - **Office hours： Friday, 10:00-11:00 AM @ Ligong Building 545**
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  - **Office hours: Tuesday, 10:00-11:00 AM @Ligong Building 555**
  - **QQ:**

EXAMPLES OF MY RESEARCH TOPICS

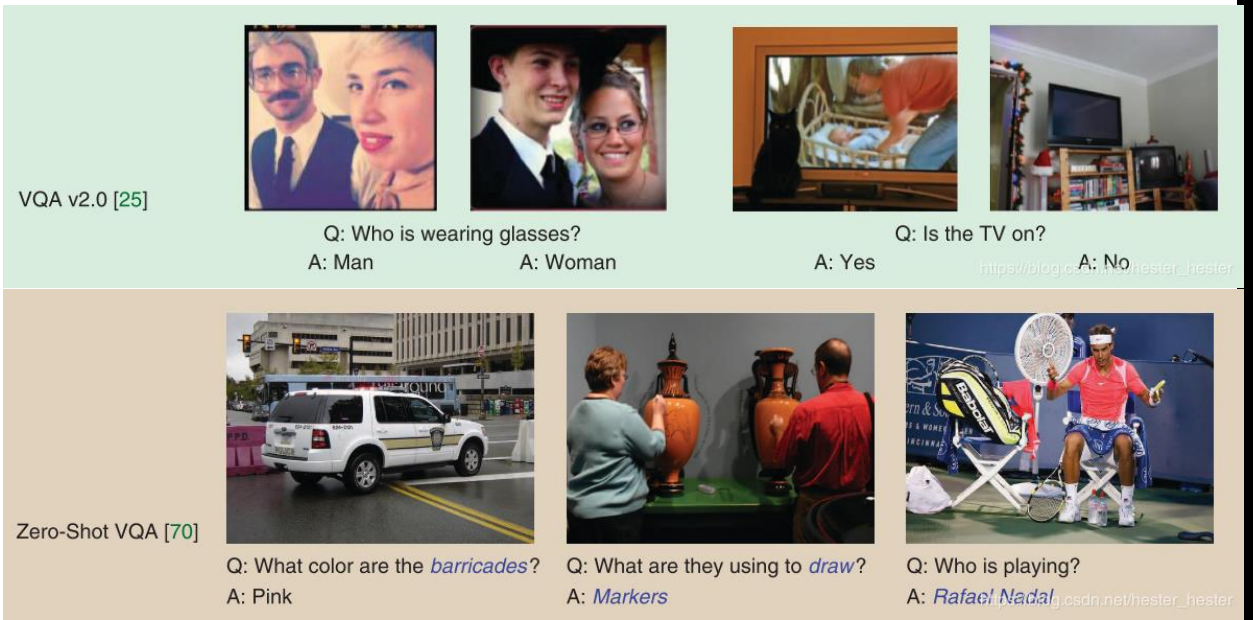
- **Image Captioning or Video Captioning**
  - **Problem**
    - How to represent the content of image or video using natural language
  - **Solution**
    - Automatic features discovery that capture higher level abstraction from image or video
    - Language Model

AI System

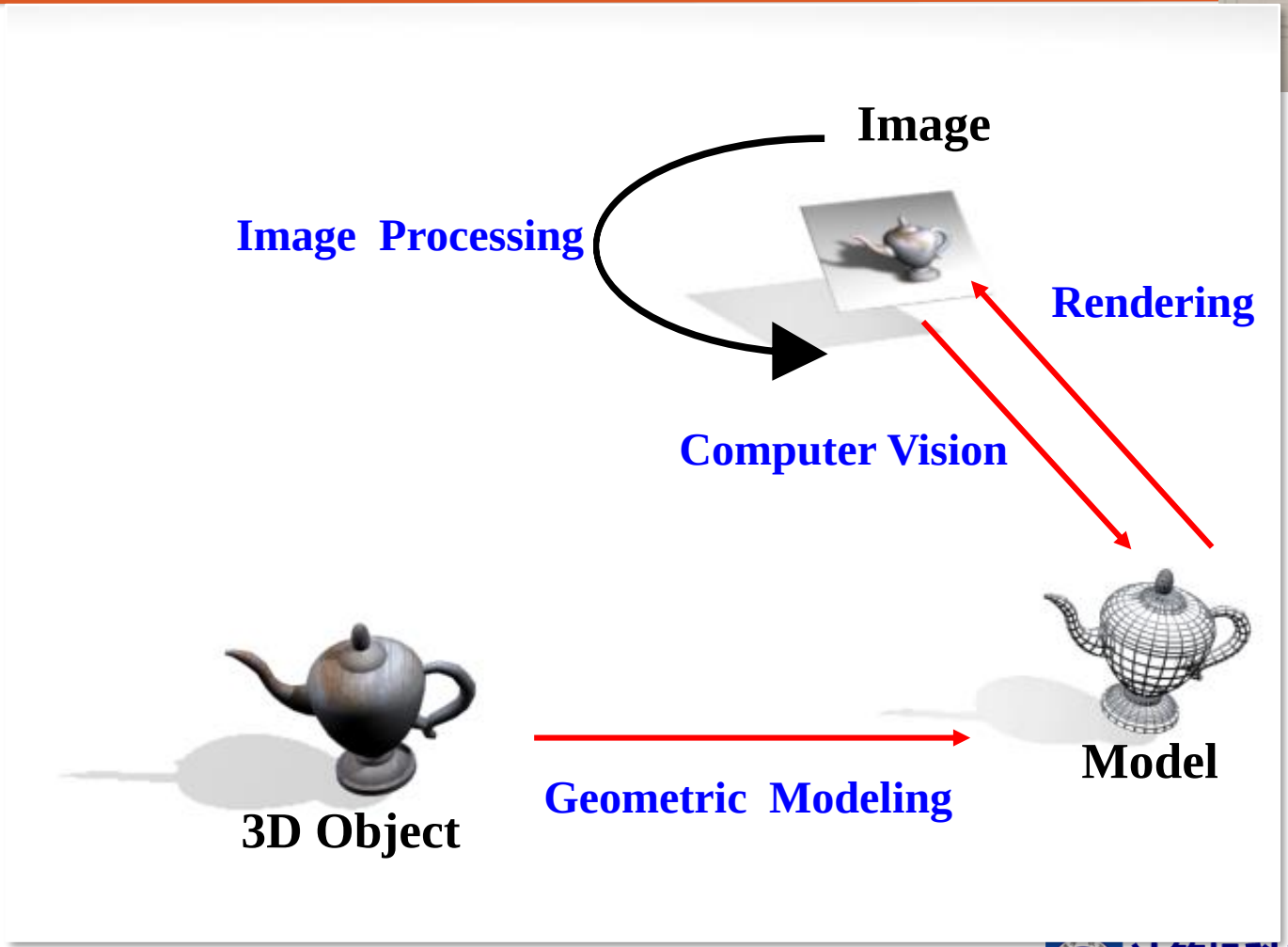
Two surfers carry their surfboards at the edge of the water

EXAMPLES OF MY RESEARCH TOPICS

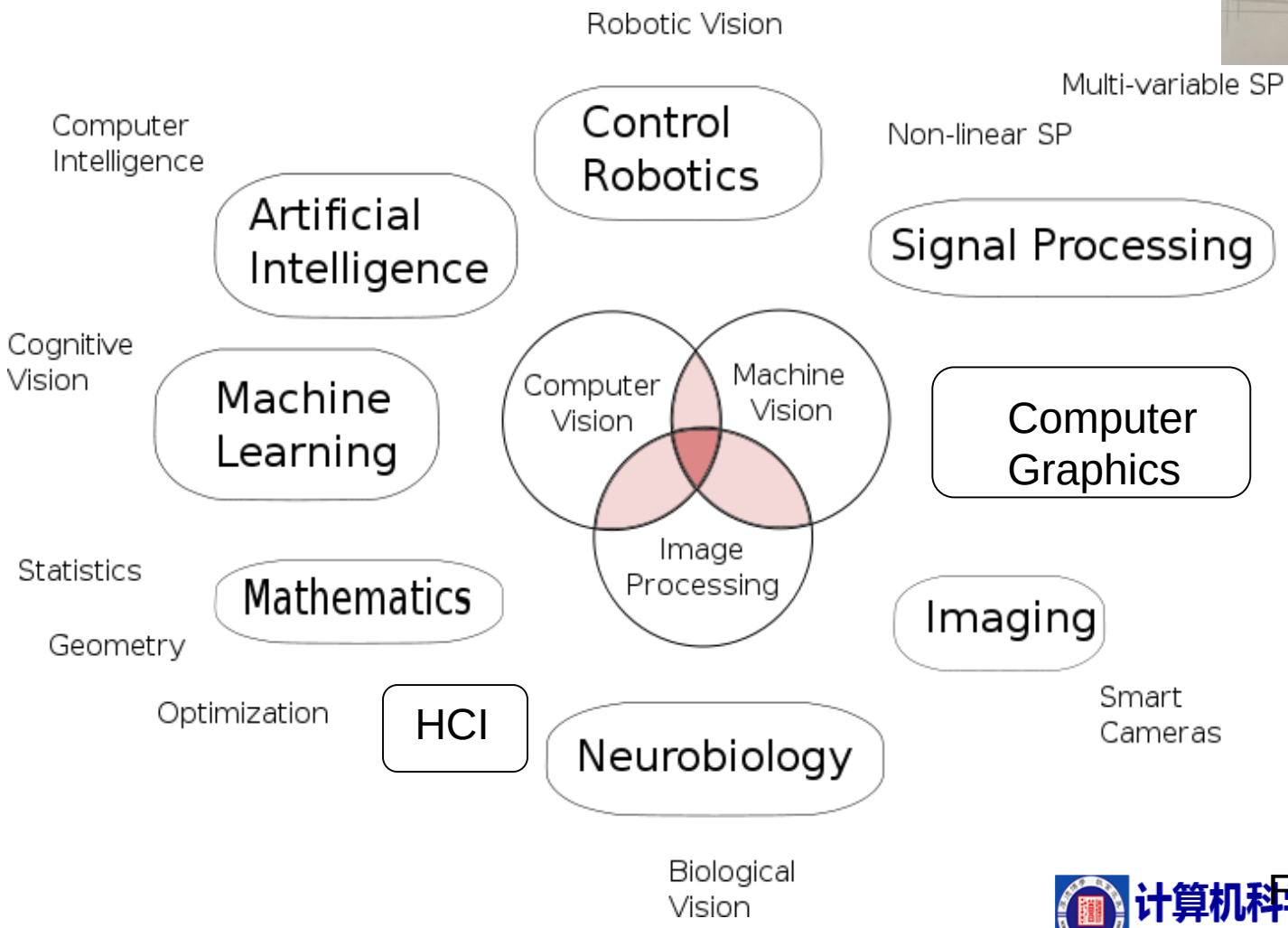
- **Visual Question Answering (VQA)**
  - **Problem**
    - How to produce a natural language based on a given image and a free-form, open-ended natural-language question about the image
  - **Solution**
    - Automatic features discovery that capture higher level abstraction from a given image or video and a question
    - Common sense Knowledge
    - Reasoning Model



THE VISUAL SCIENCES



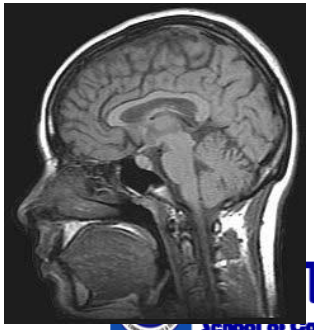
VISION IS MULTIDISCIPLINARY



From wiki

WHAT IS COMPUTER VISION?

- Computer vision is the science and technology of machines that see.
- Concerned with the theory for building artificial systems that obtain information from images.
- The image data can take many forms, such as a video sequence, depth images, views from multiple cameras, or multi-dimensional data from a medical scanner



WHAT IS COMPUTER VISION

Make computers understand images and videos.

What kind of scene?

Where are the cars?

How far is the building?

…

COMPONENTS OF A COMPUTER VISION SYSTEM

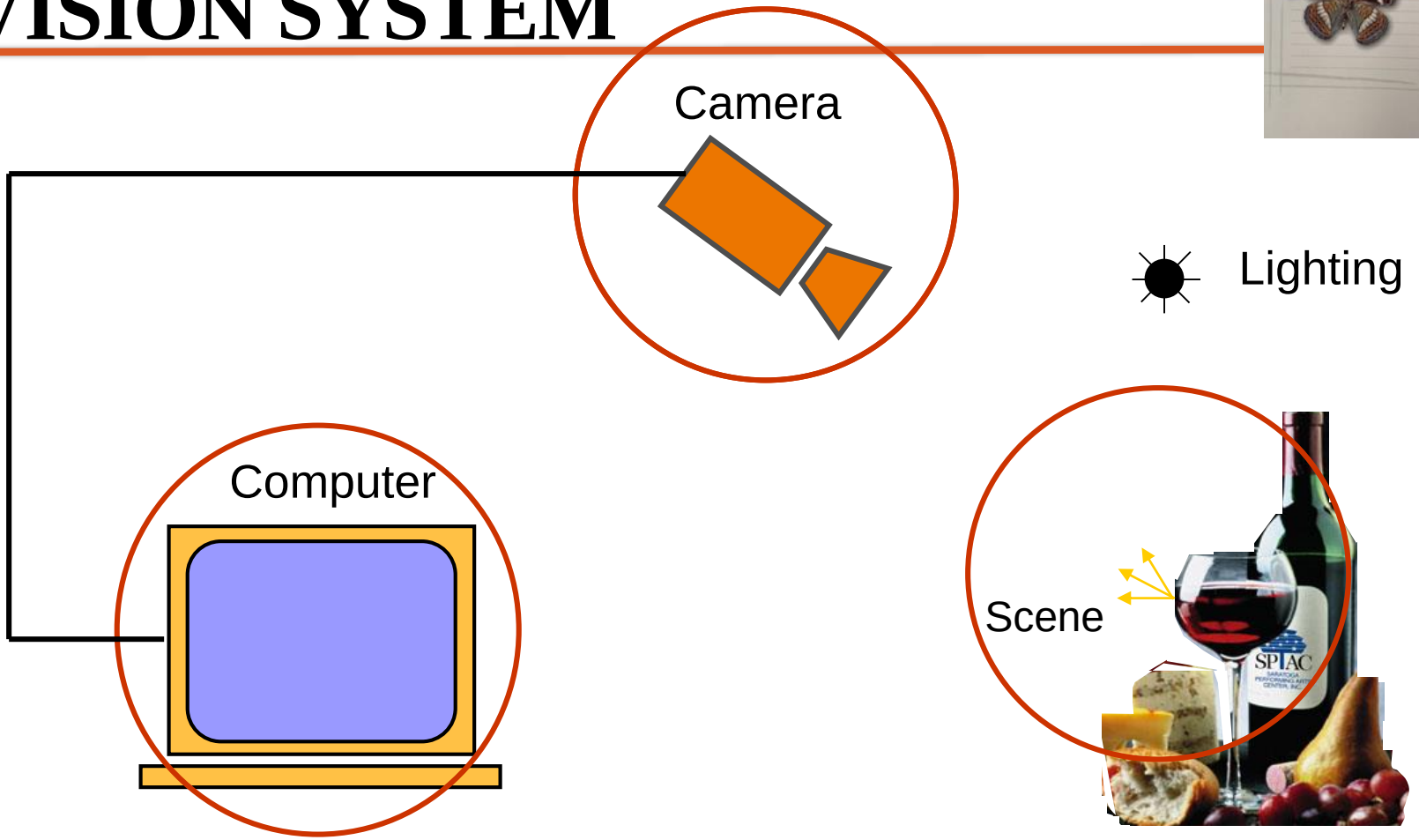


IMAGE PROCESSING V.S. COMPUTER VISION

Low Level

Image Processing

Acquisition, representation, compression, transmission

image enhancement

edge/feature extraction

Pattern matching

Computer Vision

image “understanding” (Recognition, 3D)

High Level

ABOUT THE COURSE

- **Goals of this course**
  - **Introductory course: basic concepts, classical methods, fundamental theorems**
  - **Getting acquainted with basic properties of images**
  - **Getting acquainted with various representations of image data**
  - **Acquire fundamental knowledge in processing and analysis digital images**
  - **Develop hands-on experience in processing images**
  - **Develop critical thinking about the state of the art**
  - **Familiarize with OpenCV+Python image processing**

PREREQUISITES

- Signals and systems
- Linear algebra
  - Matrices, Matrix Operations
  - Determinants, Systems of Linear Equations
  - Eigenvalues, Eigenvectors
- Statistics and probability
  - Probability density function, Probability distribution
  - Mean, Variance, Co-variance, Correlation
  - Priors, Posteriors, Likelihoods
  - Gaussian distribution
- Good programming skills

PREREQUISITES

- **Assignments**
  - **Turn-in a hard copy**
  - **Assignments=Mini-project must be implemented in OpenCV + Python**
  - **Assignments should be an individual effort**
  - **Late assignments will not be accepted without prior approval**
- **Final Project**
- **Graduate students will be given approximately 20% greater amount of work for homework assignments**

GRADING SCHEMES

- Class participation/discussion (10%)
- Assignments (50%)
  - 3 assignments
  - Assignment will be weighted
- Final Project (40%)
- **Important Deadlines:**

  Hand in project proposal: April 10, 2020

  Hand in project report: June 20, 2020

  All written in Chinese (中文书写)

  Final Presentation: June 13 and 20, 2020

FINAL PROJECT

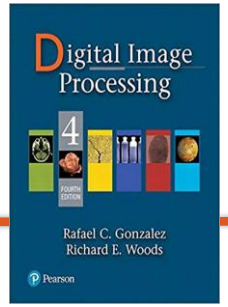
- Approved by the professor
- Student can work in a group of three
- Submit your code and final project report
- Final presentation & in class demos

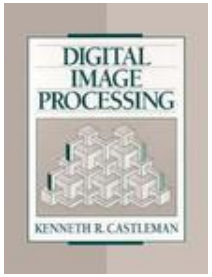
- Late policy: 20% reduction per day if you do not have good reasons

SYLLABUS SCHEDULE

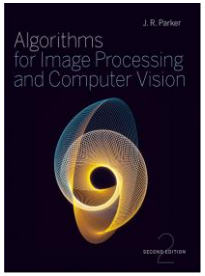
No.	Date	Lectures
1	2.29	Introduction, Image Processing Examples and Computer Imaging Systems
2	3.7	Human Visual System, Image Model
3	3.14	Spatial and Frequency Domain Image Filtering
4	3.21	Edge Detection and Hough Transform
5	3.28	Multiresolution Image Processing
6	4.4	Qingming Festival holiday closed
7	4.11	Morphological Image Processing
8	4.18	Color Image Processing
9	4.25	Visual Saliency detection
10	5.2	May Day holiday closed
11	5.9	Image Segmentation (Semantic Segmentation)
12	5.16	Feature extraction and Recognition Tasks
13	5.23	Object Detection and Tracking
14	5.30	Image Captioning
15	6.6	Dragon Boat Festival closed
16	6.13.	Visual Question Answering
17	6.20.	Testing

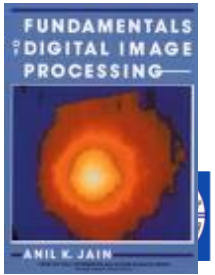
TEXTBOOKS





- **Digital Image Processing, Rafael C. Gonzalez and Richards E. Woods, Addison Wesley, 2017**
- **Digital Image Processing, Kenneth R. Castelman, Prentice Hall**
- **Digital Image Processing and Analysis (2th Edition), Gong Shengrong, Liu Chunping, Zhao Xunjie, Jiang Demao Edit., Tsinghua University Press, 2014**
- **Algorithm for Image Processing and Computer Vision, by J.R.Parker.**
- **Fundamentals of Digital Image Processing, Anil K. Jain, Prentice Hall, 1989.**





REFERENCE BOOKS

- Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010
  - 中文翻译版：艾海舟，兴军亮 等，计算机视觉：算法与应用，2011年；清华大学出版社
- DA Forsyth and J. Ponce, Computer Vision: A Modern Approach, Prentice Hall. 1st edition, 2002
- R. Jain, R. Kasturi and B. G. Schunck, Machine Vision, McGraw-Hill companies, Inc. 2003.8
- L.G. Shapiro and G.C. Stockman, Computer Vision, Prentice Hall Inc, 2001.
- M. Sonka, V. Hlavac, and R. Boyle, Image processing, analysis, and machine vision, Chapman & Hall Computing, London, 3rd Edition, THOMSON Learning, 2008.

REFERENCE BOOKS

- Pattern recognition and machine learning
  - Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.8
  - R.O. Duda,P.E. Hart and D.G. Stork, Pattern Classification，2003.6。
  - S. Theodoridis and K. Koutroumbas, Pattern Recognition, 2003.9。
  - 边肇祺，张学工 等，模式识别，清华大学出版社，2000.

WEB SITES (1)---SEARCH ENGINE

- CVPapers - Computer Vision Resource
  - http://www.cvpapers.com/
- Google search computer vision
  - Computer vision homepage
  - Computer vision online
  - Computer vision source codes
  - Computer vision test data
  - Computer vision ….
- Paper search http://www.researchindex.com

WEB SITES (2)---COURSES

Computer vision Slides and lectures of Szeliski's book's supplementary material

- UW455: Undergraduate Computer Vision, http://www.cs.washington.edu/education/courses/455/.
- UW576: Graduate Computer Vision, http://www.cs.washington.edu/education/courses/576/.
- Stanford CS233B: Introduction to Computer Vision, http://vision.stanford.edu/teaching/cs223b/.
- MIT 6.869: Advances in Computer Vision, http://people.csail.mit.edu/torralba/courses/6869/6.869.computervision.htm.
- Berkeley CS 280: Computer Vision, http://www.eecs.berkeley.edu/trevor/CS280.html.
- UNC COMP 776: Computer Vision, http://www.cs.unc.edu/lazebnik/spring09/.
- Middlebury CS 453: Computer Vision, http://www.cs.middlebury.edu/schar/courses/cs453-s10/.

WEB SITES (3)---COURSE WARE

Computer Vision Education Digital Library Collection

- http://cved.org/
  - Computer Vision
    - http://www.cs.washington.edu/education/courses/576/CurrentQtr/
  - Introduction to Computer Vision
    - http://www.cse.psu.edu/~cg486/
  - Learning and Inference in Vision
    - www.ai.mit.educourses6.899

WEB SITES (4)--- CODES, TUTORIAL

- KLT: An Implementation of the Kanade-Lucas-Tomasi Feature Tracker
  - http://www.ces.clemson.edu/~stb/klt/installation.html
- Epipolar geometry, essential matrix, etc: online tutorial
  - http://homepages.inf.ed.ac.uk/rbf/CVonline/LOCAL_COPIES/EPSRC_SSAZ/node18.html
- RANSAC
  - http://homepages.inf.ed.ac.uk/rbf/CVonline/LOCAL_COPIES/FISHER/RANSAC/
- ……

IMPORTANT WEB SITES

- GoogleResearch http://research.google.com/index.html
- OpenCV中文网站 http://www.opencv.org.cn/index.php/%E9%A6%96%E9%A1%B5
- Stanford大学vision实验室 http://vision.stanford.edu/research.html
- UCLA教授朱松纯 http://www.stat.ucla.edu/~sczhu/
- 加州大学伯克利分校CV小组 http://www.eecs.berkeley.edu/Research/Projects/CS/vision/
- 南加州大学CV实验室 http://iris.usc.edu/USC-Computer-Vision.html
- 卡内基梅隆大学CV主页 http://www.cs.cmu.edu/afs/cs/project/cil/ftp/html/vision.html
- 微软CV研究员Richard Szeliski http://research.microsoft.com/en-us/um/people/szeliski/
- 微软亚洲研究院计算机视觉研究组 http://research.microsoft.com/en-us/groups/vc/

IMPORTANT WEB SITES

- 浙江大学图像技术研究与应用（ITRA）团队：http://www.dvzju.com/
- 上海交通大学图像处理与模式识别研究所：http://www.pami.sjtu.edu.cn/
- 清华大学电子工程系智能图文信息处理实验室（丁晓青教授）：http://ocrserv.ee.tsinghua.edu.cn/auto/index.asp
- 北京大学高文教授：http://www.jdl.ac.cn/htm-gaowen/
- 清华大学艾海舟教授：http://media.cs.tsinghua.edu.cn/cn/aihz
- 中科院生物识别与安全技术研究中心：http://www.cbsr.ia.ac.cn/china/index%20CH.asp
- 深圳大学 于仕祺副教授：http://yushiqi.cn/
- 西安交通大学人工智能与机器人研究所：http://www.aiar.xjtu.edu.cn/
- 中科院自动化所医学影像研究室：http://www.3dmed.net/
- 中科院田捷研究员：http://www.3dmed.net/tian/
- 中山大学助理教授郑伟诗：http://sist.sysu.edu.cn/~zhwshi/ 人脸识别、特征匹配、聚类、检索；
- 百度深度学习研究中心博士后余轶南：http://www.cbsr.ia.ac.cn/users/ynyu/index.htm 目标检测，图像检索

TOP CONFERENCE

- ICCV：International Conference on Computer Vision
- CVPR：International Conference on Computer Vision and Pattern Recognition
- ECCV：European Conference on Computer Vision
- IJCAI：International Joint Conference on Artificial Intelligence
- AAAI：The Association for the Advance of Artificial Intelligence

GOOD CONFERENCE

- ICIP：International Conference on Image Processing
- BMVC：British Machine Vision Conference
- ICPR：International Conference on Pattern Recognition
- ACCV：Asian Conference on Computer Vision

TOP JOURNAL

- PAMI：IEEE Transactions on Pattern Analysis and Machine Intelligence
- IJCV：International Journal on Computer Vision

GOOD JOURNAL

- TIP: IEEE Transactions on Image Processing
- CVIU：Computer Vision and Image Understanding
- PR：Pattern Recognition
- PRL：Pattern Recognition Letters
- TOM：IEEE Transaction on Multimedia
- TCSVT：IEEE Transaction on Circuits and System for Video Technology
- IEEE Transaction on Signal Processing
- IEEE Transaction on Communication
- IEEE Transaction on Consumer Electronics
- IEEE Transaction on Medical Imaging
- IEEE Multimedia
- Journal of Digital Imaging

GOOD JOURNAL

- IEEE Transaction on System, Man and Cybernetics
- IEEE Transaction on Visualization and Computer Graphics
- Optical Engineering
- Multimedia Systems
- Journal of the Optical Society of America. A Optics Image Science and Vision

GOOD JOURNAL IN CHINESE

- Chinese Journal of Computers（计算机学报）
- Journal of software（软件学报）
- Acta Automatica Sinica（自动化学报）
- Acta Electronica Sinica （电子学报）
- Journal of Computer Research and Development（计算机研究与发展）
- Journal of Image and Graphics（中国图像图形学报）

MAIN RESEARCH INSTITUTIONS

- 中科院自动化所模式识别国家重点研究室
- 清华大学电子工程系
- 北京大学视觉听觉实验室
- 浙江大学
- 上海交通大学图像所
- 哈尔滨工业大学
- 国防科技大学
- 西安交通大学
- 北京交通大学信息所

Email Me Today

- Your background
  - Vision, Graphics, machine learning, image processing
  - Math (linear algebra, statistics, calculus, optimization, etc.)
  - Coding (C++, java, matlab, etc.)
- Your research Interest?
- Why do you take this class?


谢 谢