# 课程详述

## COURSE SPECIFICATION

　　以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

　　The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

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|---|---|---|
| 1. | 课程名称 Course Title | 计算机视觉　Computer Vision |
| 2. | 授课院系<br>**Originating Department** | 计算机科学与工程系 Department of Computer Science and Engineering |
| 3. | 课程编号<br>**Course Code** | CS308 |
| 4. | 课程学分 Credit Value | 3 |
| 5. | 课程类别<br>**Course Type** | 专业选修课 Major Elective Courses |
| 6. | 授课学期<br>**Semester** | 秋季 Fall |
| 7. | 授课语言<br>**Teaching Language** | 中英双语 English & Chinese |
| 8. | 授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师）<br>**Instructor(s), Affiliation& Contact**<br>（**For team teaching, please list all instructors**） | 郑锋，助理教授，计算机科学与工程系，zhengf@sustech.edu.cn<br>Feng Zheng, Assistant Professor, Department of Computer Science and Engineering, zhengf@sustech.edu.cn |
| 9. | 实验员/助教、所属学系、联系方式<br>**Tutor/TA(s), Contact** | |
| 10. | 选课人数限额(可不填)<br>**Maximum Enrolment**<br>（**Optional**） | |

| 11. | 授课方式<br>**Delivery Method** | 讲授<br>Lectures | 习题/辅导/讨论<br>Tutorials | 实验/实习<br>Lab/Practical | 其它(请具体注明)<br>Other（Please specify） | 总学时<br>Total |
|---|---|---|---|---|---|---|
| | 学时数<br>**Credit Hours** | 32 | | 32 | | 64 |

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|---|---|---|---|
| **12.** 先修课程、其它学习要求<br>**Pre-requisites or Other Academic Requirements** | CS102A<br>CS203<br>MA102B<br>MA103A | 计算机程序设计基础 A<br>数据结构与算法分析<br>高等数学（下）A<br>线性代数 I-A | Introduction to Computer Programming A<br>Data Structures and Algorithm Analysis<br>Calculus II A<br>Linear Algebra I-A |
| **13.** 后续课程、其它学习规划<br>**Courses for which this course is a pre-requisite** | | | |
| **14.** 其它要求修读本课程的学系<br>**Cross-listing Dept.** | | | |

## 教学大纲及教学日历 SYLLABUS

15. **教学目标 Course Objectives**

本课程首先介绍计算机视觉，包括视觉技术发展历程，图像形成原理，图像处理以及特征检测和匹配。在此基础上，我们将开发应用程序的基本方法，包括用于场景理解的语义分割，用于运动估计的基于视频的对象跟踪，基于图像的人体姿势估计以及用于交叉相机对象重识别的图像匹配技术。本课程的重点是在学习与理解算法与数学基础上，然后了解项目中理论与实践的区别，进而全面掌握计算机视觉技术理论与应用技巧。

This course provides an introduction to computer vision including history of vision techniques, fundamentals of image formation, image processing, and feature detection and matching. We'll develop basic methods for applications that include semantic segmentation for scene understanding, video-based object tracking for motion estimation, human pose estimation from images and image matching for cross-camera object re-identification. The focus of the course is to develop the intuitions and mathematics of the methods in lecture, and then to learn about the difference between theory and practice in the projects.

16. **预达学习成果 Learning Outcomes**

完成该课程，学生能够做到：

1. 了解视觉计算的理论和实践。 能够将计算机视觉与人类视觉的问题联系起来。

2. 能够描述图像形成和图像分析的基础。

3. 熟悉计算机视觉中涉及的主要技术方法。 描述用于图像中的配准，对齐和匹配的各种方法。

4. 了解导致图像对象和场景分类的高级概念。

5. 构建计算机视觉应用。

1. Recognize and describe both the theoretical and practical aspects of computing with images. Connect issues from Computer Vision to Human Vision

2. Describe the foundation of image formation and image analysis.

3. Become familiar with the major technical approaches involved in computer vision. Describe various methods used for registration, alignment, and matching in images.

4. Get an exposure to advanced concepts leading to object and scene categorization from images.

5. Build computer vision applications.

17. 课程内容及教学日历 （如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）
   **Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)**

第一周：导论

o 课程介绍

o 计算机视觉发展历程

o 计算机视觉技术基本概念

[实验]：搭建与配置环境，包括 anaconda，python 和 pytorch 等

Week 1: Introduction

o Curriculum introduction

o Vision technique background

o Basic vision concepts

[Lab]: Build programing platforms, including anaconda, python and pytorch etc.


第二周：图像形成原理

o 几何变换

o 光度图像形成

o 数码相机

[实验]：配置 IDE(Pycharm)和 jupyter，进行远程编程与调试

Week 2: Image formation

o Geometric primitives and transformations

o Photometric image formation

o The digital camera

[Lab]: Config IDE(Pycharm) and jupyter to remotely program and debug


第三周：图像处理：基本操作

o 点操作

o 线性过滤

o 局部操作算子

[实验]：读取图像与视频，并显示图像与视频

Week 3: Image processing: basic operations

o Point operators

o Linear filtering

o More neighborhood operators

[Lab]: Read image and video into memory, and show them


第四周：图像处理：图像变换

o 傅里叶变换

o 金字塔和小波

o 几何变换

o 全局优化

[实验]：项目一：图像过滤和混合图像

Week 3: Image processing: image transforms

o        Fourier transforms

o        Pyramids and wavelets

o        Geometric transformations

o        Global optimization

[Lab]: Project 1: Image filtering and hybrid images


第五周：

o        点与局部图像块

o        边缘检测

o        线检测

[实验]：项目一：图像过滤和混合图像

Week 5: Feature detection and matching

o        Points and patches

o        Edges

o        Lines

[Lab]: Project 1: Image filtering and hybrid images


第六周：

o        视频介绍

o        帧差

o        背景建模

[实验]：项目二：局部特征匹配

Week 6: Basic video-based processing

o        Introduction of video

o        Difference of frames

o        Background of scene

[Lab]: Project 2: Local feature matching


第七周：

o        深度学习简要介绍

o        基础模型

o        基础损失函数

o        应用

[实验]：项目二：局部特征匹配

Week 7: Deep learning

o        Introduction of deep learning

o        Basic models

o        Basic losses

o        Feature learning

o        Applications

[Lab]: Project 2: Local feature matching

第八周： 目标检测

o     HOG 特征和线性模型

o     瀑布模型与滑动窗机制

o     基于深度学习模型的目标检测

[实验]：项目三：基于滑动窗的人脸检测

Week 8: Object detection

o     HOG features and linear classification

o     Cascade models and sliding windows

o     Deep learning-based models for object detection

[Lab]: Project 3: Face detection


第九周： 图像分割

o     轮廓检测

o     拆分并合并

o     Mean shift 和模式发现

o     标准化切割

o     图形切割和基于能量的方法

[实验]：项目三：基于滑动窗的人脸检测

Week 9: Image segmentation

o     Active contours

o     Split and merge

o     Mean shift and mode finding

o     Normalized cuts

o     Graph cuts and energy-based methods

[Lab]: Project 3: Face detection


第十周： 图像语义分割

o     块分类算法

o     编码器/解码器结构

o     全卷积方法

[实验]：项目四：基于自主编码器的图像分割

Week 10: Semantic segmentation

o     Patch classification

o     Auto-Encoder

o     FCN: Fully Convolutional Networks

[Lab]: Project 4: Scene segmentation with encoder-decoder architecture


第十一周：传统跟踪方法

o     光流法

o     卡尔曼滤波

o     粒子滤波

[实验]：项目四：基于自主编码器的图像分割

Week 11: Classical tracking methods

o     Optical flow

o     Kalman filter

o     Particle filter

[Lab]: Project 4: Scene segmentation with encoder-decoder architecture


第十二周： 高级跟踪算法

o     基于检测的跟踪

o     基于深度学习的跟踪算法

[实验]：项目四：基于自主编码器的图像分割

Week 12: Advances in object tracking

o     Tracking by detection

o     Tracking using deep learning

[Lab]: Project 4: Scene segmentation with encoder-decoder architecture


第十三周： 图像检索

o     特征提取

o     快速算法

o     算法评价标准

[实验]：项目五：目标跟踪

Week 13: Image search

o     Feature extraction

o     Fast algorithms

o     Performance criteria

[Lab]: Project 5: Object tracking


第十四周： 目标再识别

o     再识别基本框架

o     基于金字塔结构的再识别算法

o     快速算法

[实验]：项目五：目标跟踪

Week 14: Object re-identification

o     Framework of object re- identification

o     Pyramidal person re- identification

o     Fast algorithms for object re- identification

[Lab]: Project 5: Object tracking

第十五周：2D 姿态估计

o 数据集介绍

o 卷积姿态机器

o Openpose 算法

o 基于金字塔残差网络

[实验]：项目五：目标跟踪

Week 15: 2D Pose estimation

o Introduction of datasets

o Convolution pose machine

o Open pose

o Pyramid residual network

[Lab]: Project 5: Object tracking


第十六周 (期中考试占用，即不上)： 3D 姿态估计

o 深度数据与设备

o 基于深度数据的 3D 手势姿态估计

o DensePose

[实验]：项目六（可选）：人体再识别

Week 16 (Optional): 3D Pose estimation

o Depth data and devices

o Depth-Based 3D Hand Pose Estimation

o DensePose

[Lab]: Project 6(Optional): Person re-identification

**18.** **教材及其它参考资料 Textbook and Supplementary Readings**

Textbook : "Computer Vision: Algorithms and Applications"

Website: http://szeliski.org/Book/

## 课程评估 ASSESSMENT

| **19.** 评估形式<br>Type of Assessment | 评估时间<br>Time | 占考试总成绩百分比<br>% of final score | 违纪处罚<br>Penalty | 备注<br>Notes |
|---|---|---|---|---|
| 出勤 Attendance | | | | |
| 课堂表现<br>Class Performance | | | | |

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|---|---|---|---|
| 小测验<br>Quiz | | | |
| 课程项目 Projects | 50% | | |
| 平时作业<br>Assignments | | | |
| 期中考试<br>Mid-Term Test | 20% | | |
| 期末考试<br>Final Exam | 30% | | |
| 期末报告<br>Final Presentation | | | |
| 其它（可根据需要改写以上评估方式）<br>Others (The above may be modified as necessary) | | | |

20.      记分方式 GRADING SYSTEM

> ☑ A. 十三级等级制 Letter Grading
> ☐ B. 二级记分制（通过/不通过） Pass/Fail Grading

## 课程审批 REVIEW AND APPROVAL

21.      本课程设置已经过以下责任人/委员会审议通过
       **This Course has been approved by the following person or committee of authority**