**Syllabus for 7476 (Advanced Computer Vision)**

**Course Summary**

This course covers Advanced Research Topics in Computer Vision. Building on the Introductory Materials in CS 6476 (Computer Vision), this class will prepare graduate students in both the theoretical foundations of Computer Vision to practical approaches to building real Computer Vision systems. A deeper dive in topics like Optimization Techniques will be explored. In addition, Statistical and Machine Learning Techniques in wide use in Computer Vision will be studied, as well as other methods for Inference and Recognition from images and videos for Scene Understanding applications. Robotics and Healthcare domains will be explored as possible avenues for Computer Vision.

The intended audience is graduate students (both M.Sc. and Ph.D. level) that are comfortable doing some learning on their own of basic material. The learning goals of the course are

1. to provide a strong foundation in classical computer vision concepts and techniques.
2. go deep in each of these topics by looking at cutting edge developments in these areas, and have each student implement several advanced methods from the literature
3. finally, inspire confidence in your ability to identify where and how to apply techniques from computer vision throughout your future career.

**Prerequisites and Requirements**

* CS6476 or Equivalent
* Data structures: You'll be writing code that builds representations of images, features, and geometric constructions.
* Programming: A good working knowledge of programming environments that support image and video analysis. Recently, this includes MATLAB and/or Python with NumPy. The lectures typically use MATLAB for discussing algorithms and the occasional demonstration. Problem sets can be done in Matlab or Python.
* Math: Linear algebra, vector calculus, linear algebra, probability and linear algebra (that is not a typo).

**Learning Objectives**

Upon completion of this course, students will be able to:

1. Describe advanced concepts in Image Understanding and Computer Vision, and be able to undertake research projects in this area.
2. Understand both the basics and the deep foundations of feature matching and detection.
3. Understand and be able to apply concepts of Machine Learning and Artificial Intelligence for Inference and Modeling for Computer Vision
4. Understand and apply concepts of Computer Vision to Robotics, Medical Imaging, and other domains.
5. Describe in detail the relationships between human perception and machine perception of images.
6. Understand system level issues in developing robust computer vision algorithms in developing real systems applied to real data.
7. Describe in technical details, algorithm used in well-established methods for recognition and tracking.
8. Develop practical skills that are necessary for building computer vision applications.

**Assignments and Exams**

The primary assessment is done through problem sets that require implementing algorithms and applying them to provided images. Problem sets account for 55% of the grade. There will be an EXAM that comprises 15%. There will be a final term project, which will be 30% of the grade.

**Academic Integrity**

Academic dishonesty will not be tolerated. This includes cheating, lying about course matters, plagiarism, or helping others commit a violation of the Honor Code. Some exams (when specifically announced in class) allow the use of self-prepared supporting information (one sheet of paper, either typed or handwritten, could be double-sided); no other support materials are allowed at tests. Plagiarism includes reproducing the words of others without both the use of quotation marks and citation. Students are reminded of the obligations and expectations associated with the Georgia Tech Academic Honor Code and Student Code of Conduct, available online at www.honor.gatech.edu.

**Learning Accommodations**

If needed, we will make classroom accommodations for students with documented disabilities. These accommodations must be arranged in advance and in accordance with the ADAPTS office (<http://www.adapts.gatech.edu>).

**Course materials**

Readings will include both seminal papers from the field to recent research papers that showcase the new trends and new methods in the Computer Vision field.

#### **Required Software:**

Problem sets will be done in Matlab or Python with OpenCV.

**Syllabus**

Here is a list of topics. Some topics may be added or removed as connects to ongoing developments in the field and in industry.

**1 Introduction**

* 1A Introduction and Overview of the Discipline of Computer Vision, some Examples
* 1B Development / Programming Environments (Open CV)
* 1C Optimzation Methids in Computer Vision

**2 Features**

* 2A Feature Detection and Matching
* 2B SIFT and Beyond SIFT
* 2C GIST and Beyond GIST
* 2D Space-Time Interest Operators

**3 Matching**

* 3A Histograms of Oriented Gradients
* 3B Deformable Part Models
* 3C Pictorial Structures
* 3B Stereo geometry
* 3C Camera calibration
* 3D Multiple views

**4 Segmentation**

* 4A Image Segmentation
* 4B Video Segmentation
* 4C Mean-shift vs. Super Pixel Methods

**5 3D Computer Vision**

* 5A Structure from Motion
* 5B Simultaneous Localization and Mapping
* 5C Shape from X

**6 Object Detection**

**7 Image and Object Categorization**

* 7A PASCAL VOC Challange
* 7B ImageNet
* 7C Machine Learning Methods for Classification

**8 Tracking**

* 8A Optical Flow methods
* 8B Particle Filter methods
* 8C Track Linking
* 8D Tracking though occlusion

**9 Looking at People**

* 9A Face Recognition and Detection
* 9B Tracking People
* 9C Activity, Action, Behavior Recognition

**11 Robotics and Computer Vision**

**12 Medical Imaging and Computer Vision**

**13 Machine Learning and Computer Vision**