# CS 436 Computer Vision Fundamentals

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**Office Hours**: Tue/Wed/Thu 3:00-4:00pm
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**Year:** 2004-05
**Quarter:** Autumn
**Category**: Sr./Grad Elective

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| **Course Code (Units)** | | CS 436 Computer Vision Fundamentals (4 Units)<br>http://suraj.lums.edu.pk/~cs436a03 |
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| **Course Description** | | This class is designed for senior-level and introductory graduate-level students of Computer Science. This course gives a broad overview of the field of computer vision, laying the foundations for advanced graduate level classes and research work in vision. This course will be conducted with an application perspective. Therefore students will be expected to implement several techniques learnt in the lectures. A good calculus, linear algebra and programming background is expected for this class. Knowledge of probability and random variables is also needed to understand the ideas presented in some modules.<br><br>The nature of the field of Computer Vision is such that it combines and integrates ideas from several different areas, including statistics, pattern recognition, machine intelligence, decision theory and image processing. Therefore, in an introductory class, it is not possible to cover each of these aspects in depth. Instead, the focus of this course is on breadth, presenting several different techniques and systems in moderate detail, so as to familiarize the student with the Computer Vision area in general, and to present some specific examples of Computer Vision systems. |
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| **Core/Elective** | | This course is an elective for both undergraduate and graduate computer science and computer engineering students. |
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| **Pre-requisites** | | Required: Data Structures and Algorithms , Linear Algebra<br>Recommended: Probability, Calculus II |
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| **Goals** | | 1. Introduce the theory and applications of Computer Vision, and provide a broad overview (breadth) of current problems and techniques in Computer Vision.<br>2. Demonstrate several simple applications in which Computer Vision techniques are useful.<br>3. Make students confident that they can write programs to solve Computer Vision problems, through the use of several programming assignments and examples.<br>4. Give examples of some current research approaches in Computer Vision. |
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| **TextBooks, Programming Environment** | | There is no single required text book. Readings will be assigned from the following:<br><br>[Shah] Fundamentals of Computer Vision, Mubarak Shah, 1992<br>[Shapiro] Computer Vision, Linda G. Shapiro, George C. Stockman, Prentice Hall, 2001<br>[Snyder] Machine Vision, Wesley E. Snyder and Hairong Qi, Cambridge, 2004<br><br>Programming Environment: C/C++ |
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| **Lectures, Tutorials & Attendance Policy** | | There will be 20 sessions of 75 minutes and 10 sessions of 50 minutes, one in-class mid-term and one final examination.<br>There is no grade for attendance, and is not required. However, students missing lectures will find it very difficult to make up for the content covered. |
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| **Grading** | | 30% Assignments (Programming as well as written)<br>10% Quizzes<br>25% Mid-term Exam<br>35% Final Exam |

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| Module | Topics | Sessions |
|---|---|---|
| 1 | **Imaging Geometry and Transformations** | *Total: 8* |
| | **Introduction**<br>Course introduction, along with an overview of the computer vision, digital images, imaging devices and the human eye, PPM and PGM formats | *2* |
| | **Transformations**<br>2D transformations, displacement models, recovering the best affine transformations, warping, image registration, 3D transformations | *4* |
| | **Imaging Geometry**<br>Camera Model, Perspective and Orthographic Cameras, Camera Calibration, Stereo | *2* |
| 2 | **Binary Image Processing** | *Total: 8* |
| | **Basic Binary Operations**<br>Thresholding, morphology, region properties, moments, connected component labeling | *2* |
| | **Edge Detection**<br>Difference masks, Laplacian of Gaussian (LoG), Canny | *3* |
| | **Shape Representation**<br>Hough Transform, Generalized Hough Transform | *2* |
| | **MIDTERM EXAM: 25%** | *1* |
| 3 | **Motion** | *Total: 7* |
| | **Pyramids**<br>Gaussian Pyramids, Sampling and Aliasing | *1* |
| | **Optical Flow**<br>Brightness constancy equation, normal vs. perpendicular flow, Lucas-Kanade method | *2* |
| | **Global Motion Estimation**<br>Affine global motion estimation, Projective global motion estimation, applications<br>Tentative: Motion Tracking | *4* |
| 4 | **Segmentation and Clustering** | *Total: 6* |
| | **Correlation and Template Matching**<br>Correlation, Normalized Correlation, Distance Transform, Medial Axis Transform, Hausdorff Distance | *2* |
| | **Applications:**<br>Background subtraction, Change Detection, skin detection | *2* |
| | **Clustering and Segmentation**<br>*K*-Means, How to choose *K,* Split and Merge, Agglomerative and Divisive Clustering, Motion Segmentation, Color Segmentation | *2* |
| | **FINAL EXAM: 30 %** | |