**Course Title: Computer Vision**

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A Program Elective for CSE

**L-T-P-C:** 3-1-0-4

Prerequisite: Linear Algebra, Vector Calculus, Probability/Statistics, Data Structure, a good working knowledge of any programming language (python, matlab, C/C++). Machine Learning and Deep Learning are the optional prerequisites for Computer Vision.

**1. Outline:** The goal of computer vision is to compute the properties of the three-dimensional world from digital images. Problems in this field include reconstructing the 3D shape of an environment, determining how things are moving, and recognizing people and objects and their activities, all through analysis of images and videos. This course will provide an introduction to computer vision, with topics including image formation, feature detection, motion estimation, image mosaics, 3D shape reconstruction, object/face detection and recognition, and deep learning. Applications of these techniques include building 3D maps, creating virtual characters, organizing photo and video databases, human computer interaction, video surveillance, automatic vehicle navigation, robotics, virtual and augmented reality, medical imaging, and mobile computer vision.

**2. Course Objectives:** The main three objectives of this course are as follows:

i) Develop an overview of computer vision
ii) Learn techniques commonly used in computer vision
iii) Acquire knowledge on computer vision research literature.
iv) Gain experience in applying computer vision algorithms to real problems.

**3. Course Syllabus:** This course can be divided in the modules given below. Based on available time slots, some topics may be dropped or added.

**Feature Detection, Description, Correspondence and Alignment:** Introduction and Overview, Light, Image Formation, Filtering, Edge Detection, Feature Detection, Harris Corner Detection, Invariance and Blob Detection, Feature Descriptors and Matching, Image Transformations, Image Alignment, RANSAC, Hough Transform, etc.

**Perspective and 3D Geometry:** Camera Models, Single-view Geometry and Calibration, Image Stitching, Epipolar Geometry, Stereo, Structure from Motion, etc.

**Recognition and Learning:** Intro to Recognition, Viola-Jones Face Detection, Bag-of-Words Model, Convolutional Neural Networks, Image Classification, Object Detection, Segmentation, Image Generation, etc.

## 4. Books:

**Text Book:**

1. Richard Szeliski***, Computer Vision: Algorithms and Applications,*** Springer**,** 2010.

**Reference Books:**

1. Richard Hartley and Andrew Zisserman, ***Multiple View Geometry in Computer Vision***, Cambridge, 2004.
2. David Forsyth and Jean Ponce, ***Computer Vision: A Modern Approach***, 2011.
3. Simon Prince, ***Computer Vision: Models, Learning, and Inference***, Cambridge University Press, 2012.

Link for details of these books: https://machinelearningmastery.com/computer-vision-books/

## 5. Pre-Requisites: The following skills are necessary for this course.

**Linear Algebra:** The student must know the following linear algebra topics: matrices, matrix operations, determinants, system of linear equations, Eigen values, Eigen vectors.

**Vector Calculus:** The student must know the following topics: scalar and vector fields, vector operations, differential operators (gradient, divergence, curl and Laplacian), integral theorems.

**Probability and Statistics:** The students should have knowledge of probability density function, probability distribution, mean, variance, co-variance, correlation, priors, posteriors, likelihoods and Gaussian distribution.

**Data Structure:** The students should have deep knowledge on data structure for implementing computer vision algorithms in an efficient way.

**Computer Programming:** The students should also have programming skills to complete assignments and projects. It would help the students to solve real world problems. Matlab, Python or C/C++ could be considered for implementing the algorithms.

**6. Grading Policy:** The grade of the students would be decided based on the written examinations, assignments and quizzes. Note that the grading policy may change based on the number of registration in the course.

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| Mid-Exam | 20% |
| End-Exam | 30% |
| Assignments | 30% |
| Scheduled Quiz | 10% |
| Class Participation | 10% |

**7. Industry Impact:** Nowadays, the use of visual information technology is growing exponentially. Most of the big IT companies like Google, Microsoft, Amazon, Facebook, etc. are working over the visual data analysis. Many startups also came in recent years in Computer Vision area. Computer Vision also has very strong relevance in Robotics and Industrial Automation. It can be utilized very effectively in smart manufacturing, medical field, biometrics area, etc.

**8. List of Companies Working On Related Topics:** The following companies are working on the related topics: Google, Microsoft, Amazon, Facebook etc.

**9. Resources:**

I. Course Title: Computer Vision: Foundations and Applications
Course Instructor: Dr. Fei-Fei Li
Website: http://vision.stanford.edu/teaching/cs131_fall1415/

II. Course Title: Computer Vision, from 3D Reconstruction to Recognition
Course Instructor: Dr. Silvio Savarese
Website: http://vision.stanford.edu/teaching/cs131_fall1415/

III. Course Title: Computer Vision
Course Instructor: Ioannis Gkioulekas
Website: http://www.cs.cmu.edu/~16385/

IV. Course Title: Convolutional Neural Networks for Visual Recognition
Course Instructor: Dr. Fei-Fei Li
Website: http://cs231n.stanford.edu/

V. Course Title: Introduction to Computer Vision
Course Instructor: Dr. Srinath Sridhar and Dr. James Tompkin
Website: https://browncsci1430.github.io/webpage/index.html

**10. Course Ethics:** Please note down the following activities leading to a fair academic honesty:

- All class work is to be done independently.
- It is best to try to solve problems on your own, since problem solving is an important component of the course, and exam problems are often based on the outcome of the assignment problems.
- You are allowed to discuss class material, assignment problems, and general solution strategies with your classmates. But, when it comes to formulating or writing solutions you must work alone.
- You may use free and publicly available sources, such as books, journal and conference publications, and web pages, as research material for your answers. (You will not lose marks for using external sources.)
- You may not use any paid service and you must clearly and explicitly cite all outside sources and materials that you made use of.
- I consider the use of uncited external sources as portraying someone else's work as your own, and as such it is a violation of the University's policies on academic dishonesty.
- Instances will be dealt with harshly and typically result in a failing course grade.

Course Plan Submitted By

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