# Computer Vision: Algorithms and Applications

In case of any doubts in this tutorial, contact Paras Mittal ( ) or Sidhant Chandak ( ).

Overall lecture plan:
We will try to cover as many of these as we can in the next three days;

1. **Introduction**:
   - Interpretation of an Image, color spaces and channels, color conversion, image-vectors.
1. **Linearity and convolution:**
   - Image filtering (average blur, gaussian functions, gaussian blur, sharpening, brightness...), edge detection, corner detection
1. **Image features and contours:**
   - Thresholding, finding contours(chain approx none and simple), contour features(contour area, moments), best fit line* (An intro to ML).
1. ***Drawing functions:**
   - Draw lines, circles, write alphabet on image.
1. **Hough Transformation:**
   - Lines, circles, convex hulls and if time permits generalisation
1. **Fourier Transforms**
2. **Histograms** (back propagation and optical flow if time permits)
3. **Convolutional neural networks(CNNs):**
   - Image classification, basic structure of a neural network, training models, cost functions,

After covering any algorithm, there will be a hands-on assignment/ demonstration for converting that algo to a working code. On the last day, we will be introducing them to OpenCV and the basic functions for the algorithms that they learned in the previous 2 days.

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**LECTURE 1:**

**INTRODUCTION:**

- Interpretation of image: vector image vs raster image
- Color spaces: RGB, HSV
- Channels: r-g-b-a and r-g-b-d, general meaning
- Conversion: rgb to hsv and vice versa, rgb to grayscale

(10 mins quiz)

**LINEARITY AND CONVOLUTION:**

- Linear filters
- Gaussian function
- 2D filters and convolution: Blurring, sharpening, edge detection (application of filters: sobel, canny edges). (Assignment : Design gaussian-blur filter)

(10 mins quiz)

**IMAGE FEATURES AND CONTOURS:**

- Thresholding GrayScale images, InRange function for HSV and RGB images. (application of these functions)
- Finding contours(2 methods) (Hands on application), contour area, and moments. (Assignment on use of contours).
- Corner detection.

(10 mins quiz)

**LECTURE 2:**

(20 mins quiz to check understanding)

**HOUGH TRANSFORMATIONS:**

- Significance and principle
- Hough transform for lines and circles.
- Generalised transforms and convex hulls.(Assignment)

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(10 mins quiz)

**FOURIER TRANSFORMS:**

- Principle, algorithm. (*Programming Assignment: Calculate fourier transforms).

(10 mins quiz)

**HISTOGRAMS:**

- Significance, principle.
- Optical Flow.

(10 mins quiz)

**LECTURE 3:**

**INTRODUCTION TO YOLO(TENSORFLOW) AND OPENCV:**

- OPENCV: Library functions for all algorithms done upto lecture 3 and comparison. (Assignments on solving basic problems using opencv)
- *Tensorflow: Introduction to CNNs, structure of a CNN, types of ML, def: cost functions, Optimisation, image classification.

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# Computer Vision Assignment 1

1. Write a function Q = convolution(Image I, Kernel H) that has arguments

a. Image I (Images may be of varying sizes and you may want to give the size as arguments. You can use the size function in Matlab.)

b. Kernel H (Again, you should allow varying size Kernels.)

The output of the function, Q, should be the convolution of I with H. Test your function and show results on the following Kernels, using the provided sample images within the assignment.

i. Averaging Kernel (3x3 and 5x5 )

ii. Gaussian Kernel ( sigma = 1,2,3 ) Use (3 sigma + 1) x (3 sigma + 1) as size of Kernel (You may want to write a separate function to generate Gaussian Kernels for different values of sigma )

iii. Sobel Edge Operators: $\begin{bmatrix}-1 & -2 & -1\\ 0 & 0 & 0\\ 1 & 2 & 1\end{bmatrix}$ and $\begin{bmatrix}-1 & 0 & 1\\ -2 & 0 & 2\\ -1 & 0 & 1\end{bmatrix}$

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iv. Prewitt Edge Operators: $\begin{bmatrix}-1 & 0 & 1\\ -1 & 0 & 1\\ -1 & 0 & 1\end{bmatrix}$ and $\begin{bmatrix}1 & 1 & 1\\ 0 & 0 & 0\\ -1 & -1 & -1\end{bmatrix}$

2. Apply the generated Averaging and Gaussian Kernels on the provided image “balloonGrayNoisy.jpg” to perform noise filtering and show the outputs. Test different filter sizes.

3. Perform edge detection on the “buildingGray.jpg” using the Sobel and Prewitt Operators and show the outputs (Compute horizontal and vertical gradients and then the magnitude of the gradient. Apply a threshold.)

Deliverables:

1. Report including Input and Output images (Soft Copy)
2. Code (Soft copy)

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Robofiller Question
Chessboard image generation

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