KICKSTART YOUR IMAGE PROCESSING ADVENTURES

BY SHACHINDRA

AGENDA

- Introduction
- Getting Started
- Concepts
- Features: Transformations of Images
- Colour Detection & Object Tracking
- Barcode Detection
- Face Detection
- Digit Recognition
- Face Recognition
- Deep Learning & Convolutional Neural Networks

INTRODUCTION

KICK-STARTING THE IMAGE PROCESSING ADVENTURES

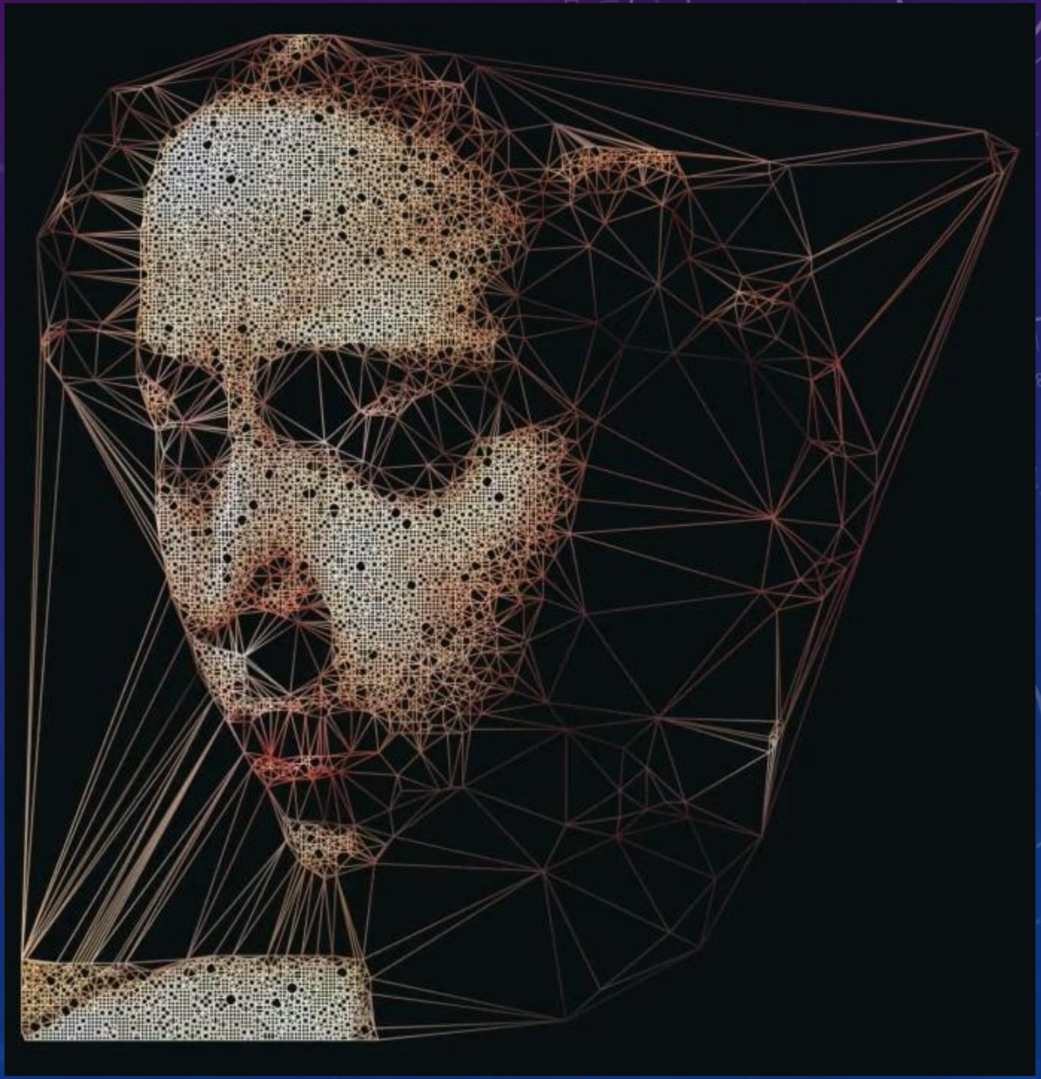
INTRODUCTION

- Image Processing is a method to perform some operations on an image, in order to get it enhanced or to extract some useful information from it
- The Processing of 2 Dimensional Data, or Images typically involves several steps:

I. Image Acquisition: Appropriate Formatting of Image for Digital Computing

II. Processing: To Extract the information of interest from the Image.

III. Image Reformatting: For Human or Machine Viewing, Storage or Documentation.



GETTING STARTED

WAYS TO START WITH IMAGE PROCESSING

GETTING STARTED

Libraries for Computer Vision and Image Search based on Programming languages and Frameworks

- OpenCV
- SimpleCV
- Mahotas
- Accord.NET Framework
- VLFeat
- Point Cloud Library (PCL)

COMPUTER VISION API

Computer Vision As A Cloud Service:

- Cloud Vision API: https://cloud.google.com/vision/
- Microsoft Cognitive Services: https://www.microsoft.com/cognitive-services/en-us/computer-vision-api
- IBM Watson Developer Cloud: http://visual-recognition-demo.mybluemix.net/
- HPE Haven OnDemand: https://www.havenondemand.com/
- Clarifai: https://www.clarifai.com/demo
- The Wolfram Language: https://www.imageidentify.com/
- Blippar: https://blippar.com/en/products/computer-vision-api/
- CloudCV: http://www.cloudcv.org/
- OrpixVision: http://www.orpix-inc.com/
- Scale API: https://www.scaleapi.com/

CONCEPTS

IMAGE PROCESSING CONCEPTS

CONCEPTS

Most Image Processing tasks are characterized by the following Categories :

1. Image Enhancement
2. Image Restoration
3. Image Coding
4. Image Analysis
5. Feature Extraction and Recognition
6. Image Understanding

IMAGE ENHANCEMENT

- Improvement of the Image being viewed to the (machine or human) Interpreter's Visual system.
- Image enhancement types of operations include contrast adjustment, noise suppression filtering, application of pseudo-colour, edge enhancement, and many others.

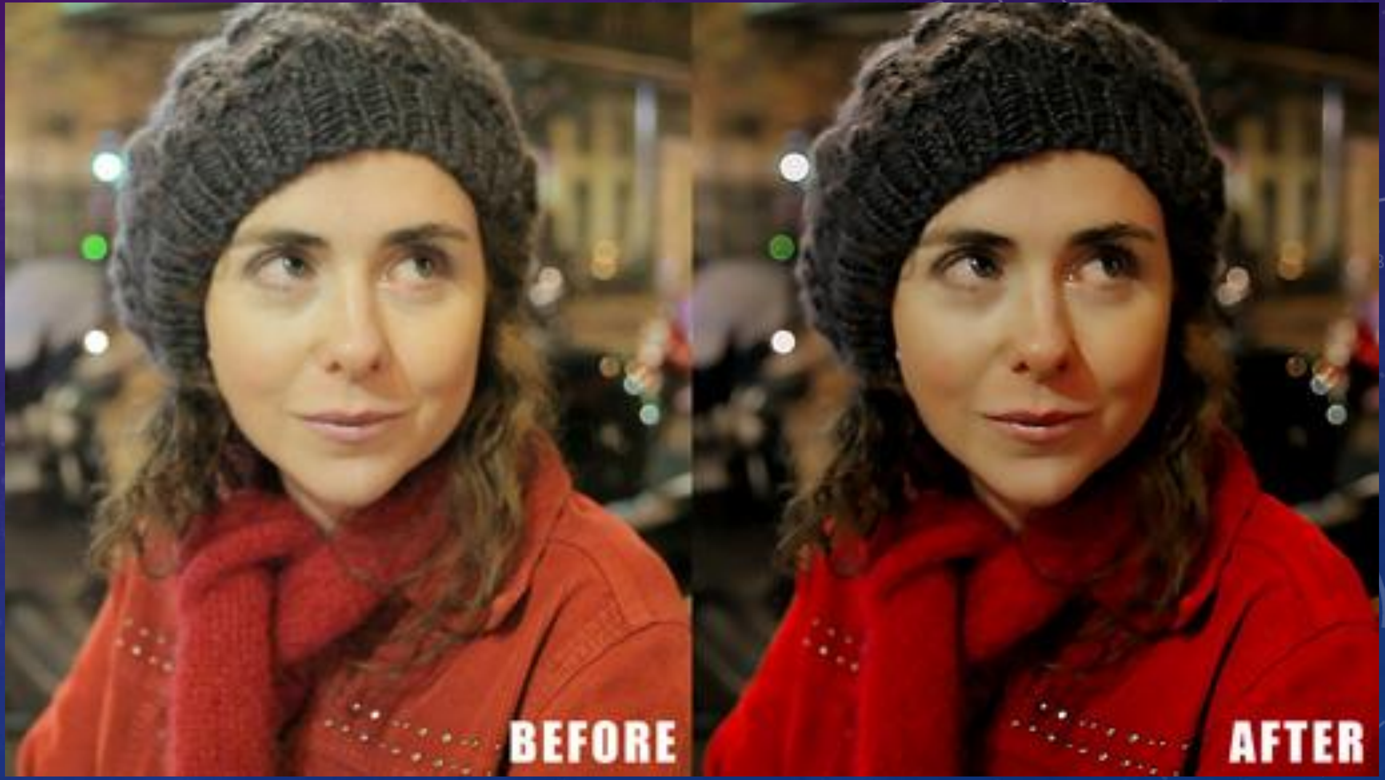


IMAGE RESTORATION

- Techniques aimed at removal of Image Degradations caused by the Image Formation Process. Removal of image blur caused by camera motion, out-of-focus imaging, or atmospheric turbulence are all image restoration problems.
- Restoration is a difficult and ill-conditioned problem which has enjoyed only limited success in real-world applications.
- The algorithms employed are, in general, quite complex and tailored to the application at hand.

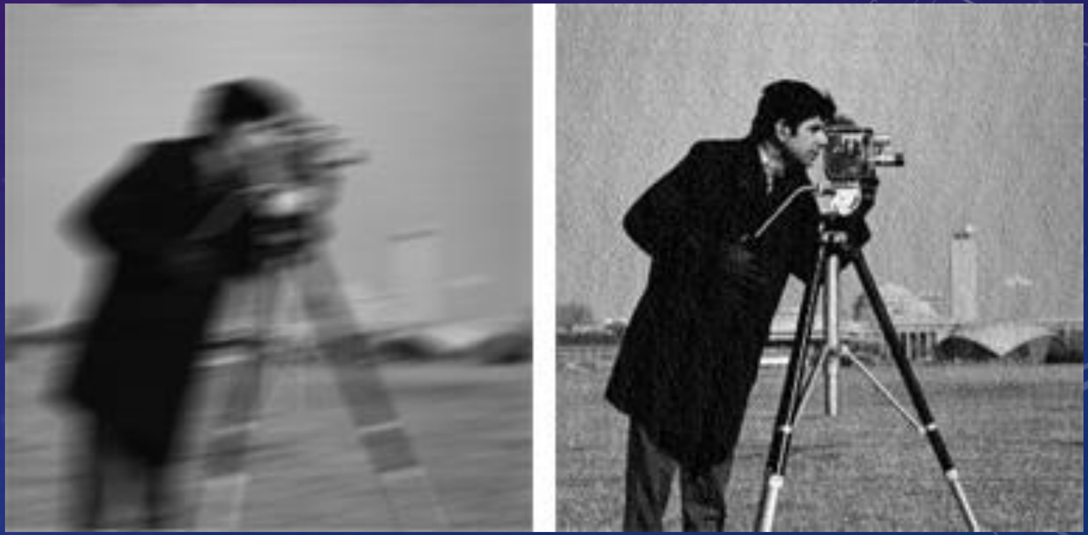


IMAGE CODING

- Compression of Image Data into an Alternate (coded) form in order to reduce storage and/or data transmission requirements improving the efficiency.
- Various Algorithms for image data compression are pulse code modulation (PCM), differential PCM (DPCM), Predictive Coding, Transform Coding, Hybrid Coding, Interframe Coding & several other adaptive techniques.

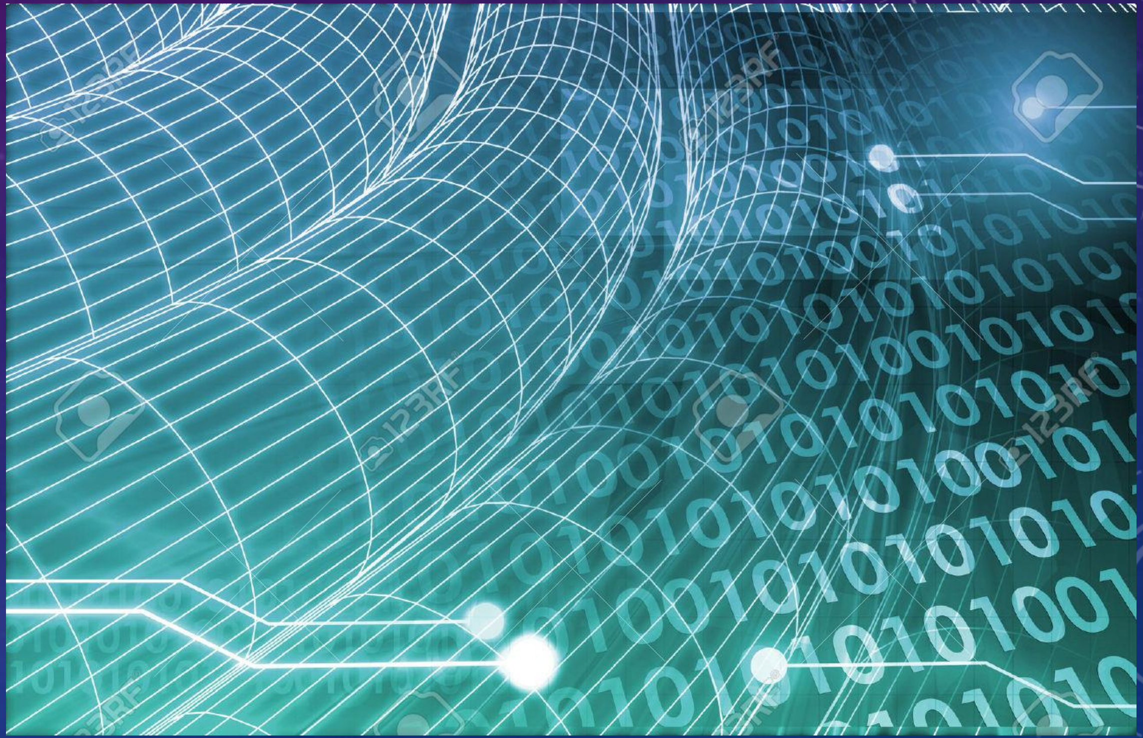
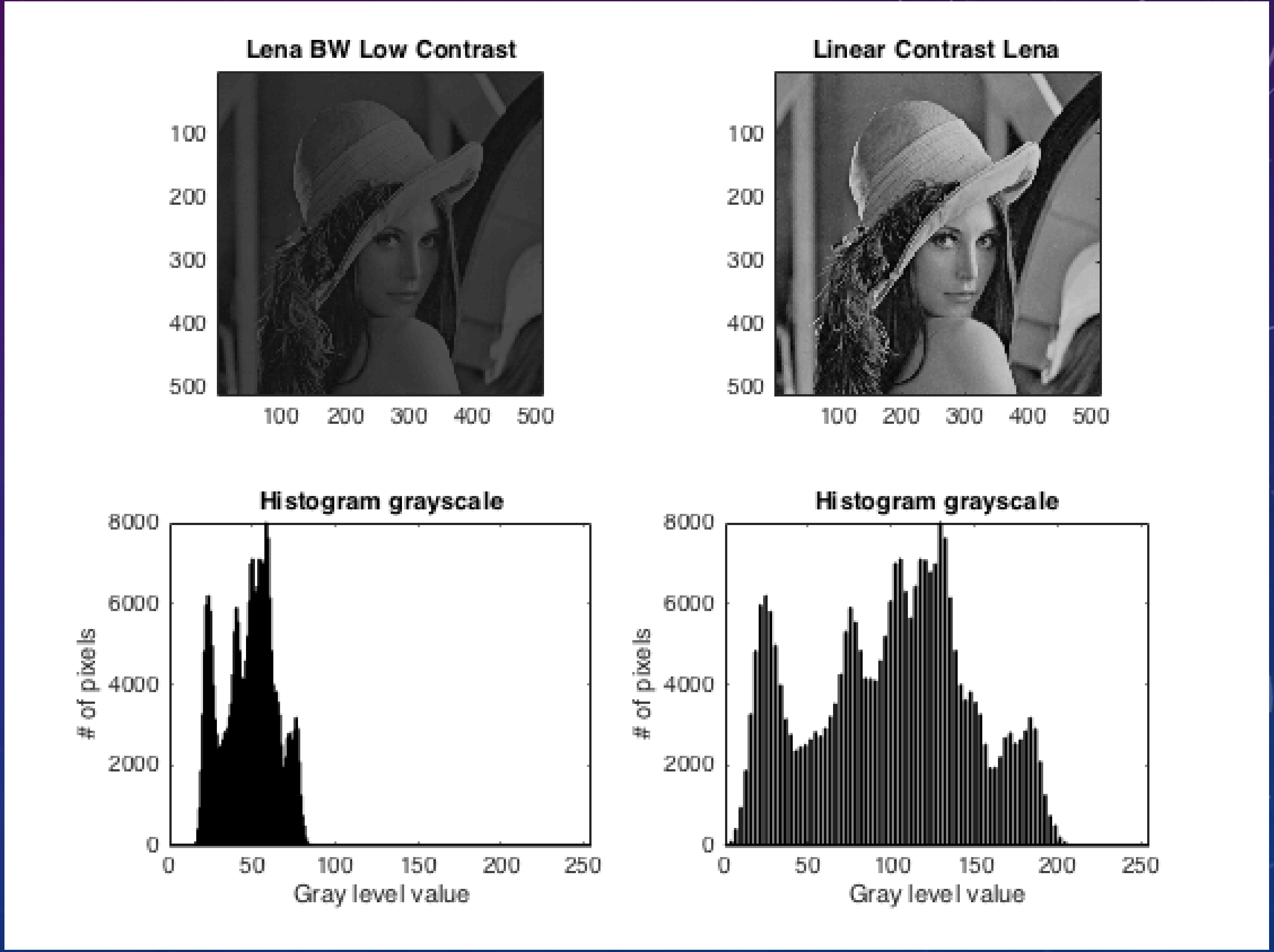


IMAGE ANALYSIS

- Estimation of various Parameters or measurements from the Image Data.
- In some context, Its referred to as denoting virtually the entire field of image processing
- Examples include Radiographic Image Mensuration for Non-Destructive Evaluation Purposes, fitting curves to image data, etc.



FEATURE EXTRACTION AND RECOGNITION

- Characterize Objects in the scene or actually identify via pattern recognition approaches.
- Examples include finding any tanks in a battlefield scene, or identifying mutant cells in a biological cell sample.
- Algorithms for implementing such tasks are varied & range from simple edge detectors to matched filtering and Sophisticated Classification Algorithms.

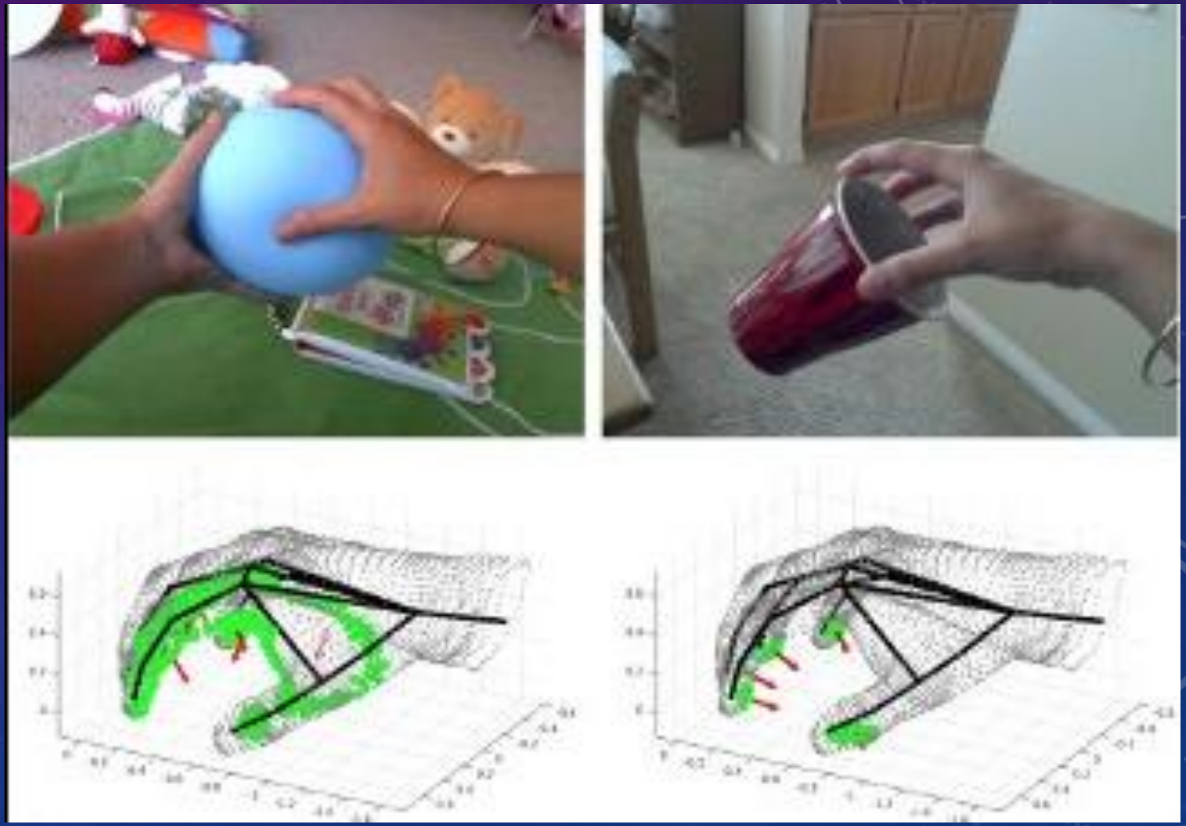


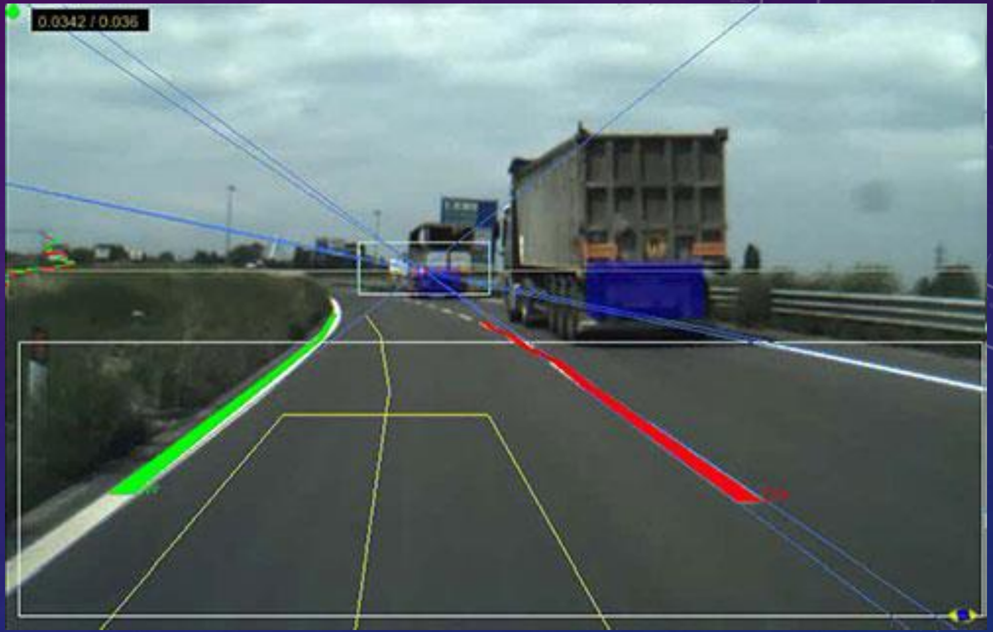
IMAGE UNDERSTANDING

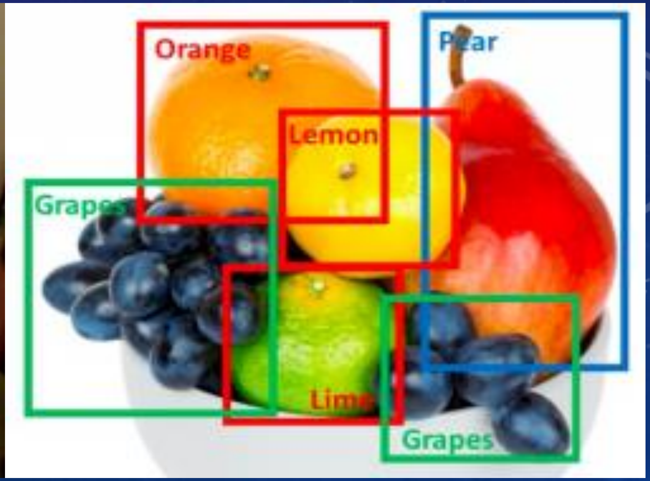
- Understand the relationships among objects in a Picture.
- The three major thrusts in this program have been

i. Smart Sensors

ii. Iconics, or visual phonetics, which involves feature extraction and analysis of structural composition

iii. Symbolic Representation, or describing objects in a scene using mathematical descriptors, grammars, or strings of symbols





FEATURES: TRANSFORMATIONS OF IMAGES

USE OF NUMPY, SK LEARN, MATPLOTLIB FOR TRANSFORMATION

TRANSFORMATIONS OF IMAGES

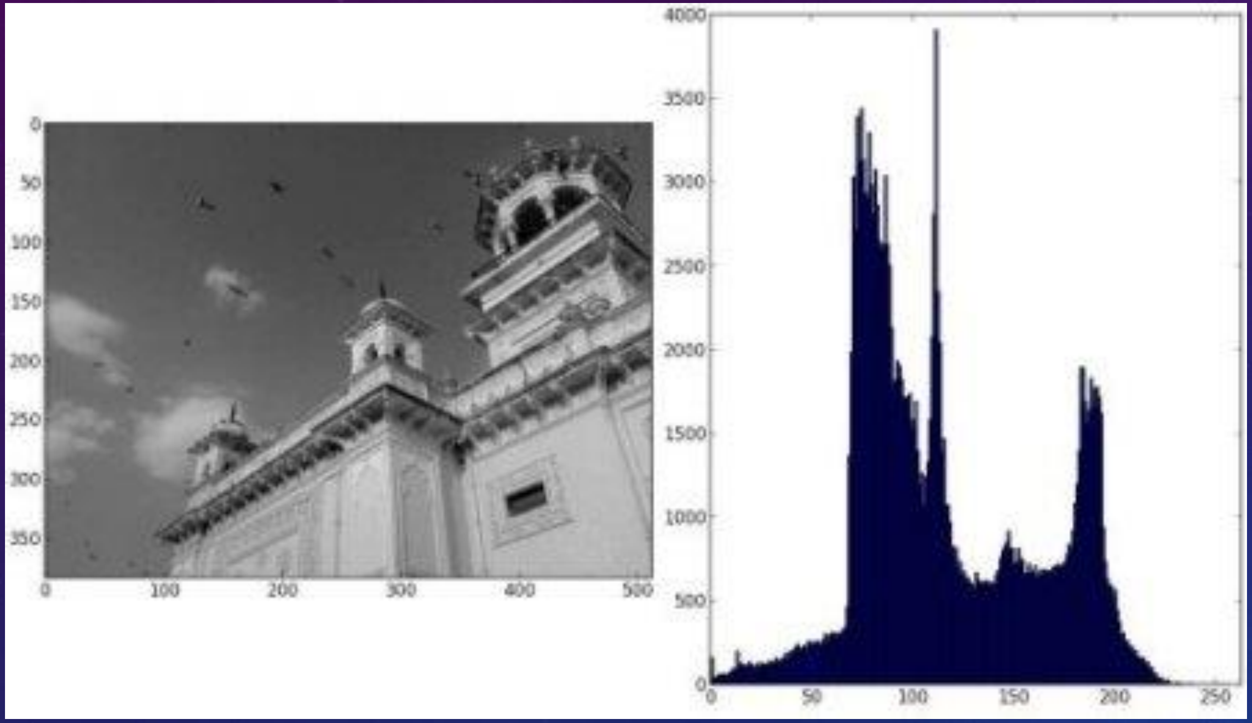
- Grayscale Histogram: Graphical representation of frequency density of image pixel values. It is helpful in identifying the Pixel Distribution in an image.
- It is a plot with pixel values in X-axis and corresponding number of pixels in the image on Y-axis.
- Use cv2.calcHist() function to Find the Histogram

cv2.calcHist(images, channels, mask, histSize, ranges[, hist[, accumulate]])

- Seam Carving: Used for content-aware resizing of Images. Seam Carving can not only be used for reducing image size, but also for increasing image size as well.
- Convert the input image to Grayscale, and compute the Sobel Gradient Magnitude Representation i.e. Energy Map.
- Apply transform.seam_carve to get the carved image. The seam_carve function accepts four required parameters:

1. The input image that we are applying seam carving to.
2. An energy map.
3. The direction in which we'll be applying seam carving (either horizontal or vertical).
4. The number of seams to remove. At this point in time the seam_carve function only supports down-sampling images — no up-sample support is provided.

TRANSFORMATIONS OF IMAGES

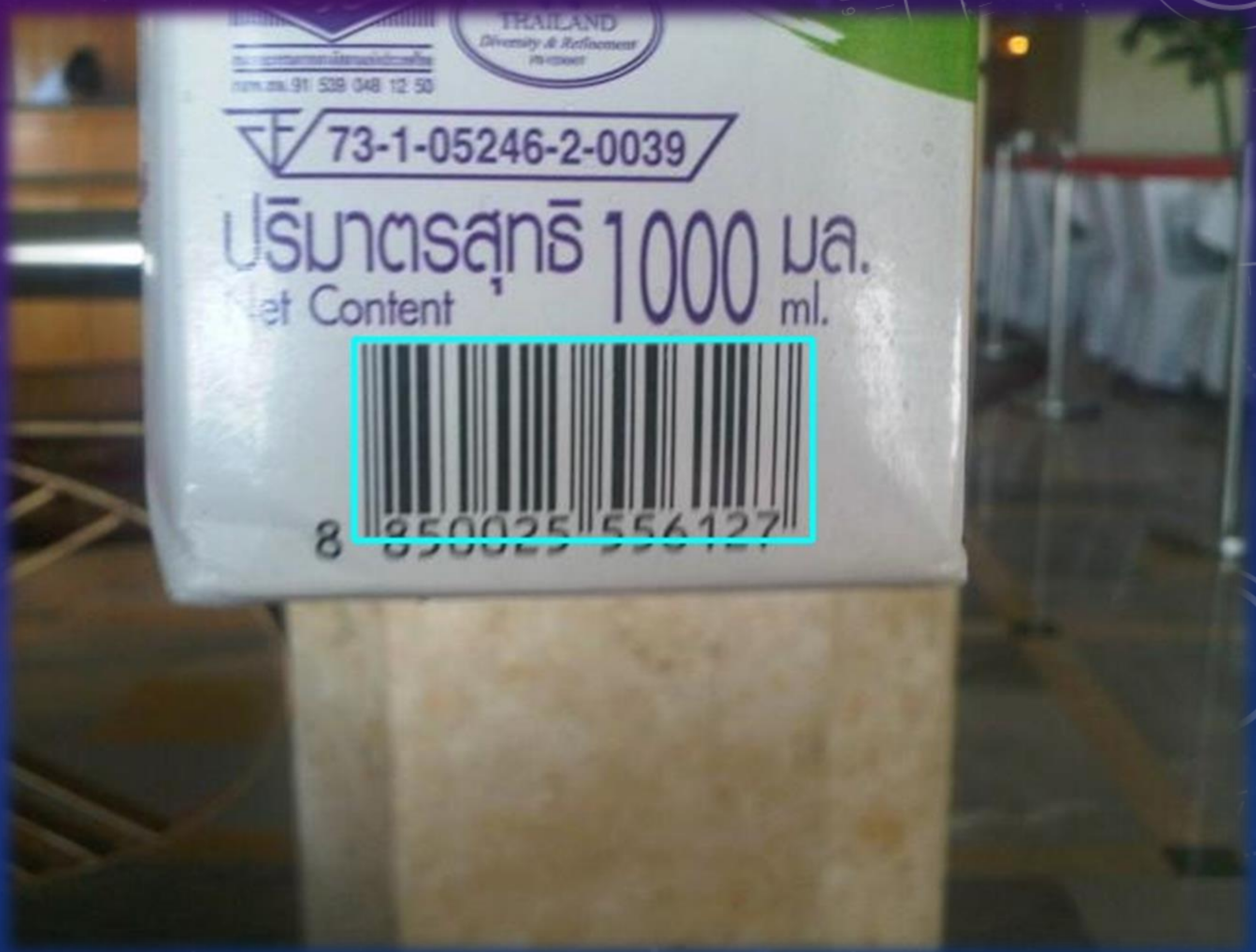


Grayscale Histogram

Seam Carving

BARCODE DETECTION

DETECTING BARCODES IN IMAGES



BARCODE DETECTION

Algorithm for Detecting Barcodes in Images

- Compute the Scharr Gradient Magnitude representations in both the *x* and *y* direction.
- Subtract the *y*-gradient from the *x*-gradient to reveal the Barcoded Region.
- Blur and Threshold the Image to get only the regions of High Illumination (Barcode Region) & Blackout all other portion.
- Apply a closing kernel to the Threshold Image.
- Now apply some Erosion to remove simple Noises or small False Detection.
- Apply dilation for compensation.
- Find the largest contour in the image (maximum area – which is most probably, The Barcode). Get smallest possible bounding rectangle for it.

For implementing a more robust Barcode Detection Algorithm, Several considerations have to be done:

1. The orientation of the Image
2. Apply ML Techniques such as Haar cascades or HOG + Linear SVM to “scan” the image for barcoded regions.

FACE DETECTION

DETECTING FACES IN AN IMAGE OR VIDEO

FACE DETECTION

Algorithm for Detecting Face:

- Read the image and Convert it to Grayscale. Many operations in OpenCV are done in Grayscale.
- faceCascade.detectMultiScale function detects the actual face. The detectMultiScale function is a general function that detects objects. Since we are calling it on the face cascade, that's what it detects.

1. The first option is the Grayscale image.
2. The second is the scaleFactor. Since some faces may be closer to the camera, they would appear bigger than those faces in the back. The scale factor compensates for this.
3. The Detection Algorithm uses a moving window to detect objects. minNeighbors defines how many objects are detected near the current one before it declares the face found.
4. minSize assigns the size of each window.

While Haar Cascades are quite fast and can obtain decent accuracy, they have two prominent shortcomings:

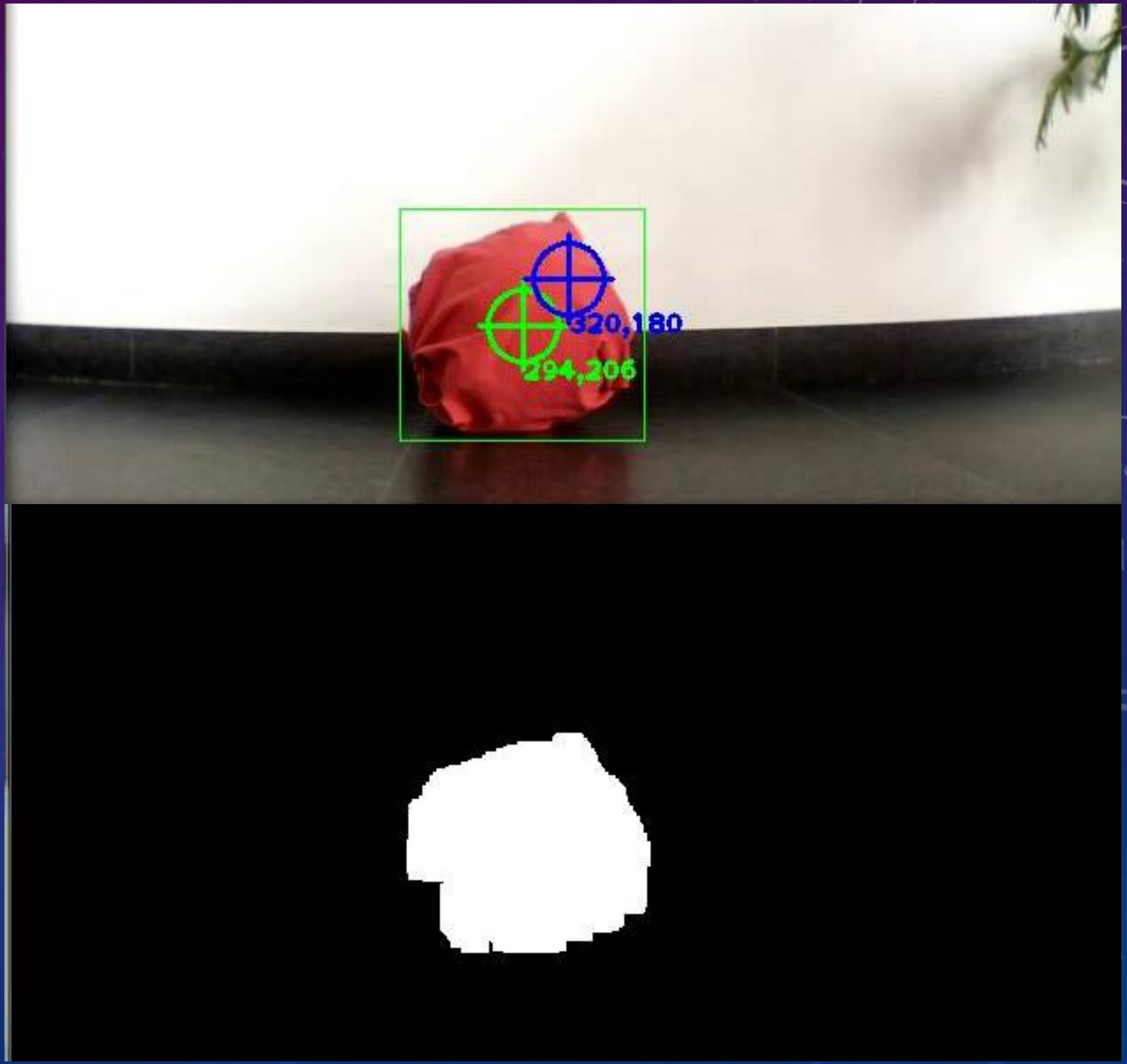
1. Tweak the parameters of detectMultiScale to get the detection just right for many images.
2. Prone to False Positives with Variations in Image

COLOUR DETECTION & OBJECT TRACKING

COLOUR DETECTION AND FACE TRACKING IN IMAGES

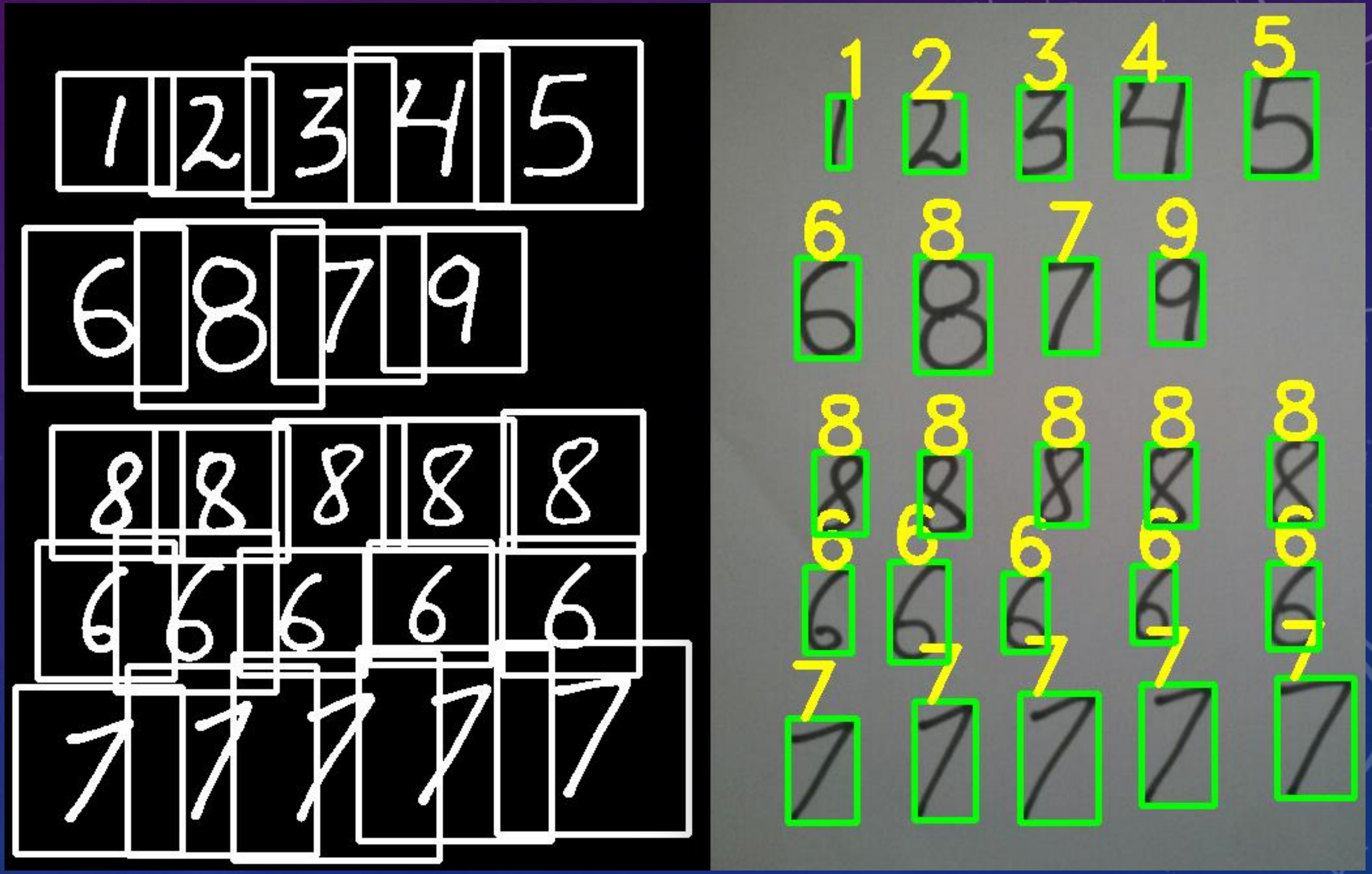
COLOUR DETECTION

- HSL stands for Hue, Saturation, and Lightness (or Luminosity), and is also often called HLS.
- HSV stands for Hue, Saturation, and Value, and is also often called HSB (B for brightness).
- A third model, common in computer vision applications, is HSI (I for intensity)
- RGB (Red, Green, and Blue) refers to a system for representing the colors to be used on a computer display.
- Red, Green and Blue can be combined in various proportions to obtain any color in the visible spectrum.



DIGIT RECOGNITION

RECOGNIZING DIGITS IN AN IMAGE



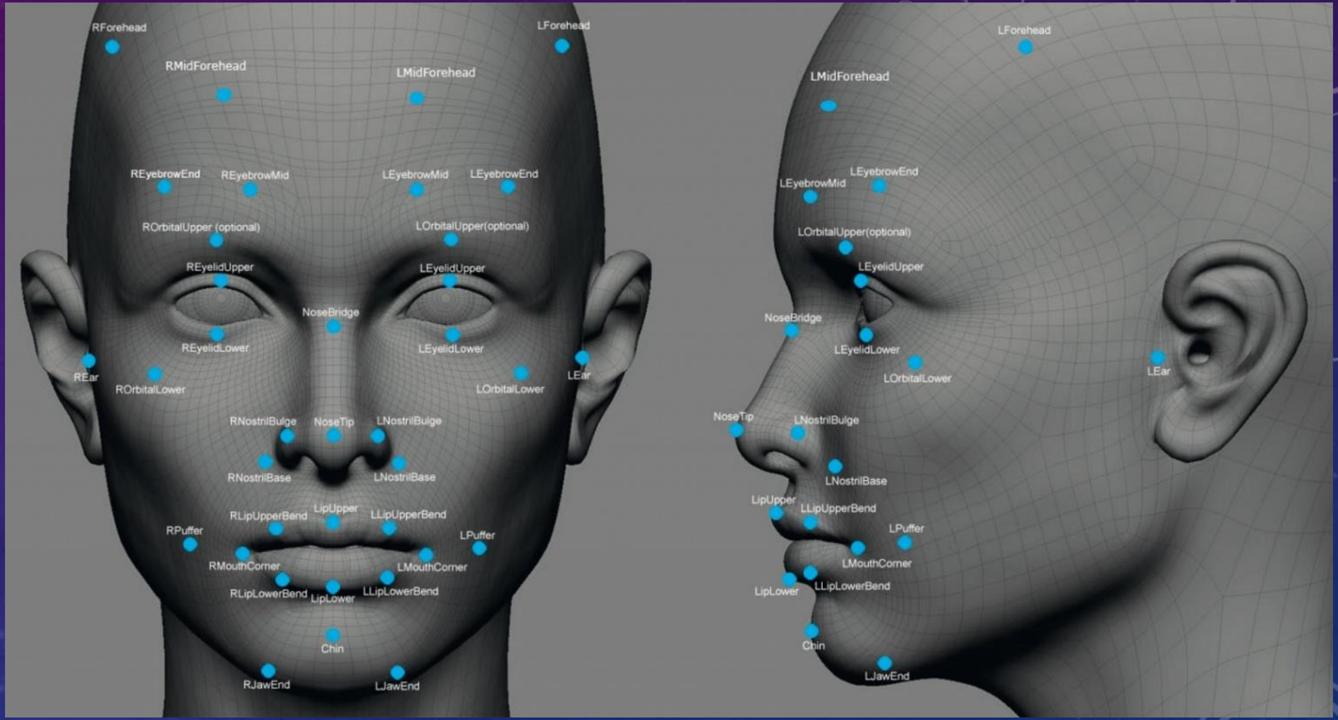
DIGIT RECOGNITION

To Detect handwritten digits -

- Have a Database of Handwritten Digits - MNIST database. The MNIST database is a set of 70000 samples of handwritten digits where each sample consists of a grayscale image of size 28×28.
- For each handwritten digit in the database, extract HOG features and train a Linear SVM. Implement the following steps:
    1. Calculate the HOG (Histogram of Oriented Gaussians) features for each sample in the database.
    2. Train a multi-class linear SVM with the HOG features of each sample along with the corresponding label.
    3. Save the classifier in a file.
- Use the classifier trained above for Testing to predict digits.

1. Apply a Gaussian filter to the grayscale image to remove noisy pixels then use fixed thresholding, then,
2. Calculate the contours in the image and bounding box for each contour to calculate the HOG features for each bounding Square to Predict the Digit using our Classifier.
3. Draw the Bounding Box and the Predicted Digit on the Input Image

FACE RECOGNITION



RECOGNIZING A FACE FROM A SAMPLE DATA (TRAINING THE SAMPLE DATA)

FACE RECOGNITION

The 3 major steps to Recognize Face:

1. Find a good database of Faces with Multiple images for Each individual: Yale Face Database that contains 165 grayscale images of 15 individuals (11 images each with different facial expression like happy, sad, normal, sleepy etc.) in .gif form.
2. Detect faces in the database images and use them to train the face recognizer.
3. Test the face recognizer to recognize faces it was trained for.

10 images of the total 11 images of each individual is used in training the Face Recognizer and the remaining Single Image of each individual is used to test our Face Recognition Algorithm.

- The Face Recognizer object has functions like FaceRecognizer.train to train the recognizer and FaceRecognizer.predict to recognize a face. OpenCV currently provides 3 Face Recognizer:

1. Eigenface Recognizer - createEigenFaceRecognizer()
2. Fisherface Recognizer - createFisherFaceRecognizer()
3. Local Binary Patterns Histograms Face Recognizer - createLBPHFaceRecognizer() which is used in this example.

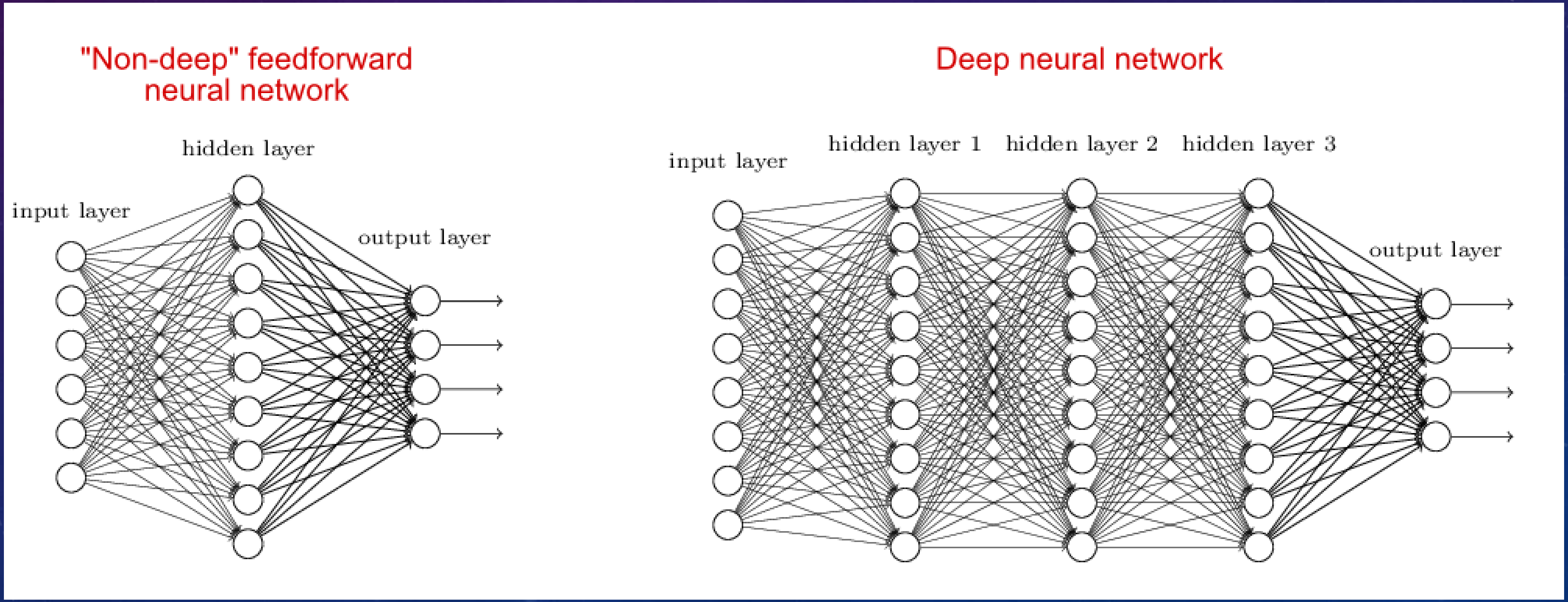
Perform the training using the FaceRecognizer.train function with input values as images of faces and the corresponding labels assigned to these faces and then pass the result to function FaceRecognizer.predict which gives the confidence score of the Recognition. A confidence value of 0.0 is a perfect recognition.

DEEP LEARNING

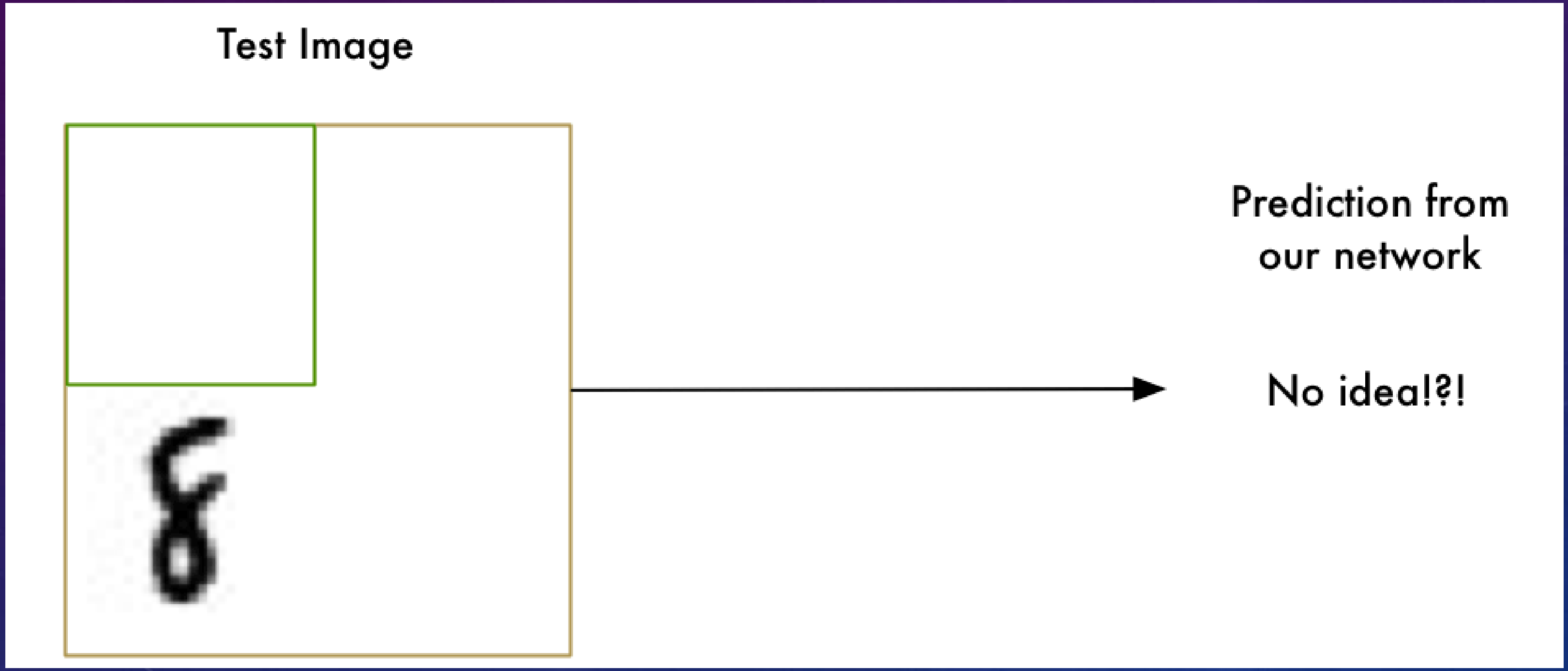
DEEP LEARNING & CONVOLUTIONAL NEURAL NETWORKS

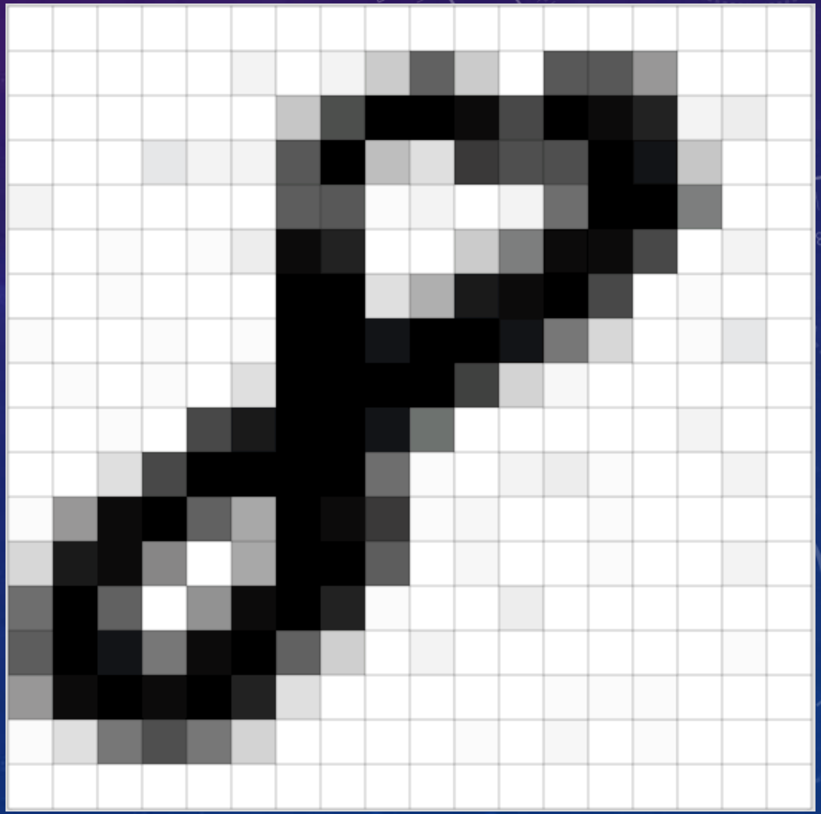
DEEP LEARNING & CONVOLUTIONAL NEURAL NETWORKS

- Deep Learning: A Subfield of Machine Learning. Machine learning only works when you have data — preferably a lot of data.
- Convolutional Neural Networks: CNN introduces extra concepts over the simple fully connected feed-forward Neural Network



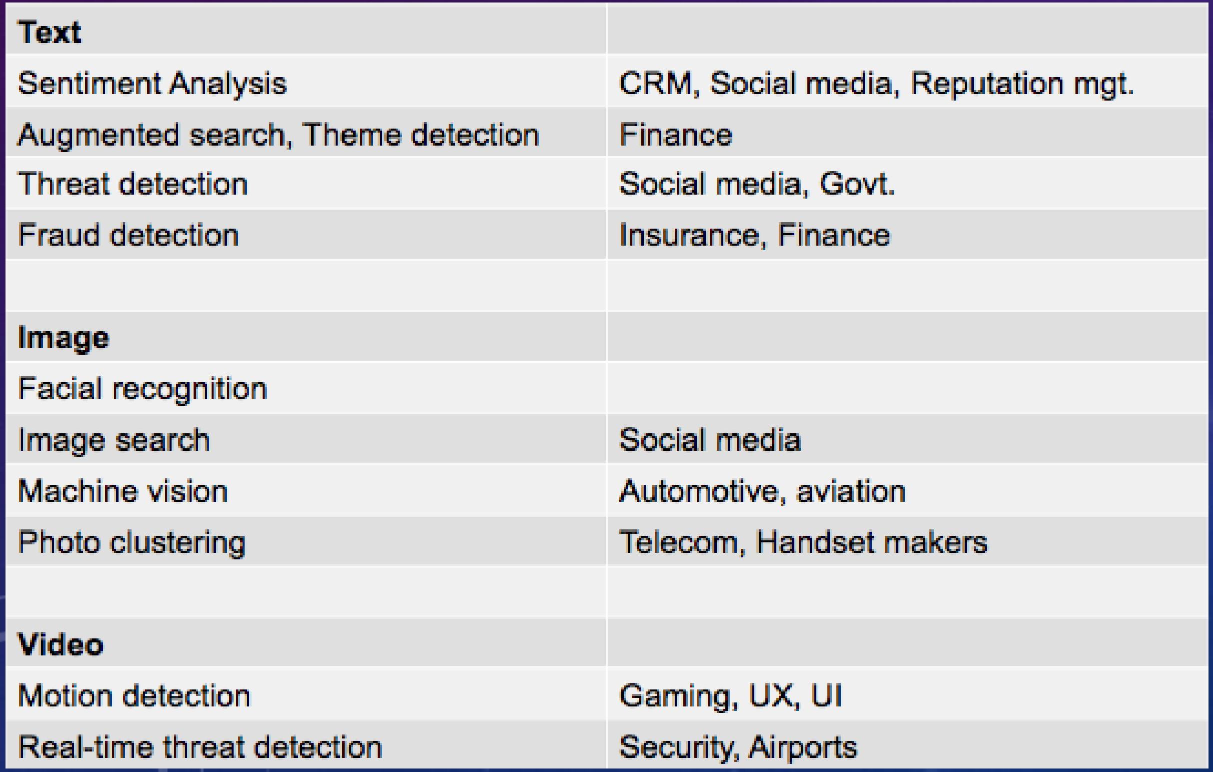
DEEP LEARNING & CONVOLUTIONAL NEURAL NETWORKS



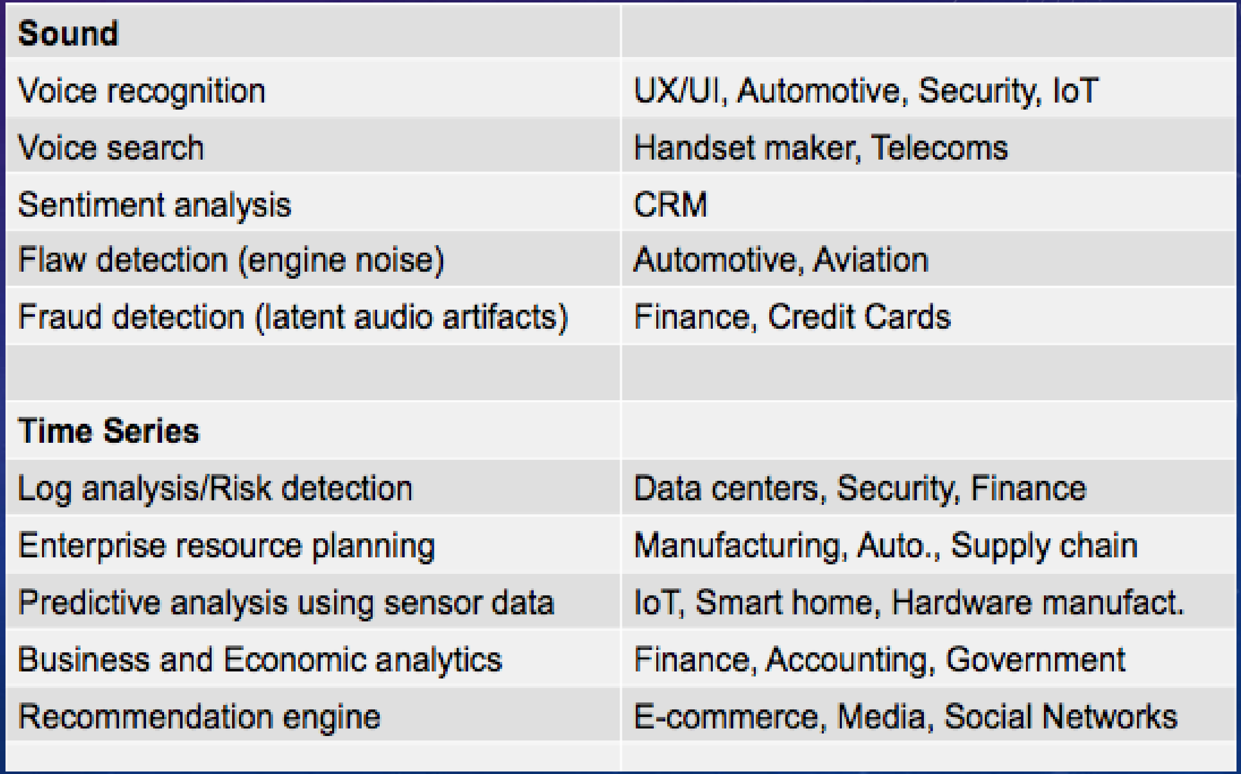


DEEP LEARNING & CONVOLUTIONAL NEURAL NETWORKS

Deep learning excels at identifying patterns in unstructured data, which most people know as media such as images, sound, video and text. Below is a list of sample use cases we've run across, paired with the sectors to which they pertain.



Text	
Sentiment Analysis	CRM, Social media, Reputation mgt.
Augmented search, Theme detection	Finance
Threat detection	Social media, Govt.
Fraud detection	Insurance, Finance
Image	
Facial recognition	
Image search	Social media
Machine vision	Automotive, aviation
Photo clustering	Telecom, Handset makers
Video	
Motion detection	Gaming, UX, UI
Real-time threat detection	Security, Airports



Sound	
Voice recognition	UX/UI, Automotive, Security, IoT
Voice search	Handset maker, Telecoms
Sentiment analysis	CRM
Flaw detection (engine noise)	Automotive, Aviation
Fraud detection (latent audio artifacts)	Finance, Credit Cards
Time Series	
Log analysis/Risk detection	Data centers, Security, Finance
Enterprise resource planning	Manufacturing, Auto., Supply chain
Predictive analysis using sensor data	IoT, Smart home, Hardware manufact.
Business and Economic analytics	Finance, Accounting, Government
Recommendation engine	E-commerce, Media, Social Networks

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For The Workshop Content, Please Visit:

https://github.com/Shachindra

THANK YOU

LETS GET STARTED WITH IMAGE PROCESSING