Python – OpenCV

cross-platform open source computer vision library written in C and C++

Dr. Sarwan Singh
NIELIT Chandigarh

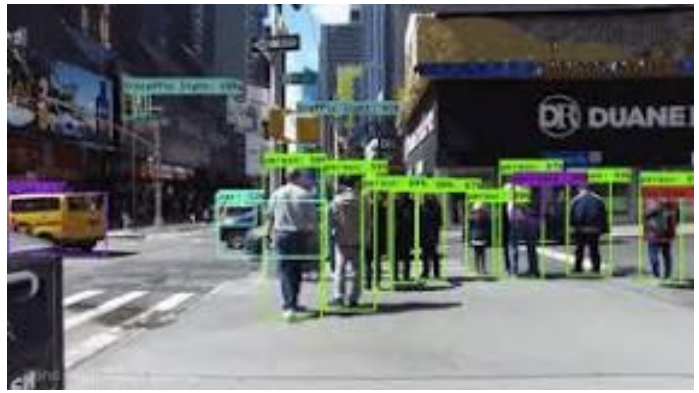
Agenda

- Introduction –History
- Overview
- Applications
- Modules
- Examples

"computer vision creates meaningful interpretation/ descriptions of objects from their images"

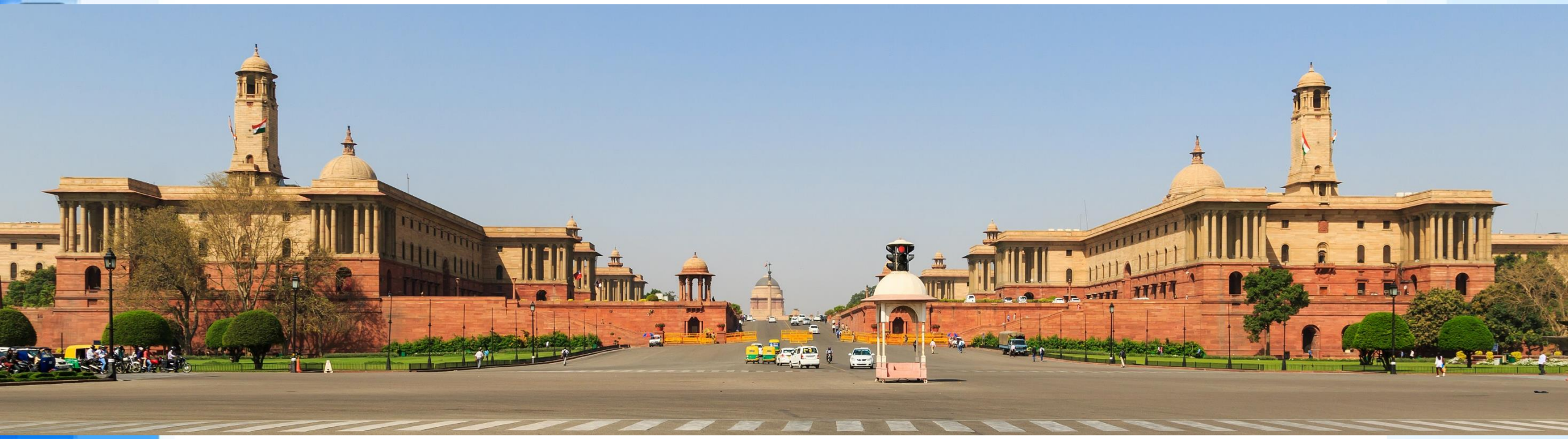
Computer Vision

- Computer Vision is an interdisciplinary field that deals with how computers can be made to gain a high-level understanding from digital images or videos.
- The idea here is to automate tasks that the human visual systems can do. So, a computer should be able to recognize objects such as that of a face of a human being or a lamppost or even a statue



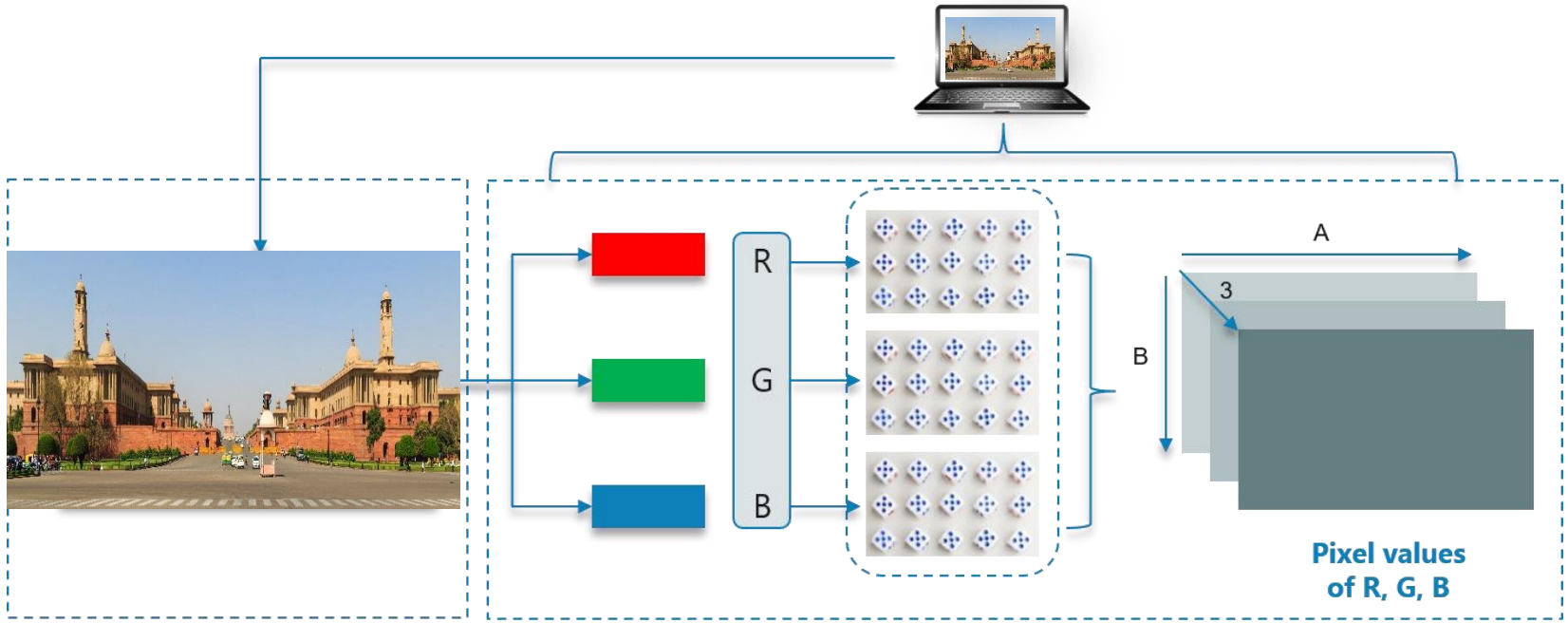
How does computer read an image

- Lets take an example of famous *Raisina Hills*
- The computer reads any image as a range of values between 0 and 255.
- For any color image, there are 3 primary channels – Red, Green and Blue



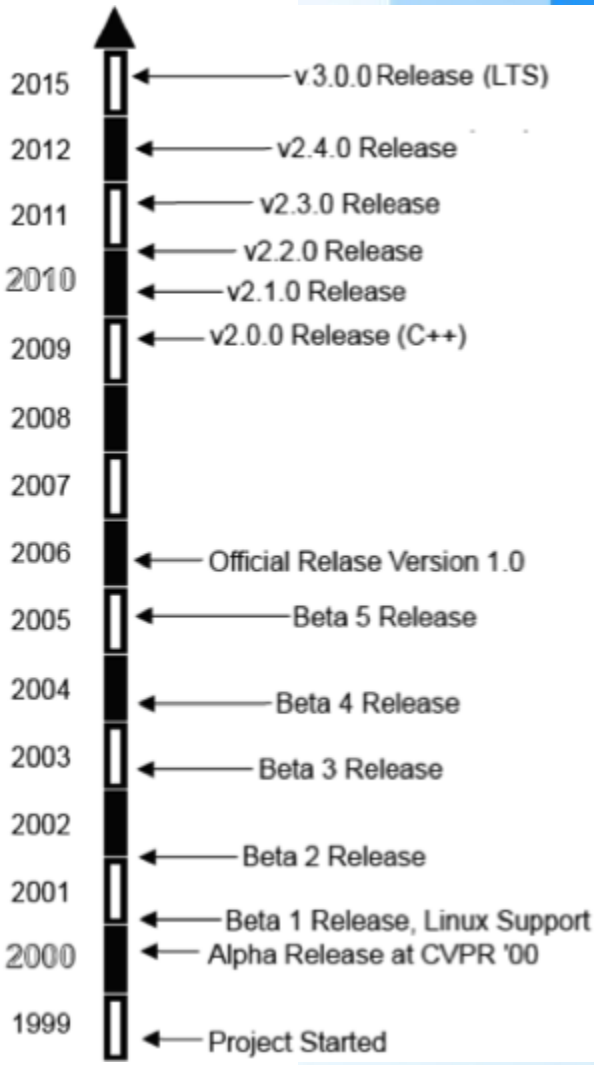
How does computer read an image

- A matrix is formed for every primary color and later these matrices combine to provide a Pixel value for the individual R, G, B colors.
- Each element of the matrices provide data pertaining to the intensity of brightness of the pixel.



OpenCV - Introduction

- OpenCV - Open Source Computer Vision Library.
- Free for commercial and research use
- founded at Intel in 1999
- now under active development, now receiving ongoing support from Willow Garage.
- It has a BSD license, 10M downloads, 500K+ lines of code.
- Cross platforms support-Linux, Windows and Mac OS.
- Portable – iPhone, Android.
- Language support – C/C++ ,Python



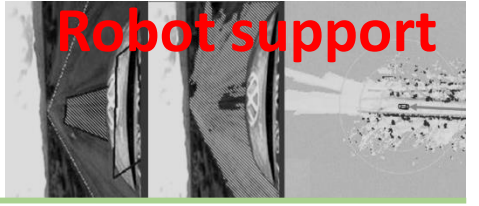
History

- OpenCV was started at Intel in 1999 by **Gary Bradsky**, and the first release came out in 2000.
- **Vadim Pisarevsky** joined Gary Bradsky to manage Intel's Russian software OpenCV team.
- In 2005, OpenCV was used on Stanley, the vehicle that won the 2005 DARPA Grand Challenge.
- Later, its active development continued under the support of Willow Garage with Gary Bradsky and Vadim Pisarevsky leading the project.
- OpenCV now supports a multitude of algorithms related to Computer Vision and Machine Learning and is expanding day by day.
- OpenCV supports a wide variety of programming languages such as C++, Python, Java, etc.

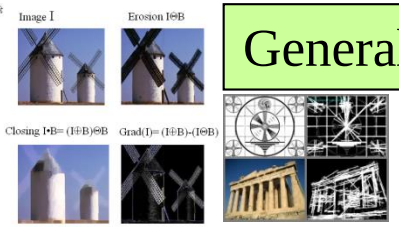
Source : https://docs.opencv.org/

OpenCV Overview: > 500 functions

opencv.willowgarage.com



General Image Processing Functions



Geometric Descriptors

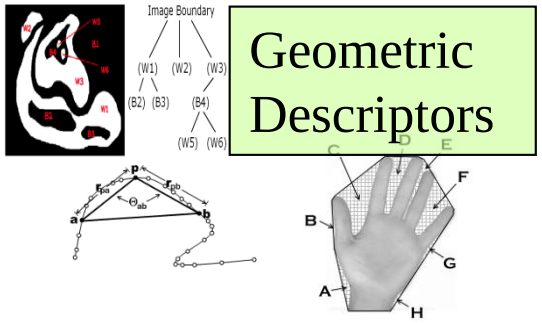
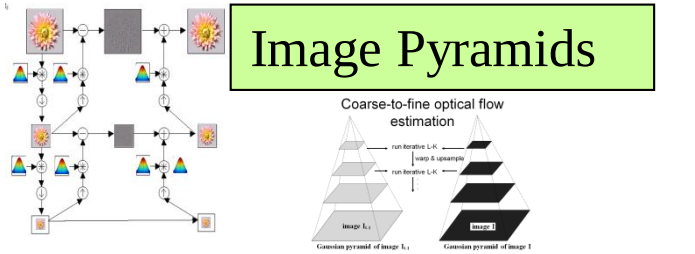
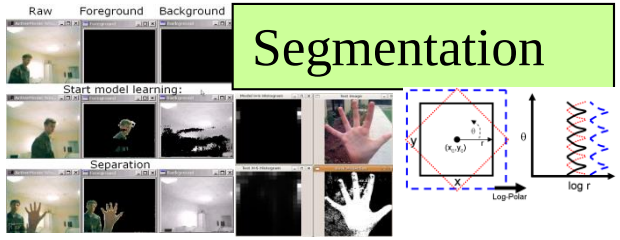


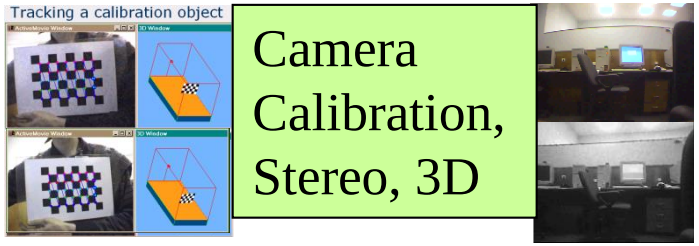
Image Pyramids



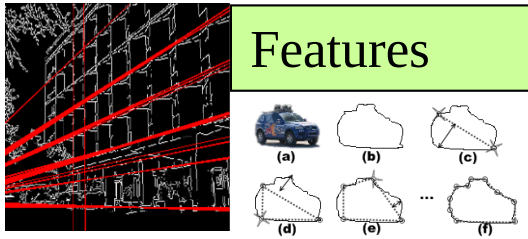
Segmentation



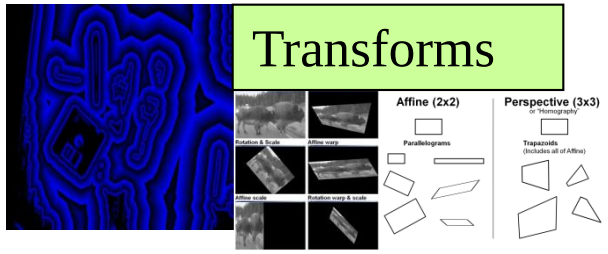
Camera Calibration, Stereo, 3D



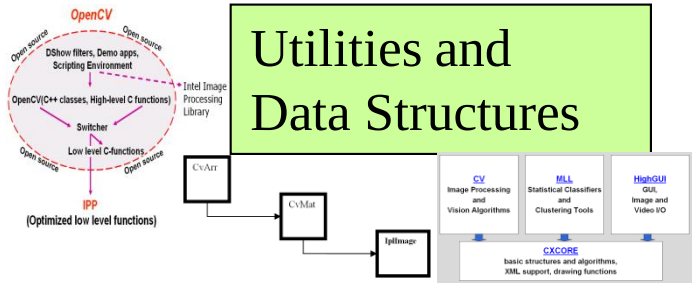
Features



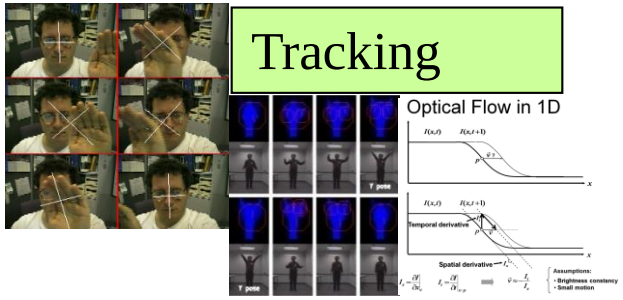
Transforms



Utilities and Data Structures

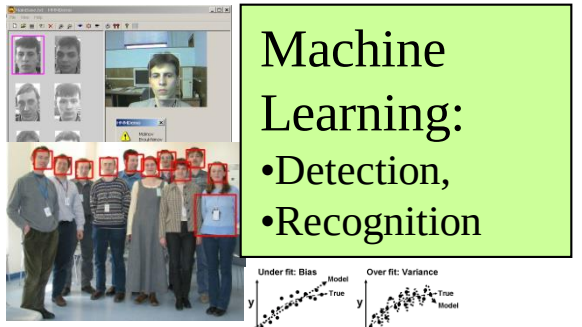


Tracking

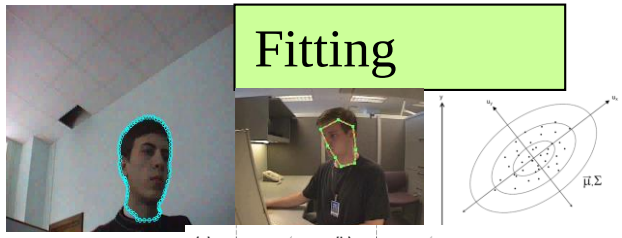


Machine Learning:

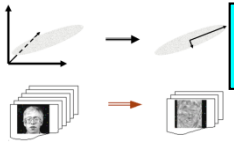
- Detection,
- Recognition



Fitting



Matrix Math



Computer vision application

- **Robotics**
  - Localization-determine robot location automatically
  - Navigation
  - Obstacles avoidance
  - Assembly (peg-in-hole, welding, painting)
  - Manipulation (e.g. PUMA robot manipulator)
  - Human Robot Interaction (HRI): Intelligent robotics to interact with and serve people
- **Medicine**
  - Classification and detection (e.g. lesion or cells classification and tumor detection)
  - 2D/3D segmentation
  - 3D human organ reconstruction (MRI or ultrasound)
  - Vision-guided robotics surgery

Security

- Biometrics (iris, finger print, face recognition)
- Surveillance-detecting certain suspicious activities or behaviors

Transportation

- Autonomous vehicle
- Safety, e.g., driver vigilance monitoring

Industrial Automation Application

- Industrial inspection (defect detection)
- Assembly
- Barcode and package label reading
- Object sorting
- Document understanding (e.g. OCR)

source: tutorialspoint.com

OpenCV-Python

- OpenCV-Python is a library of Python bindings
- OpenCV-Python is a Python wrapper for the original OpenCV C++ implementation.
- OpenCV-Python makes use of **Numpy**

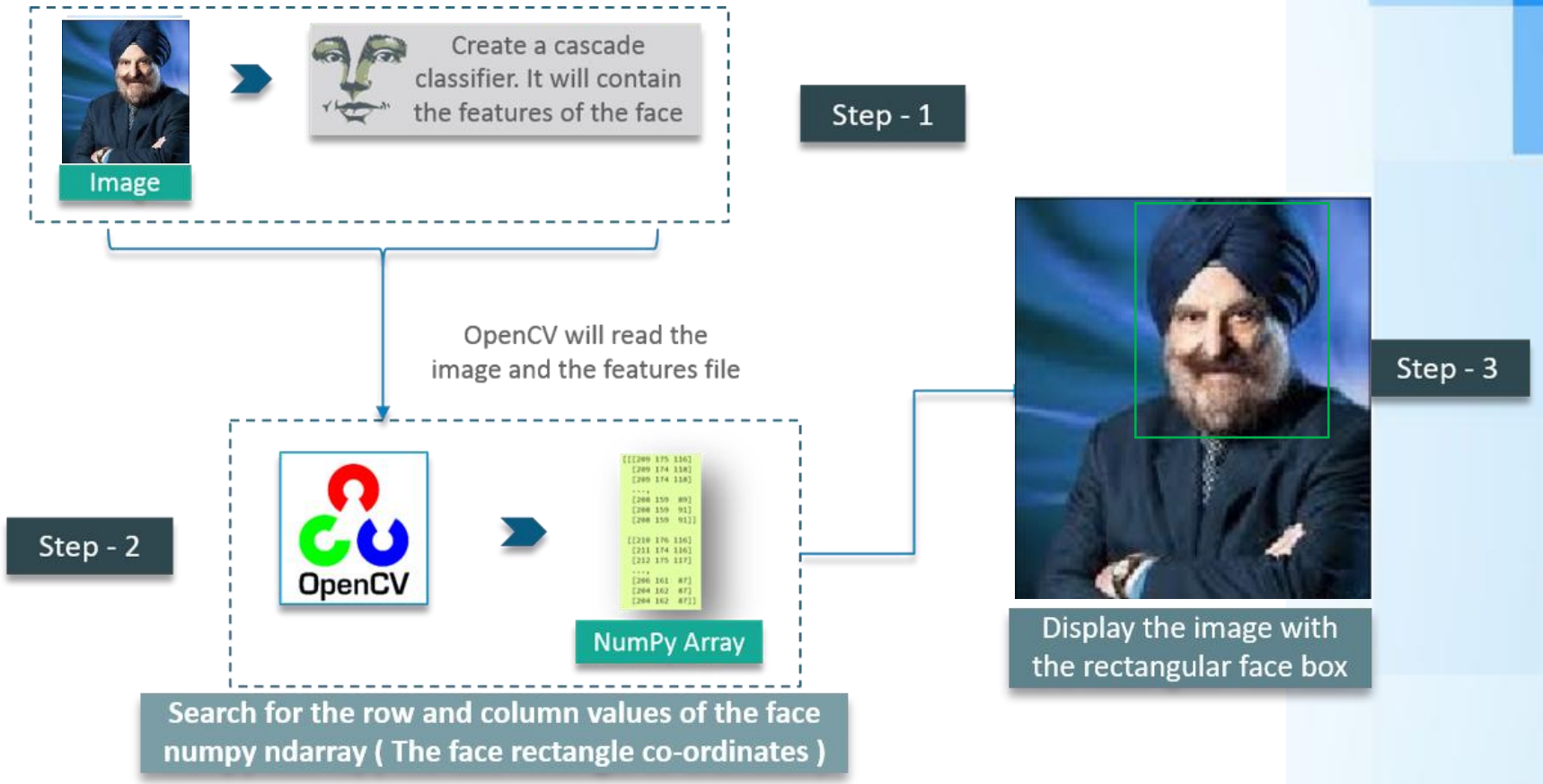
Modules

- openCV has a modular structure including several shared/static libraries
  - core – basic structures and algorithms
  - imgproc – image processing algorithms (image filtering, geometrical image transformations, histograms, etc.)
  - video – video analysis (such as motion estimation and object tracking)
  - highgui – built-in simple UI, in addition we use Qt
  - Calib3d – camera calibrations and 3d reconstruction
  - features2d -2D features framework (feature detectors, descriptors and descriptor matchers)
  - objdetect – detection of objects and other items (e.g. faces, eyes, etc)
  - ml – machine learning classes used for statistical classification, regression and clustering of data
  - gpu- GPU-accelerated algorithms

OpenCV functions for Reading, Showing, Writing an Image File

- **imread() function** – reading an image.
  - supports various image formats like PNG, JPEG, JPG, TIFF, etc.
- **imshow() function** – showing an image in a window.
  - The window automatically fits to the image size
  - supports various image formats like PNG, JPEG, JPG, TIFF, etc.
- **imwrite() function** – writing an image.
  - supports various image formats like PNG, JPEG, JPG, TIFF, etc.

Face Detection



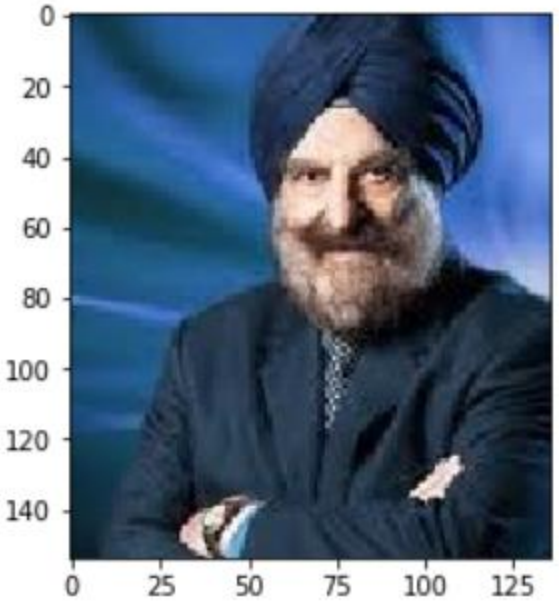
cv2.imshow() vs matplotlib.show()

```python
import cv2
# read and load an image
img = cv2.imread('kapany.jpg')
cv2.imshow('image_Kapany',img)
cv2.waitKey(0)
cv2.destroyWindow('image_Kapany')

#writing same image to some other format
#cv2.imwrite('image_kapany.png',img)

```

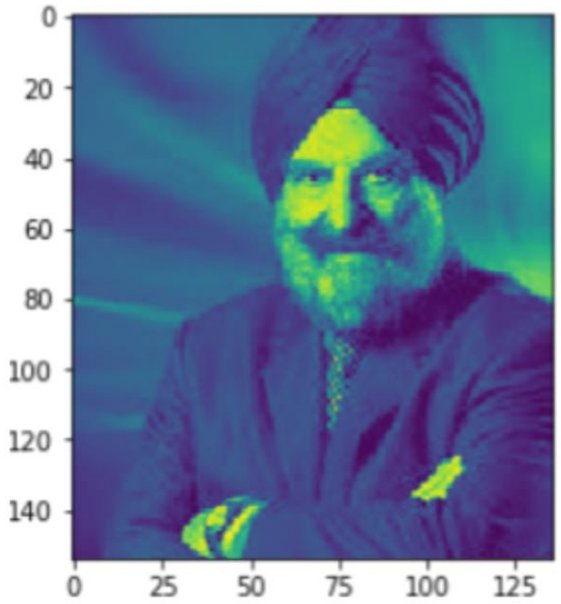
```python
#Display image using cv2 and matplotlib
port cv2
import matplotlib.pyplot as plt
# read and load an image
img = cv2.imread('kapany.jpg')
# load image using cv2....and do processing.
plt.imshow(img)
# as opencv loads in BGR format by default, we want to show it in RGB.
#use following code
#plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
plt.show()
```

cvtColor() function to convert this image to grayscale.

```
1 plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
2 plt.show()
```

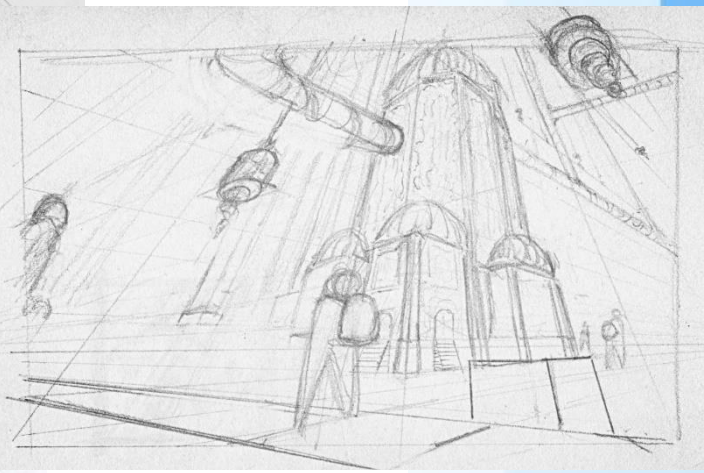



```
1 plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2GRAY))
2 plt.show()
```



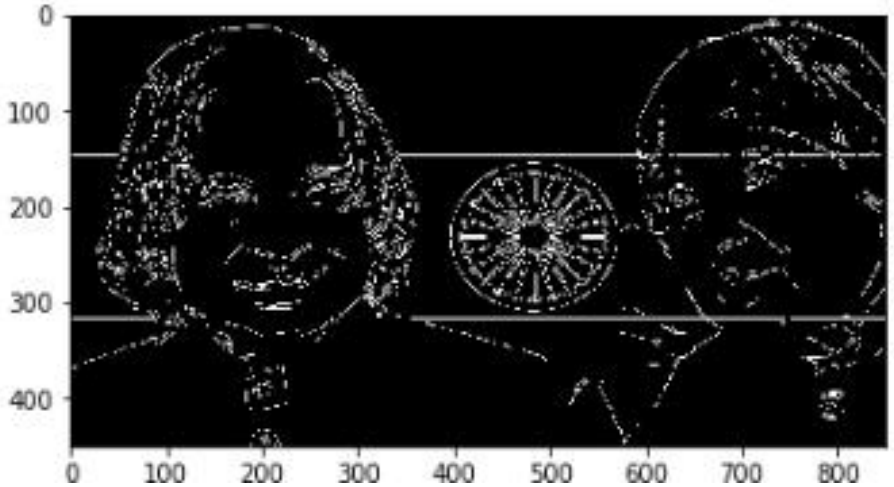
Edge Detection

- Rough sketch with edges differentiating images/objects and their poses from background can be used to identify the object easily by human eye. Same goes with computer vision or motor applications
- openCV has simple and useful function - Canny() for detecting edges.



Edge Detection

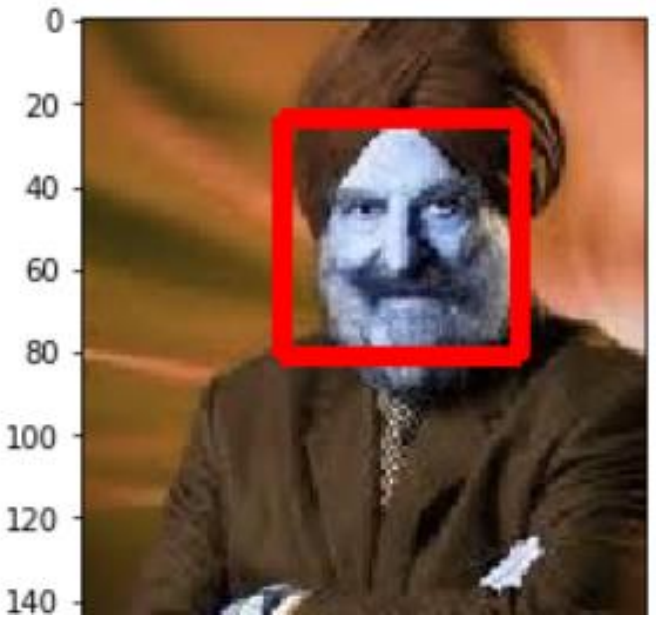
```
1 import cv2
2
3 img = cv2.imread("apj.jpg")
4 plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB)), plt.show()
5
6 cv2.imwrite('edges_apj.jpg',cv2.Canny(img,200,300))
7 plt.imshow(cv2.cvtColor(cv2.imread('edges_apj.jpg'), cv2.COLOR_BGR2RGB))
8 plt.show()
```



Face Detection

- one of the important and fascinating application of computer vision and brain behind automation of Things around us.
- OpenCV has built-in face detection.
- **Haar** cascade classifier for face detection

```python
import  cv2
img = cv2.imread("kapany.jpg")
face_detection= cv2.CascadeClassifier('haarcascade_frontalface_default.xml')
#convert it into grayscale
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
#using face_detection.detectMultiScale, perform actual face detection
faces = face_detection.detectMultiScale(gray, 1.3, 5)
for (x,y,w,h) in faces:
    img = cv2.rectangle(img,(x,y),(x+w, y+h),(255,0,0),3)

plt.imshow(img), plt.show()
```



Eye Detection

- Prebuilt classifiers for face and eyes in OpenCV are :
  - haarcascade_frontalface_default.xml
  - haarcascade_eye.xml

```python
#eye detection using haarcascade
import  cv2
img = cv2.imread("apj.jpg")
eye_cascade = cv2.CascadeClassifier('haarcascade_eye.xml')

#convert it into grayscale
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

eyes = eye_cascade.detectMultiScale(gray, 1.03, 5)

for (ex,ey,ew,eh) in eyes:
    img = cv2.rectangle(img,(ex,ey),(ex+ew, ey+eh),(0,255,0),2)

plt.imshow(img), plt.show()
```

Jupyter Notebook Link

- Computer Vision - OpenCV

Github Repository Link

- https://github.com/sarwansingh/Python/tree/master/ORD