IMAGE PROCESSING

WEEK-1

3. Image manipulation

- **Image manipulation:**

  Image manipulation means changing or modifying an image to improve it or extract import information.It includes : enhancing,transformation,filtering,editing,restoring.

- **Types of image manipulation:**
- Geometric transformation- Change the position,size,or orientation of images.
- Intensity/Color Manipulation- Improves contrast by spreading brightness values.
- Filtering/Convolution Operations- Filtering is used to modify Pixel values using a kernel
- Morphological Operations- Used in binary images to modify shapes.
- Image restoration- Fixes or cleans corrupted images:like: Noise removal,deblurring,super-resolution,missing-pixel recovery

- **Resize:**
- Resizing means changing the width and height of the image.
- It is used for making an image:
  - Bigger - Upsampling - newpixel are created, interpolation decides how to fill the data
  - Smaller - downsampling - it removes pixels ,sometimes details are lost
- Used for standardising the image.
- How resizing works:
- When an image is resized , new pixel values are calculate.
- **Common methods used:**
  - Nearest neighbor interpolation : This is the fastest method, it picks the closest pixel,used in- simple graphics,pixel art.
  - Bilinear interpolation : it considers 4 nearest pixels , used in photos and ml processing
  - Bicubic interpolation : it picks 16 nearest pixels , used for high-quality resizing

- **Crop:**

- Cropping means cutting out a specific rectangular region from an image and removes the rest

- **Need? :**

a. Focus on the important subject
b. Remove unwanted background
c. Improve composition
d. Change aspect ratio
e. Zoom into a specific region
f. Prepare input for ML models

- **Working -**

- Cropping is done by selecting a region of interest(ROI) using coordinates

- **Common cropping uses:**

  - Manual crop : user selects the region with mouse
  - Automatic crop : used in ml and cv for face detection crop, object detection crop
  - Center crop : commonly used in deep learning, Crops the central region to a fixed size

- **Rotate:**
  - Rotation means turning an image around its center by a certain angle
- **Need?:**

a. Fixing tilted images
b. Image augmentation for ml models
c. Artistic effects
d. Aligning scanned documents
e. Correcting orientation
f. Matching orientation in computer vision tasks\

- **Working :**
  - Every pixel is shifted to a new location
  - Every spaces may appear -> filled with:
  - Black pixels , white pixels , border replication
  - The image size may increase because corners move outward

- **Flip:**
  - Flipping means mirroring an image across an axis
  - **These are of two types:**

a. Horizontal flip
   - Mirrors the image left <-> right
   - Used in : Data augmentation , making images symmetrical , mirror effects

b. Vertical flip
   - Mirrors the image top <-> bottom
   - Used in : image augmentation , artistic transformations , correcting camera orientation

c. Bot flips(Horizontal + Vertical)

d. This produces a 180 deg rotation-like effect.
   - Need? :
   - Data augmentation in ml
   - Creating mirror effects
   - Fixing incorrect camera orientation
   - Styling and creativity
   - Increasing dataset size for CNN training

- **Working:**
- Horizontal flip : each pixel at (x,y) moves to (width-x-1,y)
- Vertical flip : each pixel at (x,y) moves to (x, height-y-1)
- Flipping doesn’t change - image size , aspect ratio

- **Blurring:**
  - Blurring means making an image smoother by reducing sharp details and noises.
- **Need?:**

a. Reducing noise
b. Smoothing rough edges
c. Preparing for edge detection
d. Creating background blur
e. Removing details
f. Preprocessing for ML/CV models

- **Working:**
  - It works by averaging neighbouring pixels so sudden intensity changes become softer.
  - Blurring uses a kernel that slides over the image
  - For each pixel :
    - Multiply surrounding pixels by kernel values
    - Add them
    - Replace center pixel with the result

- **Types of blur:**

1. Average blur - uses simple average of surrounding pixels, good for quick noise reduction
2. Gaussian blur - uses a gaussian distribution,giving more weight to central pixels ,best for reducing noise
3. Median blur: replaces each pixel with the median of its neighbourhood, helps in removing salt-and-pepper noise
4. Bilateral blur :smoothes images but keeps edges sharp

- **Sharpen :**
  - Sharpening enhances edges and fine details in an image
  - It increases the contrast between neighbouring pixels, making image looks clearer
  - It works by sharpening by using high-pass filter kernel that highlights changes in intensity

- **Thresholding:**
  - Thresholding converts a grayscale image-> binary image by comparing each pixel to a fixed threshold value
  - Types of thresholding

a. Simple thresholding
b. Adaptive thresholding
c. Otsu’s thresholding

- **Canny edge detection:**
  - Canny is a multi-step algorithm used to detect edges with high accuracy and low noise
  - Steps involved -> noise reduction,gradient calculation,non-maxima, double threshold

- **Image transformation-**
  Image transformation refers to modifying the geometric structure or overall appearance of an image.It changes the position,size,orientation,or shape of the image while keeping the pixels values consistent or adjusting them properly.

1. Scaling:
   - Changing the size of the image by zooming in or zooming out
   - Upscaling(making image bigger)
   - downscaling(making image smaller)
2. Rotation:
   - Rotates the image by a certain angle
3. Cropping:
   - Trims away the edges focusing on the arts of the image.
   - Like cutting out distraction to focus on main subject
4. Affine transformation:
   - It maintains the lines and parallelism within the image
   - Includes- rotation,scaling,translation,shearing

- **codes:**
- Hands on - https://colab.research.google.com/drive/11Hm5bgR-seJ2KOfMm4FatZ15zN2S4qEE
- POC -
- Convert a real-time webcam feed to edge-detected view.
  - https://colab.research.google.com/drive/1RJhzEM4THJweEq3kmD_ICB0n62MYY9U1
- Auto-crop face from images using OpenCV Haar cascades.
  - https://colab.research.google.com/drive/19qIIBblHIYoZHbb-zfHTYHRVNdqZ7Ls1#scrollTo=PkzhkXMarMJ7