



Define Image

An image is a two-dimensional array of pixels (picture elements) that represent visual information. Each pixel contains color information or intensity values.

Common formats: JPEG, PNG.

Structure of Digital Images

- **Pixels:** The smallest unit of a digital image, arranged in a grid. Each pixel has a value representing its intensity and/or color.
- **Resolution:** The total number of pixels in an image, typically expressed as width × height (e.g., 1920 × 1080).
- All images consist of pixels in a grid. A 640 x 480 image has 640 rows and 480 columns. There are $640 \times 480 = 307200$ pixels.

Bit Depth:

The number of bits used to represent each pixel (e.g., 8-bit, 16-bit)

Color Channels:

- **Grayscale:** A single channel where each pixel intensity ranges from black (0) to white (255).
- **Color:** Multiple channels (e.g., RGB – Red, Green, Blue) combined to represent colors.

What is Grayscale?

Grayscale refers to a type of image representation that uses only one channel, where each pixel has an intensity value ranging from black (0) to white (255). This means the image contains only shades of gray, without any color information.

Where is Grayscale Used?

- Image Processing & Analysis: Grayscale images simplify computations.
- Machine Learning & AI: Used in facial recognition, medical imaging (X-rays, MRI), and pattern detection.

What is RGB?

RGB (Red, Green, Blue) is a color model used in digital imaging where each pixel in an image is represented using a combination of three primary colors:

Red (R)
Green (G)
Blue (B)

Each of these colors has an intensity value ranging from 0 to 255, and by mixing them in different proportions, you can create millions of colors.

How RGB Works

If $R = 255$, $G = 0$, $B = 0$, the color is pure red.
If $R = 0$, $G = 255$, $B = 0$, the color is pure green.
If $R = 0$, $G = 0$, $B = 255$, the color is pure blue.
If $R = 255$, $G = 255$, $B = 255$, the color is white.
If $R = 0$, $G = 0$, $B = 0$, the color is black.

Why is RGB Used?

RGB is the standard color model used in:

Computer screens, TVs, and mobile devices
Digital cameras and image processing
Graphics design and video games

Difference Between Color and Grayscale Images

Image Processing

Image processing is a technique to perform operations on images to enhance them, extract useful information, or convert them into a desired format. It has applications in computer vision, medical imaging, surveillance, and more.

Image processing involves techniques to enhance, analyze, or transform images using mathematical operations. Examples include:

- Enhancement: Adjusting brightness, contrast, or sharpness.
- Analysis: Extracting features, edges, or objects.

What is OpenCV?

OpenCV (Open Source Computer Vision Library) is an open-source computer vision and machine learning software library. It provides a collection of tools and algorithms to process images and videos.

- `cv.imread( FileName, Flag )` to Read an image from a storage.
- `cv.imshow( window_Name, Image )` to display an image in a window.
- `cv.imwrite( File_Name, Image )` to write and save an image to the storage.
- A common color mode where images are represented using three channels (Red, Green, Blue).
- OpenCV reads images in BGR order by default, not RGB. To convert to RGB, use: `cv2.cvtColor(image, cv2.COLOR_BGR2RGB)`.

When reading images using `cv2.imread`, you can specify the following flags:

```
cv2.IMREAD_COLOR (Default): Reads a full-color image with three channels (BGR).  
cv2.IMREAD_GRAYSCALE: Reads the image as grayscale (1 channel).
```

How install main libraries

Install Anaconda, create a new environment, install Jupyter, open the command prompt, and enter the following commands

- `pip install opencv-python`
- `pip install tensorflow`
- `pip install keras`
- `pip install numpy`
- `pip install matplotlib`

Read and display image as RGB

```
import cv2  
from matplotlib import pyplot as plt  
  
# Load an image (replace 'image.jpg' with your image path)  
image = cv2.imread('image.jpg')  
  
# Convert BGR (OpenCV default) to RGB for proper display
```

```
image_rgb = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)

# Display the image
plt.imshow(image_rgb)
plt.title("Loaded Image")
plt.axis('off')
plt.show()
```

Loaded Image



Convert Image to Grayscale

```
import cv2
import matplotlib.pyplot as plt

# Load the image
image = cv2.imread("image.jpg")

# Convert to grayscale
gray_image = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)

# Show the image
plt.imshow(gray_image, cmap="gray")
plt.axis("off")
plt.show()
```



How can read and write image?

```
import cv2

# Step 1: Read an image from storage
image = cv2.imread('image.jpg', cv2.IMREAD_COLOR)

# Step 2: Display the image in a window
cv2.imshow('Original Image', image)

# Step 3: Wait for a key press (0 means wait indefinitely)
key = cv2.waitKey(0)

# Step 4: Save the image to a new file if a specific key is pressed
(e.g., 's')
if key == ord('s'): # If 's' key is pressed
    cv2.imwrite('saved_image.jpg', image) # Save the image
    print("Image saved as 'saved_image.jpg'")

# Step 5: Close all OpenCV windows
cv2.destroyAllWindows()

Image saved as 'saved_image.jpg'
```

Getting the width and height of an image

```
import cv2
```

```
# Load the image
image = cv2.imread("image.jpg")

# Get dimensions
height, width, channels = image.shape

print(f"Width: {width}, Height: {height}")

Width: 612, Height: 612
```