

# Module 2 - Image Processing with OpenCV and Pillow

## What is a Digital Image?

- A digital Image can be interpreted as a rectangular array of numbers
- Images are comprised of a rectangular grid of blocks called pixels
  - We can represent these pixels with numbers called intensity values
- An image can take on an almost unlimited number of values, but digital images have intensity values between zero and 255
- Pillow is a popular library for working with images in Python
- OpenCV is a library used for Computer Vision

## Image Processing with OpenCV - Ex1

Completed Lab Exercise - attached

## Manipulating Images

- Copying allows you to create a new image independent of the original
- Flipping images changes the image's orientation - We can flip an image by changing the index value of a pixel or intensity

## Manipulating Images One Pixel at a Time

- Cropping is cutting out the part of the image and throwing out the rest
- OpenCV can perform pixel manipulations

## Basic Image Manipulation with Pillow - Ex2

Completed Lab Exercise - attached

# Basic Image Manipulation with OpenCV - Ex3

Completed Lab Exercise - attached

## Pixel Transformations

- Histograms: A histogram counts the number of occurrences of a pixel, and it's a useful tool for understanding and manipulating images
- Intensity Transformations: An Intensity Transformation changes an image one pixel at a time. Some image transformations depend on neighbouring pixels

## Histograms and Intensity Transformations

Completed Lab Exercise

## Geometric Operations

- Geometric Transformation: We change the coordinates of the image x and y. In PIL we can scale the image by specifying the integer number of pixel's using the method `.resize()`
- Geometric Scaling: Scaling is where we reshape the image, we can shrink or expand the image in a horizontal and or vertical direction. `.resize()` can also be used to scale an image in OpenCV or PIL
- Geometric Translation: Translation is where we shift the image, we can shift an image horizontally or vertically. In OpenCV, `.warpAffine()` allows you to translate an image by x pixels in the horizontal direction and y pixels in the vertical direction
- Geometric Rotation: Rotates an image by an angle theta. In OpenCV, `.getRotationMatrix2D()` allows you to rotate an image by the angle inputted

## Geometric Transformations with Pillow

Completed Lab Exercise

# Spatial Operations in Image Processing

- Linear Filtering: Linear filtering applies a linear convolution between an image and a kernel (also called a mask or filter). The output pixel is a weighted sum of its neighbours, determined by the kernel.
- Edge Detection: Edge detection identifies areas of rapid intensity change. These areas often correspond to object boundaries in an image
- Median Filters: A non-linear filtering technique where the output pixel is the median of the surrounding neighbourhood. It's effective for removing salt-and-pepper noise while preserving edges

## Practice Assessment Completion

### Practice Assessment

#### Assignment details

##### Submitted

May 5, 5:29 AM PDT

##### Attempts

Unlimited

[↻ Retry](#)

#### Your grade

To pass you need at least 50%. We keep your highest score.

**100%**

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1. What type of image operation can convolution perform?

1 point

- ☐ Edge Detection
- ☐ Sharpening
- ☐ Blurring
- ☒ All of the above

2. What is linear filtering?

1 point

- ☐ It is a standard way to add text data
- ☒ It is a standard way to filter Images using convolution

3. A video sequence is a :

1 point

- ☒ sequence of images
- ☐ a large image

4. OpenCV :

1 point

- ☒ has more functionality than PIL library, but is more difficult to use
- ☐ identical to PIL

5. In OpenCV an image is a:

1 point

- ☒ a numpy array, with intensity values as 8-bit unsigned
- ☐ an image object

## ChatGPT Q&A

<https://chatgpt.com/share/6818ae99-5ed4-8001-ba28-3af775924913>