Image Processing Lab 1

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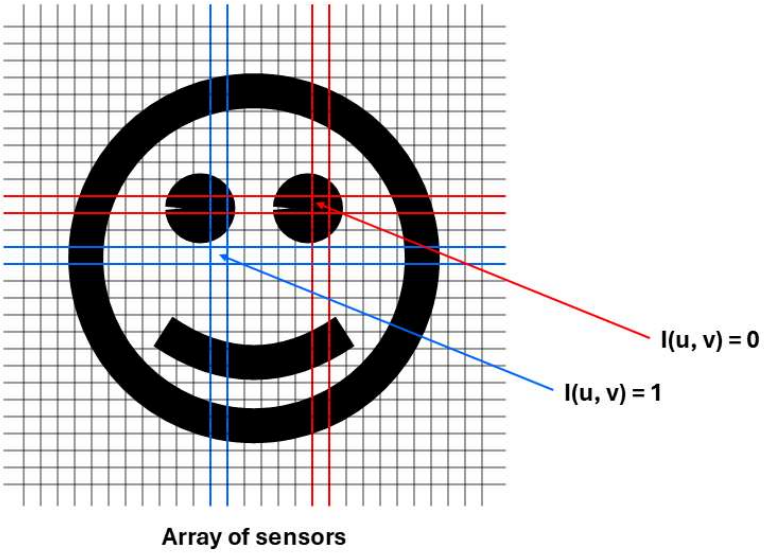
Digital Images

A digital image is composed of a finite number of elements, each of which has a particular location and value, called Pixels.

Digital Image Formation

In digital world, representing a function $f(x) = y$ involves important steps to ensure it can be processed by computers. You simply need to discretize the inputs, and then define a finite set of possible outputs.

An image can be thought of as a function in pixels' location $I(u, v) = P$. To be able to process it on a computer, you need to select discret u, v points and set a finite levels of possible P values.

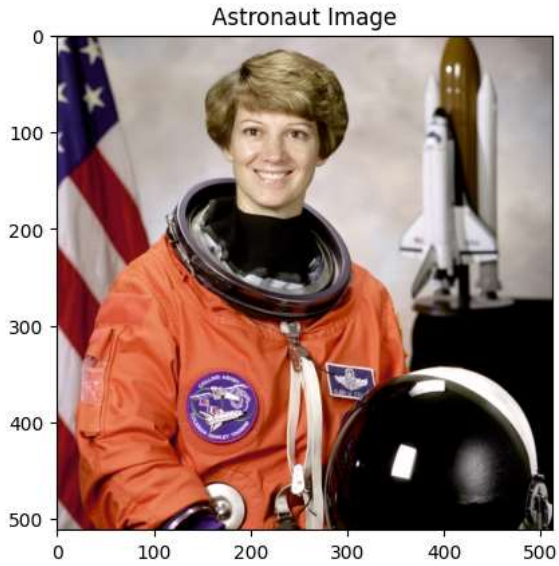


The creation of digital images is done over 3 steps:

1. **Acquisition** converts the light into a *continuous* electrical signals using an array of sensors.
2. **Sampling** involves selecting discrete points from the continuous signal.
3. **Quantization** assigns a finite set of values to the selected pixels.

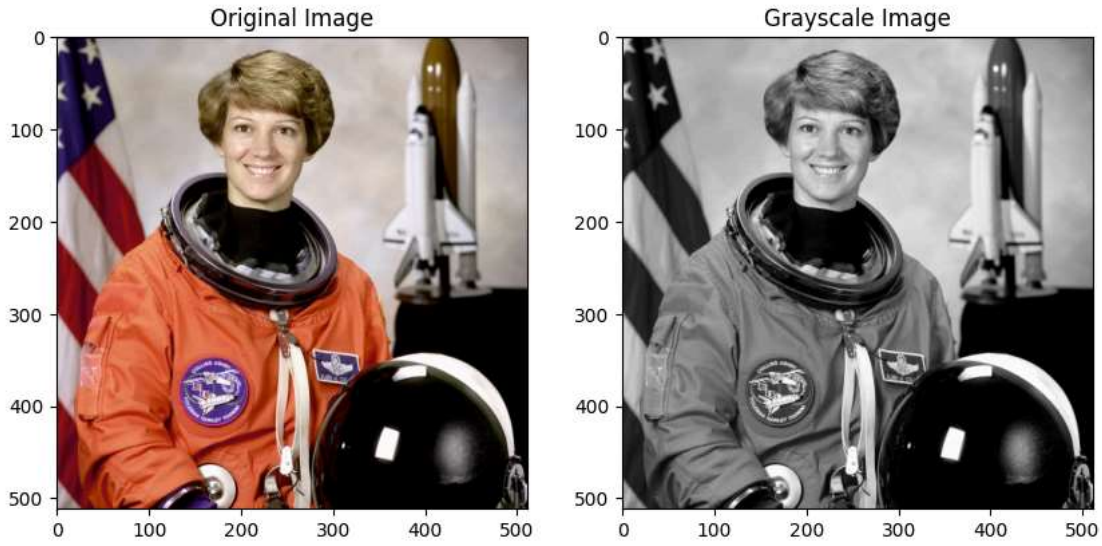
Hands-on Import and show an image

```
from skimage import data
import matplotlib.pyplot as plt

# Load a built-in image from skimage
image = data.astronaut()  # Load the astronaut image (RGB)

# Display the image using matplotlib
plt.imshow(image)

plt.title('Astronaut Image')
plt.show()
```



Hands-on Convert color image to grayscale

```
from skimage import color

# Load a built-in image from skimage (astronaut image in RGB)
image = data.astronaut()

# Convert the image to grayscale
gray_image = color.rgb2gray(image)

# Display the original and grayscale images side by side
fig, axes = plt.subplots(1, 2, figsize=(10, 5))

# Display the original RGB image
axes[0].imshow(image)
axes[0].set_title("Original Image")

# Display the grayscale image
axes[1].imshow(gray_image, cmap='gray')
axes[1].set_title("Grayscale Image")
plt.show()
```



Hands-on Image Shape and Data Type

```
# Show the size of the grayscale image
print(f"Grayscale image size (height, width): {gray_image.shape}")
print(f"Grayscale image Data type: {gray_image.dtype}")
```

```
Grayscale image size (height, width): (512, 512)
Grayscale image Data type: float64
```

```
# Show the size of the grayscale image
print(f"Original image size (height, width): {image.shape}")
print(f"Original image Data type: {image.dtype}")
```

```
Original image size (height, width): (512, 512, 3)
Original image Data type: uint8
```

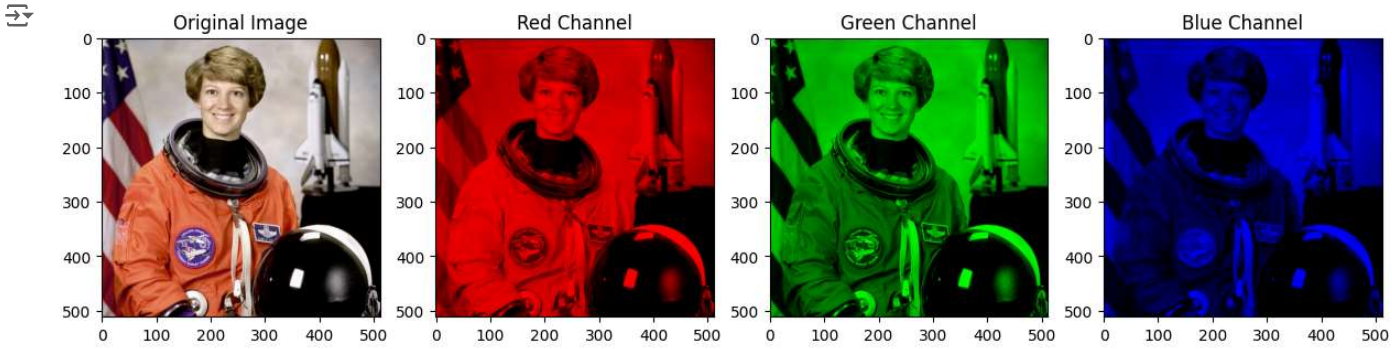
Example

Determine the number of bytes necessary to store an uncompressed RGB color image of size 640 × 480 pixelsusing 8, 12,16, and 64 bits per color channel.

Bit-depth	Rows	Columns	Channels	Bytes per element	Size in bytes
8	384	512	3	8/8 = 1	589,824
12	384	512	3	12/8 = 1.5	884,736
16	384	512	3	16/8 = 2	1,179,648
64	384	512	3	64/8=8	4,718,592

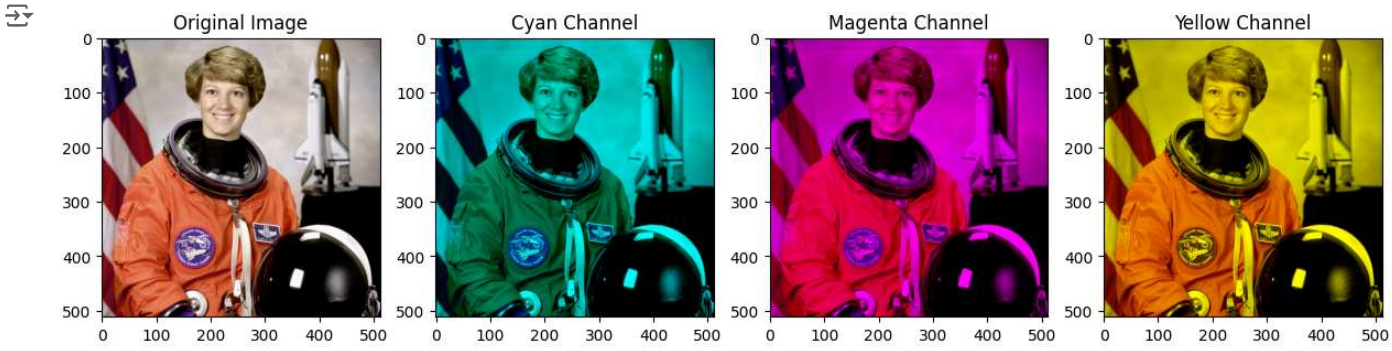
Hands-on Split RGB image into its 3 channels

```
import numpy as np
# Load the built-in astronaut image
image = data.astronaut()

# Split the image into R, G, B channels
red_channel = image[:, :, 0]
green_channel = image[:, :, 1]
blue_channel = image[:, :, 2]
allBlack = np.zeros_like(red_channel)

just_red = np.stack((red_channel, allBlack, allBlack), axis=2)
just_green = np.stack((allBlack, green_channel, allBlack), axis=2)
just_blue = np.stack((allBlack, allBlack, blue_channel), axis=2)


# Create a plot to display the original and the channels
fig, axes = plt.subplots(1, 4, figsize=(15, 5))

# Original image
axes[0].imshow(image)
axes[0].set_title("Original Image")

# Red channel
axes[1].imshow(just_red)
axes[1].set_title("Red Channel")

# Green channel
axes[2].imshow(just_green)
axes[2].set_title("Green Channel")

# Blue channel
axes[3].imshow(just_blue)
axes[3].set_title("Blue Channel")
plt.show()
```



Hands-on CMY channels

```
gb_image = np.stack((allBlack, green_channel, blue_channel), axis=2)
rb_image = np.stack((red_channel, allBlack, blue_channel), axis=2)
rg_image = np.stack((red_channel, green_channel, allBlack), axis=2)

# Create a plot to display the original and the channels
fig, axes = plt.subplots(1, 4, figsize=(15, 5))

# Original image
axes[0].imshow(image)
axes[0].set_title("Original Image")

# Red channel
axes[1].imshow(gb_image)
axes[1].set_title("Cyan Channel")

# Green channel
axes[2].imshow(rb_image)
axes[2].set_title("Magenta Channel")

# Blue channel
axes[3].imshow(rg_image)
axes[3].set_title("Yellow Channel")
plt.show()
```



> **Note**: Another way to do this is just simply setting the channel you want to remove in the original image to zeros

Hands-on Modifying Pixels Values

```
org_im = data.astronaut()
fk_im = org_im.copy()

fk_im[99:104, 200:206, 0] = 20
fk_im[99:104, 200:206, 1] = 150
fk_im[99:104, 200:206, 2] = 180

fk im[102:107, 244:250, 0] = 20
```

```
fk_im[102:107, 244:250, 1] = 150
fk_im[102:107, 244:250, 2] = 180


# Create a plot to display the original and the channels
fig, axes = plt.subplots(1, 2)

# Original image
axes[0].imshow(org_im)
axes[0].set_title("Original Image")

# Fake image
axes[1].imshow(fk_im)
axes[1].set_title("Fake Image")
plt.show()
```