Image processing using OpenCV

VORTEX ACADEMY

THE ART OF THINKING

Eng. Mai Allam

What will we discuss today?

- Introduction to Images
- Reading Images & Video
- Resizing and Rescaling Frames
- Drawing Shapes & Putting Text
- Image Transformations
- BITWISE operations & Masking
- Assignments & Questions

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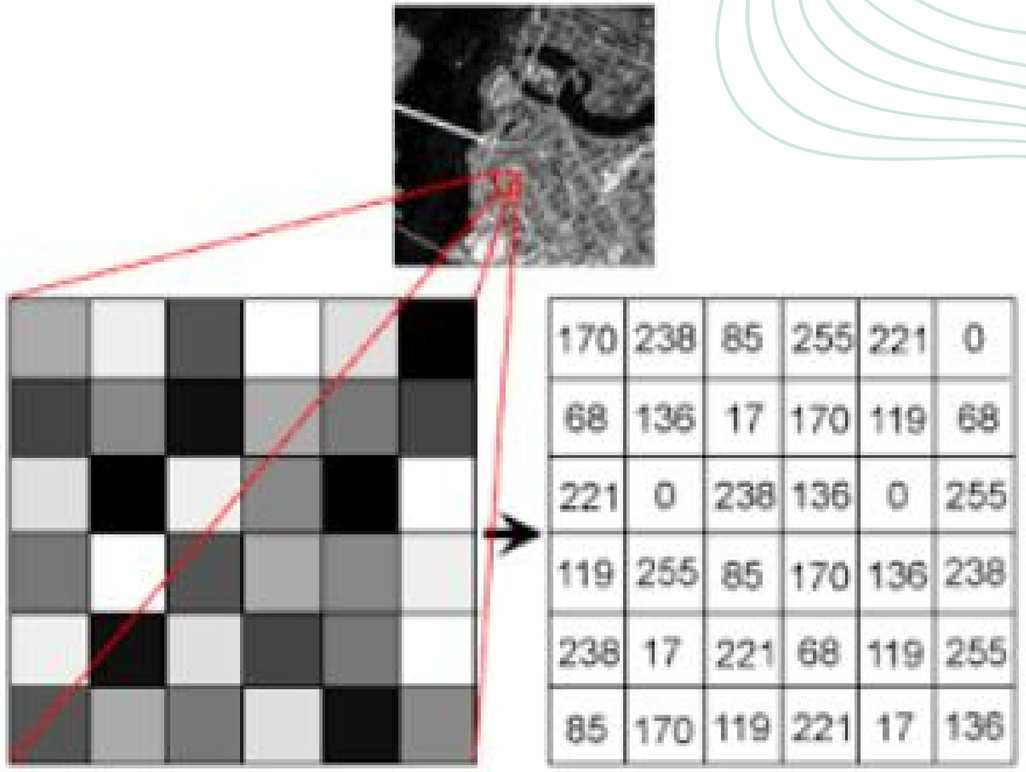
Introduction to Images

Image Representation [Grayscale]

Every number represents the pixel intensity at that particular location. In the above image, I have shown the pixel values for a grayscale image where every pixel contains only one value. the intensity of the black color at that location.



170	238	85	255	221	0
68	136	17	170	119	68
221	0	238	136	0	255
119	255	85	170	136	238
238	17	221	68	119	255
85	170	119	221	17	136

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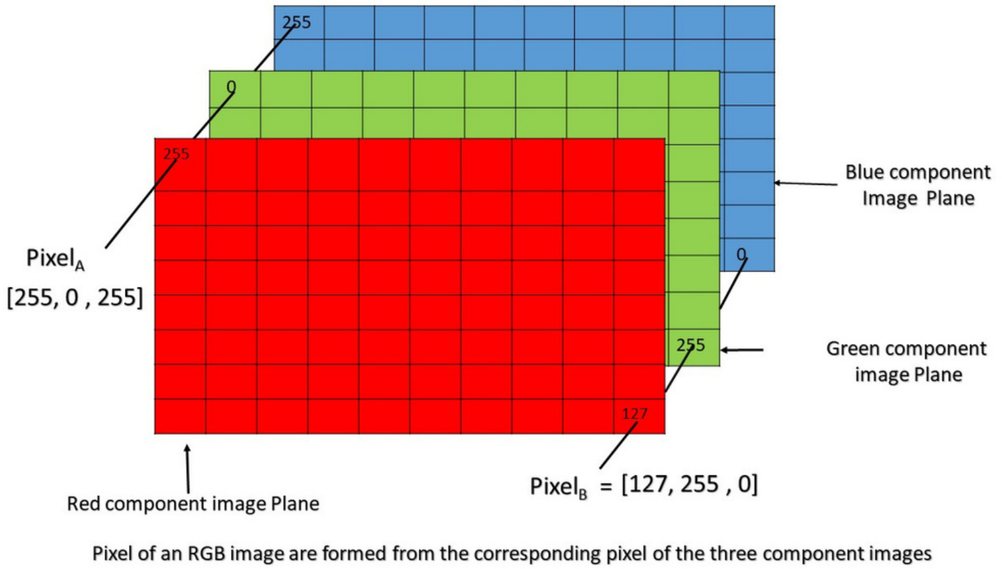
Introduction to Images

Image Representation [RGB]

An RGB image can be viewed as three different images(a red scale image, a green scale image, and a blue scale image) stacked on top of each other, and when fed into the red, green, and blue inputs of a color monitor, it produces a color image on the screen.



Pixel of an RGB image are formed from the corresponding pixel of the three component images

RGB[: , : , 1] represents the Red color plane of the RGB image
RGB[: , : , 2] represents the Green color plane of the RGB image
RGB[: , : , 3] represents the Blue color plane of the RGB image

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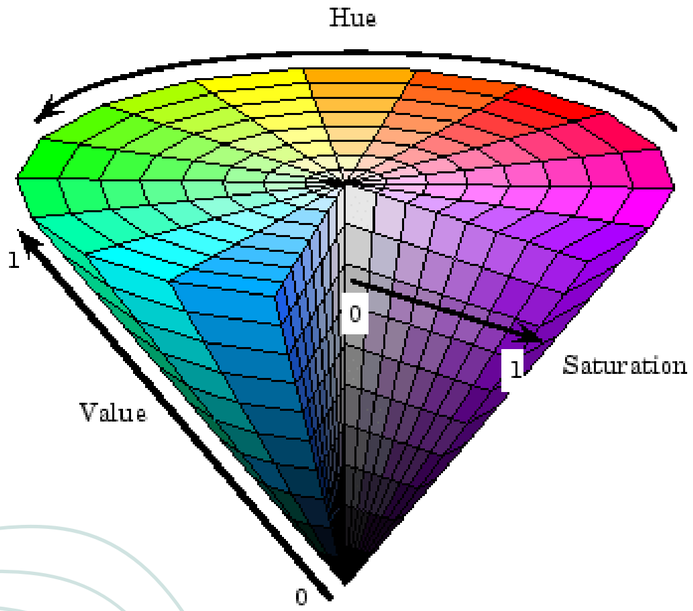
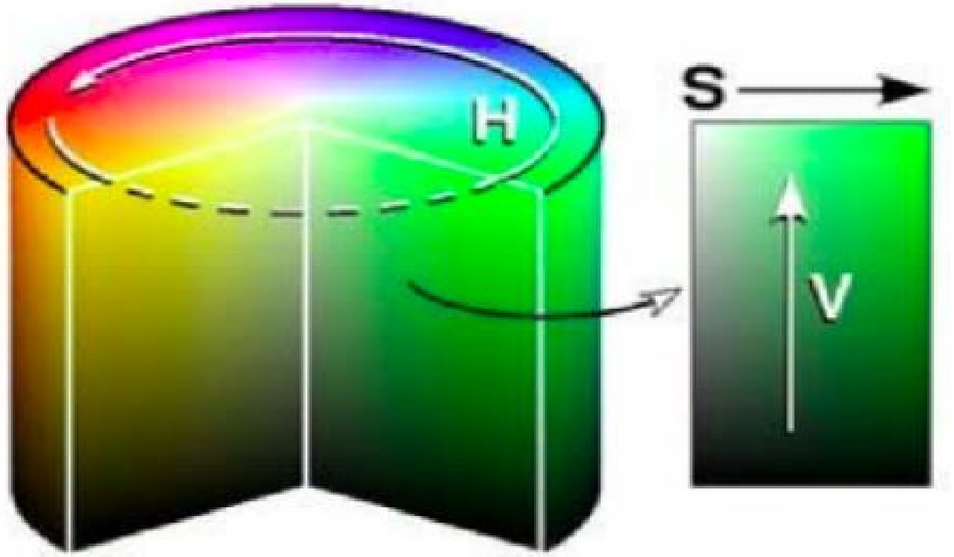
Introduction to Images

Other Representation [BGR, HSV,..]





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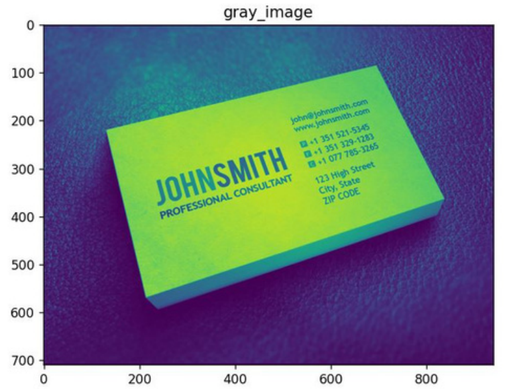
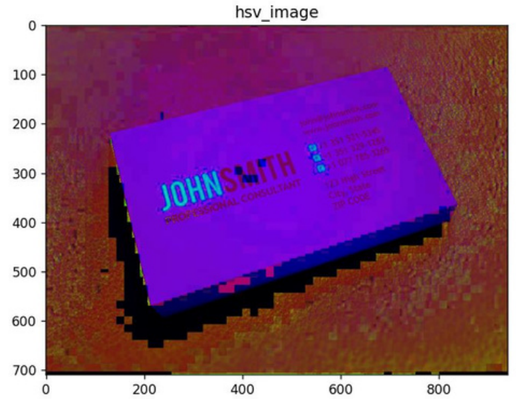
Reading Images

```python
#import the required libraries
import numpy as np
import matplotlib.pyplot as plt
import cv2


image = cv2.imread('D:/vortex/MATE 2023/training phase/ms2/opencv/opencv/jhonsmith.jpg')

#converting image to Gray scale
gray_image = cv2.cvtColor(image,cv2.COLOR_BGR2GRAY)

#plotting the grayscale image
plt.imshow(gray_image)
plt.title("gray_image")
plt.show()

#converting image to HSV format
hsv_image = cv2.cvtColor(image,cv2.COLOR_BGR2HSV)

#plotting the HSV image
plt.imshow(hsv_image)
plt.title("hsv_image")
plt.show()

```





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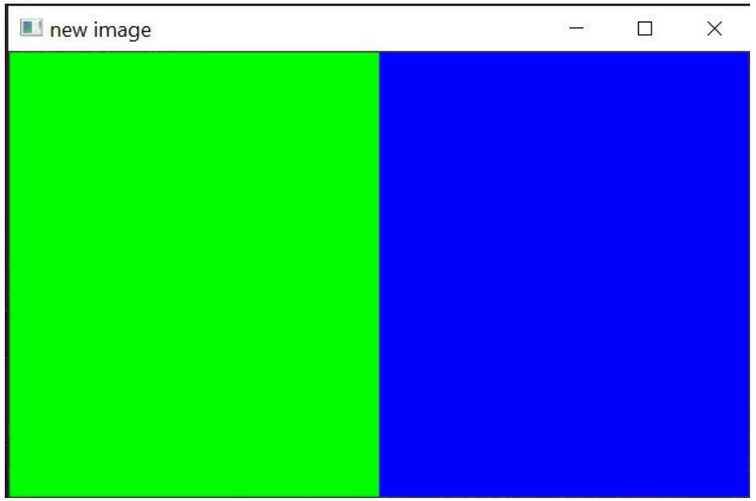
Creating Images

```python
import cv2

import numpy as np
nw_img = np.ones((300,500,3), dtype=np.uint8)
nw_img[:,0:250] = (0,255,0)
nw_img[:,250:500] = (255,0,0)
cv2.imshow("new image", nw_img)
cv2.waitKey(0)
cv2.destroyAllWindows()
```



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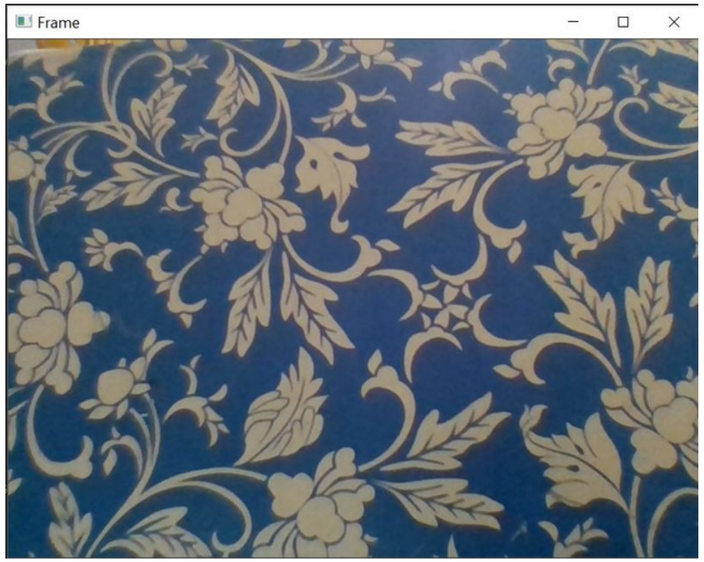
Reading Video

```python
import cv2
# Create an object to read from camera
video = cv2.VideoCapture(0)
# check if camera is opened previously or not
if (video.isOpened() == False):
    print("Error reading video file")

# set resolutions. so, convert them from float to integer.
frame_width = int(video.get(3))
frame_height = int(video.get(4))
size = (frame_width, frame_height)

# Below VideoWriter object will create a frame of above defined The output is stored in 'filename.avi' file.
result = cv2.VideoWriter('filename.avi',cv2.VideoWriter_fourcc(*'MJPG'),10, size)

while(True):
    ret, frame = video.read()

    if ret == True:
        # Write the frame into the file 'filename.avi'
        result.write(frame)
        # Display the frame saved in the file
        cv2.imshow('Frame', frame)
        # Press S on keyboard to stop the process
        if cv2.waitKey(1) & 0xFF == ord('s'):
            break
    # Break the loop
    else:
        break

# When everything done, release the video capture and video write objects
video.release()
result.release()
# Closes all the frames
cv2.destroyAllWindows()
```



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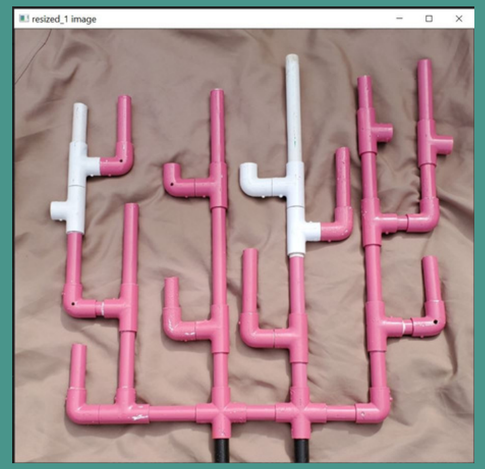
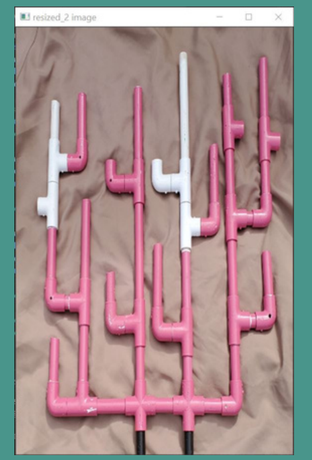
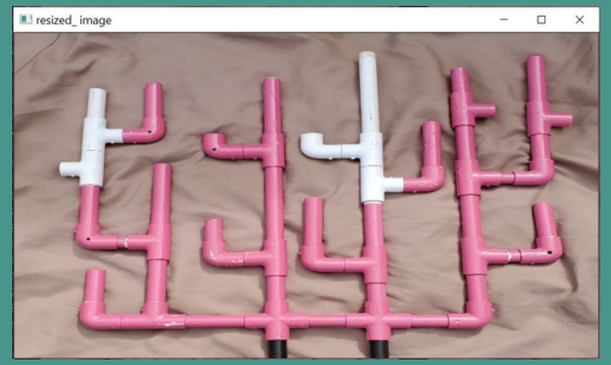
Resizing and Rescaling Frames

```python
import cv2

img = cv2.imread('D:/vortex/MATE 2023/training phase/ms2/opencv/opencv/coral3.jpg')

scale_percent = 60 # percent of original size
width = int(img.shape[1] * scale_percent / 100)
height = int(img.shape[0] * scale_percent / 100)
dim = (width, height)

# resize image
resized_1 = cv2.resize(img, dim)
cv2.imshow("resized_1 image", resized_1)

width = 440
dim = (width, height) # keep original height
resized_2 = cv2.resize(img, dim)

cv2.imshow("resized_2 image", resized_2)

width = int(img.shape[1] * scale_percent / 100)
height = 400
dim = (width, height) # keep original width
resized_3 = cv2.resize(img, dim)

cv2.imshow("resized_ image", resized_3)

cv2.waitKey(0)
cv2.destroyAllWindows()
```







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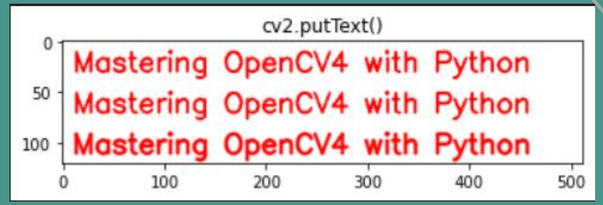
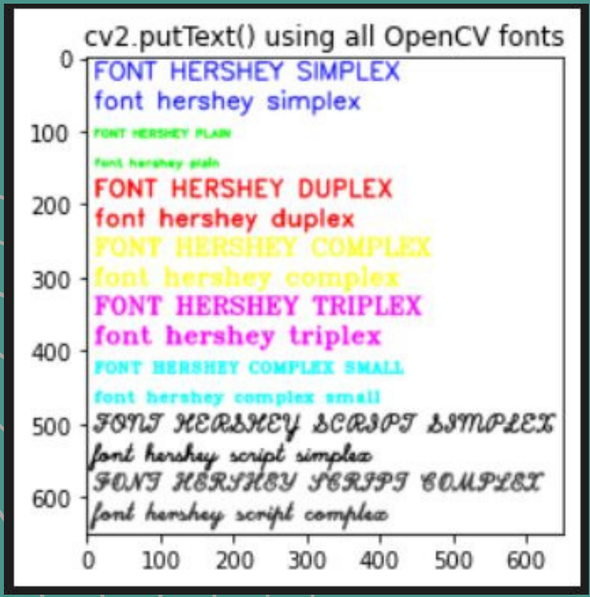
Putting Text

```
# We draw some text in the image:
cv2.putText(image, 'Mastering OpenCV4 with Python', (10, 30), cv2.FONT_HERSHEY_SIMPLEX, 0.9, colors['red'], 2, cv2.LINE_4)
cv2.putText(image, 'Mastering OpenCV4 with Python', (10, 70), cv2.FONT_HERSHEY_SIMPLEX, 0.9, colors['red'], 2, cv2.LINE_8)
cv2.putText(image, 'Mastering OpenCV4 with Python', (10, 110), cv2.FONT_HERSHEY_SIMPLEX, 0.9, colors['red'], 2, cv2.LINE_AA)
```






```
# Dictionary containing some strings to output:
fonts = {0: "FONT HERSHEY SIMPLEX", 1: "FONT HERSHEY PLAIN", 2: "FONT HERSHEY DUPLEX", 3: "FONT HERSHEY COMPLEX",
         4: "FONT HERSHEY TRIPLEX", 5: "FONT HERSHEY COMPLEX SMALL ", 6: "FONT HERSHEY SCRIPT SIMPLEX",
         7: "FONT HERSHEY SCRIPT COMPLEX"}
```

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Drawing Shapes with mouse events

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```python
# mouse callback function
def draw_circle(event, x, y, flags, param):
    """Mouse callback function"""

    global circles
    if event == cv2.EVENT_LBUTTONDBLCLK:
        # Add the circle with coordinates x,y
        print("event: EVENT_LBUTTONDBLCLK")
        circles.append((x, y))
    if event == cv2.EVENT_RBUTTONDBLCLK:
        # Delete all circles (clean the screen)
        print("event: EVENT_RBUTTONDBLCLK")
        circles[:] = []
    elif event == cv2.EVENT_RBUTTONDOWN:
        # Delete last added circle
        print("event: EVENT_RBUTTONDOWN")
        try:
            circles.pop()
        except (IndexError):
            print("no circles to delete")
```

```python
# Structure to hold the created circles:
circles = []
# We create the canvas to draw: 600 x 600 pixels, 3 channels, uint8 (8-bit unsigned integers)
# We set the background to black using np.zeros():
image = np.zeros((600, 600, 3), dtype="uint8")
# We create a named window where the mouse callback will be established:
cv2.namedWindow('Image mouse')
# We set the mouse callback function to 'draw_circle':
cv2.setMouseCallback('Image mouse', draw_circle)
# We draw the menu:
draw_text()
# We get a copy with only the text printed in it:
clone = image.copy()

while True:
    # We 'reset' the image (to get only the image with the printed text):
    image = clone.copy()
    # We draw now only the current circles:
    for pos in circles:
        # We print the circle (filled) with a  fixed radius (30):
        cv2.circle(image, pos, 30, colors['blue'], -1)
    # Show image 'Image mouse':
    cv2.imshow('Image mouse', image)
    key = cv2.waitKey(1)
    # Continue until 'q' is pressed:
    if key == ord('q') or key == ord("Q"):
        break
# Destroy all generated windows:
cv2.destroyAllWindows()
```

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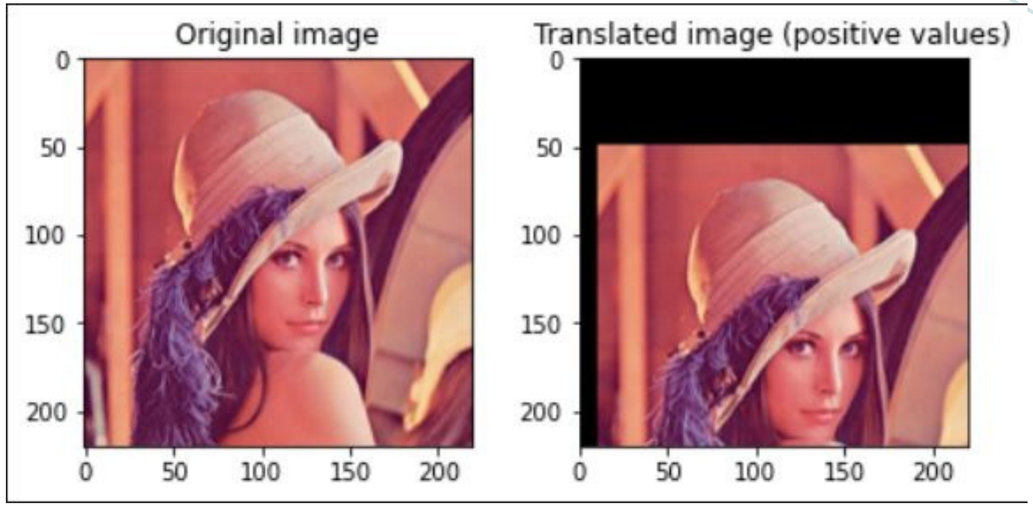
Geometric transformations of images

Translation

```python
# Import required packages:
import cv2
import matplotlib.pyplot as plt
import numpy as np


def show_with_matplotlib(color_img, title, pos):
    """Shows an image using matplotlib capabilities"""

    # Convert BGR image to RGB
    img_RGB = color_img[:, :, ::-1]
    plt.subplot(1, 2, pos)
    plt.imshow(img_RGB)
    plt.title(title)
    plt.tight_layout(w_pad=2)
    #plt.axis('off')


# Read the input image:
image = cv2.imread('assets\images\lenna.png')

# Show loaded image:
show_with_matplotlib(image, 'Original image', 1)
height, width = image.shape[:2]

M = np.float32([[1, 0, 10], [0, 1, 50]])

# Once this transformation Matrix is created, we can pass it to the function cv2.warpAffine():
dst_image = cv2.warpAffine(image, M, (width, height))

# Show the translated image:
show_with_matplotlib(dst_image, 'Translated image (positive values)', 2)
```



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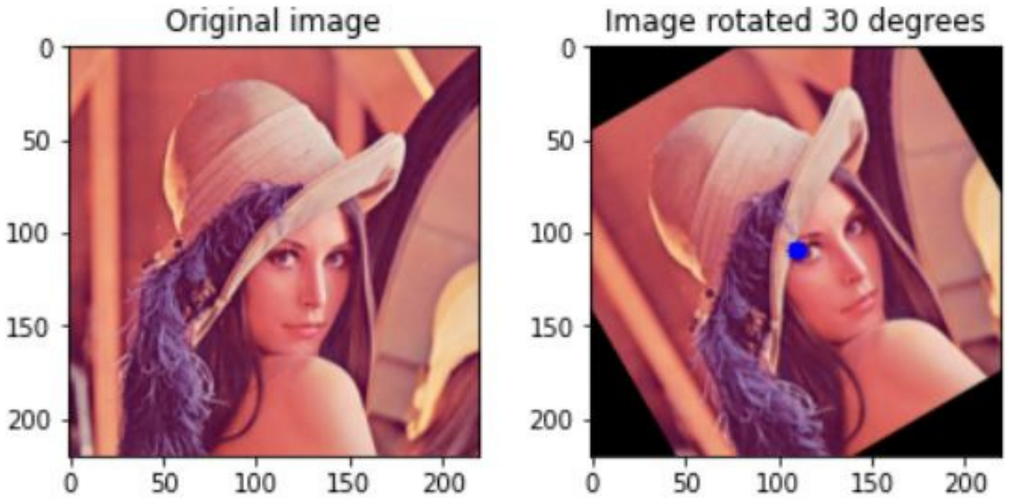
Geometric transformations of images

Rotating

```python
# Import required packages:
import cv2
import matplotlib.pyplot as plt
import numpy as np


def show_with_matplotlib(color_img, title, pos):
    """Shows an image using matplotlib capabilities"""

    # Convert BGR image to RGB
    img_RGB = color_img[:, :, ::-1]
    plt.subplot(1, 2, pos)
    plt.imshow(img_RGB)
    plt.title(title)
    plt.tight_layout(w_pad=2)
    #plt.axis('off')


# Read the input image:
image = cv2.imread('assets\images\lenna.png')
height, width = image.shape[:2]
# Show loaded image:
show_with_matplotlib(image, 'Original image', 1)

M = cv2.getRotationMatrix2D((width / 2.0, height / 2.0), 30, 1)
dst_image = cv2.warpAffine(image, M, (width, height))

# Show the center of rotation and the rotated image:
cv2.circle(dst_image, (round(width / 2.0), round(height / 2.0)), 5, (255, 0, 0), -1)
show_with_matplotlib(dst_image, 'Image rotated 30 degrees', 2)
```



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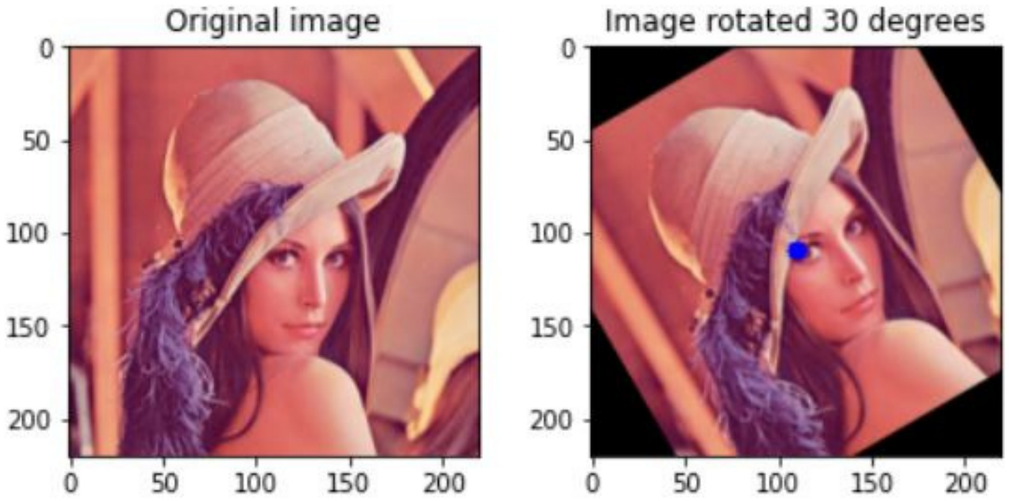
Geometric transformations of images

Perespective Transform

```python
# Import required packages:
import cv2
import matplotlib.pyplot as plt
import numpy as np


def show_with_matplotlib(color_img, title, pos):
    """Shows an image using matplotlib capabilities"""

    # Convert BGR image to RGB
    img_RGB = color_img[:, :, ::-1]
    plt.subplot(1, 2, pos)
    plt.imshow(img_RGB)
    plt.title(title)
    plt.tight_layout(w_pad=2)
    #plt.axis('off')


# Read the input image:
image = cv2.imread('assets\images\lenna.png')
height, width = image.shape[:2]
# Show loaded image:
show_with_matplotlib(image, 'Original image', 1)

M = cv2.getRotationMatrix2D((width / 2.0, height / 2.0), 30, 1)
dst_image = cv2.warpAffine(image, M, (width, height))

# Show the center of rotation and the rotated image:
cv2.circle(dst_image, (round(width / 2.0), round(height / 2.0)), 5, (255, 0, 0), -1)
show_with_matplotlib(dst_image, 'Image rotated 30 degrees', 2)
```



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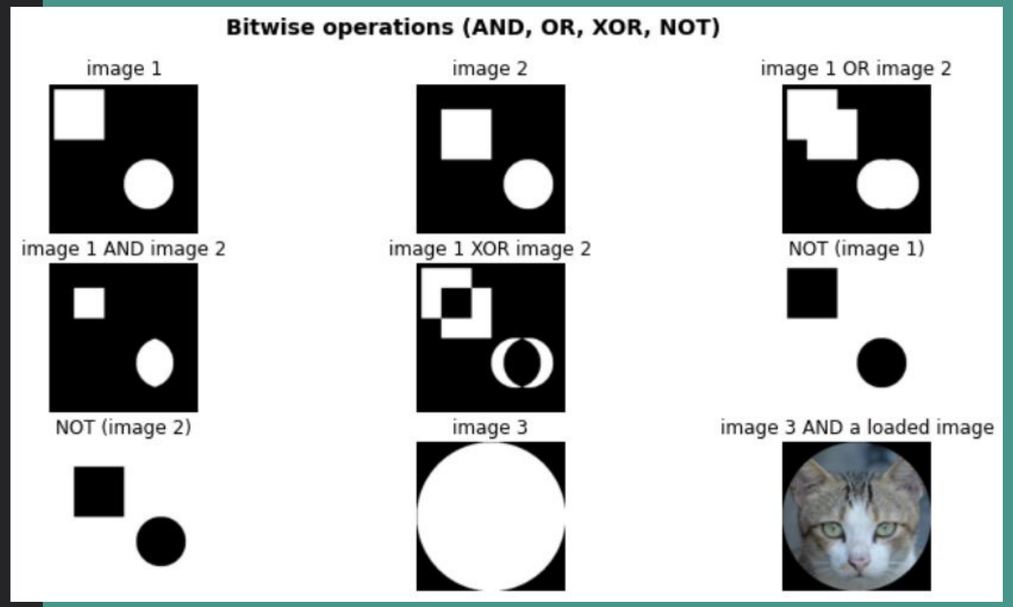
BITWISE operations GrayScale Images

```python
img_1 = np.zeros((300, 300), dtype="uint8")# Create the first image:
cv2.rectangle(img_1, (10, 10), (110, 110), (255, 255, 255), -1)
cv2.circle(img_1, (200, 200), 50, (255, 255, 255), -1)

img_2 = np.zeros((300, 300), dtype="uint8")# Create the second image:
cv2.rectangle(img_2, (50, 50), (150, 150), (255, 255, 255), -1)
cv2.circle(img_2, (225, 200), 50, (255, 255, 255), -1)

bitwise_or = cv2.bitwise_or(img_1, img_2)# Bitwise OR
bitwise_and = cv2.bitwise_and(img_1, img_2)# Bitwise AND
bitwise_xor = cv2.bitwise_xor(img_1, img_2)# Bitwise XOR
bitwise_not_1 = cv2.bitwise_not(img_1)# Bitwise NOT
bitwise_not_2 = cv2.bitwise_not(img_2)# Bitwise NOT

# Display all the resulting images:
show_with_matplotlib(cv2.cvtColor(img_1, cv2.COLOR_GRAY2BGR), "image 1", 1)
show_with_matplotlib(cv2.cvtColor(img_2, cv2.COLOR_GRAY2BGR), "image 2", 2)
show_with_matplotlib(cv2.cvtColor(bitwise_or, cv2.COLOR_GRAY2BGR), "image 1 OR image 2", 3)
show_with_matplotlib(cv2.cvtColor(bitwise_and, cv2.COLOR_GRAY2BGR), "image 1 AND image 2", 4)
show_with_matplotlib(cv2.cvtColor(bitwise_xor, cv2.COLOR_GRAY2BGR), "image 1 XOR image 2", 5)
show_with_matplotlib(cv2.cvtColor(bitwise_not_1, cv2.COLOR_GRAY2BGR), "NOT (image 1)", 6)
show_with_matplotlib(cv2.cvtColor(bitwise_not_2, cv2.COLOR_GRAY2BGR), "NOT (image 2)", 7)

# See how these operations can be used to work with images:
image = cv2.imread('assets\images\cat.png')# Load the original image:

img_3 = np.zeros((300, 300), dtype="uint8")# Create the image to be used as mask:
cv2.circle(img_3, (150, 150), 150, (255, 255, 255), -1)

bitwise_and_example = cv2.bitwise_and(image, image, mask=img_3)# Bitwise AND using the img_3 as mask:

# Show these two images:
show_with_matplotlib(cv2.cvtColor(img_3, cv2.COLOR_GRAY2BGR), "image 3", 8)
show_with_matplotlib(bitwise_and_example, "image 3 AND a loaded image", 9)
```



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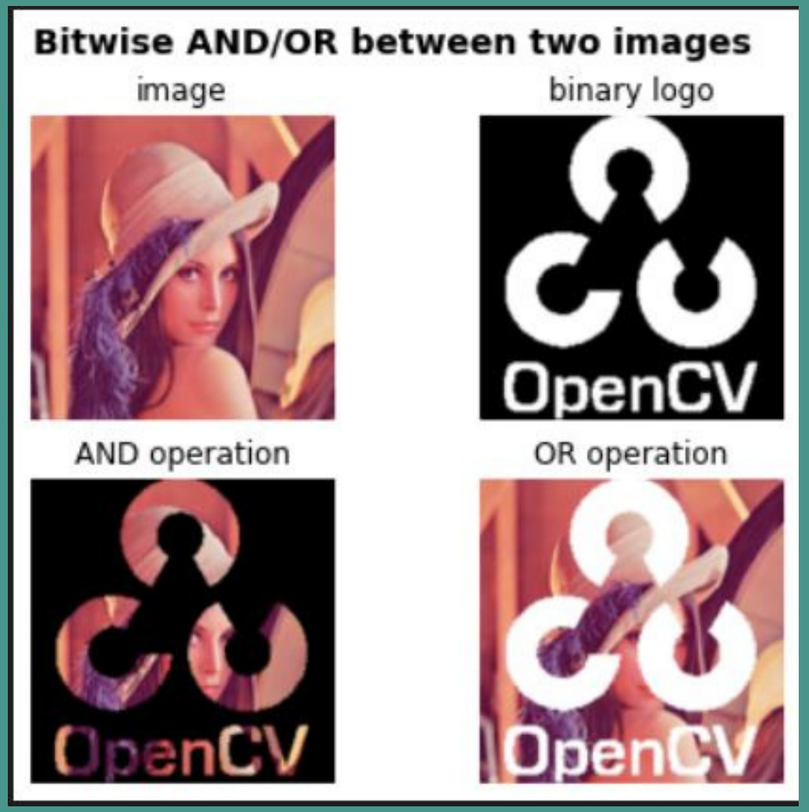
BITWISE operations Colored Images

```
# Create the dimensions of the figure and set title:
plt.figure(figsize=(6, 5))
plt.suptitle("Bitwise AND/OR between two images", fontsize=14, fontweight='bold')

# Load the original image (250x250):
image = cv2.imread('assets\images\lenna.png')
image = cv2.resize(image, (250, 250))
# Load the binary image (but as a GBR color image - with 3 channels) (250x250):
binary_image = cv2.imread('assets\images\opencv_binary.png')

# Bitwise AND
bitwise_and = cv2.bitwise_and(image, binary_image)

# Bitwise OR
bitwise_or = cv2.bitwise_or(image, binary_image)

# Display all the resulting images:
show_with_matplotlib(image, "image", 1)
show_with_matplotlib(binary_image, "binary logo", 2)
show_with_matplotlib(bitwise_and, "AND operation", 3)
show_with_matplotlib(bitwise_or, "OR operation", 4)

# Show the Figure:
plt.show()
```



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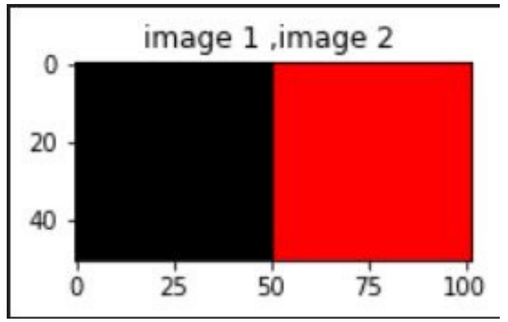
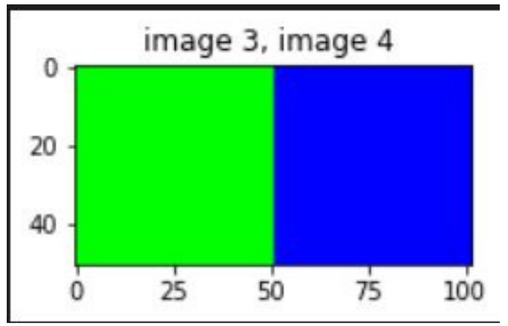
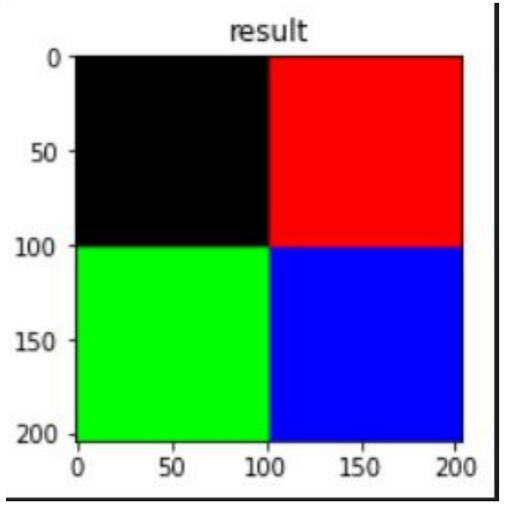
Assignments Task 1

```python
import cv2
import matplotlib.pyplot as plt
import numpy as np

def show_with_matplotlib(color_img, title):
    plt.figure(figsize=(3, 3))
    img_RGB = color_img[:, :, ::-1]
    plt.imshow(color_img)
    plt.title(title)
    plt.show()

image_1 = np.full((51, 51, 3), (0, 0, 0), dtype= np.uint8)
image_2 = np.full((51, 51, 3), (255, 0, 0), dtype= np.uint8)
image_3 = np.full((51, 51, 3), (0, 255, 0), dtype= np.uint8)
image_4 = np.full((51, 51, 3), (0, 0, 255), dtype= np.uint8)

vert1 = np.concatenate((image_1, image_2), axis= 1)
vert2 = np.concatenate((image_3, image_4), axis= 1)

result = np.concatenate((vert1, vert2), axis= 0)

width, height = result.shape[:2]

result = cv2.resize(result, (width * 2, height * 2), interpolation=cv2.INTER_LINEAR)

show_with_matplotlib(vert1, "image 1 ,image 2 ")
show_with_matplotlib(vert2, "image 3, image 4 ")
show_with_matplotlib(result, "result")
```







VORTEX ACADEMY
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Assignments

Task 2

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```python
import cv2
video = cv2.VideoCapture(0)# Create an object to read from camera

if (video.isOpened() == False):# check if camera is opened previously or not
    print("Error reading video file")

frame_width = int(video.get(3))# set resolutions. so, convert them from float to integer.
frame_height = int(video.get(4))
size_video = (frame_width, frame_height)

# Below VideoWriter object will create a frame of above defined The output is stored in 'filename.avi' file.
result = cv2.VideoWriter('savedVideo.avi',cv2.VideoWriter_fourcc(*'MJPG'),10, size_video)

switch, count = "z", 0
while(True):
    ret, frame = video.read()

    frame_rotated = cv2.rotate(frame,cv2.ROTATE_90_COUNTERCLOCKWISE)
    frame_gray = cv2.cvtColor(frame, cv2.COLOR_RGB2GRAY)
    frame_hsv = cv2.cvtColor(frame, cv2.COLOR_RGB2HSV)

    if ret == True:
            key = cv2.waitKey(1)

            if switch == "z": cv2.imshow('Frame', frame)

            if key == ord("q") or key == ord('Q'): break

            if key == ord("r") or key == ord("R"):
                switch = "r"
                cv2.destroyAllWindows()

            if key == ord("c") or key == ord("C"):
                switch = "c"
            if key == ord("S") or key == ord("s"):
                switch = "s"
                cv2.destroyAllWindows()
            if key == ord("h") or key == ord("H"):
                switch = "h"
                cv2.destroyAllWindows()
            if key == ord("g") or key == ord("G"):
                switch = "g"
                cv2.destroyAllWindows()
            if key == ord("z") or key == ord("Z"):
                switch = "z"
                cv2.destroyAllWindows()
            if key == ord("x") or key == ord("X"):
                switch = "x"
                cv2.destroyAllWindows()

            if switch == "r" :cv2.imshow("ROTATE_90", frame_rotated)

            if switch == "c":
                count += 1
                path = 'saved frames/'+ str(count) + '.png'
                cv2.imwrite(path, frame)
                switch = 'z'

            if switch == "h": cv2.imshow('frame_hsv', frame_hsv)

            if switch == "x":
                cv2.imshow('Frame', frame)
                cv2.imshow('frame_rotated', frame_rotated)
                cv2.imshow('frame_hsv', frame_hsv)
                cv2.imshow('Frame_gray', frame_gray)

            if switch == "g": cv2.imshow('Frame_gray', frame_gray)

            if switch == "s":
                result.write(frame) # Write the frame into the file 'filename.avi'
                cv2.imshow('Frame', frame)

# When everything done, release the video capture and video write objects
video.release()
result.release()
cv2.destroyAllWindows() # Closes all the frames
```

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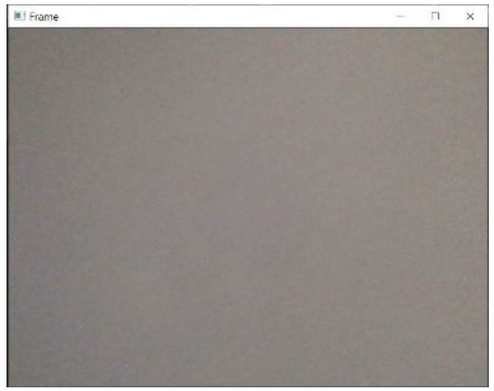
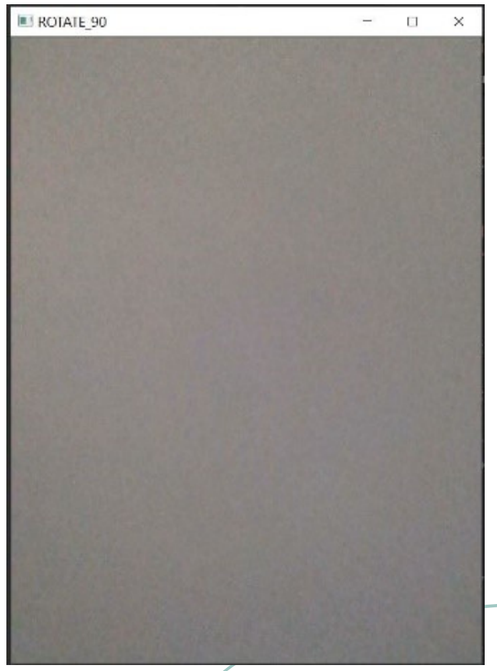
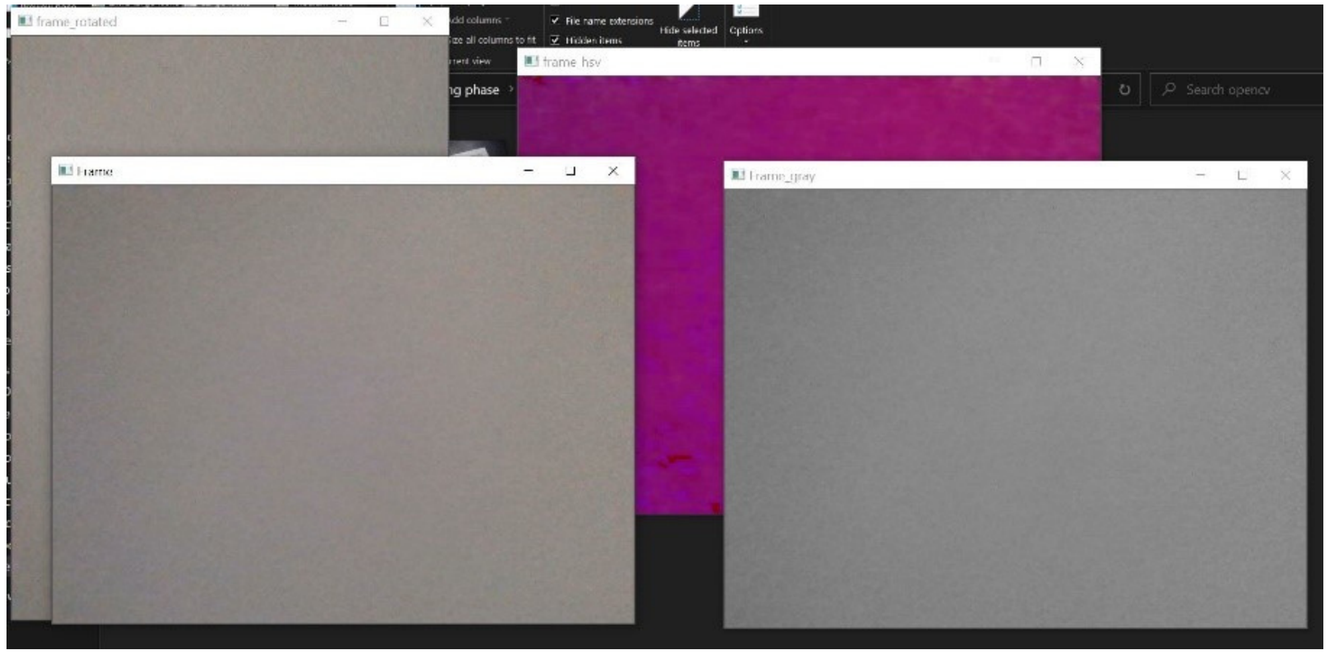
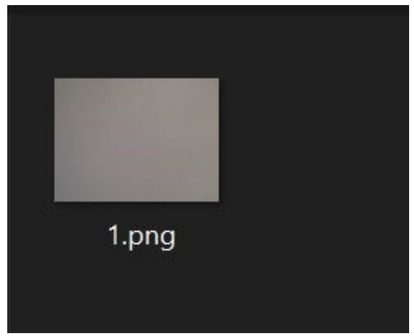
Assignments

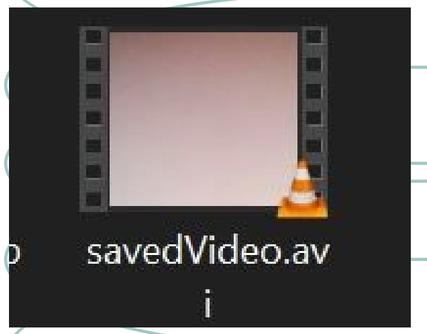
Task 2











Assignments

Task 3

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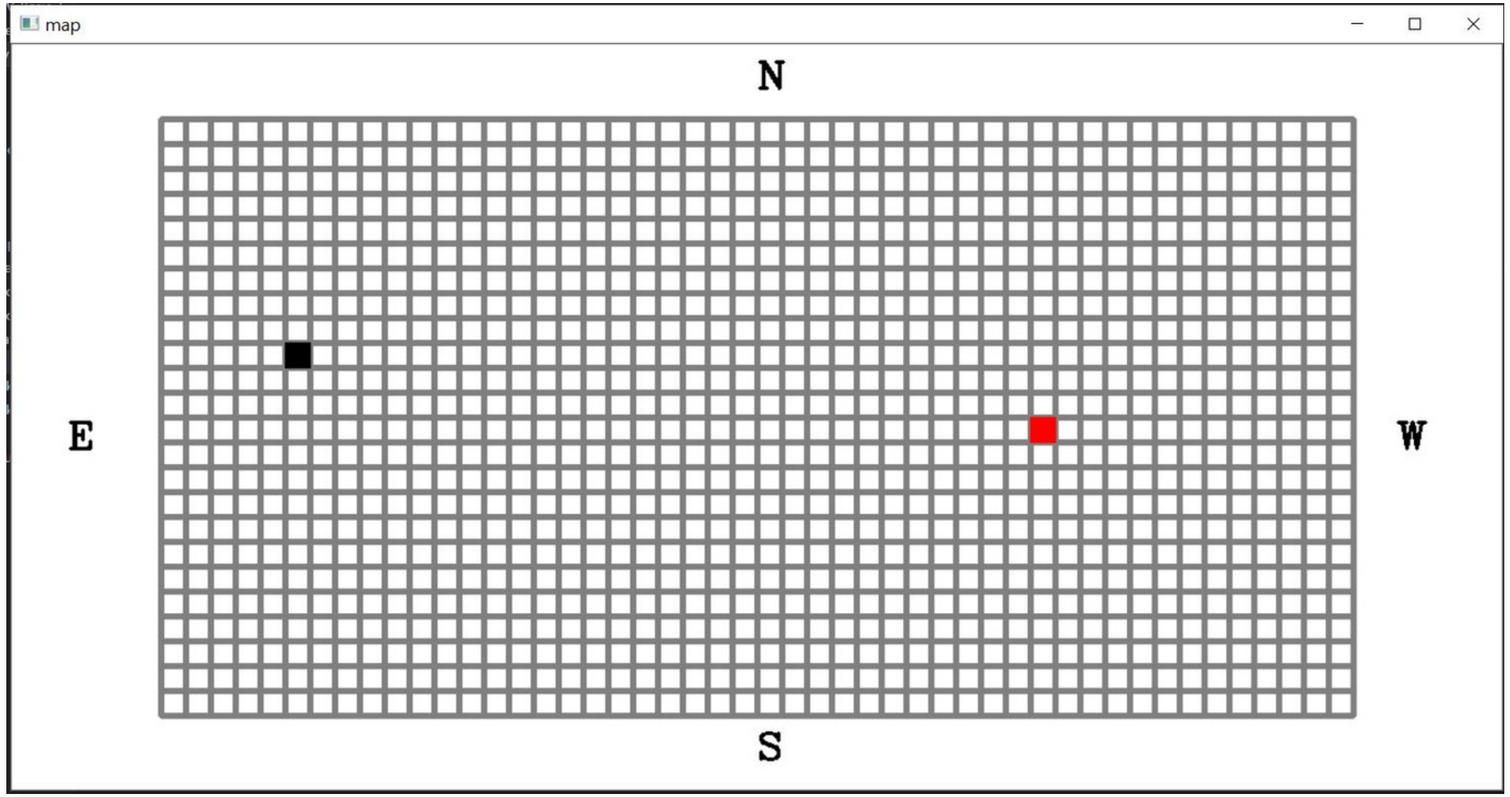
```python
import cv2
import numpy as np

font=cv2.FONT_HERSHEY_COMPLEX

class FloatMap:
    def __init__(self) -> None:
        self.map = self.draw_map()
        self.cells_locations = []
        self.get_cells_locations()
        cv2.rectangle(self.map, *self.cells_locations[9][5], (0, 0, 0), -1)

    def draw_map(self):
        grid_image = np.ones((600, 1200, 3), dtype=np.uint8)*255

        for j in range(60, 560, 20):
            cv2.line(grid_image, (120, j), (1080, j), (128, 128, 128), 3)

        for i in range(120, 1100, 20):
            cv2.line(grid_image, (i, 60), (i,540), (128, 128, 128), 3)

        cv2.putText(grid_image,"W",(1115,325),font,1,0,2)
        cv2.putText(grid_image,"E",(45,325),font,1,0,2)
        cv2.putText(grid_image,"N",(600,35),font,1,0,2)
        cv2.putText(grid_image,"S",(600,575),font,1,0,2)

        return grid_image

    def get_cells_locations(self):
        for i in range(60, 540, 20):
            current_locations = []
            for j in range(120, 1080, 20):
                current_locations.append([(j, i), (j+20, i+20)])
            self.cells_locations.append(current_locations)

```

```python
class FloatDestination:
    def __init__(self, speed, direction, time) -> None:
        self.distance = speed*time*60*60
        self.y = self.distance*np.cos(direction*np.pi/180.)
        self.x = self.distance*np.sin(direction*np.pi/180.)

        self.y_direction = "north" if self.y > 0 else "south"
        self.x_direction = "east" if self.x > 0 else "west"

        self.distance = np.round(self.distance/1000, 3)
        self.y = np.round(abs(self.y)/1000, 2)
        self.x = np.round(abs(self.x)/1000, 2)


        self.y_delta = int(np.round(self.y/2))
        self.x_delta = int(np.round(self.x/2))

        self.new_y = 9 - self.y_delta if self.y_direction == "north" else 9 + self.y_delta
        self.new_x = 5 + self.x_delta if self.x_direction == "east" else 5 - self.x_delta

    def get_destination(self):
        return self.new_x, self.new_y


float_map = FloatMap()
float_map_image = float_map.map

speed = float(input("Enter the speed: "))
angle = float(input("Enter the angle: "))
time = float(input("Enter the time: "))

float_map_cells = float_map.cells_locations
x, y = FloatDestination(speed, angle, time).get_destination()

cv2.rectangle(float_map_image, *float_map_cells[y][x], (0, 0, 255), -1)

cv2.imshow("map", float_map_image)
cv2.waitKey(0)
cv2.destroyAllWindows()
```

Assignments Task 3

```
PS D:\vortex\MATE 2023\training phase\ms2\OpenCV2> python -u "d:\vortex\MATE 2023\training phase\ms2\OpenCV2\float.py"
Enter the speed: 0.117
Enter the angle: 96
Enter the time: 144
```



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Assignments Task 4

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```python
import cv2
import numpy as np

colors = {'blue': (255, 0, 0), 'green': (0, 255, 0), 'red': (0, 0, 255), 'yellow': (0, 255, 255),
          'magenta': (255, 0, 255), 'cyan': (255, 255, 0), 'white': (255, 255, 255), 'black': (0, 0, 0),
          'gray': (125, 125, 125), 'rand': np.random.randint(0, high=256, size=(3,)).tolist(),
          'dark_gray': (50, 50, 50), 'light_gray': (220, 220, 220)}

def draw_text():
    menu_pos = (10, 500)
    menu_pos2 = (10, 525)
    menu_pos3 = (10, 550)
    menu_pos4 = (10, 575)

    cv2.putText(image, 'Double left click: add a circle', menu_pos, cv2.FONT_HERSHEY_SIMPLEX, 0.7, (255, 255, 255))
    cv2.putText(image, 'Simple right click: delete last circle', menu_pos2, cv2.FONT_HERSHEY_SIMPLEX, 0.7, (255, 255, 255))
    cv2.putText(image, 'Double right click: delete all circle', menu_pos3, cv2.FONT_HERSHEY_SIMPLEX, 0.7,(255, 255, 255))
    cv2.putText(image, 'Press \'q\' to exit', menu_pos4, cv2.FONT_HERSHEY_SIMPLEX, 0.7, (255, 255, 255))

# mouse callback function
def draw_circle(event, x, y, flags, param):
    """Mouse callback function"""

    global circles
    if event == cv2.EVENT_LBUTTONDBLCLK:
        circles.append((x, y))
    if event == cv2.EVENT_RBUTTONDBLCLK:
        circles[:] = []
    elif event == cv2.EVENT_RBUTTONDOWN:
        try:
            circles.pop()
        except (IndexError):
            print("no circles to delete")
    # if event == cv2.EVENT_MOUSEMOVE:
    #     print("event: EVENT_MOUSEMOVE")
    # if event == cv2.EVENT_LBUTTONUP:
    #     print("event: EVENT_LBUTTONUP")
    # if event == cv2.EVENT_LBUTTONDOWN:
    #     print("event: EVENT_LBUTTONDOWN")
```

```python
circles = []

image = np.zeros((600, 600, 3), dtype="uint8")

cv2.namedWindow('Image mouse')

cv2.setMouseCallback('Image mouse', draw_circle)

draw_text()

clone = image.copy()

while True:

    image = clone.copy()

    for pos in circles:
        cv2.circle(image, pos, 30, colors['blue'], -1)

    cv2.imshow('Image mouse', image)

    key = cv2.waitKey(1)
    if key == ord('q') or key == ord("Q"):
        break

cv2.destroyAllWindows()
```

Assignments Task 4

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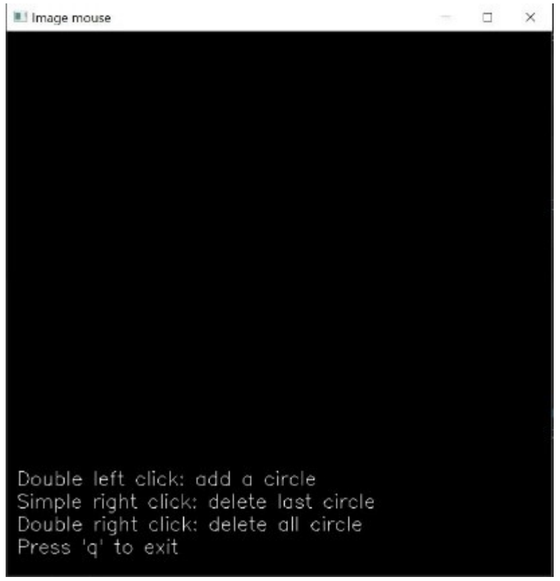
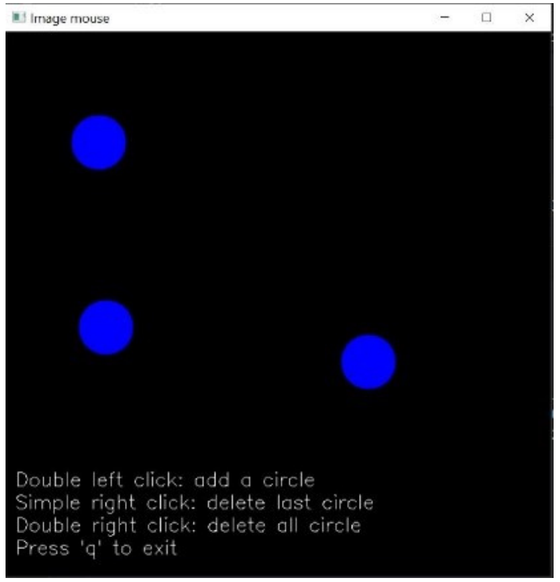
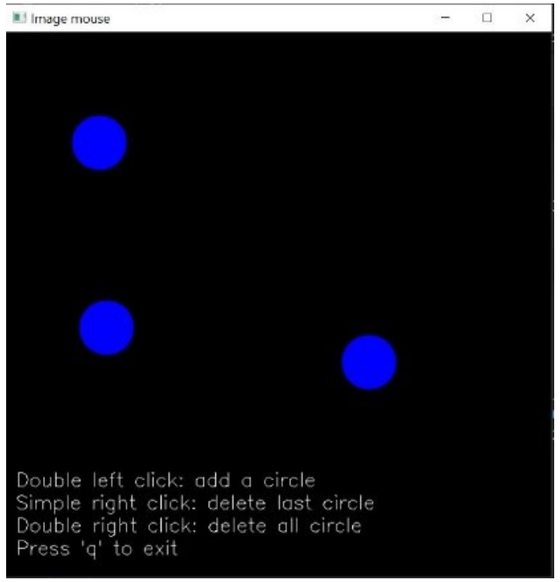
Output



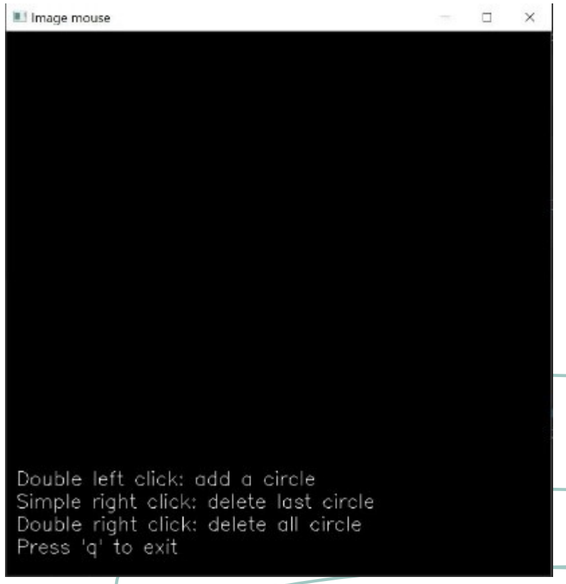
Double left click 3 times



Simple right click 1 time



double right click



Assignments

Task 5 [Order is a must]

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```python
import numpy as np
import cv2

jhonsmith=cv2.imread("jhonsmith.jpg")
jhonsmith = cv2.resize(jhonsmith, (450,250))
h, w, c = jhonsmith.shape

circles=[]
counter=0
text=""

def draw_circle(event, x, y, flags, param):

    global circles, counter
    try:
        if event==cv2.EVENT_LBUTTONDOWN:
            circles.append((x, y))
            counter+=1
    except IndexError:
        print("only 4 points")

    if event == cv2.EVENT_RBUTTONDBLCLK: # Delete all circles
        circles[:] = []
        counter = 0

    elif event == cv2.EVENT_RBUTTONDOWN: # Delete last added circle
        try:
            circles.pop()
            counter-=1
        except (IndexError):
            print("no circles to delete")

dst_image = clone = jhonsmith.copy()

cv2.namedWindow('jhonsmith')
cv2.setMouseCallback('jhonsmith', draw_circle)
```

```python
while True:
    image = clone.copy()
    key=cv2.waitKey(1)
    for pos in circles:
        cv2.circle(image,pos,3,(0,0,255),-1)

    if counter==4:
        points1=np.float32([circles[0],circles[1],circles[2],circles[3]])
        points2=np.float32([[0,0],[w,0],[0,h],[w,h]])
        matrix=cv2.getPerspectiveTransform(points1,points2)
        dst_image=cv2.warpPerspective(jhonsmith,matrix,(w,h))

    if counter==0:
            text="choose upper left point"
            cv2.putText(image,text,(10,20),cv2.FONT_HERSHEY_SIMPLEX,0.6,(255,255,255),1)

    if counter==1:
        text="choose upper right point"
        cv2.putText(image,text,(10,20),cv2.FONT_HERSHEY_SIMPLEX,0.6,(255,255,255),1)

    if counter==2:
        text="choose lower left point"
        cv2.putText(image,text,(10,20),cv2.FONT_HERSHEY_SIMPLEX,0.6,(255,255,255),1)

    if counter==3:
        text="choose lower right point"
        cv2.putText(image,text,(10,20),cv2.FONT_HERSHEY_SIMPLEX,0.6,(255,255,255),1)

    im_v = cv2.vconcat([image, dst_image])
    cv2.imshow("jhonsmith", im_v)

    if key== ord('Q') or key== ord('q'):
        break

cv2.destroyAllWindows()
```

Assignments

Task 5 [Order is a must]

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Output

Simple left click 1 time

Simple left click 2 times

Simple left click 3 times

Simple left click 4 times

Simple right click 1 time

Simple right click 2 times

Simple left click 4 times

Double right click

Simple left click 4 times

Assignments

Task 5 [Order doesn't matter]

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```python
import cv2
import numpy as np
import matplotlib.pyplot as plt

myPoints, c =[], 0

def mouse(event,x,y,flag,params):
    global c
    if event == cv2.EVENT_LBUTTONDOWN:
        myPoints.append((x,y))
        c+=1
    if event == cv2.EVENT_RBUTTONDBLCLK: # Delete all circles
        myPoints[:] = []
        c=0
    elif event == cv2.EVENT_RBUTTONDOWN: # Delete last added circle
        try:
            myPoints.pop()
            c-=1
        except (IndexError):
            print("no points to delete")

def reorder():
    x,y=0,0
    mx=1e9
    newPoints = []
    for i in myPoints:
        if i[0]+i[1]<mx:
            mx = i[0]+i[1]
            x,y = i[0],i[1]
    newPoints.append((x,y))

    mx=0
    for i in myPoints:
        if i[0]-i[1]>mx:
            mx = i[0]-i[1]
            x,y = i[0],i[1]
    newPoints.append((x,y))
    mx=1e9
    for i in myPoints:
        if i[0]-i[1]<mx:
            mx = i[0]-i[1]
            x,y = i[0],i[1]
    newPoints.append((x,y))

    mx=0
    for i in myPoints:
        if i[0]+i[1]>mx:
            mx=i[0]+i[1]
            x,y=i[0],i[1]
    newPoints.append((x,y))
    return newPoints

jhonsmith = cv2.imread("jhonsmith.jpg")
jhonsmith = cv2.resize(jhonsmith, (450,250))

width = jhonsmith.shape[1]
height = jhonsmith.shape[0]

cv2.namedWindow('jhonsmith')
cv2.setMouseCallback("jhonsmith", mouse)
warp = copy = jhonsmith.copy()
while True:
    copy = jhonsmith.copy()
    key = cv2.waitKey(1)
    for pos in myPoints: cv2.circle(copy, pos, 3 ,(0,0,255),-1)

    im_v = cv2.vconcat([copy, warp])
    cv2.imshow("jhonsmith", im_v)
    try:
        if c==4:
            myPoints = reorder()
            pts1 = np.float32(myPoints)
            pts2 = np.float32([[0, 0],[width, 0], [0, height],[width, height]])
            matrix = cv2.getPerspectiveTransform(pts1, pts2)
            warp = cv2.warpPerspective(jhonsmith, matrix, (width, height))
    except: pass
    if key ==ord('q') or key ==ord('Q'):
        cv2.destroyAllWindows()
        break
```

Assignments

Task 5 [Order doesn't matter]

Output

Simple left click 1 time

Simple left click 2 times

Simple left click 3 times

Simple left click 4 times

Double right click

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Assignments Task 6 [Manual]

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```python
import cv2
import numpy as np

original = cv2.imread("coral3.jpg")
original = cv2.resize(original, (350,350))

img_to_compare = cv2.imread("coral4.jpg")
img_to_compare = cv2.resize(img_to_compare, (500,500))

image = np.zeros_like(original)
image =cv2.resize(image,(1100,600))

img = img_to_compare[:, :, ]
top_corner = img[0:1000, 0:1000]
image[50:550, 50:550] = top_corner

img = original[:, :, ]
down_corner = img[0:1000, 0:1000]
image[50:400, 655:1005] = down_corner

def draw_text(image):
    menu_pos1 = (590, 450)
    menu_pos2 = (590, 475)
    menu_pos3 = (590, 500)
    menu_pos4 = (590, 525)

    cv2.putText(image, 'Simple left click and drag: add a Blue rectangle', menu_pos1, cv2.FONT_HERSHEY_SIMPLEX, 0.6, (255, 255, 255))
    cv2.putText(image, 'Simple right click and drag: add a Green rectangle', menu_pos2, cv2.FONT_HERSHEY_SIMPLEX, 0.6, (255, 255, 255))
    cv2.putText(image, 'Press \'D\': clear the screen', menu_pos3, cv2.FONT_HERSHEY_SIMPLEX, 0.6,(255, 255, 255))
    cv2.putText(image, 'Press \'q\': to exit', menu_pos4, cv2.FONT_HERSHEY_SIMPLEX, 0.6, (255, 255, 255))


draw = False
ix, iy = -1, -1
```

```python
def rectangle_shape(event, x, y, flags, param):
    global ix,iy,draw

    if event == cv2.EVENT_LBUTTONDOWN:
        draw =True
        ix, iy = x, y

    elif event == cv2.EVENT_LBUTTONUP:
        draw =False
        color = (255, 0, 0)
        cv2.rectangle(image, (ix, iy), (x, y), color, 3)

    if event == cv2.EVENT_RBUTTONDOWN:
        draw =True
        ix, iy = x, y

    elif event == cv2.EVENT_RBUTTONUP:
        draw =False
        color = (0, 255, 0)
        cv2.rectangle(image, (ix, iy), (x, y), color, 3)


draw_text(image)
clone = image.copy()

cv2.namedWindow("the health of a coral colony")
cv2.setMouseCallback("the health of a coral colony", rectangle_shape)


while True:
    cv2.imshow("the health of a coral colony", image)

    key =cv2.waitKey(1)

    if key == ord('D') or key == ord("d"):
        image = clone.copy()

    elif key == ord('q') or key == ord("Q"):
        cv2.destroyAllWindows()
        break
```

Assignments Task 6 [Manual]

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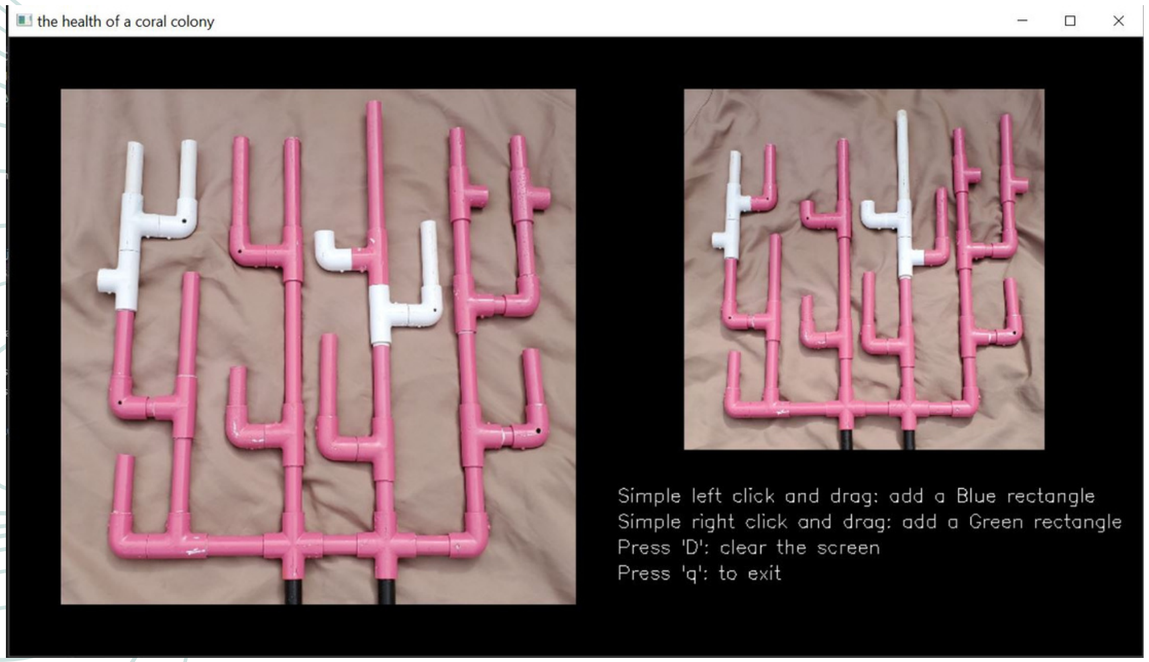

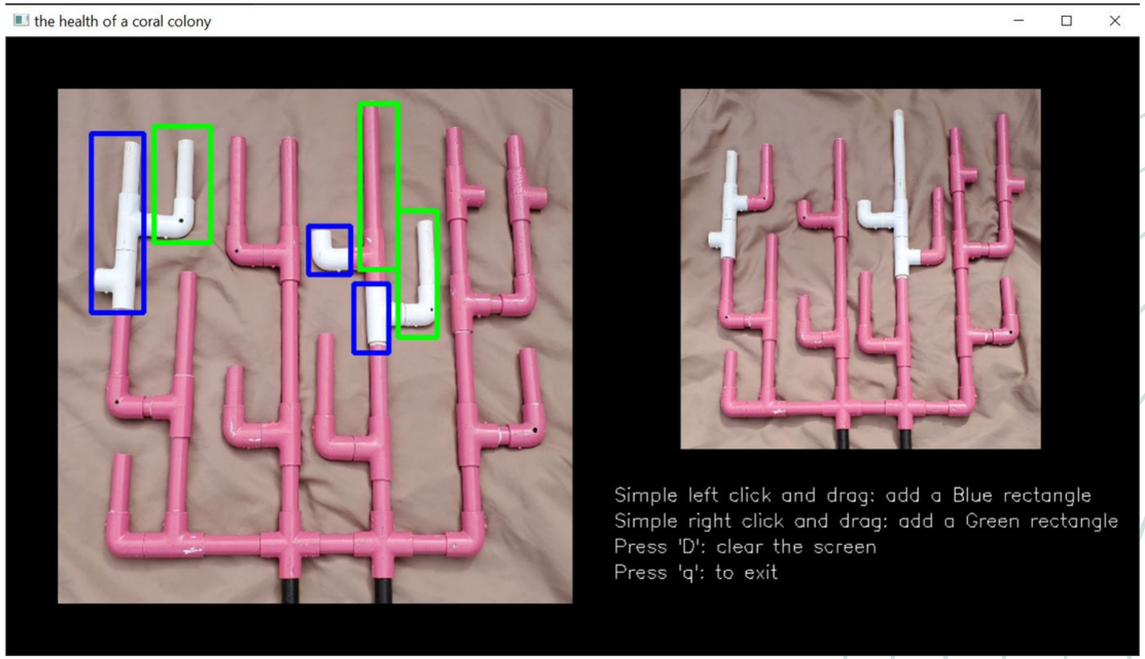

Assignments Task 6 [Autonomous]

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```python
import cv2
import numpy as np
import imutils
image = cv2.imread("coral3.jpg")
image = cv2.resize(image, (500, 500))
hsv_image = cv2.cvtColor(image, cv2.COLOR_BGR2HSV)
frame = cv2.imread("coral4.jpg")
frame = cv2.resize(frame, (500,500))
hsv_frame = cv2.cvtColor(frame, cv2.COLOR_BGR2HSV)

lower = np.array([16, 0, 0], dtype = "uint8")
upper = np.array([180, 255, 255], dtype = "uint8")

mask_image = cv2.inRange(hsv_image, lower, upper)
no_background_image = cv2.bitwise_and(hsv_image, hsv_image, mask = mask_image)
no_background_image = cv2.cvtColor(no_background_image, cv2.COLOR_HSV2BGR)

mask_frame = cv2.inRange(hsv_frame, lower, upper)
no_background_frame = cv2.bitwise_and(hsv_frame, hsv_frame, mask = mask_frame)
no_background_frame = cv2.cvtColor(no_background_frame, cv2.COLOR_HSV2BGR)

gray_image = cv2.cvtColor(no_background_image,cv2.COLOR_BGR2GRAY)
gray_frame = cv2.cvtColor(no_background_frame,cv2.COLOR_BGR2GRAY)

#=========================================================

sift = cv2.SIFT_create()
kp_image, desc_image = sift.detectAndCompute(gray_image,None)

FLANN_INDEX_KDTREE = 0
index_params = dict(algorithm = FLANN_INDEX_KDTREE, trees = 5)
search_params = dict(checks=30)

kp_gray_frame, desc_frame = sift.detectAndCompute(gray_frame, None)

flann = cv2.FlannBasedMatcher(index_params,search_params)
matches = flann.knnMatch(desc_image,desc_frame,k=2)

good_points = []
for m, n in matches:
    if m.distance < 0.7*n.distance:
        good_points.append(m)
```

```python
img3 = cv2.drawMatches(gray_image, kp_image, gray_frame, kp_gray_frame, good_points, gray_frame)

query_pts = np.float32([kp_image[m.queryIdx].pt for m in good_points]).reshape(-1, 1, 2)
train_pts = np.float32([kp_gray_frame[m.trainIdx].pt for m in good_points]).reshape(-1, 1, 2)

matrix , mask = cv2.findHomography(query_pts, train_pts, cv2.RANSAC, 5.0)
matches_mask = mask.ravel().tolist()

h, w = gray_image.shape
pts = np.float32([[0, 0],[0, h], [w, h], [w, 0]]).reshape(-1, 1, 2)
dst = cv2.perspectiveTransform(pts, matrix)

homography = cv2.polylines(gray_frame, [np.int32(dst)], True, (255, 0, 0), 5)

diff = cv2.absdiff(gray_image, homography)

thresh = cv2.threshold(diff, 0, 255, cv2.THRESH_BINARY | cv2.THRESH_OTSU)[1]

kernel = np.ones((5, 5), np.uint8)
dilate = cv2.dilate(thresh, kernel, iterations=3)
erode = cv2.erode(dilate, kernel, iterations=6)

contours = cv2.findContours(erode.copy(), cv2.RETR_TREE, cv2.CHAIN_APPROX_SIMPLE)
contours = imutils.grab_contours(contours)

for contour in contours:
    if cv2.contourArea(contour) >700:
        x, y, w1, h1 = cv2.boundingRect(contour)
        if w1 > 27 and w1 < 70:
            cv2.rectangle(image, (x, y), (x+w1, y+h1), (0, 255, 0), 2)
            cv2.rectangle(frame, (x, y), (x+w1, y+h1), (0, 255, 0), 2)

        if w1 > 27 and h1 >= 97 and h1 <= 130 and h1!=110:
            cv2.rectangle(image, (x, y), (x+w1, y+h1), (255, 0, 0), 2)
            cv2.rectangle(frame, (x, y), (x+w1, y+h1), (255, 0, 0), 2)


x = np.zeros((500, 10, 3), np.uint8)
cv2.imshow("diffrence", np.hstack([image, x, frame]))

cv2.waitKey(0)
cv2.destroyAllWindows()
```

Assignments Task 6 [Autonomous]

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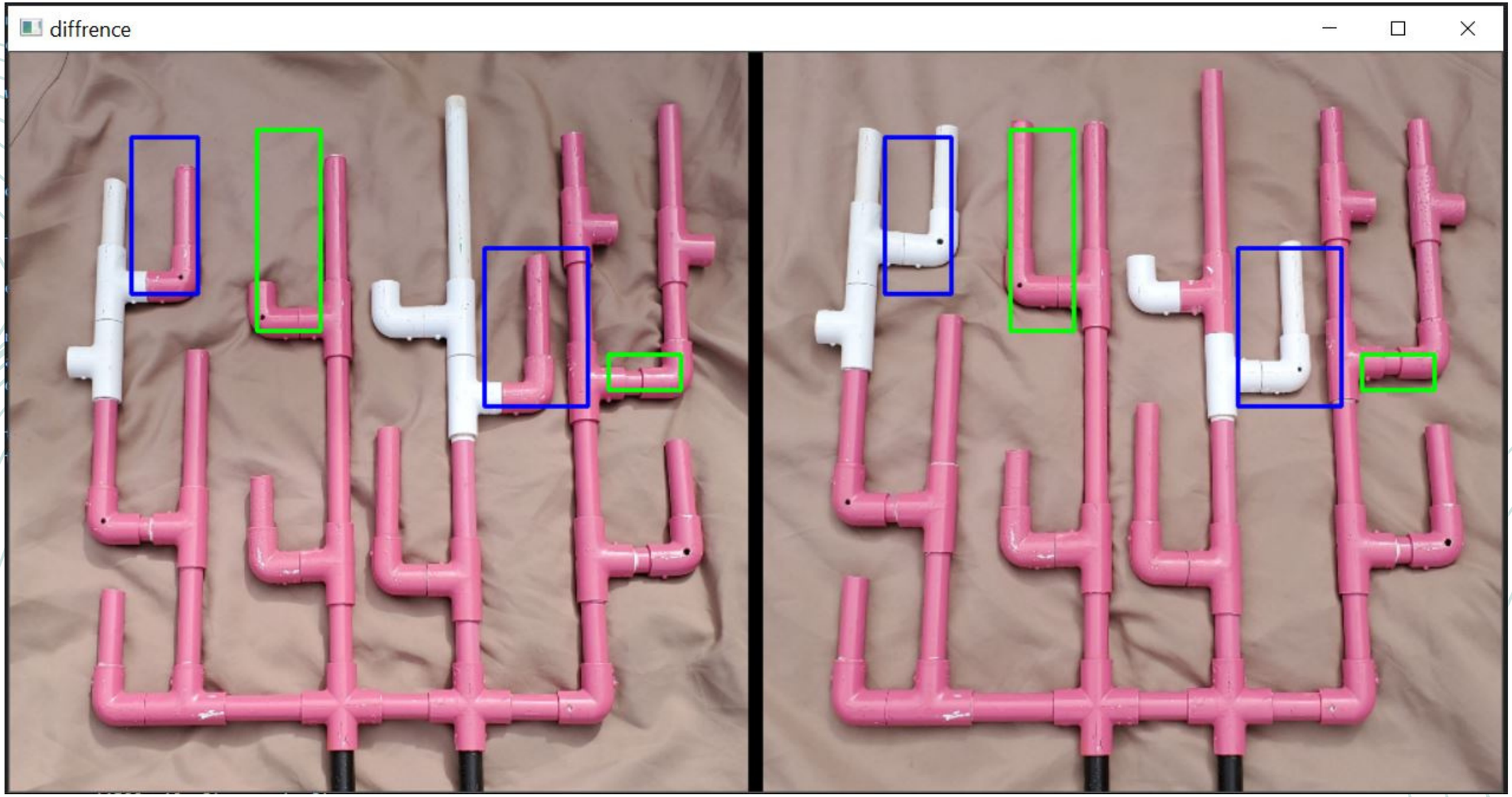

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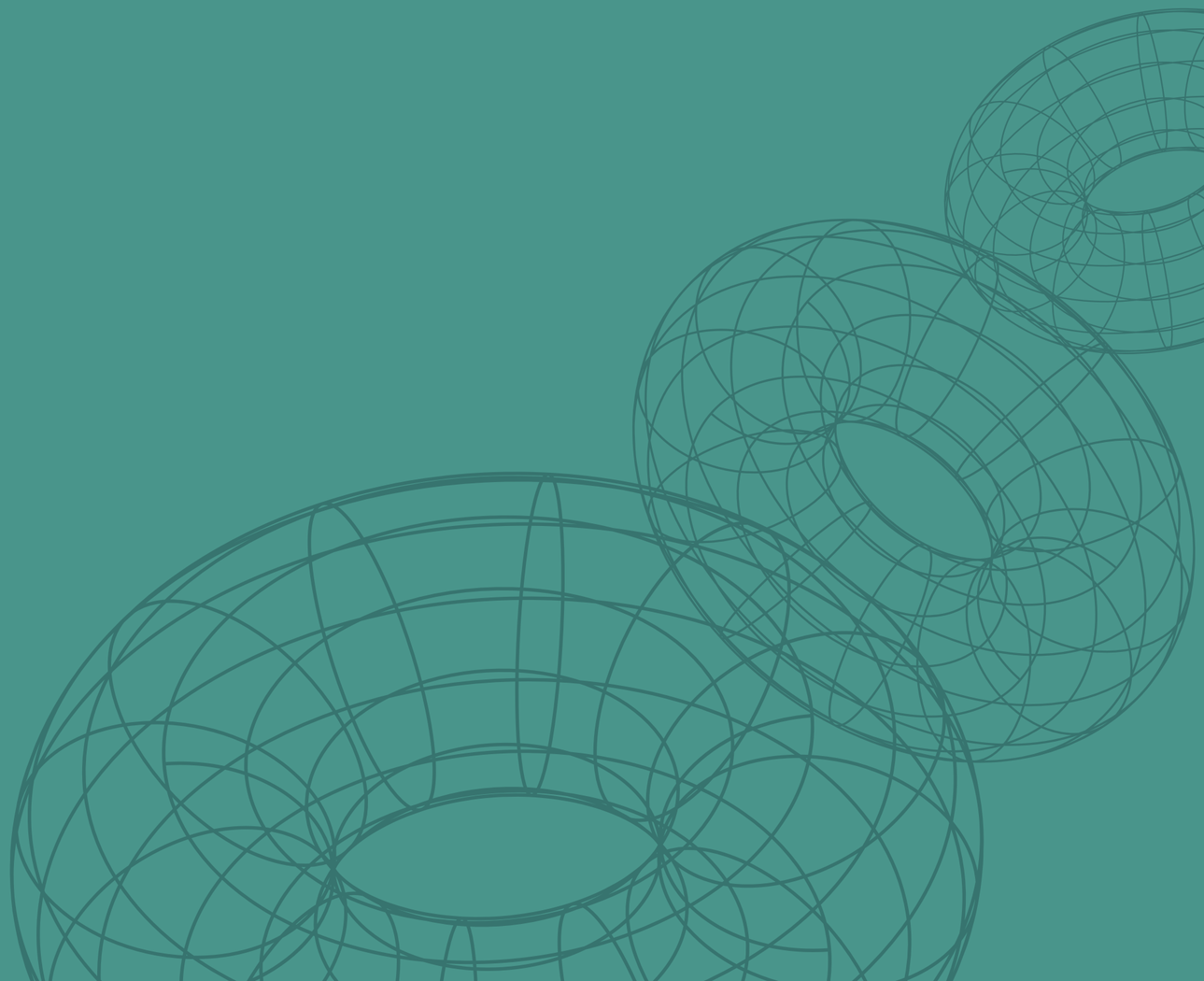
Do you have any questions?



Free Resources

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OpenCV Basics - Free Code Camp --> https://www.youtube.com/watch?v=oXlwWbU8l2o
OpenCV Basics - Murtaza --> https://www.youtube.com/watch?v=WQeoO7MI0Bs
Detecting Clicks --> https://www.youtube.com/watchv=DaQoorJQSZQ&list=PLMoSUbG1Q_r_sc0x7ndCsqdlkL7dwrmNF&index=8

Websites with useful Articles:
pyimagesearch --> https://pyimagesearch.com/category/image-processing/
LearnOpenCV --> https://learnopencv.com/getting-started-with-opencv/

Computer Vision Lectures:
First Principles of Computer Vision --> https://www.youtube.com/channel/UCf0WB91t8Ky6AuYcQV0CcLw
Introduction to Computer Vision --> https://www.udacity.com/course/introduction-to-computer-vision--ud810

Recommended OpenCV book (read till chapter 8)
Mastering OpenCV Book --> https://www.amazon.com/Mastering-OpenCV-Python-practical-processing/dp/1789344913