Digital Image Processing

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Homework1

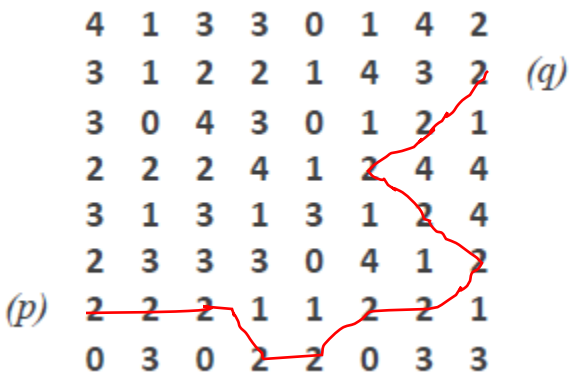
1.

a. V = {2}

4-adjacent path:

No path available!

8-adjacent path:

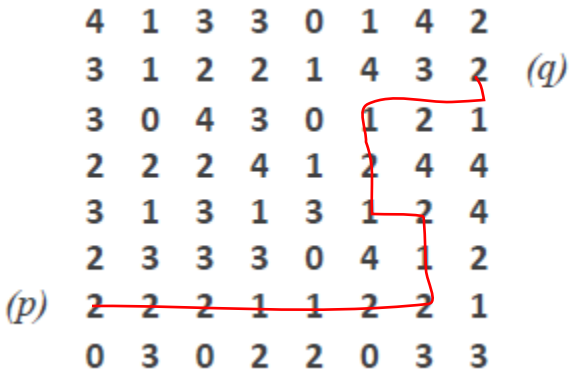


m-adjacent path:

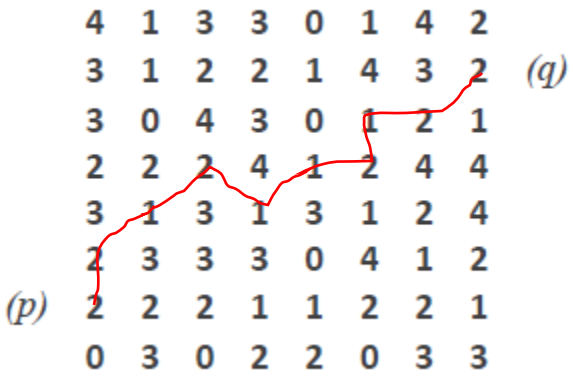
No path available!

b. V = {1,2}

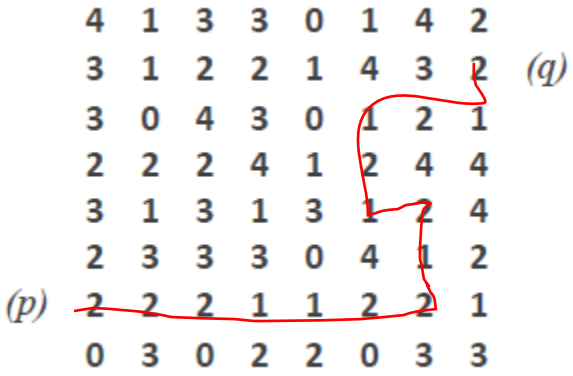
4-adjacent path:



8-adjacent path:

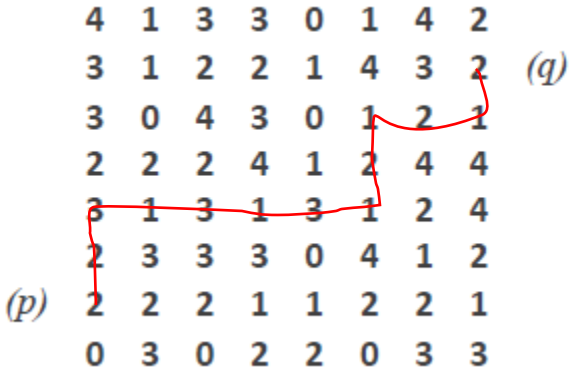


m-adjacent path:

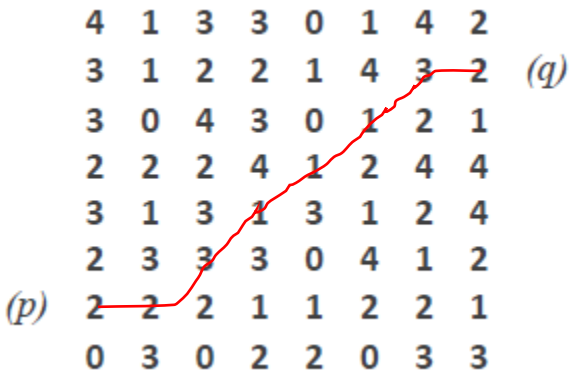


c. V = {1,2,3}

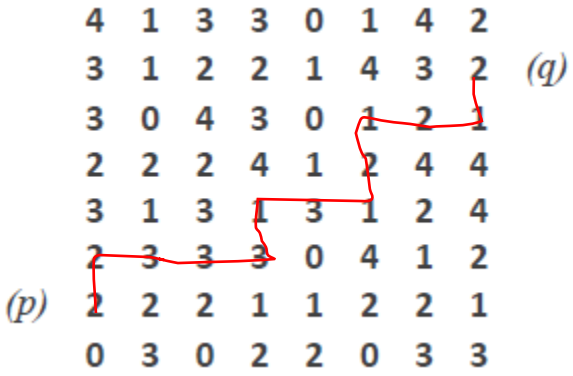
4-adjacent path:



8-adjacent path:

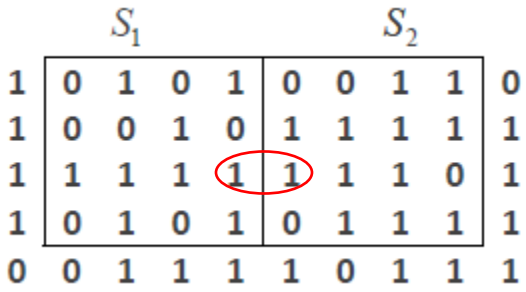


m-adjacent path:



d.

They are 4-adjacent:



e.

They are 8-adjacent because they are 4-adjacent!

f.

They are m-adjacent because they are 4-adjacent!

g.

we know that: $256 = 2^8$

Therefore, there are 8 bit-planes for the image.

h.

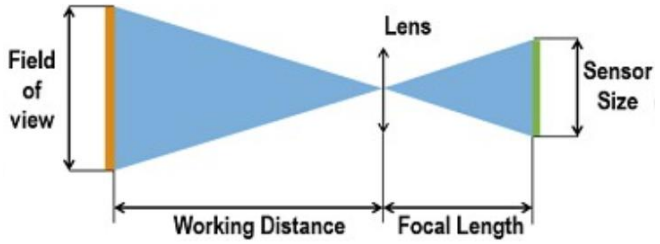
Planes with higher numbers are more significnt as they represent higher order bits.

i.

1025 x 512 x 8 / 8 = **2^{19} bytes**

j.

Firstly, we have to find the target size which can be obtained by the following equation considering the image below):



target size / target distance = sensor size / focal length

➔ **Target size = 7 / 35 * 1000 = 200 mm**

Hence, there are 2048/200 (10) pixels per mm. Therefore, the **resolution is 10/2 (5) linepairs per mm.**
(Resolution = 5 lp/mm)

k.

(number of pixels) X (pixel size) = storage space

→ (n) x 2^3 bit = 2^{25} bit → **n = 2^{22} pixels**

l.

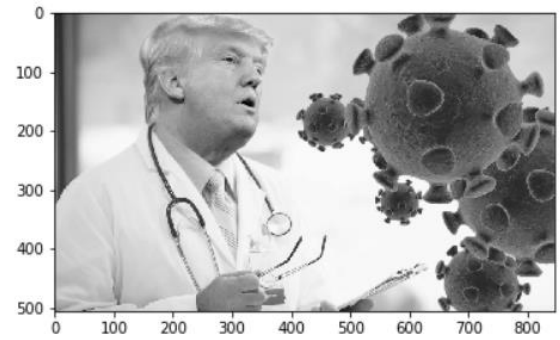
2^9 x 2^9 x (pixel size) = 2^{21} → pixel size = 2^3

Hence, **the image has 8 gray levels**

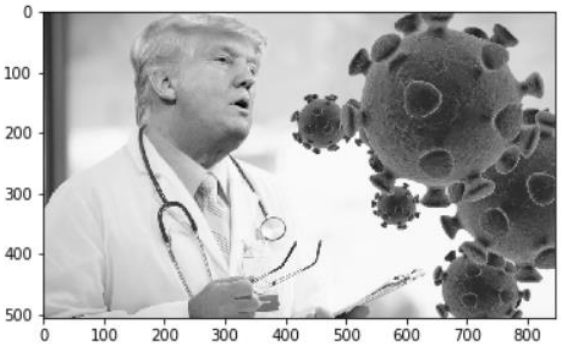
2.

Grayscale:

a.

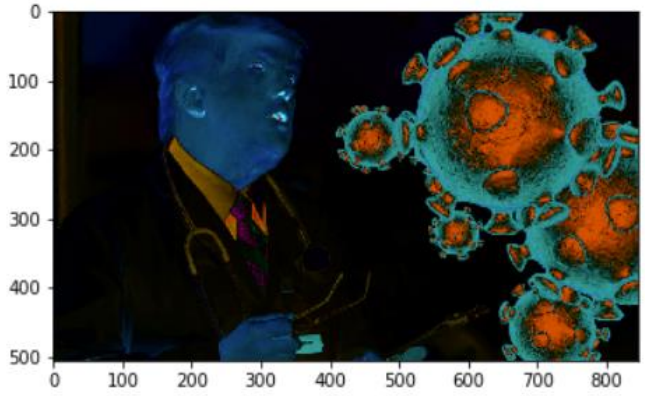


b.

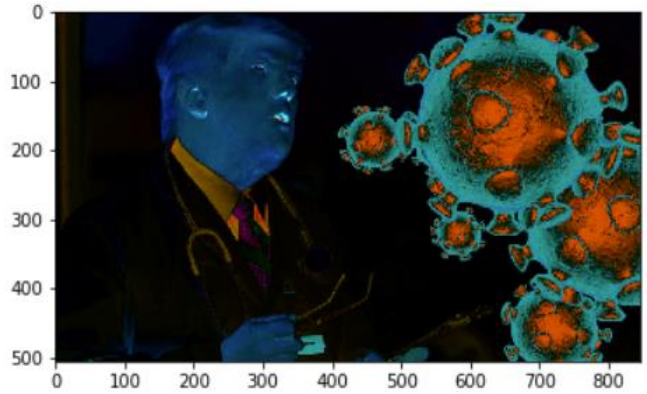


CMYK:

a.

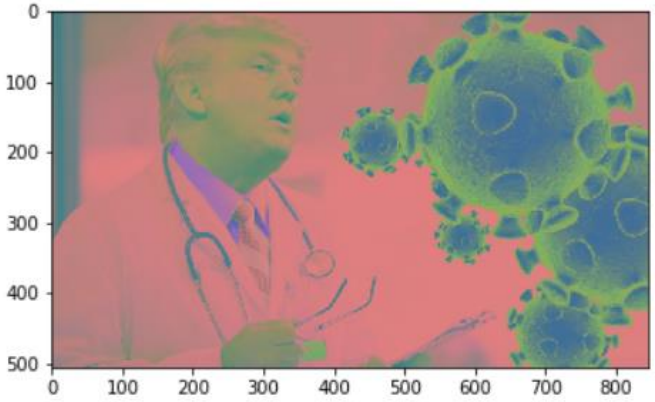

0
100
200
300
400
500
0
100
200
300
400
500
600
700
800

b.

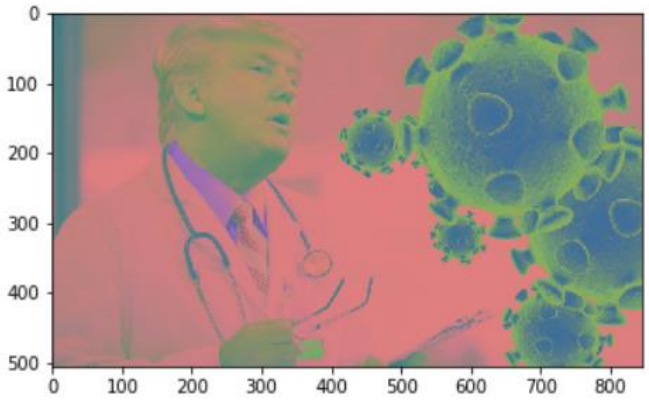

0
100
200
300
400
500
0
100
200
300
400
500
600
700
800

YUV:

a.

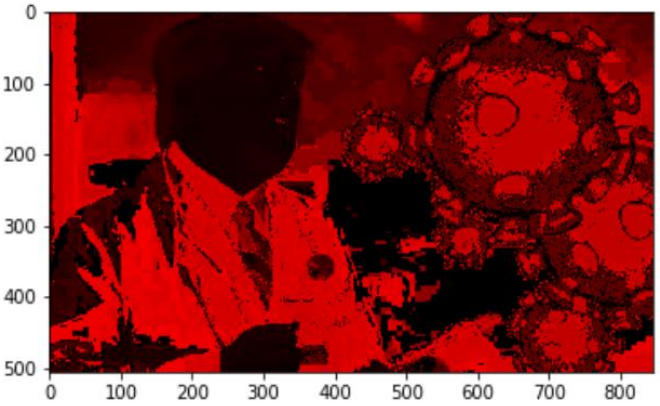

0
100
200
300
400
500
0
100
200
300
400
500
600
700
800

b.

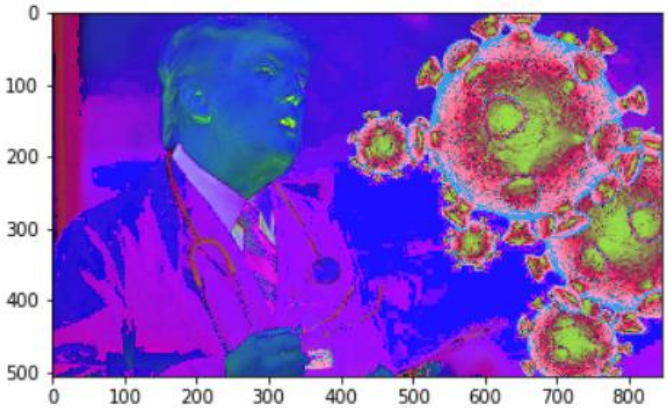

0
100
200
300
400
500
0
100
200
300
400
500
600
700
800

HSV:

a.


0
100
200
300
400
500
0
100
200
300
400
500
600
700
800

b.

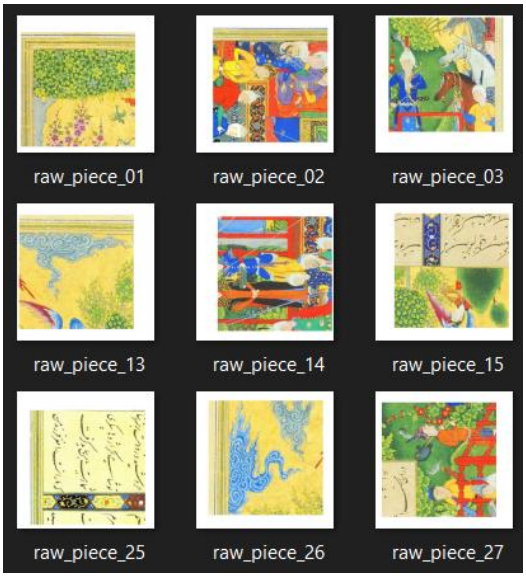

0
100
200
300
400
500
0
100
200
300
400
500
600
700
800

3.

a.

Pieces are saved in the folder named ‘output/ p3.a.images’:

Some samples are as follows:



b.

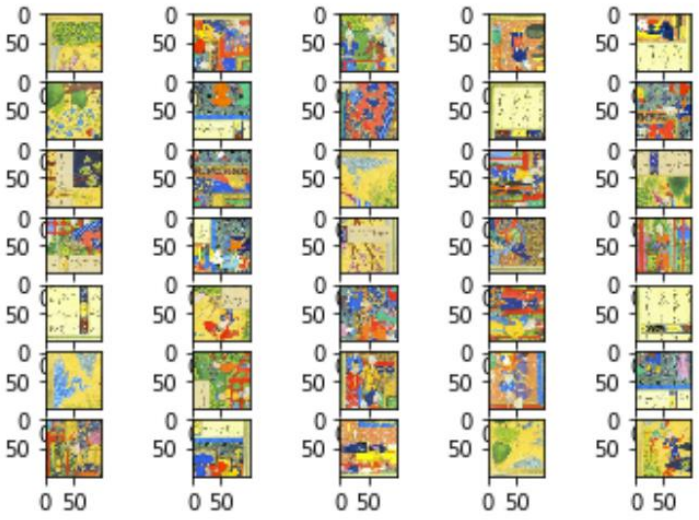
Pieces are saved in the folder named ‘output/ p3.b.images’:

Some samples are as follows:

c.

Pieces are saved in the folder named ‘output/ p3.c.images’:

In [33]:
```
# plotting resized blocks:
shape = np.resize(np.array(resized_blocks), (7,5)).shape
for i in range(len(resized_blocks)):
    plt.subplot2grid(shape, (i//shape[1], i%shape[1]))
    plt.imshow(resized_blocks[i])
plt.show()
```



Some samples are as follows:

d.

Obtained order for 100x100 patches:

e.

Obtained order for original patches:

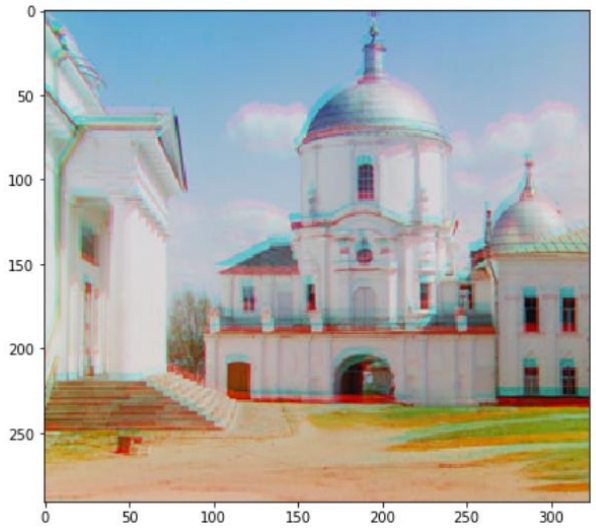
4.

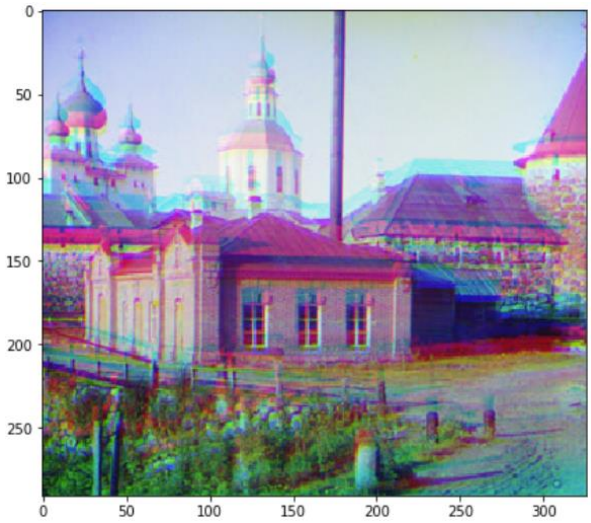
(related script is p4)

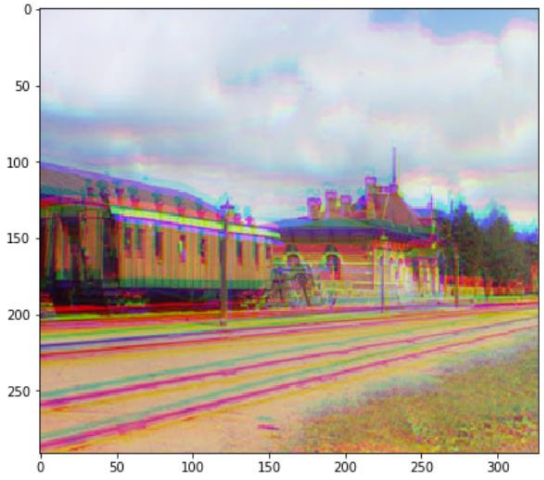
Following outputs are for three composites of 7^{th}, 9^{th} and 11^{th} images respectively:

b.

Merge of three channels without alignment:





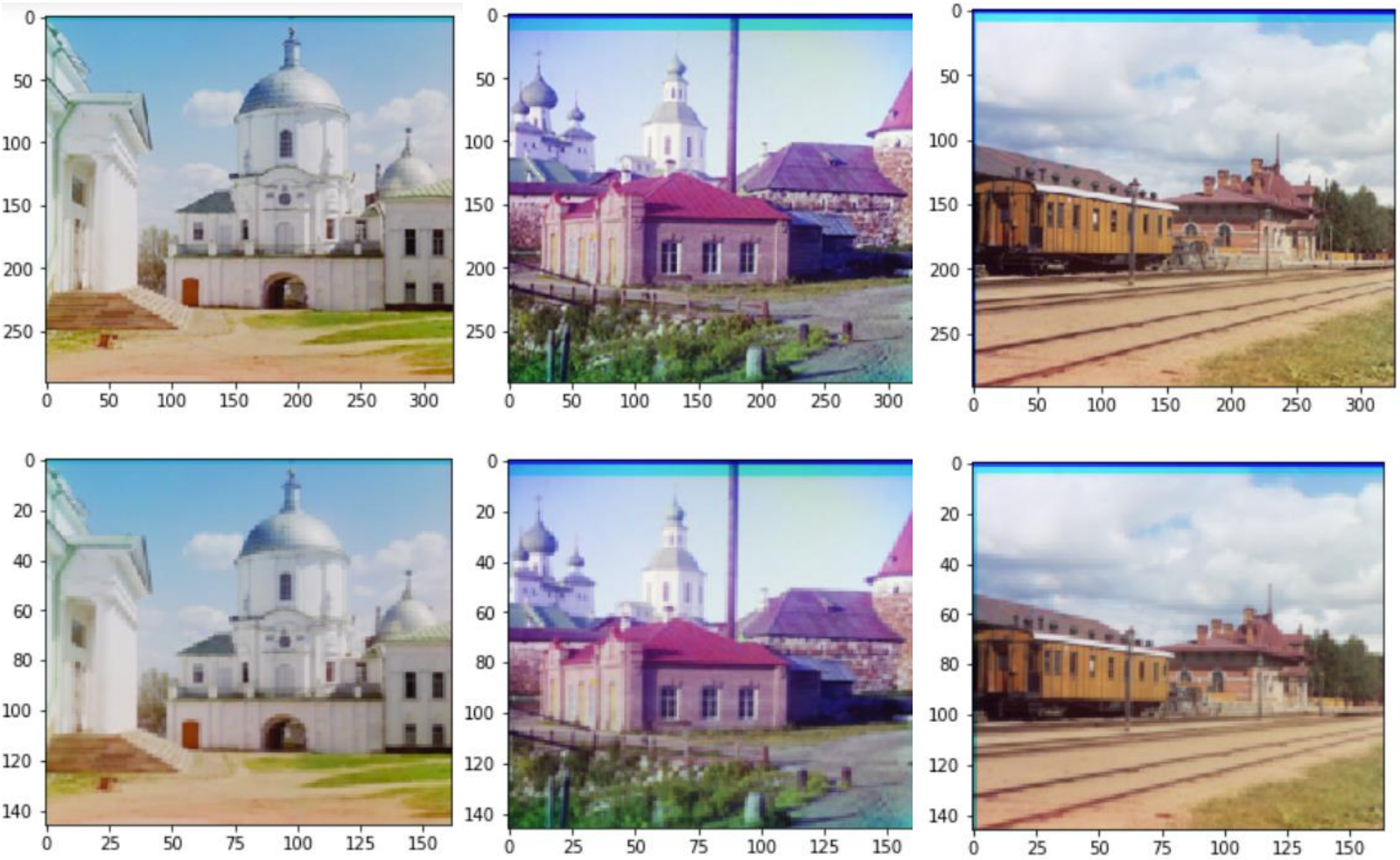


c.

Keeping first (red) channel fixed, following results are obtained by aligning other two channels:

d.

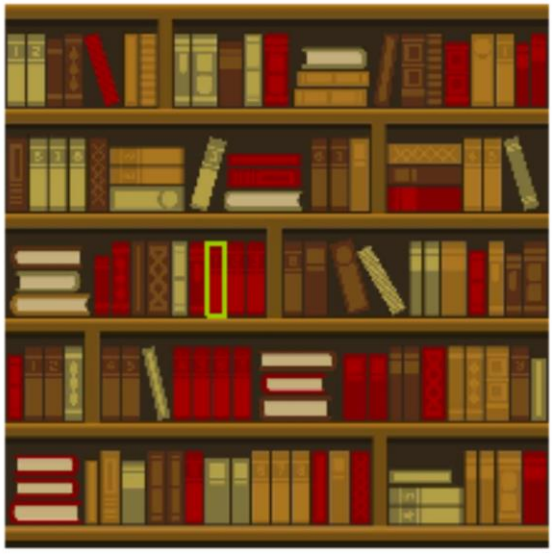
Resolution pyramid results are as follows:



5.

a.

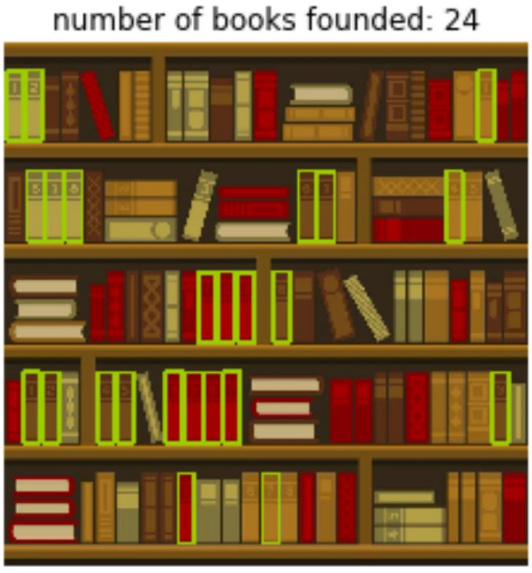
Detected book is shown below by a highlighted green outline:



b.

Other volumes of the intended book are shown below by highlighted green outlines:

(Note that outlines are specified by books' coordination)



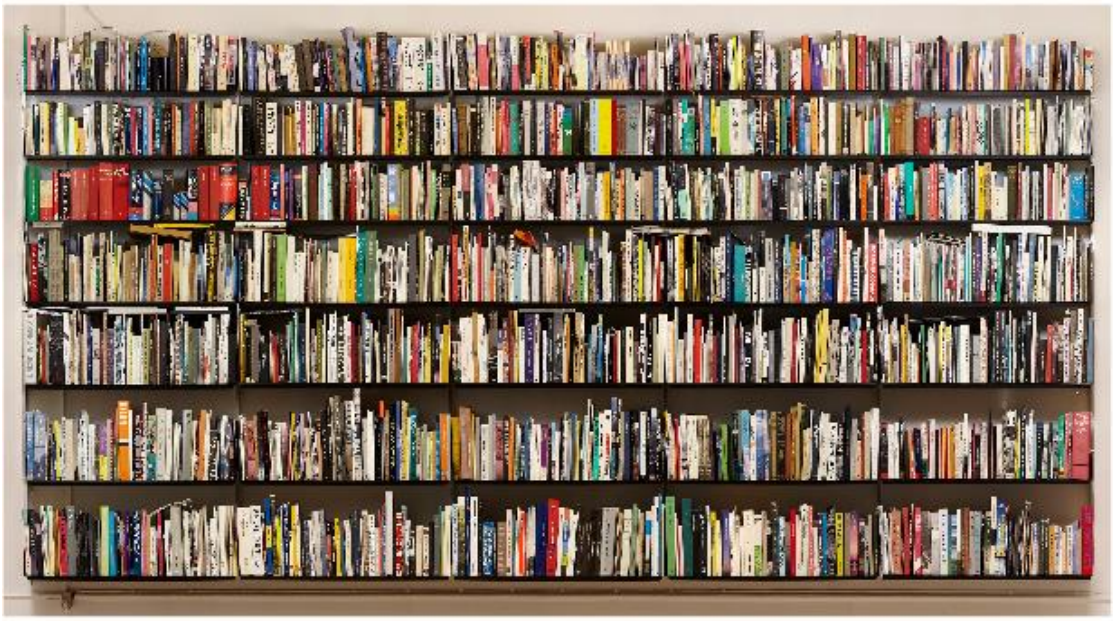
c.

???

e.

Cubic interpolation is used for the function:

original



downsampled(1/4)

f.

unfortunately, couldn’t be found after resizing!

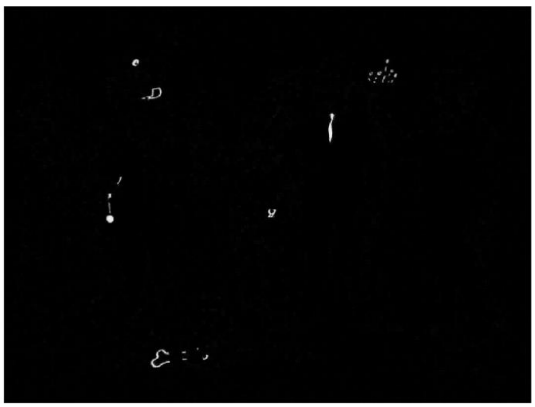
g.

???

6.

a.

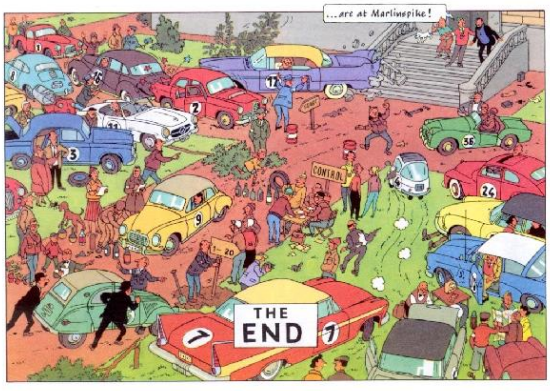
Puzzle1:

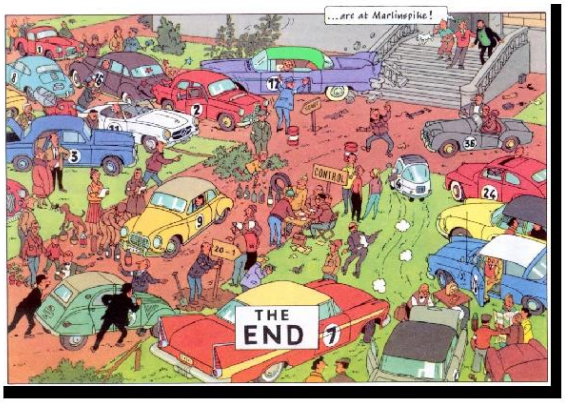


b.

Puzzle2:

after matching





c.

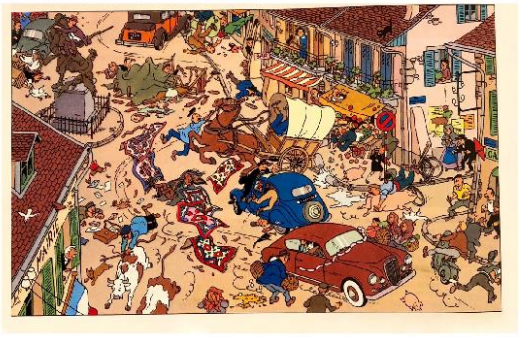
Puzzle3:

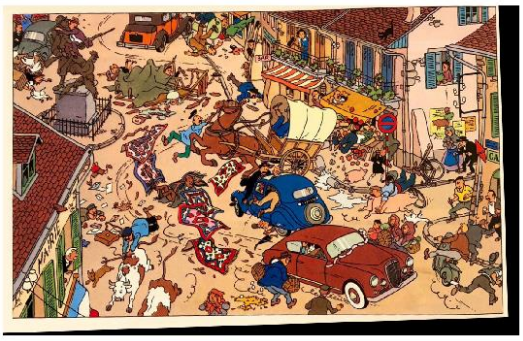
after matching

d.

Puzzle4:

after matching





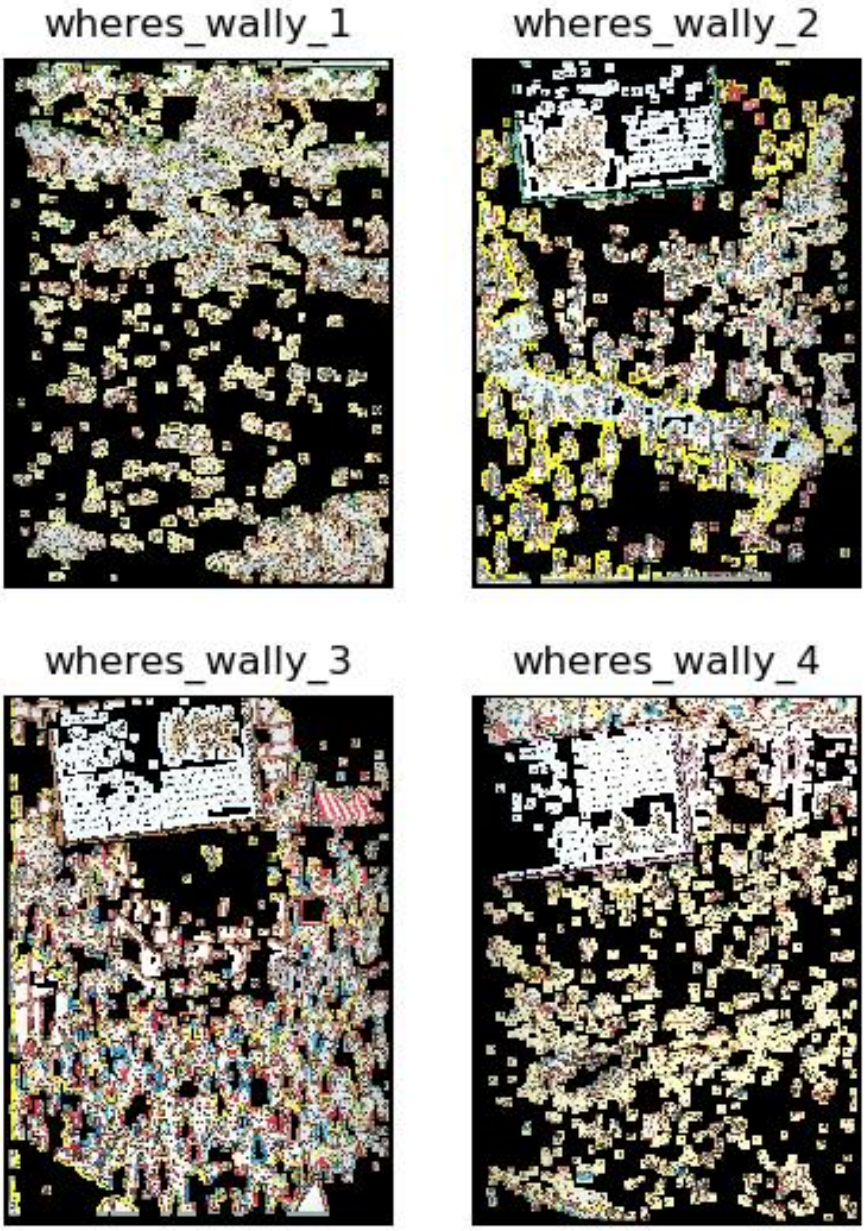
7.

a.

```
WHITE FOR Image1
(255, 250, 248)
(208, 212, 189)

RED FOR Image1
(252, 101, 120)
(236, 57, 16)
```

b.



c & d.

Unfortunately, correct points were not detected by the code for any of the images!!

8.

???

9.

a.

According to obtained results in problem 2, it seems that CMYK is the best and Euclidean distance metric is preferred since computation of distance between colors are in color space and Euclidean distance is a standard metric for distance.

b.

The process of converting a continuous image to a discrete grid in order to become digital is called digitizing. For example when we capture an image by a camera what is really happens is that we are casting a continuous 2D scene on a 2D grid of pixels which are discrete.

c.

Each megapixel of camera defines a camera sensor consisting of a block of 1000x1000 pixels. Considering the fact that resolution and quality of an image is rooted in the number of its source's sensor pixels, images captured from 20-megapixel camera, generally, have greater resolution and quality and therefore requires more storage.

d.

Digital images consist of a rectangular grid of evenly spaced pixels. Resampling is a more general concept which includes mathematical techniques used to create a new version of the image with a different width and/or height in pixels. Reducing an image size is called downsampling (subsampling). In color image or video processing, this is often done to reduce the amount of data that needs to be transmitted or stored, taking advantage of the fact that the human visual system has poorer acuity for color information than it does for intensity.

e.

Yes, it is possible. By computing weighted average of R, G and B channels' values. The most common weights are the ones introduced in problem 2.