문제 1

1 / 1점

Suppose you performed feature matching and calculated the distance of the best matching and the second best matching. Find the final matching pairs when NNDR = 0.35 is used.

Feature index of image A	The best matching feature index of image B	The second best matching feature index of image B	The best matchinig distance	The second best matching distance
1	1	2	3	10
2	1	4	2	5
3	3	4	2	10
4	3	4	2	5
5	4	5	1	5

----- < 학생이 제출한 답안 > -----

Feature index of image A

1 -> NNDER = 3/10 = 0.3

2 -> NNDER = 2/5 = 0.4

3 -> NNDER = 2/10 = 0.2

4 -> NNDER = 2/5 = 0.4

5 -> NNDER = 1/5 = 0.2

NNDR = 0.35, Matching result should be lower than 0.35. Thus, < index 1, 3, 5 >

문제 2

0.5 / 1점

Calculate the integral image of the input image(1pt) and show how to find the sum of the pixels in bold using the Integral image(1pt).

1	1	1	1	1
2	2	**2**	**2**	**2**
3	3	**3**	**3**	**3**
3	3	**3**	**3**	**3**
3	3	3	3	3

----- < 학생이 제출한 답안 > -----

Integral image :
1 2 3 4 5
3 6 9 12 15
6 12 18 24 30
9 18 27 36 45
12 24 36 48 60

=>

9 = 6+3+2-2 ,
12 = 9+4+2-3,
15 = 12+5+2-4
18 = 12+9+3-6
24 = 18+12+3-9
30 = 24+15+3-12
27 = 18+18+3-12
36 = 27+24+3-18
45 = 36+30+3-24

* you should show how to find the sum of the pixels in bold using the Integral image.

문제 3

1 / 1점

Explain the meaning of the last parameter.

```
void cv::CascadeClassifier::detectMultiScale ( InputArray          image,
                                               std::vector< Rect > & objects,
                                               std::vector< int > & numDetections,
                                               double               scaleFactor =
                                               1.1,
                                               int                  minNeighbors =
                                               3,
                                               int                  flags = 0,
                                               Size                 minSize = Size(),
                                               Size                 maxSize = Size()
```

----- < 학생이 제출한 답안 > -----

Maximum possible object size. Object lager than maxSize that are ignored.

검출하기 위한 최대 사이즈. Object 크기가 maxSize 값보다 더 크면 무시된다.

문제 4

1 / 1점

Perform histogram back-projection for the current image. The ROI of the previous image is set as bold rectangle area on the left. Assume dynamic range of image is from 0 to 7, and set the number of bins as 8.

Previous image

1	1	1	1	1
1	**3**	**3**	1	1
1	**2**	**3**	1	0
1	1	1	1	0
0	1	1	1	0

Current image

1	1	1	1	1
1	2	2	2	1
1	3	3	1	0
1	3	3	0	0
1	0	0	0	0

----- < 학생이 제출한 답안 > -----

-> inbold

2 : 1/4 = 0.25
3 : 3/4 = 0.75

=> Histogram back-projection

0 0 0 0 0
0 0.25 0.25 0.25 0
0 0.75 0.75 0 0
0 0.75 0.75 0 0
0 0 0 0 0

문제 5

2 / 2점

Explain why you need at least four corresponding pairs to estimate a 2D perspective matrix.

----- < 학생이 제출한 답안 > -----

The dimension of the matrix is 3*3.
However, only 8 elements in the matrix should be known (h33 is fixed value, 1).
=> 4 corresponding pair should be given at least, to estimate a 2D perpective matrix.

3 by 3 matrix에서 8개의 value를 알아야하기 때문에 2D perspective matrix를 계산하기 위해서는 최소 4개의 corresponding pairs가 필요하다.

문제 6

2 / 2점

Explain how you can generate an panoramic image from two image with no user interaction (that is, the panoramic image should be generated automatically). You should explain the process step by step.

----- < 학생이 제출한 답안 > -----

First, extract the feature of two images.

Second, compare and match the features between two images.

Third, make a homography matrix (using matching points)

Last, convert the image (through the homography matrix) and connects the converted images

문제 7

2 / 2점

Assume that we have a camera whose focal length is 5, number of pixels per unit distance in x and y direction is as 200, skew parameter is 0, and the position of principal point in the image plane is (100,100). The camera is located at (0,0,0) in 3D world coordinate, and the principle axis is parallel to z-axis of 3D world coordinate. Show camera projection matrix of this camera.(1pt) What is the position of the projected point when a 3D point is (10, 20, 10, 1).(1pt)

----- < 학생이 제출한 답안 > -----

k = f*Sxx f*Sxy u0
0 f*Syy v0
0 0 1

= 1000 0 100
0 1000 100
0 0 1

[R|t] = 1 0 0 0
0 1 0 0
0 0 1 0

P=k[R|t] = 1000 0 100 0
0 1000 100 0
0 0 1 0

P* {3D point} =
10000 + 1000
20000 + 1000
10

=> 11000
21000
10

=> (x,y) = (1100, 2100)

문제 8

2 / 2점

You are given an image below. In order to compress the image, you apply DCT. Then you apply Inverse-DCT to reconstruct the image. Then what is the MSE between the input image and the reconstructed image?(1pt) Explain why. (1pt)

10	15	15	15	15
11	14	15	16	17
11	50	56	55	66
12	43	44	42	41
12	31	30	29	28

----- < 학생이 제출한 답안 > -----

Suppose applying a DCT to compress an image, and then use Inverse-DCT to restore it. In this case, the restored image is identical to the original image. Thus MSE will be 0.

DCT 후 Inverse-DCT를 하게 되면 재구성된 이미지는 원본 이미지와 동일하게 된다. 이 경우는 MSE=1일 수 밖에 없다.
(MSE는 원본 이미지와 재구성된 이미지의 픽셀 값 차이로 구성되기 때문)

* MSE = 0