Midterm Exam

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1 Question 1

Following are the steps to segregate the coins.

a)

1. Selected a kernel of size (5,5).

2. Performed morphological transformation on a the image to erode the image in 7 iterations.

3. Performed morphological transformation on a the image to dilate the image in 4 iterations.

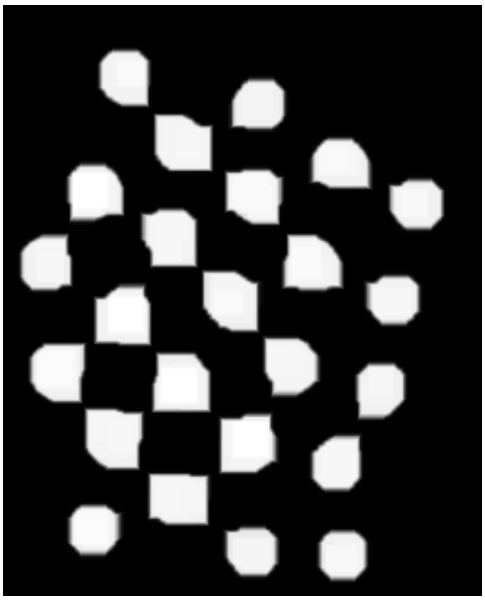

Figure 1: Coin segregated Image.

b)

1. Inverted the pixels of the resultant from part a).

2. Performed blob detection to detect the black blobs.

3. Reinverted the image and circle the detected blobs.

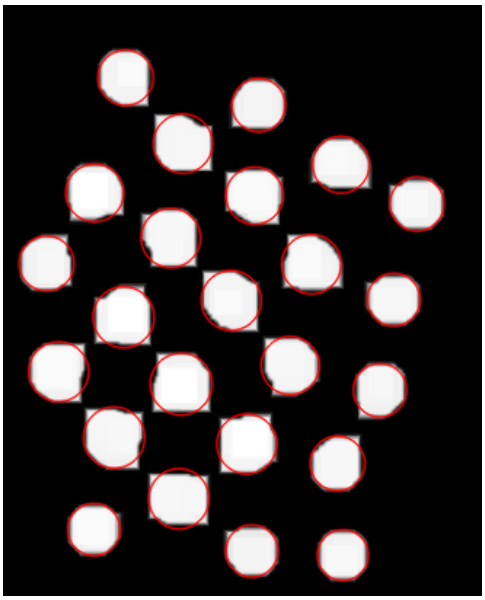

Figure 2: Blob detected image.

```
(final) ameya@ameya-ROG-Zephyrus-G14-GA401QH-GA401QH:~/UMD/ENPM-673/Midterm/Code$ python question1.py
No. of coins detected:  24
```

Figure 3: Number of coins detected.

2 Question 2

Following are the steps to stich the given images.

1. Coverted the copies of the given images in grayscale.
2. Used SIFT feature detector to find keypoints and descriptors of both the images.
3. Matched the descriptors of both the images.
4. Found homography matrix using RANSAC with the help of comman keypoints between the images.
5. Performed warpPerspective and combined the images.

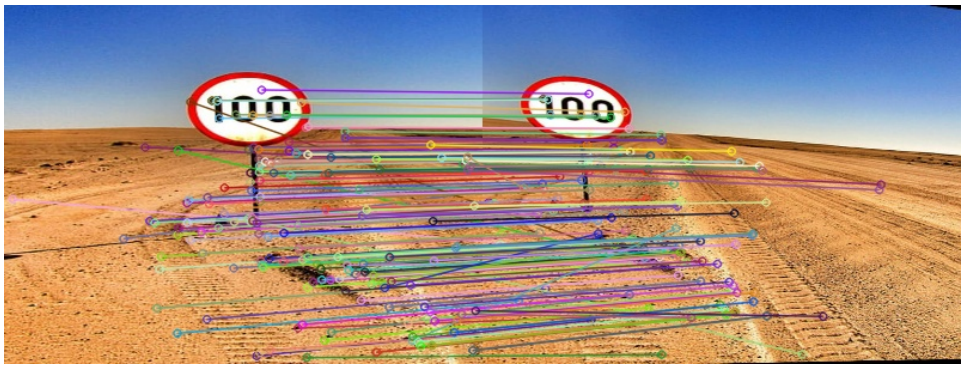

Figure 4: Matched features in the image.

Figure 5: Stitched Image.

3 Question 3

a) The minimum number of points to solve the equations manually are 8.

b) The pipeline for camera calibration is as follows:

1. Perform Canny edge detection.

2. Straight line fitting to detect linked edges.

3. Intersecting the image to detect corners.

4. Matching image corners and 3D target checkerboard corners by counting if target is visible in an image.

5. Thus by calculating the K matrix we get conversion from image points to world points.

c) Following are the steps used for calibration (finding the K matrix)

1. Given are the 8 pixel coordinates(u, v) and World Coordinates(X, Y, Z) such that, $\begin{bmatrix} u \\ v \\ w \end{bmatrix} = \begin{bmatrix} alpha_x & s & x_0 & 0 \\ 0 & alpha_y & y_0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} * \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$

2. Used them to compute **A** matrix of size **(16, 12)**

3. Computed Projection matrix **P** for the equation,

$$\mathbf{A} * \mathbf{P} = 0$$

of size **(12, 1)**

4. The **P** matrix is found by computed as eigenvector corresponding to the least eigen value of **A**.

5. The **P** matrix divided by its last lement and then reshaped to dimensions **(3, 4)**.

6. The **P** matrix consists of **M** matrix as

$$\mathbf{P} = [\mathbf{M} \mid]$$

.

7. The **P** matrix is then reshaped to dimensions **(3, 4)**.

8. Found **Q** and **R** matrics by performing

$$\mathbf{P} = \mathbf{KR}[\mathbf{I} \mid -C]$$

.

9. The **R** matrix found is the upper triangular**K** matrix.

d) The program for computing K matrix is present in Codes section (question3.py)

```
K Matrix:
[[-1.61901802e+03  1.89270966e+00  8.00113193e+02]
 [ 0.00000000e+00 -1.61202594e+03  6.16150419e+02]
 [ 0.00000000e+00  0.00000000e+00  1.00000000e+00]]
```

Figure 6: Stitched Image.

4 Question 4

Following are the steps to perform K-means algorithm to seperate the image into 4 classes.

1. Assume 4 random RGB values from the image as the initial mean values..

2. Iterated over every pixel of the given image and calculated their eucledian distances from the means .

3. Segregated the pixel values into four seperate lists based on the minimum distance from the means.

4. Computed the new means as the average of the pixel values in the respective clusters.

5. Performed steps 3 and 4 till the mean values are converged within a set threshold (0.1 in this case).

Figure 7: Original Image.

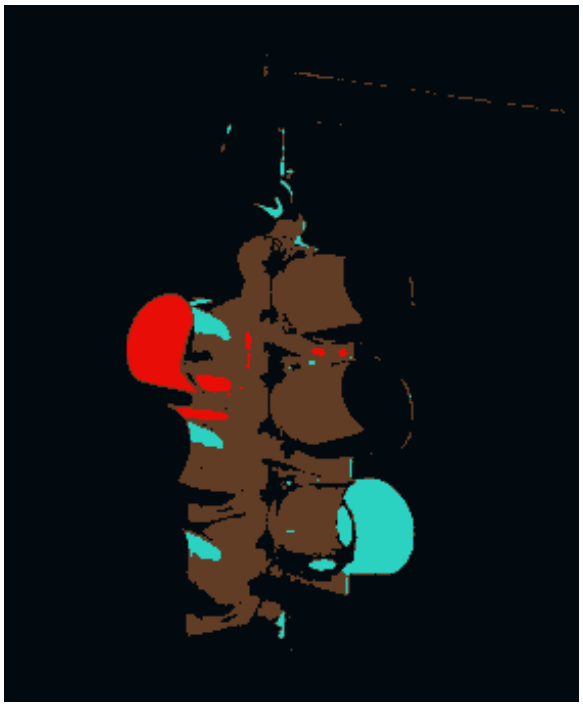

Figure 8: Seperated Image.