Homework 3: EE569

Ishaan Vasant

6989-5065-37

ivasant@usc.edu

Problem 1: Geometric Modification

Abstract

Geometric Modification is a process which involves changing the coordinates and location of pixels while keeping the value of pixel locations fixed. Applications such as translation, rotation and scaling were performed in this problem and they were used for puzzle matching, warping and distortion correction.

Approach

For the first part, the coordinates of the corners were found, the angle to rotate was found and the sub images were rotated and scaled to the correct size. These rotated and scaled sub-images were then fit into the holes of the main image after finding the hole coordinates. Bilinear interpolation was used in the rotation and scaling processes. For the second part, the image was split into 4 triangles and the pixels were warped accordingly to obtain the final result. For the third part, the lens distorted image was corrected using the equations and values provided.

Results

Fig 1: Output Image with lines along the edges of filling images

Fig 2: Output Image without lines

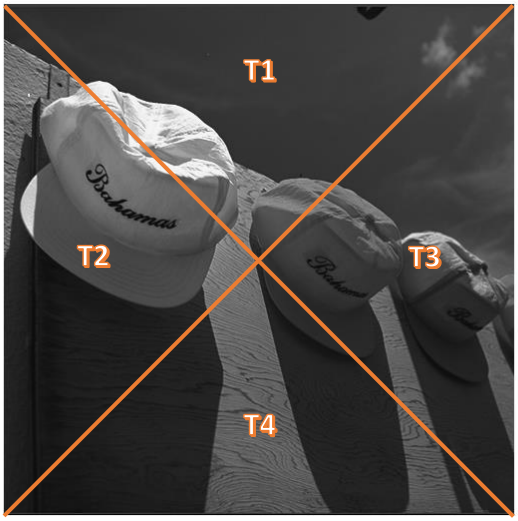


Fig 3: Hat image divided into 4 triangles

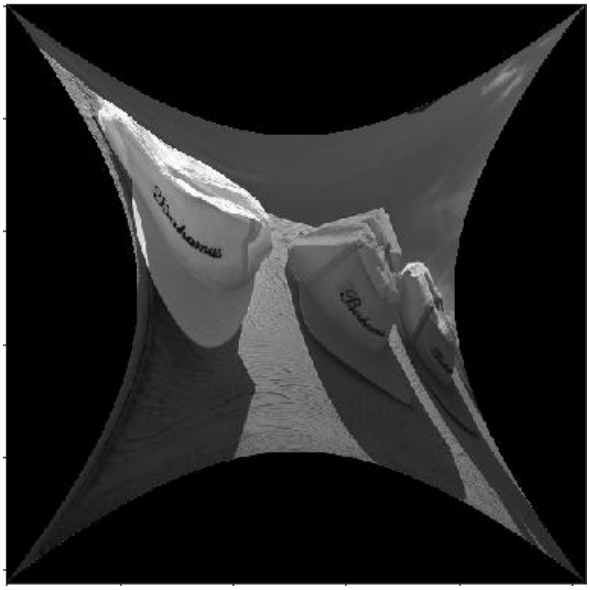


Fig 4: Hat image warped

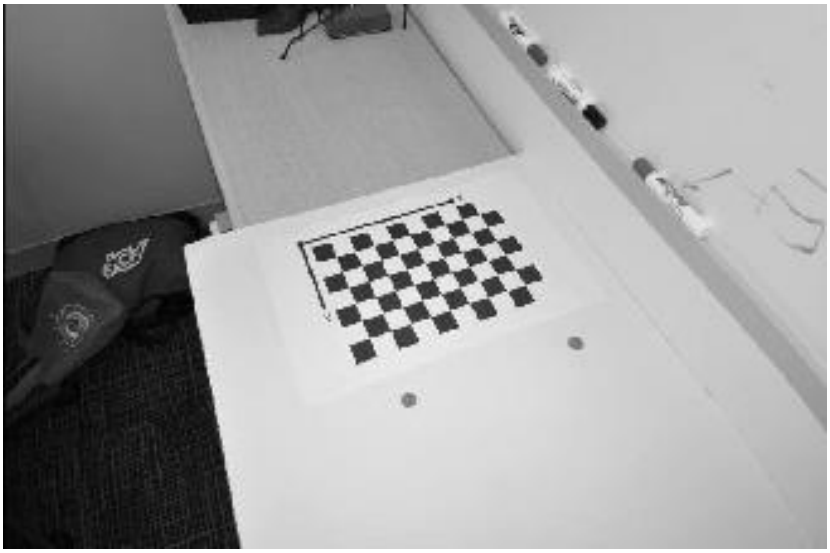


Fig 5: Lens Distortion Corrected Image

Discussion

a) The corner coordinates for lighthouse 1 are: (81,116), (224,184), (183,79), (120,222)
The centre coordinates for lighthouse 1 are: (152,105)
The angle of rotation for lighthouse 1 is 69.9285 degrees clockwise
The top-left coordinates for lighthouse 1's corresponding hole are: (158,63)

The corner coordinates for lighthouse 2 are: (9,126), (213,109), (101,16), (120,219)
The centre coordinates for lighthouse 2 are: (111,138)
The angle of rotation for lighthouse 2 is 130.213 degrees clockwise
The top-left coordinates for lighthouse 2's corresponding hole are: (32,279)

The corner coordinates for lighthouse 3 are: (4,41), (252,215), (210,4), (47,252)
The centre coordinates for lighthouse 3 are: (129,128)
The angle of rotation for lighthouse 3 is 10.231 degrees anticlockwise
The bottom-right coordinates for lighthouse 3's corresponding hole are: (488,486)

After rotating and scaling the sub-images, they were fit into corresponding holes in the main image but there were white outlines seen at those locations (seen in Fig 1). This was corrected by scaling the sub-images to 162x162 or 164x164 and therefore using a slightly magnified sub-image to fit into the holes. This removed the holes and did not affect the rest of the image otherwise. Bilinear interpolation was implemented and due to this, the sub-images are very slightly blurred. It is not very noticeable, and the final image (seen in Fig 2) is still of good quality.

b) The image was split into 4 triangles as shown in Fig 3 and the pixels were warped accordingly to obtain the final result in Fig 4.

c) The lens distorted image was corrected, and the output image was reported in Fig 5. The lens distorted image is similar to the barrel distorted image.
Machine learning is an aspect of artificial intelligence that enables systems to learn from data and pattern automatically without explicitly programming it to. Machine learning algorithms build a mathematical model based on the data and use it to perform the task. In supervised learning, the data possesses features as well as labels. In unsupervised learning, the data only possesses features and no output labels. Here, methods such as clustering help in organizing the data and visualizing patterns. Semi-supervised learning is a combination of the first two where some data indices have labels, and some don't. Classification is where the labels belong to a set of predefined values or classes. Regression is where the output labels can take on any value within a certain range. Linear regression is one such type of regression. In this type of regression, a linear model is used to fit the data. The model uses an error term as a basis for choosing the model and the model with the least error (difference between the data points and the model curve) is chosen to approximate the data and patterns.

Problem 2: Morphological Processing

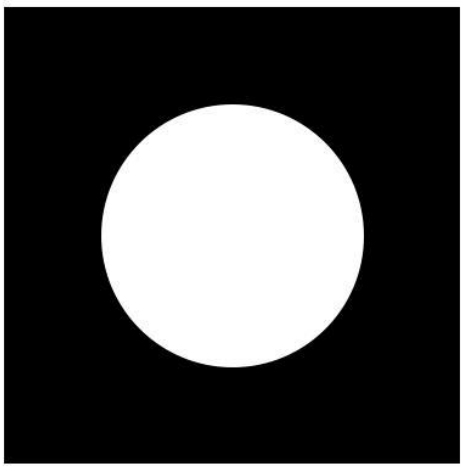
Abstract

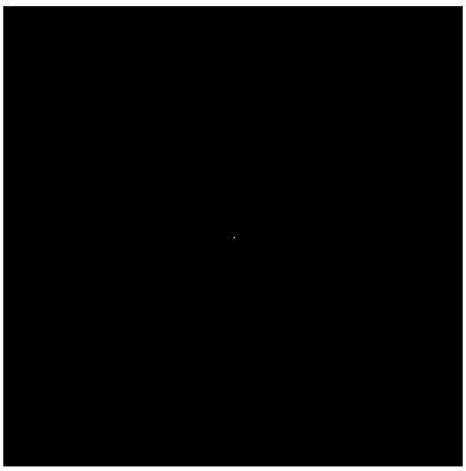
Morphological processing involves techniques that are non-linear and deal with the morphology of an image. Morphological processing usually does not deal with the actual pixel values and hence most such operations are done on binary images. A few morphological techniques such as shrinking, thinning and skeletonizing have been performed and discussed.

Approach

For the first part, shrinking, thinning and skeletonizing techniques were applied to all 4 Pattern images using the respective conditional and unconditional masks bases on the pattern tables provided. The results were compared and discussed. For the second part, the Deer image was analyzed, and the defected pixels were identified using a 3x3 filter with 0 in the center and 1s all around. Pixel locations which matched this filter were identified to be the defect points in the image and they were corrected to white pixels. For the third part, the color image was read and converted to grayscale. Then the canny edge detector was used to produce the outlines of the rice grains into a binary image. The image was then dilated and filled using built-in functions. The filled image was shrunk to give white dots. These were used to count the number of rice grains. The image was eroded, and the area and centroid location of each grain was calculated. The centroid locations were used to group the grains by type and the area was used to sort the groups by size.

Results





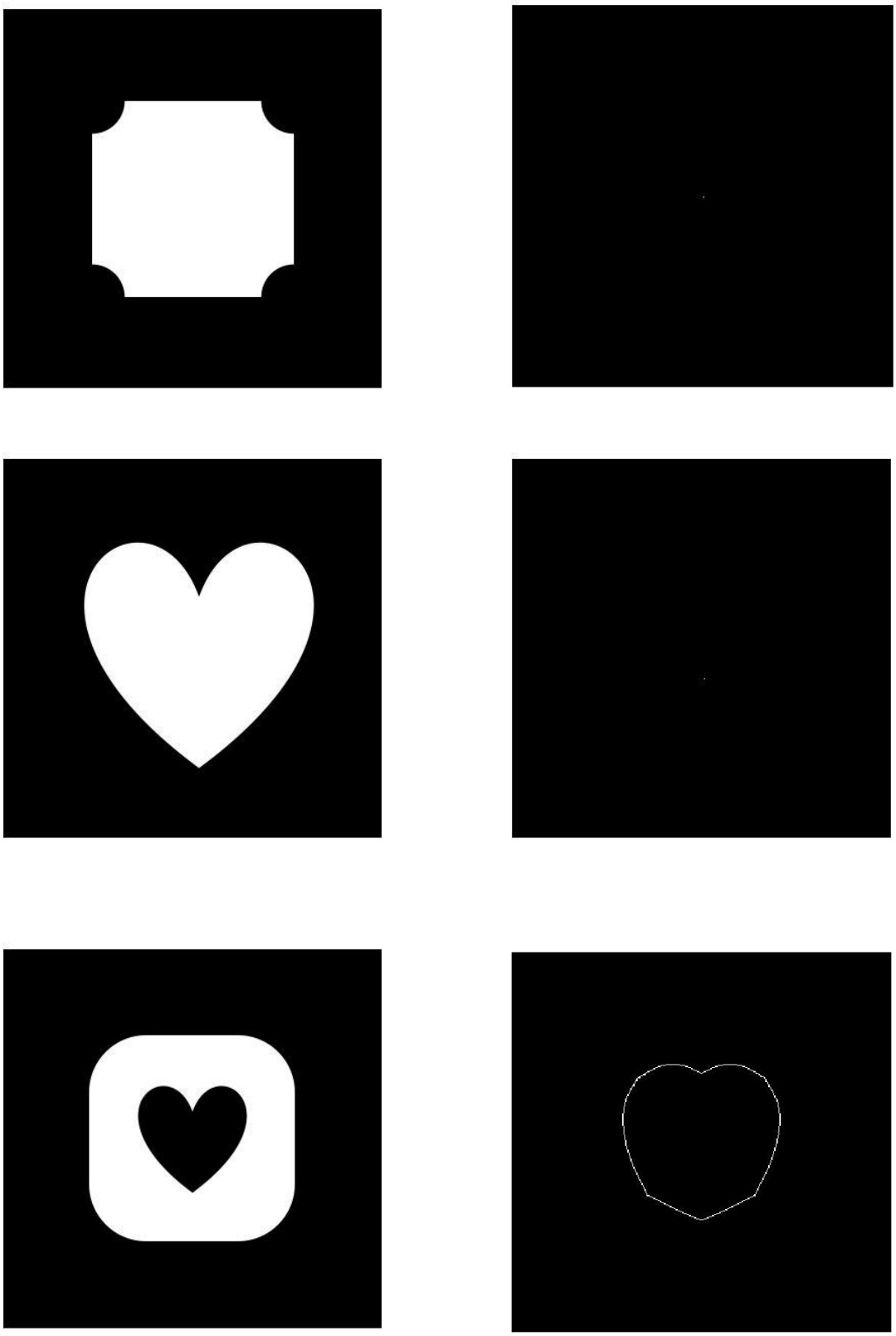
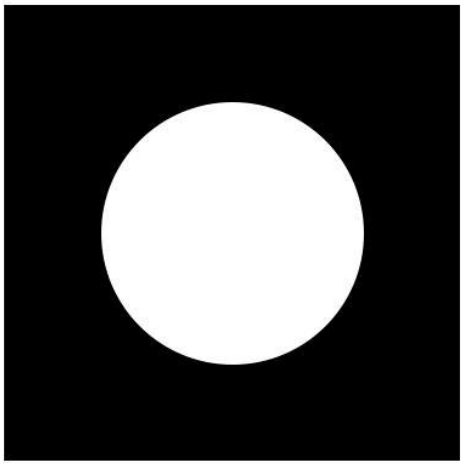
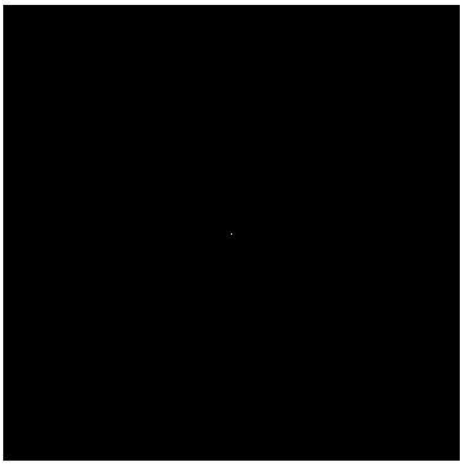
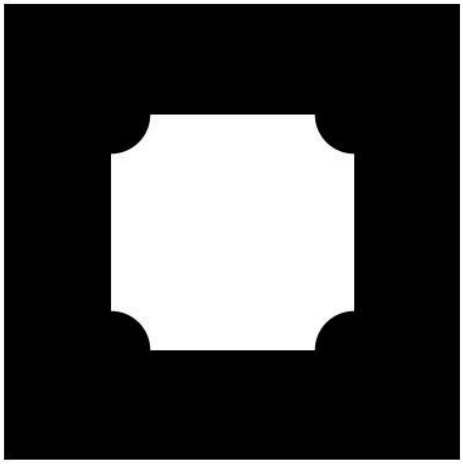
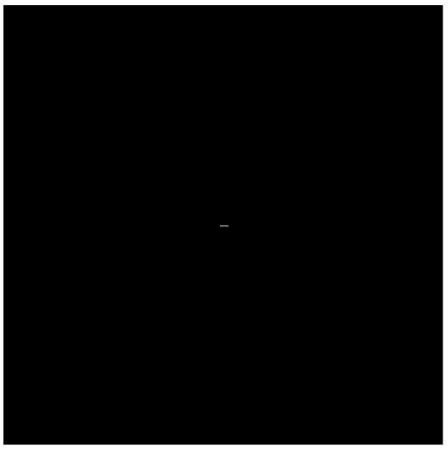


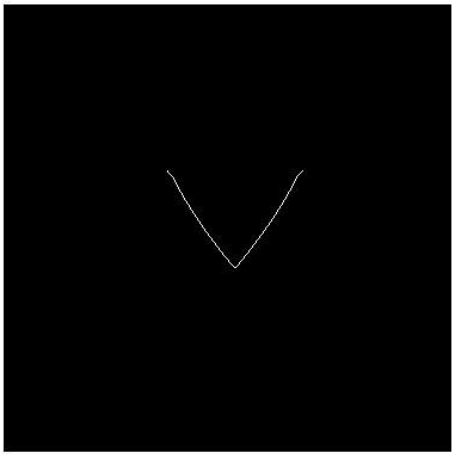
Fig 6: Shrinking of Pattern images











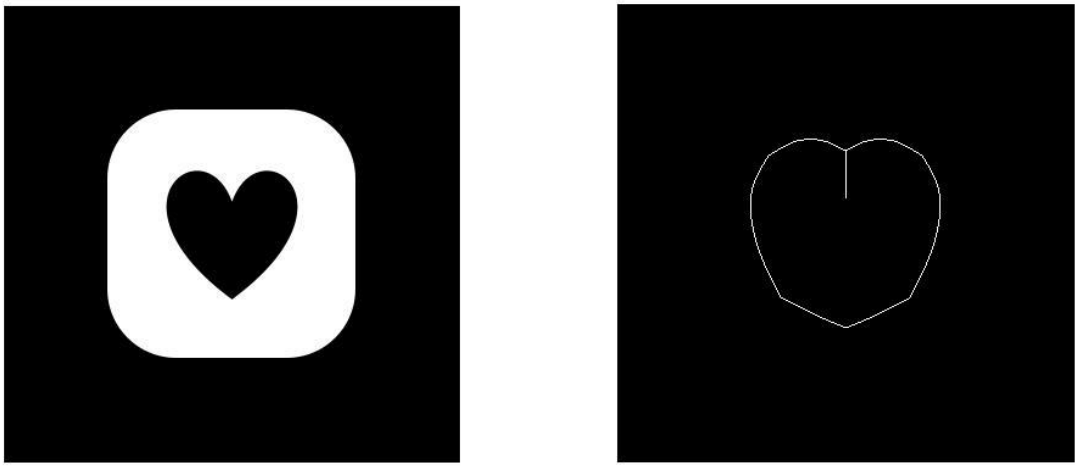
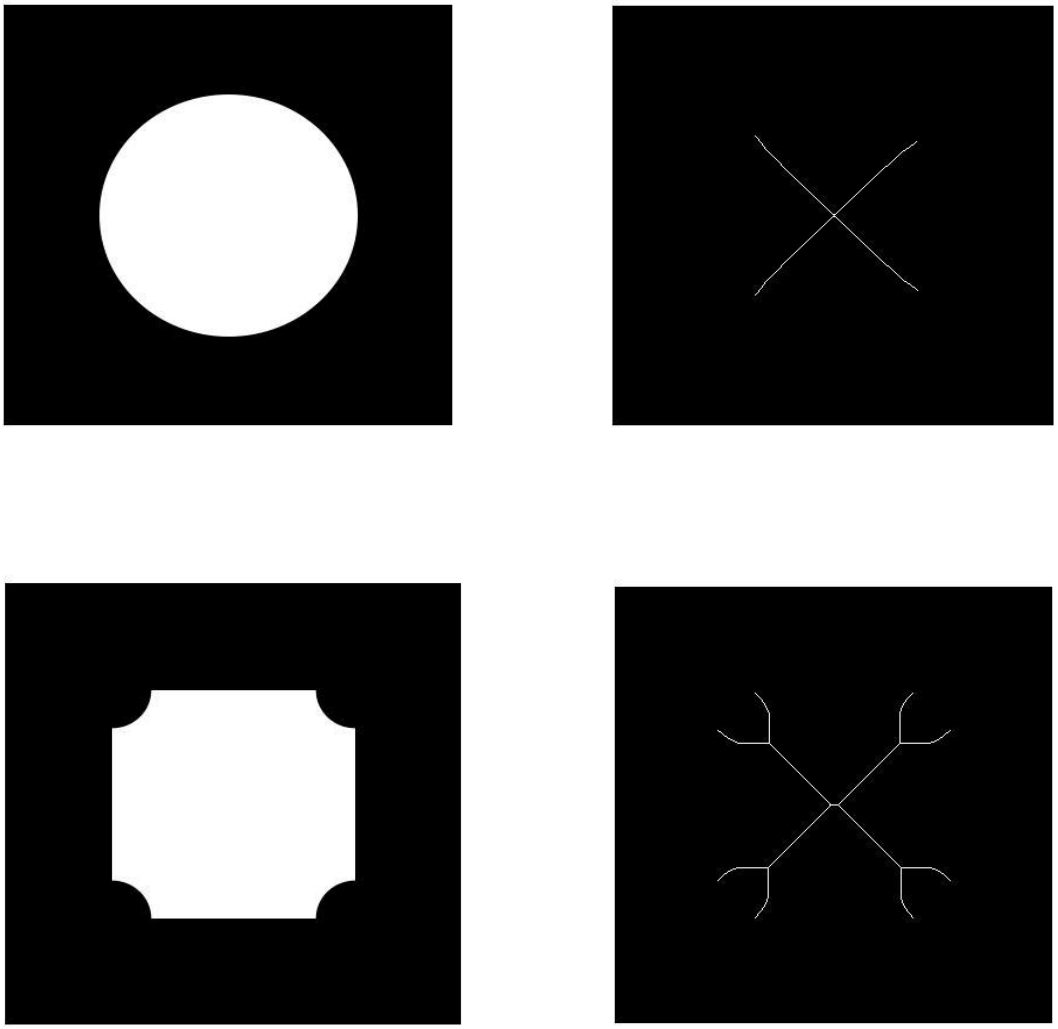


Fig 7: Thinning of Pattern images



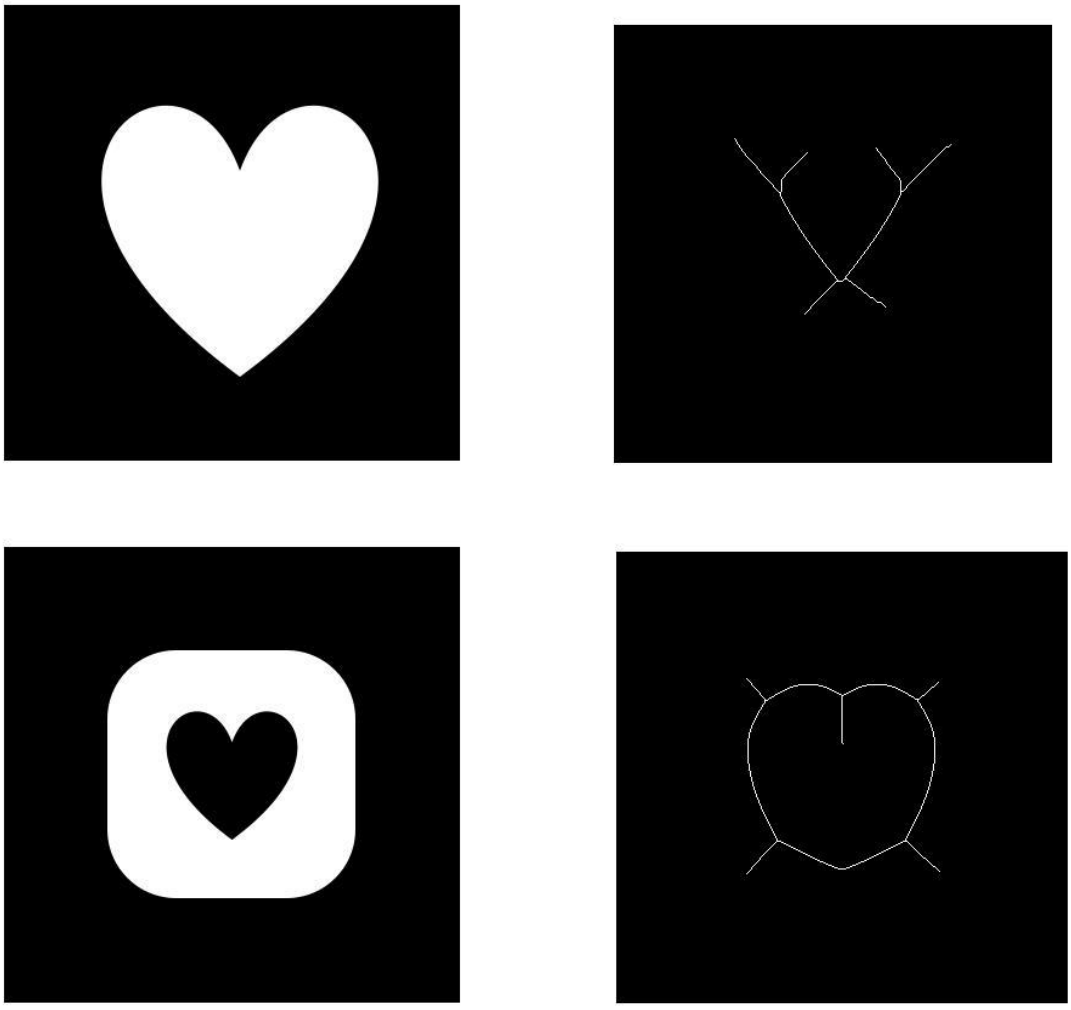


Fig 8: Skeletonizing of Pattern images

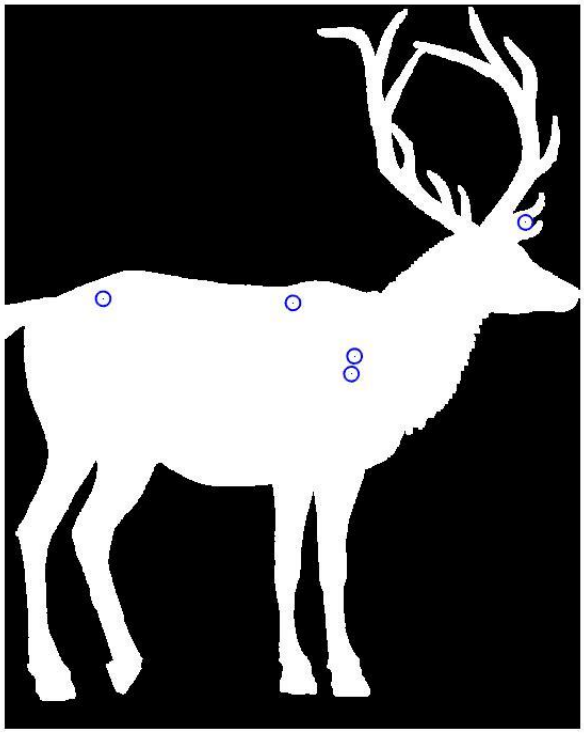


Fig 9: Deer image with defect regions at the centre of the blue circles

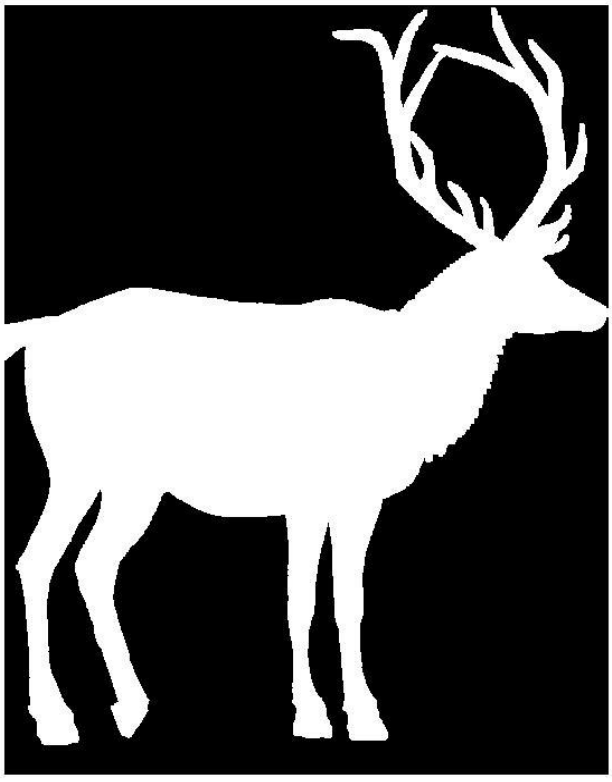


Fig 10: Deer image with defects removed

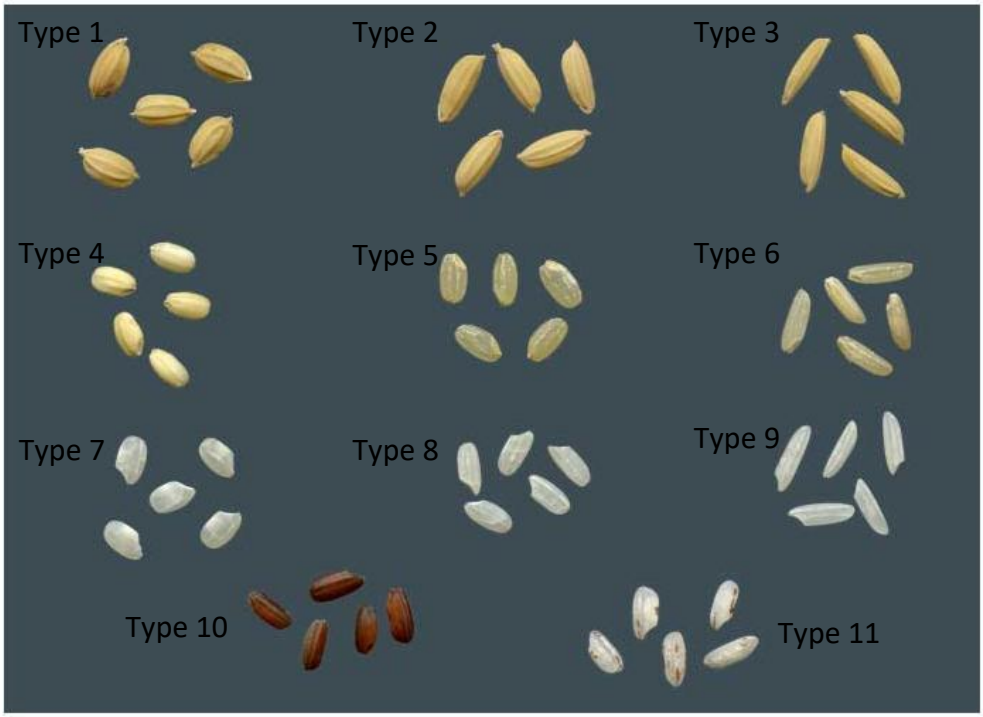


Fig 11: Rice image annotated with type number

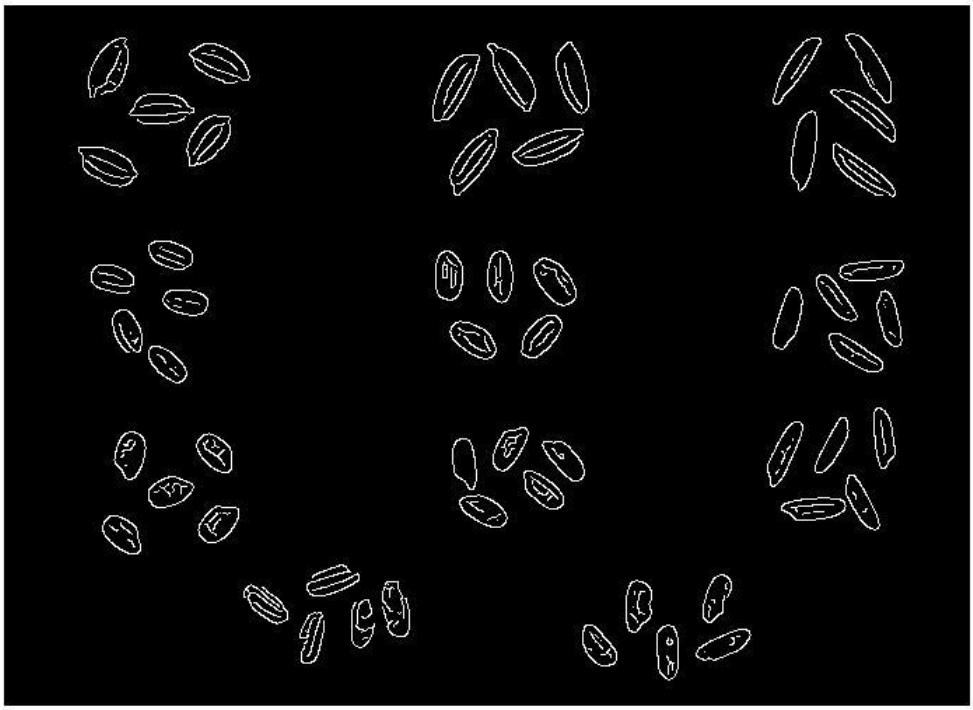


Fig 12: Canny edge detection of Rice image

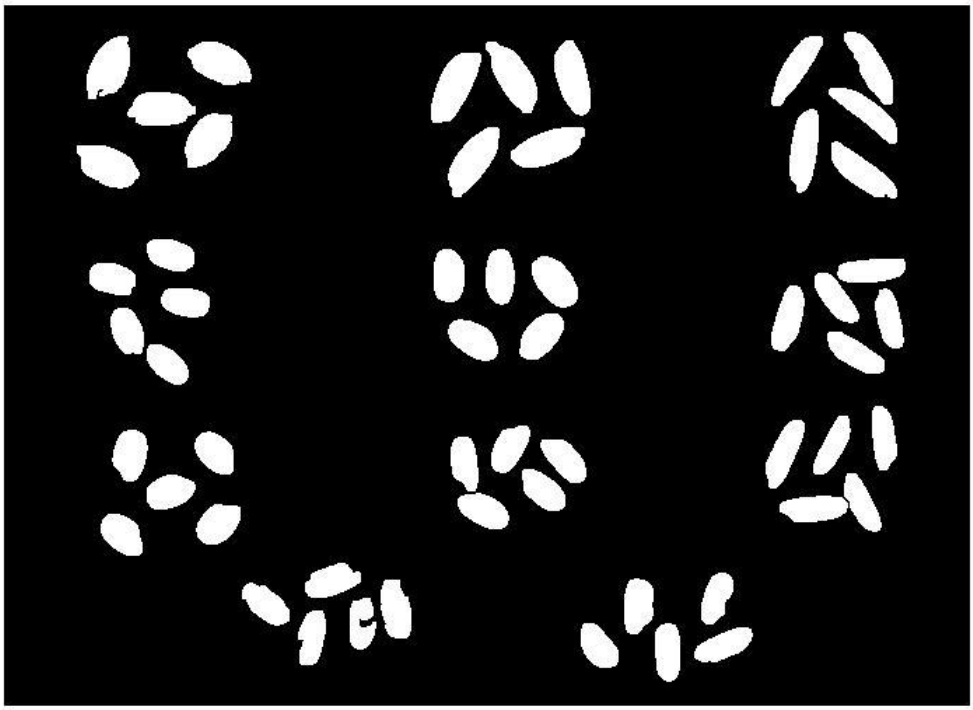


Fig 13: Filling of the edge detected image

Fig 14: Result of shrinking the filled image

Fig 15: Rice image annotated with area of each grain

Discussion

a) Shrinking of Pattern 1 and Pattern 2 results in a single white dot at the centre of the image since they are completely closed and filled. Shrinking of Pattern 3 is similar, but the white dot appears to be slightly lower than the centre. This is due to the fact that the Pattern 3 image is not horizontally symmetric. Shrinking of Pattern 4 does not result in a single dot since it is not a completely filled image. Instead it results in an outline of a heart.

   Thinning of Pattern 1 also leads to a single white dot in the centre like in the shrinking case. This happens due to the fact that the object of the image is circular. Thinning of Pattern 2 results in a small thin horizontal line in the centre which is expected. Thinning of Patter 3 results in a V shape which is loosely defined as the thinning of the left and right parts of the heart shape separately. Thinning of Pattern 4 is similar to its shrinking but there is a small extra line down the middle where the two halves meet due to the shape of the initial object.

   Skeletonizing of Pattern 1 results in an X shape which forms the basis for the circle pattern. Skeletonizing of Pattern 2 also results in an X shape but with V shaped endings, illustrating the corners of the original image. Skeletonizing of Pattern 3 leads to a shape similar to its thinning but with V shaped endings at the three points. Skeletonizing of Pater 4 results in an outline similar to its thinning but with 4 lines projecting out as if to the boundaries of the original image.

b) The Deer image was analyzed and identified to have defects. The defect points were located as the following: (209,500), (282,95), (286,277), (337,336), (354,333)
These were single black pixels in the white body, and they were corrected to white pixels.

c) 1. The total number of rice grains were counted to be equal to 55.
2. The size of the rice grains were compared using their area. They were grouped by their type and were sorted with respect to their average area. The sorted list is as follows: -

Type	Average Area
10	364.4
4	374
9	387.8
11	388
8	395
6	398.8
7	433
5	481.6
3	526.8
1	644.8
2	695