Project 3 of CSE 473/573

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Abstract

To learn and implement the concepts of Morphological Image Processing,Image Segmentation,Hough Transform. This project would give hands on experience and knowledge on these topics.

1 Morphological Image Processing

Morphological operators often take a binary image and a structuring element as input and combine them using a set operator

Dilation

Dilation is one of the two basic operators in the area of mathematical morphology. The basic effect of the operator on a binary image is to gradually enlarge the boundaries of regions of foreground pixels

Erosion

The basic effect of the operator on a binary image is to erode away the boundaries of regions of foreground pixels (*i.e.* white pixels, typically). Thus areas of foreground pixels shrink in size, and holes within those areas become larger.

Opening - an erosion followed by a dilation

Opening and closing are two important operators from mathematical morphology. They are both derived from the fundamental operations of erosion and dilation. The basic effect of an opening is somewhat like erosion in that it tends to remove some of the foreground (bright) pixels from the edges of regions of foreground pixels. However it is less destructive than erosion in general. As with other morphological operators, the exact operation is determined by a structuring element.

Closing a dilation followed by an erosion

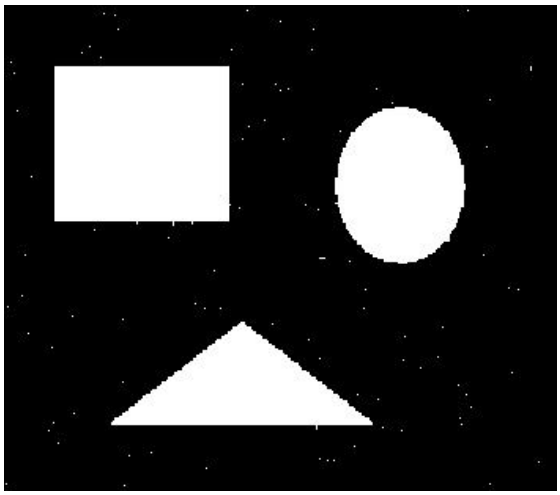
Closing is similar in some ways to dilation in that it tends to enlarge the boundaries of foreground (bright) regions in an image (and shrink background color holes in such regions), but it is less destructive of the original boundary shape.

Noise Removal:

There are two approaches to do Noise Removal:

1. Closing followed by opening
2. Opening followed by closing

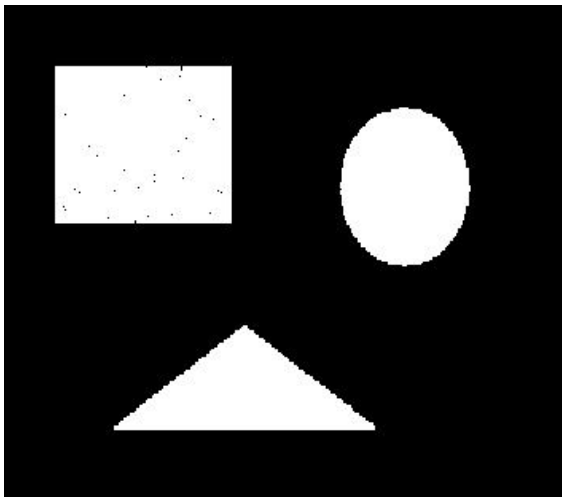
Closing followed by opening:



I. Closing

II. Opening after Closing (res_noise1)

Opening followed by closing:



I. Opening

II. Closing after Opening (res_noise2)

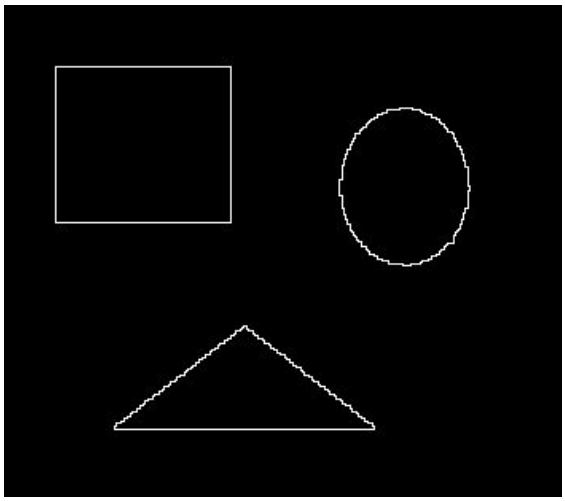
From the above images we can see that Noise pixels outside the objects area are removed by opening operation and noise pixels inside the objects are is removed by closing operation.

Difference between the two algorithms

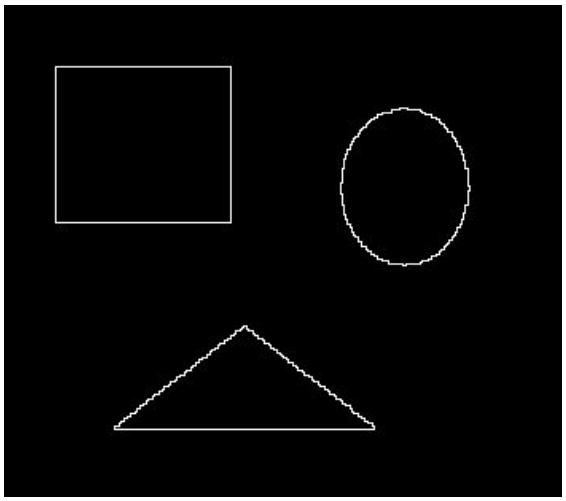
On comparing the two algorithms, we can see that there is a subtle difference in the results of the two algorithm. However, the difference is not huge and it is negligible.

Boundary Extraction:

The formula for boundary extraction is given by: Boundary = A - A erosion B



I. res_bound_1



II. res_bound_2

2 Image Segmentation And Point Detection

2a. Point detection

Point detection can be done with various masks, on trying out with 3x3 and 5x5 masks, 5x5 masks provided better results, thus, the below mask is used for this image to do the point detection.

-1	-1	-1	-1	-1
-1	-1	-1	-1	-1
-1	-1	24	-1	-1
-1	-1	-1	-1	-1
-1	-1	-1	-1	-1

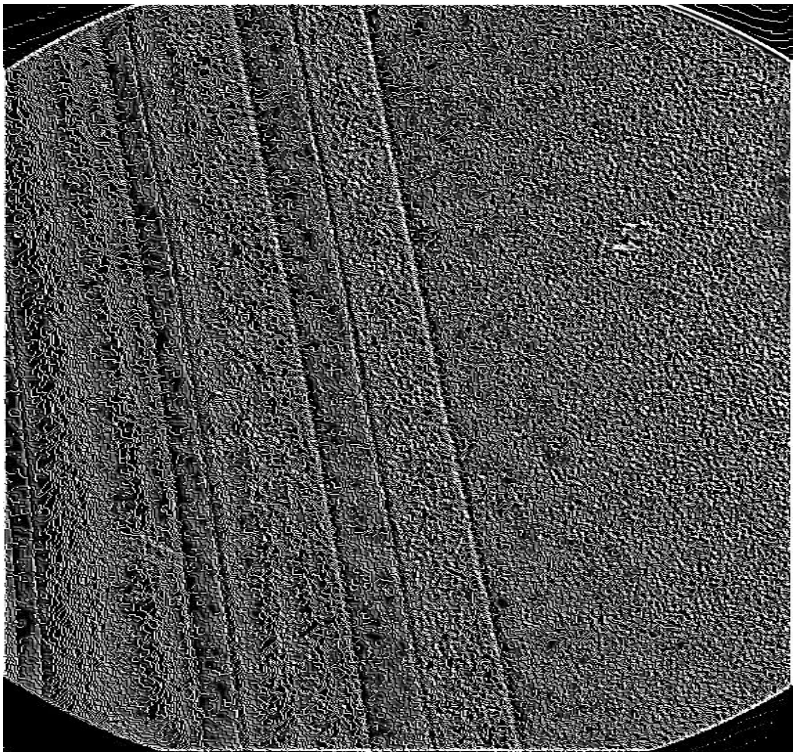


Fig: Point detection before thresholding

Procedure followed:

1. The input image is convoluted with the kernel of size 5 x 5 shown above.
2. Threshold is calculated for the convolved output. The threshold is taken as the 90% of the maximum pixel value in the image.
3. The pixel values less than the threshold is set to zero and pixel values greater than the threshold is set to 1.
4. The pixel values updated image is our output.

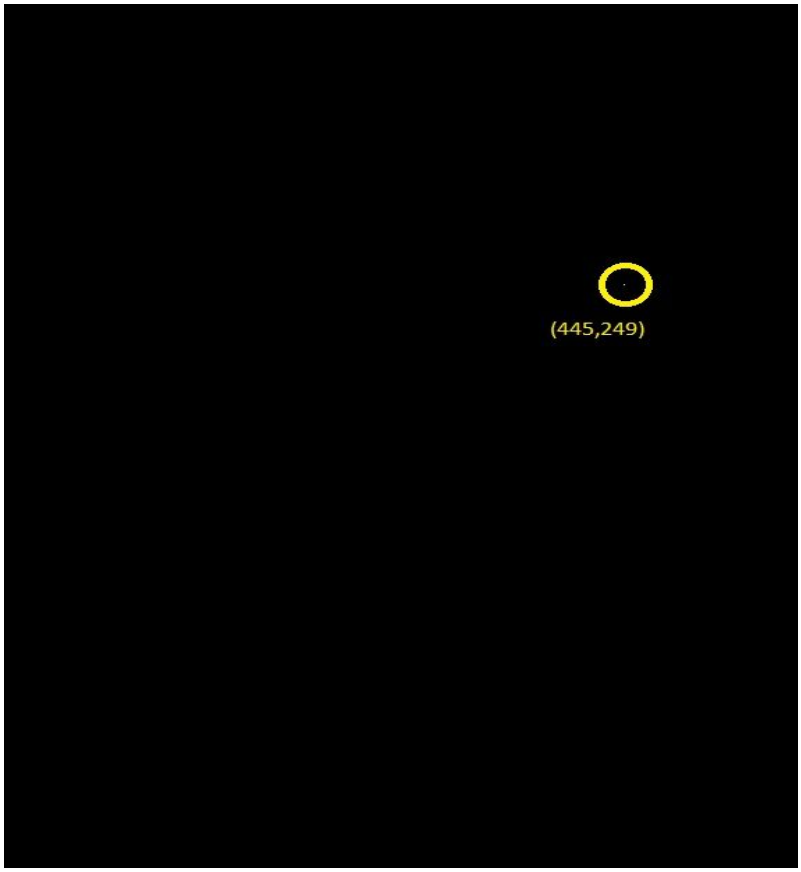


Fig: Output after thresholding.

In the given image, the number of points detected is 1 whose coordinates is (445,249)

Task 2. b: Segmentation

The objective is to subdivide an image into its constituent parts or objects for subsequent processing such as recognition. It is one of the most important steps leading to the analysis of processed image data.

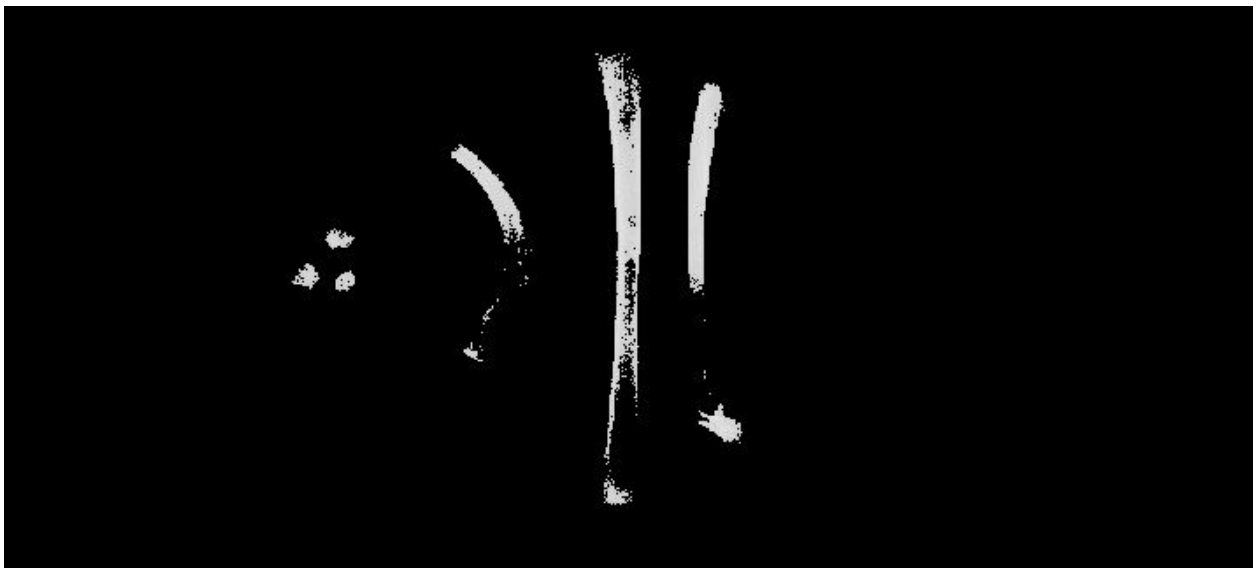


Fig: Segmentation result

Procedure:

1. Histogram is plotted for the given image
2. The histogram is too biased towards zero. Thus we omit all the black pixels.
3. By observing the histogram, the threshold is picked and pixel values which has value less than the threshold is updated with zero eventually differentiate the required region with white colour and the background with black colour.
4. The resultant image will be segmented image.

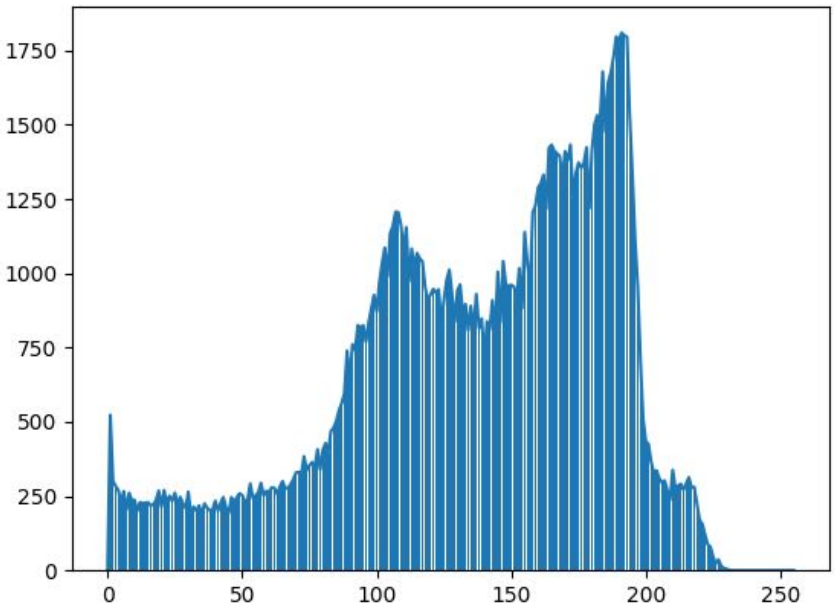


Fig: Histogram of the image. Threshold = 205

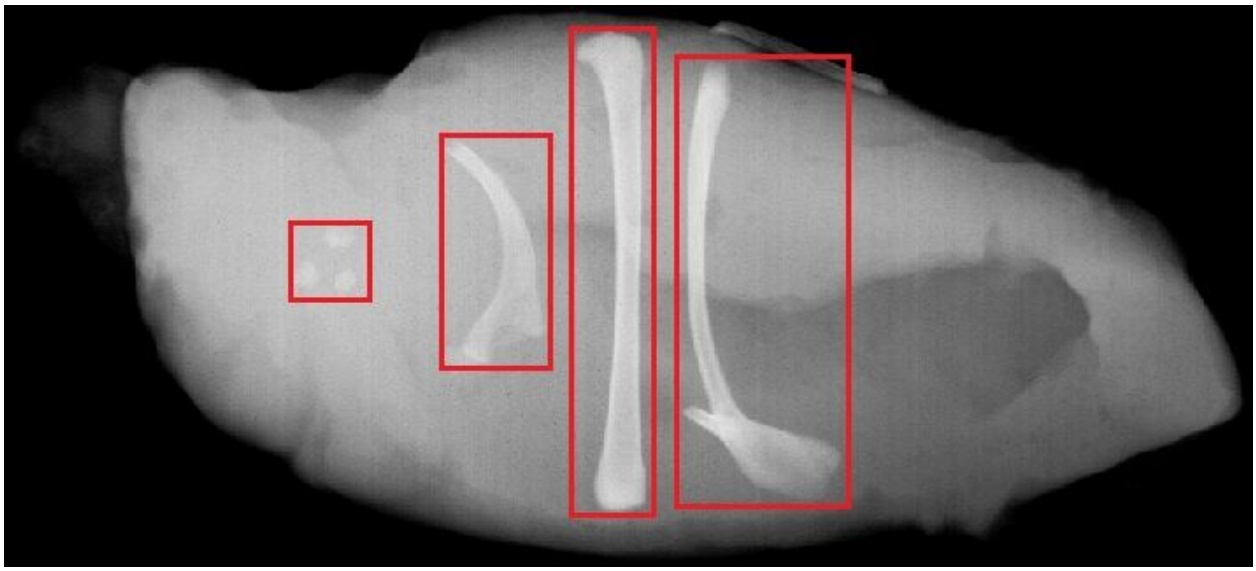


Fig: bounding box around the segmented pixels

Coordinates of the bounding boxes are:

	Object 1	Object 2	Object 3	Object 4
Top Left	(160,120)	(255,80)	(320,25)	(387,45)
Top Right	(200,125)	(300,80)	(365,25)	(423,45)
Bottom Left	(160,165)	(255,204)	(320,287)	(387,251)
Bottom Right	(200,165)	(300,204)	(365,287)	(423,251)

3 Hough Transform

Hough Transform is a popular technique to detect any shape, if you can represent that shape in mathematical form.

A line can be represented as $y = mx + c$ or in parametric form, as $\rho = x\cos\theta + y\sin\theta$ where ρ is the perpendicular distance from origin to the line, and θ is the angle formed by this perpendicular line and horizontal axis measured in counter-clockwise

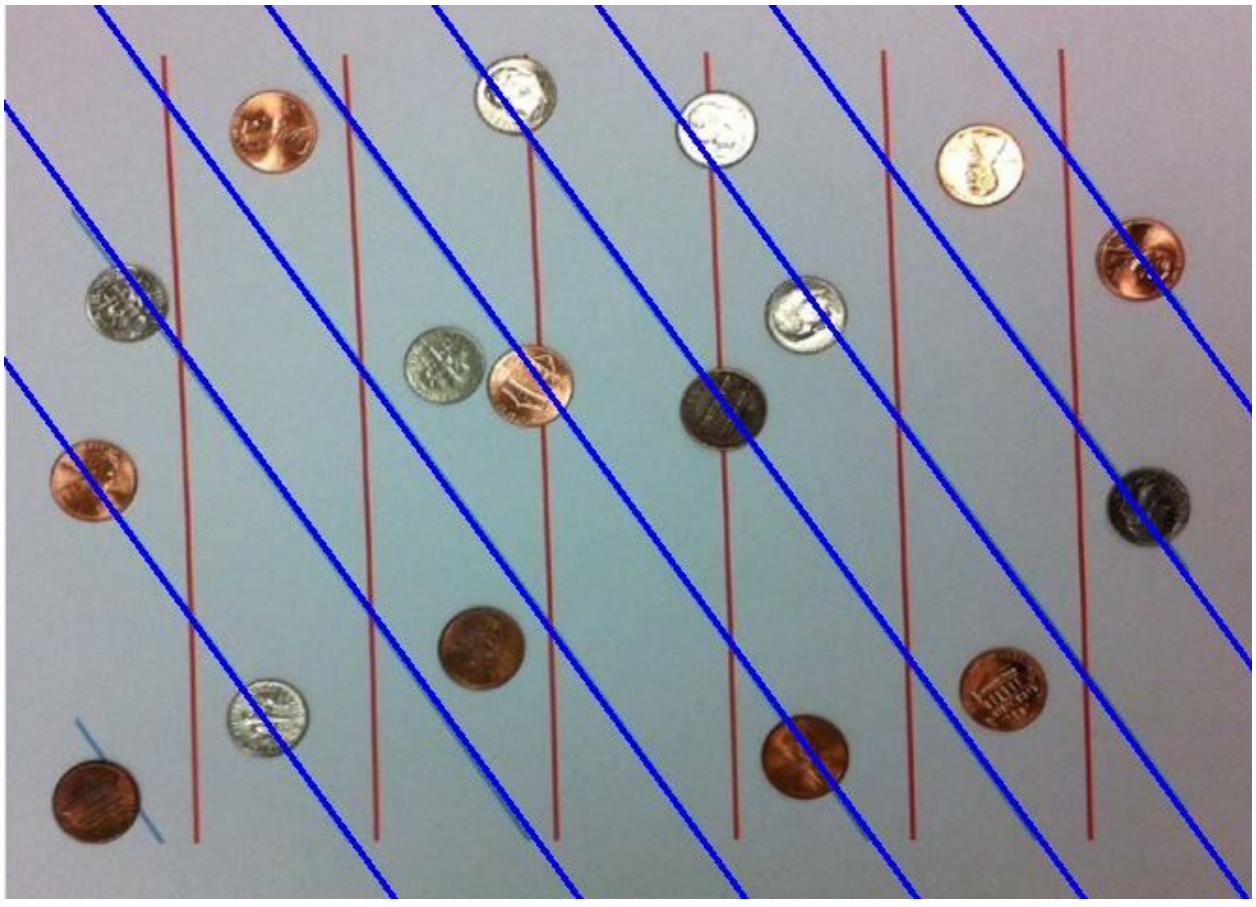


Fig: Blue lines detected. 8/9 Lines detected.

Algorithm steps:

1. The first step is to perform edge detection. Sobel edge detection algorithm is performed and edges from the input image is obtained in binary form.
2. We have to transform the edge points in the image space into the polar space.
3. In order to do the transformation the diagonal for the image is calculated which would be the the range of the rho and -90 and 90 will be the range of the thetas
4. Fill the accumulator matrix by calculating the rho value for all the possible theta values for each edge points
5. For each edge point and for each θ value, find the nearest ρ value and increment that index in the accumulator.
6. Peak values are calculated in the accumulator matrix. Peak values represent the maximum number of intersecting sine waves in hough space.
7. Using the coordinates (rho and theta) of the peak values, the point is transformed into a line in the image space.

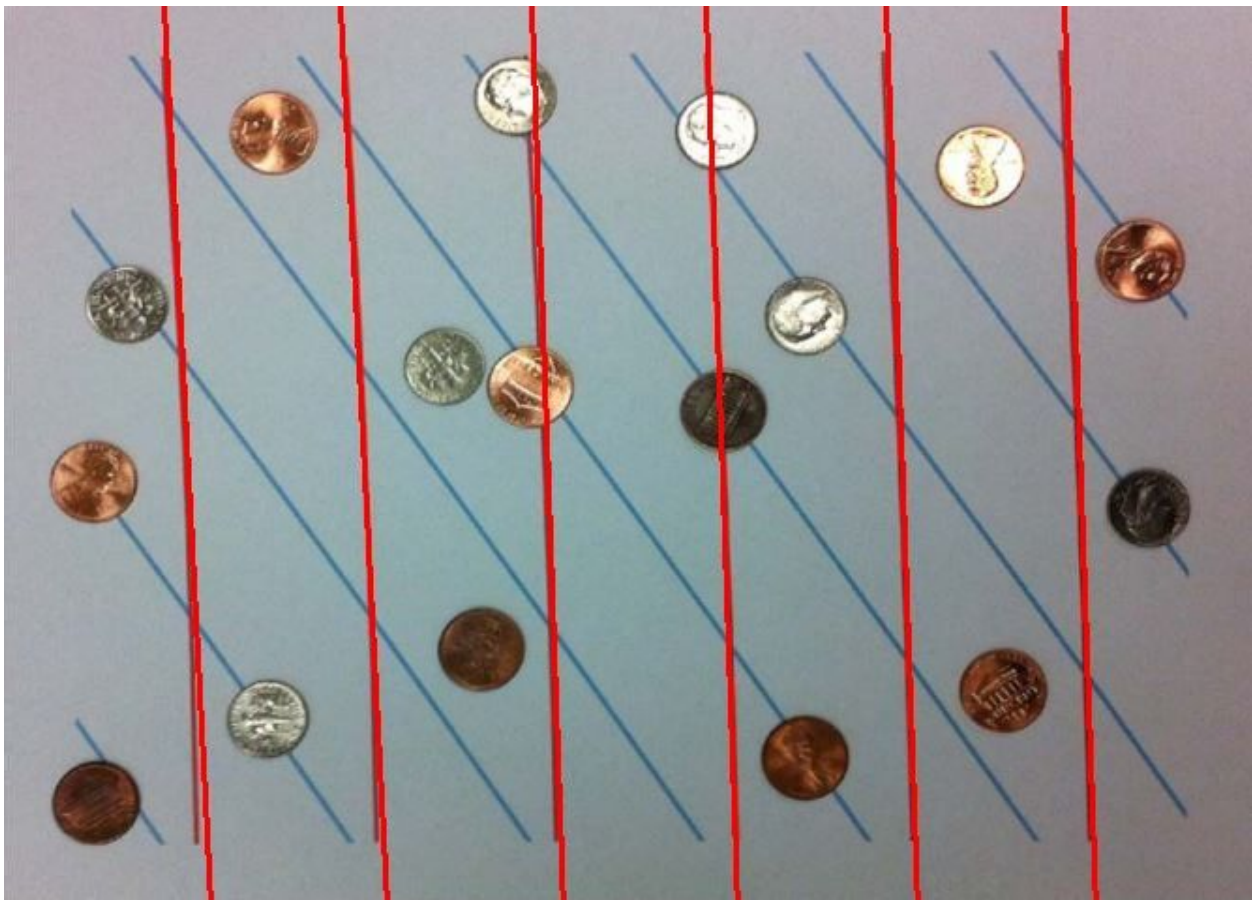


Fig: Red lines detected. 6/6 lines detected.