APPLIED PHYSICS 157

Activity 7

FEATURE EXTRACTION FROM LABELED BLOBS

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WFY-FX-2

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The outputs presented in the succeeding pages are created using MATLAB. Moreover, the codes are uploaded in Github.

ACTIVITY

Objectives:

- Extract features from four different objects using regionprops in MATLAB

Figure 1. Original images used for the activity. From left to right: beads, coins, dice, rice grains

Figure 2. Grayscale images of the reference image.

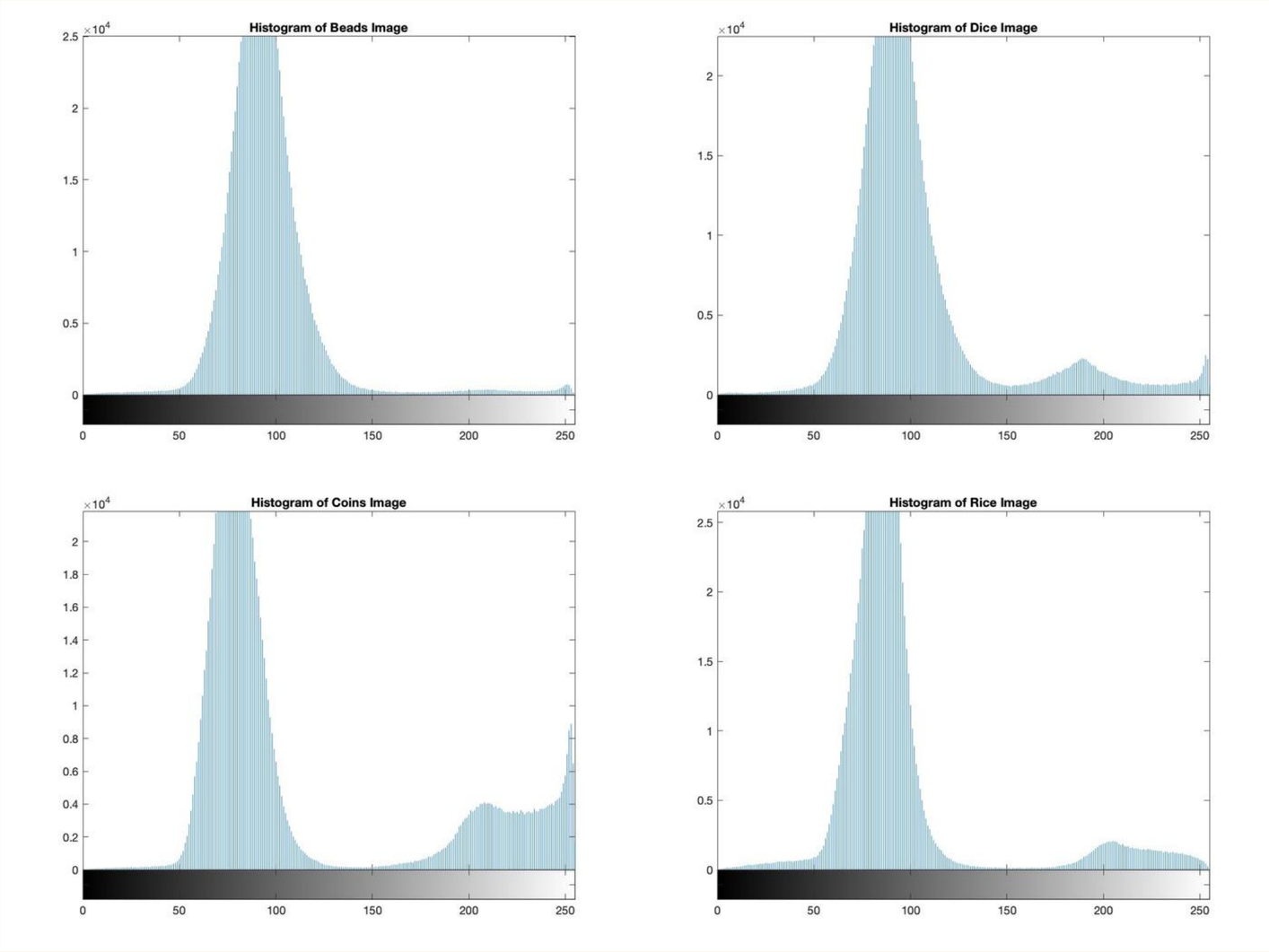

Figure 3. Histogram of the grayscale images.

After analyzing the histograms of the images used in the experiment, I applied thresholding by setting appropriate ranges for each image. Specifically, I set the threshold for the beads image starting from 225, for the dice image from 181, for the coins image from 170, and for the rice grains image starting from 190. The thresholding resulted to grayscale images with artifacts and holes in the desired region of interest. With that, there is a need for further enhancement of the images. This was implemented using morphological operations.

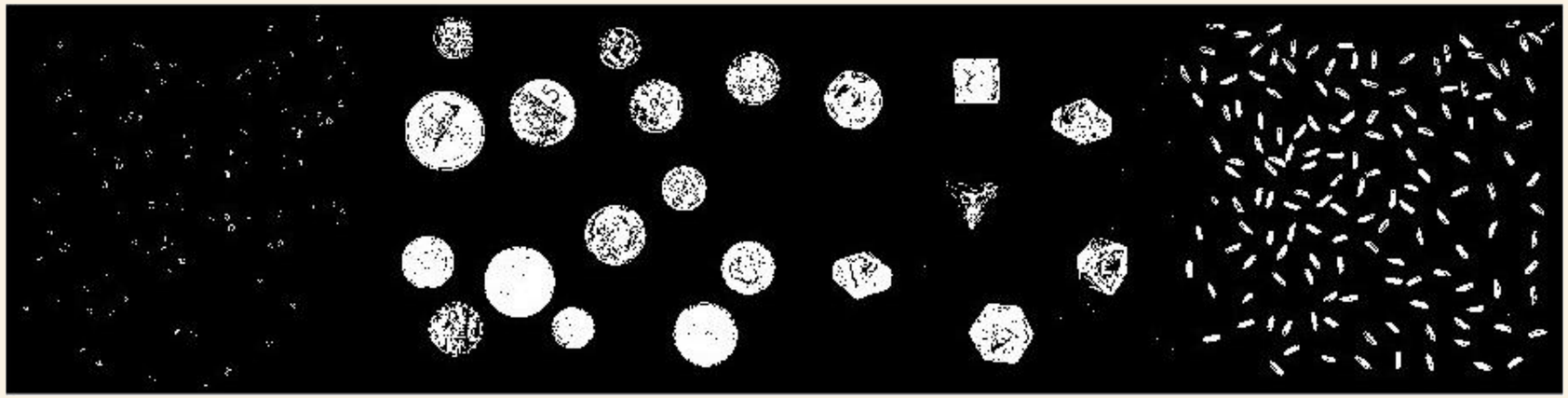

Figure 4. Thresholded grayscale images

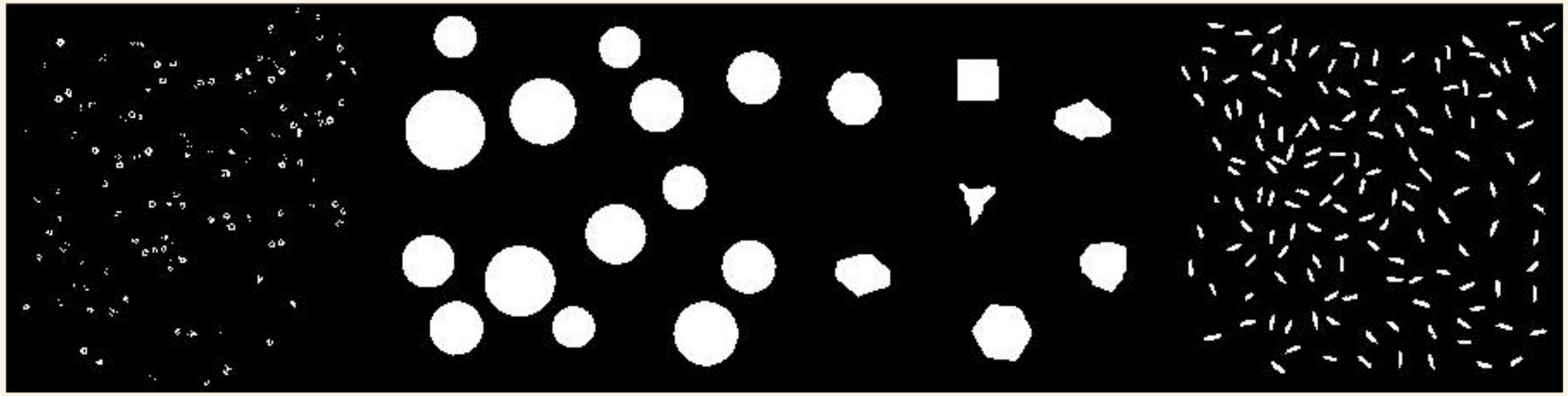

Figure 5. Cleaned thresholded grayscale images

Figure 5 shows the cleaned version of the thresholded grayscale images. I used different morphological operations to arrive with the best segmentation. Specifically, I used imclose, imopen, imfill, imerode, and bwmorph with varying operations.

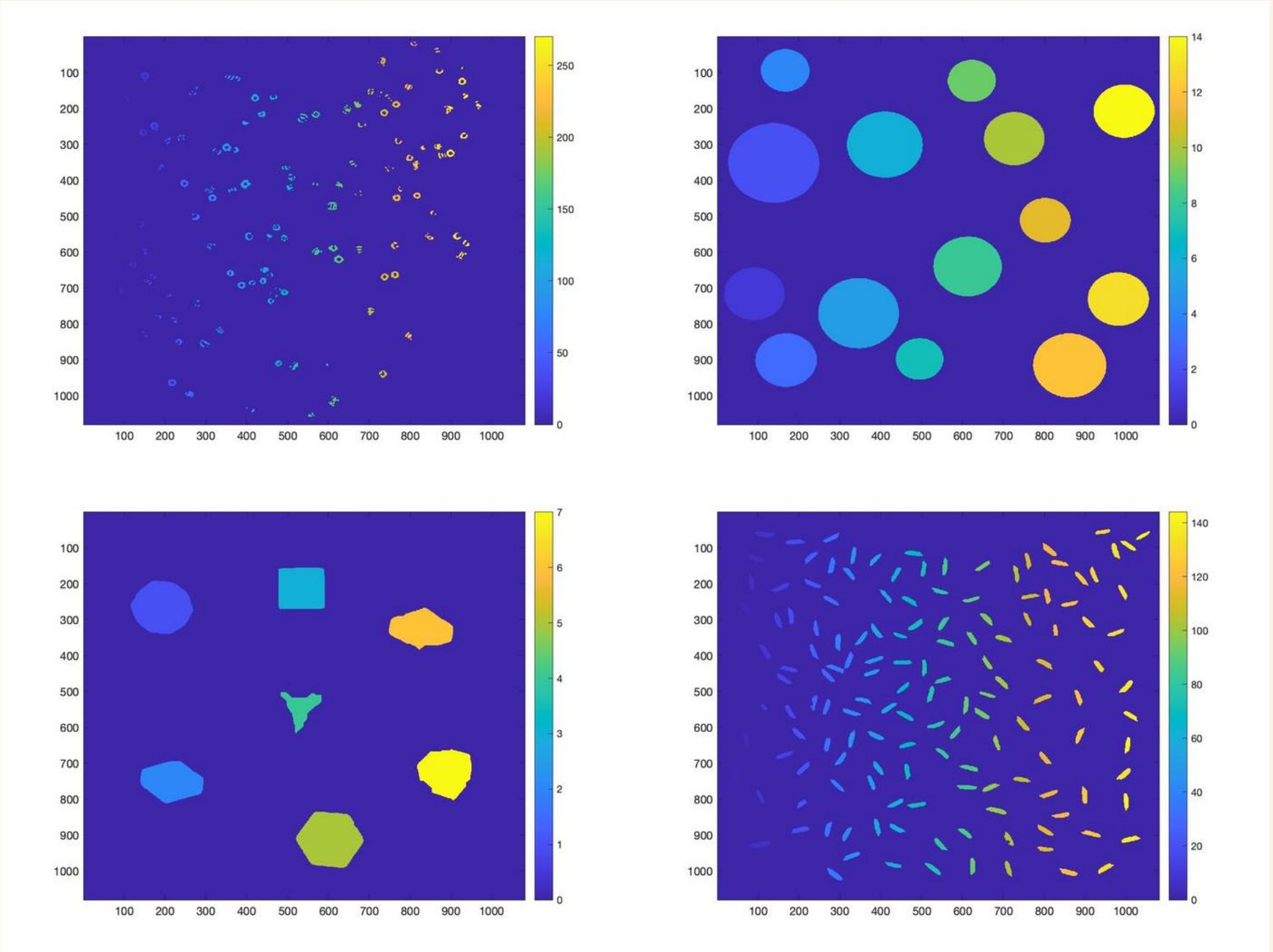

Figure 6. Labeled images using bwlabel

Figure 6 shows the labeled images using **bwlabel**. The **bwlabel** is important before using **regionprops** since it assigns unique labels to connected components, enabling accurate analysis of properties for each individual region. I then used **regionprops** to get the eccentricity, bounding box, and centroid of the images. The succeeding slides show the result.

Table 1. Properties of the beads

	Area	Centroid		BoundingBox			
1	175	57.1486	841.4457	48.5000	833.5000	17	16
2	21	54.4762	338.2857	50.5000	336.5000	8	4
3	14	54.1429	353.0714	51.5000	351.5000	5	3
4	12	77.3333	542.6667	75.5000	540.5000	4	4
5	29	85	545.5172	81.5000	542.5000	7	6
6	47	90.2553	550.4468	84.5000	544.5000	10	10
7	65	93.5077	700.4154	85.5000	697.5000	15	7
8	36	91.0278	707.1667	86.5000	704.5000	9	5
9	30	93.9333	714.8333	90.5000	712.5000	7	5
10	16	99.8125	169.1875	97.5000	166.5000	4	5
11	43	107.1860	169.2558	103.5000	165.5000	8	7
12	13	108.3846	175.6154	106.5000	173.5000	4	4
13	67	116.4179	634.4030	112.5000	628.5000	9	12
14	66	126.0303	636.4848	121.5000	627.5000	8	16
15	243	146.5679	266.7202	136.5000	256.5000	20	20
16	60	143.6667	527.6000	137.5000	523.5000	12	8
17	7	140.5714	515.7143	139.5000	513.5000	2	4
18	286	151.0734	109.3322	140.5000	99.5000	21	23
19	7	144.2857	514	142.5000	512.5000	3	3
20	21	146.6190	592.5714	143.5000	590.5000	6	4
21	7	146	518.2857	144.5000	516.5000	3	3
22	25	147.0800	824.2400	144.5000	820.5000	6	6
23	44	151.5682	603.9545	146.5000	599.5000	9	8
24	16	150.3125	679.6250	148.5000	676.5000	4	6
25	32	153.4375	834.5000	148.5000	830.5000	8	7
26	32	152.4688	593.3125	149.5000	589.5000	6	8
27	33	157.5152	681.9697	153.5000	678.5000	8	7
28	40	164.2750	686.1250	159.5000	681.5000	9	9
29	231	173.6623	248.2641	164.5000	238.5000	19	20
30	17	166.8824	663.6471	164.5000	660.5000	5	6
31	26	175.8077	670.4231	172.5000	666.5000	6	7
32	29	178.6207	258.9310	174.5000	256.5000	8	5
33	16	179.1875	777.5000	176.5000	775.5000	5	4
34	12	184.5000	371.5000	182.5000	369.5000	4	4
35	47	187.9787	780.7234	184.5000	775.5000	6	11
36	18	188.5556	365.8333	185.5000	363.5000	6	4
37	48	192.6458	359.4583	186.5000	356.5000	12	7
38	21	202	289	199.5000	286.5000	5	5
39	35	207.4286	296	203.5000	292.5000	8	7
40	53	210.3396	284.9811	204.5000	280.5000	10	9
41	35	210.6286	721.1714	204.5000	716.5000	11	8
42	245	217.1918	963.8980	207.5000	953.5000	20	20
43	29	219.4483	783.7931	215.5000	781.5000	8	5
44	45	225.4889	793.3333	219.5000	789.5000	10	7
45	11	226.4545	785.8182	224.5000	783.5000	4	4
46	140	236	849.1071	225.5000	841.5000	17	18
47	19	229.0526	851.2105	226.5000	848.5000	5	5
48	2	228.5000	856.5000	227.5000	855.5000	2	2
49	16	232.2500	279.8750	230.5000	276.5000	4	6
50	21	234	287	231.5000	284.5000	5	5
51	20	237.1000	275.9500	234.5000	273.5000	5	5
52	247	247.6316	408.5749	237.5000	398.5000	20	22
53	21	245	276	242.5000	273.5000	5	5
54	21	245.0476	284.7143	242.5000	281.5000	5	6
55	24	251.9583	993.3333	249.5000	989.5000	5	7
56	188	262.4947	995.7553	253.5000	986.5000	17	18
57	22	260.8182	159.3182	258.5000	155.5000	5	7
58	12	267.2500	153.2500	263.5000	151.5000	6	4
59	21	269	495	266.5000	492.5000	5	5
60	151	276.9205	504.3576	266.5000	491.5000	18	20
61	26	273.4615	159.1538	270.5000	155.5000	6	7
62	21	275	748	272.5000	745.5000	5	5
63	26	277.0769	142.5385	274.5000	138.5000	5	7
64	36	281.0833	736.1111	276.5000	733.5000	9	5
65	19	282.2632	750.1579	279.5000	747.5000	5	5
66	75	290.3867	858.0667	285.5000	848.5000	11	17
67	18	291.7222	845.8333	289.5000	843.5000	5	5
68	65	299.6000	851.6923	293.5000	846.5000	12	10
69	29	300.8966	426.7586	297.5000	422.5000	7	8
70	2	300.5000	863.5000	299.5000	862.5000	2	2
71	94	309.1702	583.9894	302.5000	575.5000	13	17
72	5	303.6000	862.2000	302.5000	860.5000	2	3
73	14	305.6429	427.1429	303.5000	424.5000	4	5
74	53	311.4717	431.4717	304.5000	425.5000	12	10
75	20	308.1000	856.0500	305.5000	853.5000	5	5
76	237	316.4641	449.2068	306.5000	439.5000	20	19
77	4	312.5000	419	311.5000	417.5000	2	3
78	12	315.5000	420.1667	313.5000	417.5000	4	5
79	33	319.8788	315.1515	316.5000	310.5000	7	9
80	19	319.1579	424.1579	316.5000	421.5000	5	5
81	21	321	579	318.5000	576.5000	5	5
82	5	326.6000	320.2000	325.5000	318.5000	2	3
83	17	327.7647	816.1765	325.5000	813.5000	5	5
84	60	334.1000	322.3000	328.5000	315.5000	10	13
85	56	334.3214	819.1429	328.5000	813.5000	12	11
86	23	333.8696	810.9130	330.5000	807.5000	6	7
87	38	339.2632	823.4211	334.5000	818.5000	10	9
88	293	351.2014	308.4437	340.5000	297.5000	23	21
89	26	349.6154	110.7692	346.5000	106.5000	7	8
90	187	360.4385	658.8503	351.5000	650.5000	17	17
91	44	357.0455	112.2727	352.5000	107.5000	9	10
92	37	357.5676	428.8378	354.5000	423.5000	6	10

The table above displays the properties of the individual beads in the image. Based on the results, it is evident that the area of the beads varies within a certain range. This variation could be attributed to the small size of the beads, which may introduce distortions in the image. Additionally, this variability in area could be influenced by the morphological operations employed to separate the beads from the background.

Table 2. Properties of the coins

	Area	Centroid		BoundingBox			
1	17151	91.0457	716.2047	16.5000	642.5000	149	147
2	38832	138.5847	351.9339	27.5000	240.5000	223	222
3	17578	168.8718	900.7984	93.5000	825.5000	151	150
4	11059	166.7646	94.0199	106.5000	34.5000	120	119
5	30332	345.9953	770.2590	247.5000	672.5000	197	196
6	26865	410.3280	300.7135	317.5000	208.5000	186	184
7	10701	494.9831	897.7025	436.5000	839.5000	117	116
8	21857	612.3477	639.8447	528.5000	556.5000	168	167
9	10823	622.7763	122.8148	563.5000	64.5000	118	117
10	17274	726.3596	283.9344	652.5000	209.5000	148	149
11	12045	802.2771	511.2585	740.5000	449.5000	124	124
12	25022	862.0335	915.4658	772.5000	825.5000	179	179
13	17516	981.1424	730.8846	906.5000	656.5000	150	149
14	17314	995.2172	207.3548	920.5000	133.5000	150	148

Table 3. Properties of the dice

	Area	Centroid		BoundingBox			
1	16969	193.1782	265.9649	116.5000	191.5000	153	148
2	13002	216.9487	750.9502	140.5000	693.5000	154	119
3	12758	534.2554	212.9570	477.5000	155.5000	114	115
4	4997	533.2045	545.2594	483.5000	502.5000	101	114
5	18991	603.7937	912.3840	520.5000	834.5000	166	157
6	12264	827.6353	325.8425	748.5000	266.5000	157	117
7	13574	887.5958	725.0038	816.5000	661.5000	133	142

Table 4. Properties of the rice grains

	Area	Centroid		BoundingBox			
1	443	31.0293	194.4221	19.5000	173.5000	25	41
2	516	43.8740	735.1124	36.5000	711.5000	14	47
3	453	68.7837	267.2141	52.5000	251.5000	30	35
4	383	71.2898	633.2428	62.5000	613.5000	17	39
5	456	94.9079	129.8333	74.5000	120.5000	42	20
6	438	84.5274	196.8014	77.5000	172.5000	14	47
7	569	106.6415	926.0475	83.5000	916.5000	48	19
8	521	116.4741	62.3474	91.5000	55.5000	49	14
9	336	106.3065	793.2649	96.5000	774.5000	20	37
10	503	118.4553	389.7694	103.5000	368.5000	28	42
11	160	114.9750	544.4250	108.5000	534.5000	15	18
12	514	155.6187	210.7977	130.5000	197.5000	46	26
13	470	148.5128	301.7106	138.5000	278.5000	20	44
14	458	165.2074	677.0218	144.5000	665.5000	42	22
15	454	163.2048	465.5286	146.5000	449.5000	37	30
16	444	175.5766	437.7477	151.5000	428.5000	45	18
17	459	178.2941	557.3573	165.5000	537.5000	28	39
18	492	190.7073	83.5183	167.5000	76.5000	48	13
19	490	180.7429	289.9612	173.5000	266.5000	15	46
20	498	203.7550	885.2169	181.5000	876.5000	44	19
21	455	199.6462	618.6352	184.5000	601.5000	33	33
22	475	211.1495	714.7474	194.5000	695.5000	32	36
23	285	207.1789	812.9579	195.5000	801.5000	24	24
24	467	233.6360	200.6702	213.5000	186.5000	41	26
25	474	228.7595	126.5612	214.5000	111.5000	33	34
26	440	236.0341	388.6705	226.5000	367.5000	21	43
27	411	237.8345	531.0560	228.5000	511.5000	18	44
28	415	242.1904	325.0964	235.5000	301.5000	14	44
29	469	270.9851	456.6546	256.5000	436.5000	31	37
30	444	268.0788	542.8041	258.5000	521.5000	19	42

Tables 2, 3, and 4 present the area, centroid, and bounding box properties for the coins, dice, and rice grain images, respectively. Table 2 highlights the variation in coin areas, enabling the identification of coins belonging to the same denomination. In contrast, table 3 illustrates the distinct difference between the segmented image and the triangular-shaped dice. This difference can be attributed to the reflective nature of the dice rather than the applied morphological operations. Finally, table 4 showcases the variability in rice grain sizes.

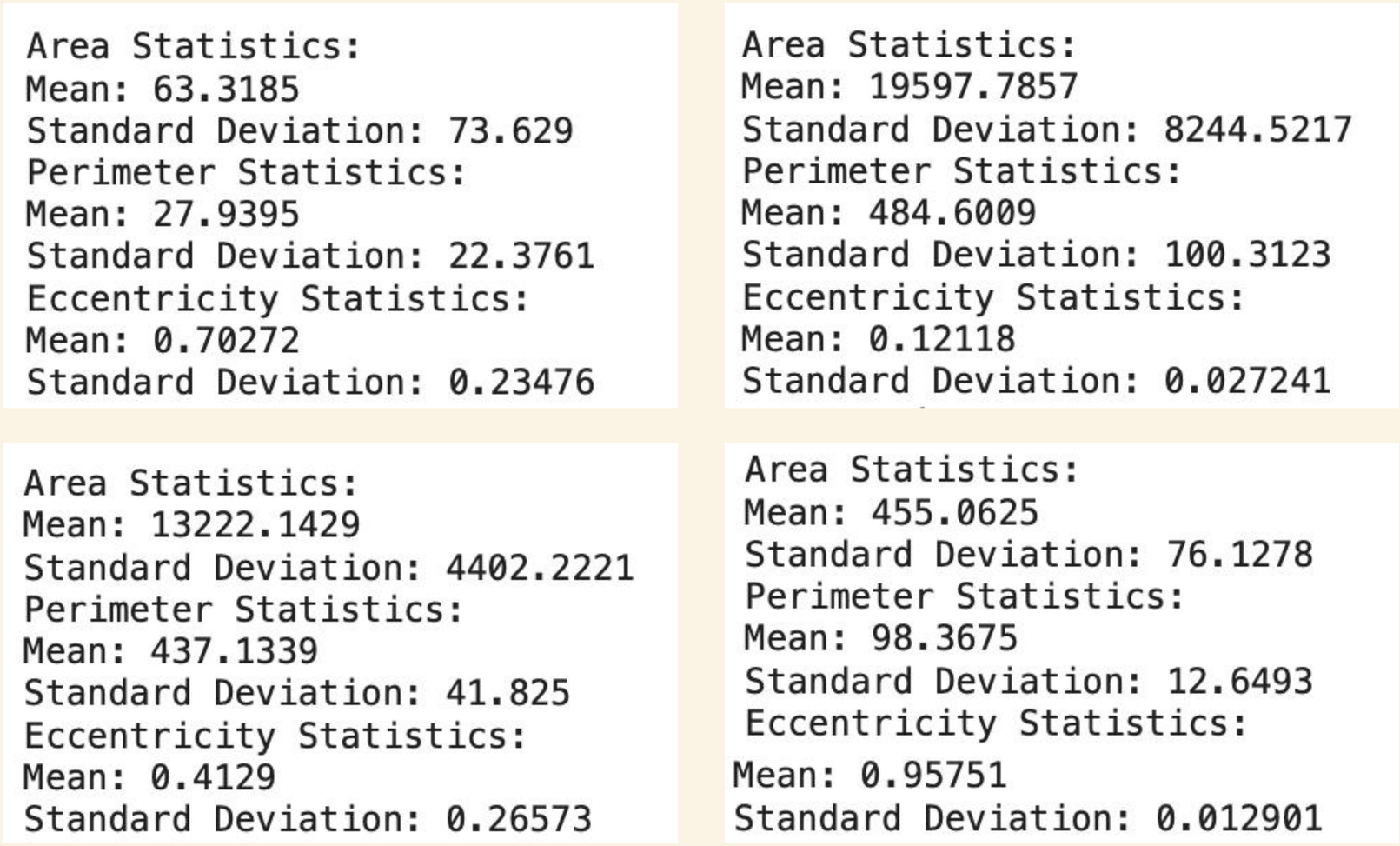

Figure 7. Summary statistics of beads (top left), coins (top right), dice (bottom left), and rice grains (bottom right)

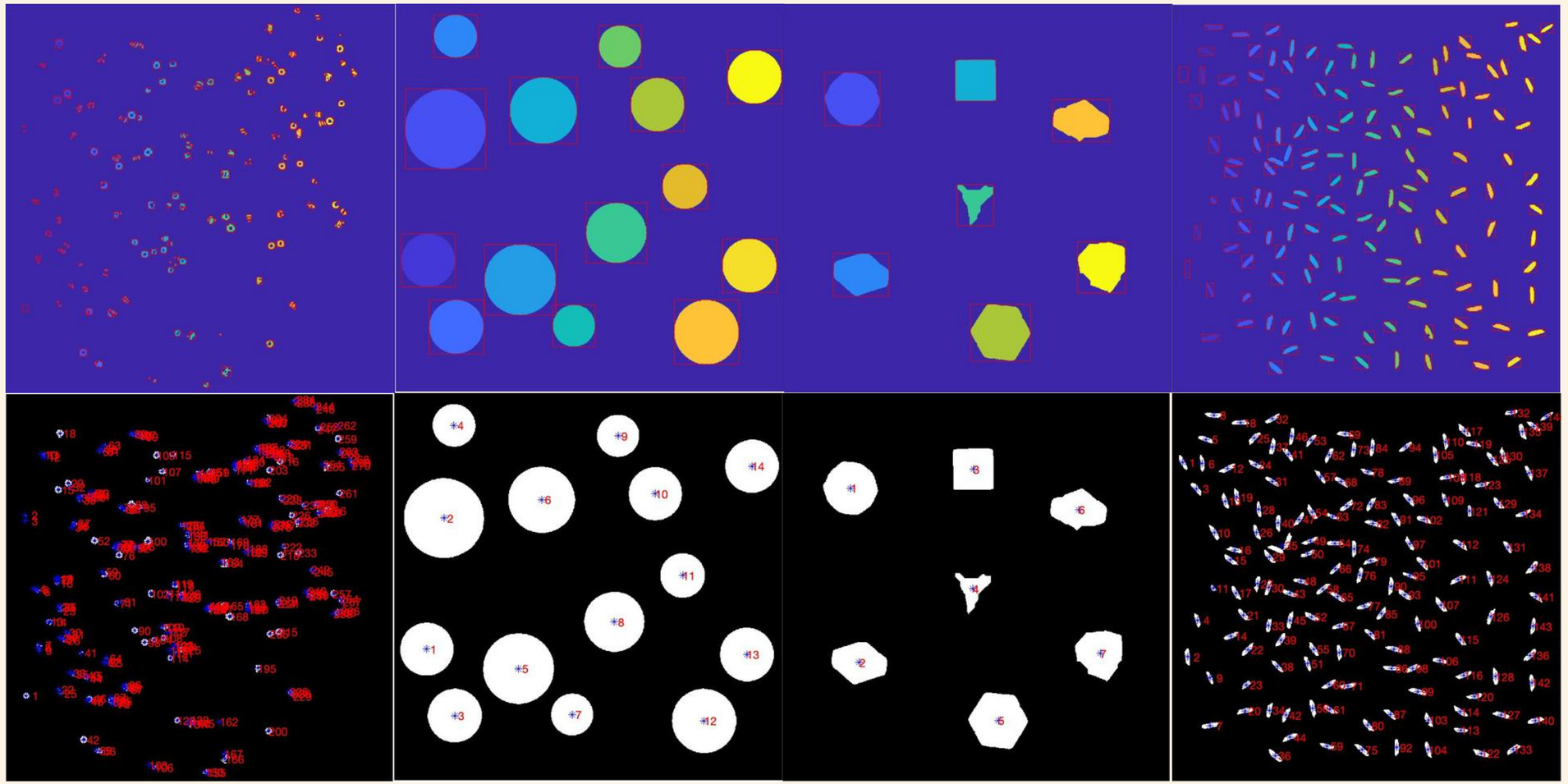

Figure 8. Bounding box (top) and centroid (bottom) properties of the cleaned images

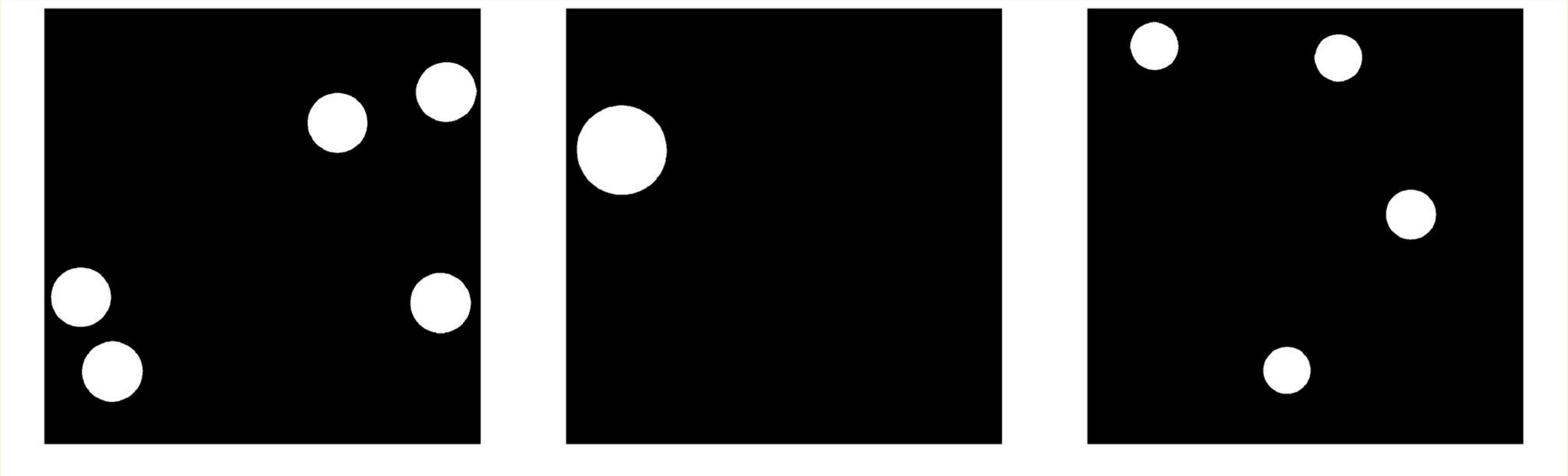

Figure 8. Limiting properties in the cleaned coin image.

I successfully generated binary images that isolate objects or regions based on specific criteria or ranges. In the coins image, the leftmost image segmentated the 25-cent coins, the center image segmentated the 20-peso coin, and the last image segmentated the 5-cent coins.

REFLECTION

RATING: 100 / 100

The most challenging part of this activity is making sure that the images that I will analyze are cleaned properly. This is to remove any artifacts that may change the desired results. Overall, I enjoyed creating this activity starting from gathering data to understanding the data. I believe familiarizing this activity will be an important step in understanding machine learning that I am eager to learn more. I'd give myself 100/100 since I was able to meet the required objectives for this experiment.

References

https://www.mathworks.com/help/images/morphological-filtering.html
https://www.mathworks.com/help/images/ref/bwmorph.html
https://towardsdatascience.com/understanding-morphological-image-processing-and-its-operations-7bcf1ed11756