Feature Extraction from Images

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OVERVIEW OF THE ACTIVITY

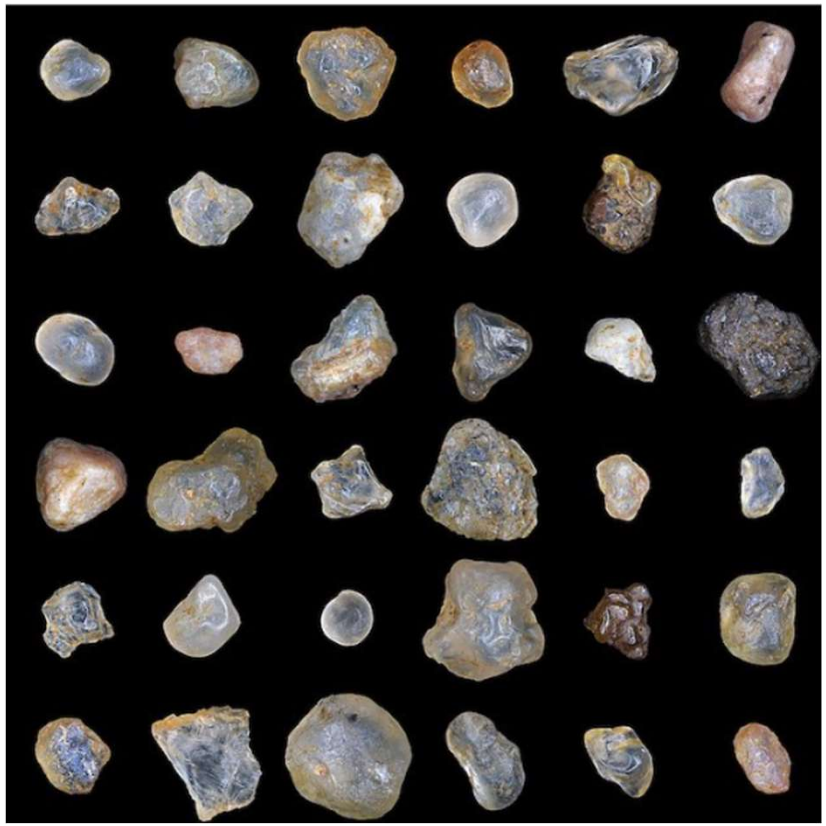
Image feature extraction entails the identification and extraction of significant visual attributes, also known as features, from images. This is done with the aim of minimizing the quantity of data required to describe the image, while retaining its crucial details. [1]

In this activity, we had the opportunity to explore beyond the basic visual information and dive into more complex image processing techniques to extract important features and patterns from the image. So, let's take advantage of these techniques to uncover valuable insights from our visual data!

OBJECTIVES

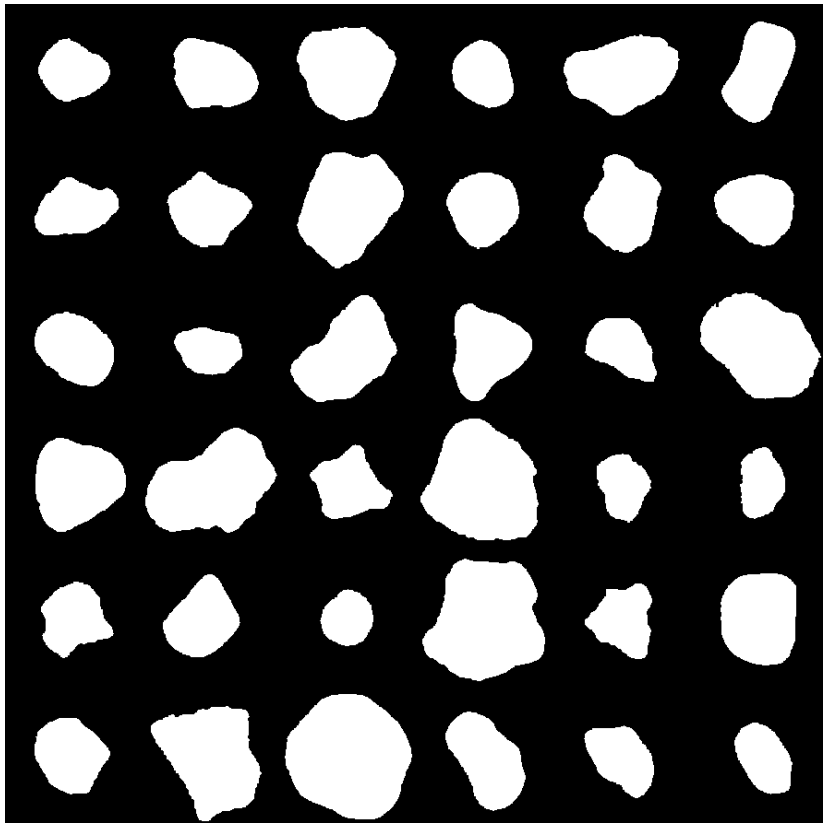
- Familiarize with ImageJ software and its tools for image processing and feature extraction.
- Use ImageJ's feature extraction tools to identify and extract properties such as size, shape, texture, and color from the images of the objects.

ORIGINAL SAND IMAGE



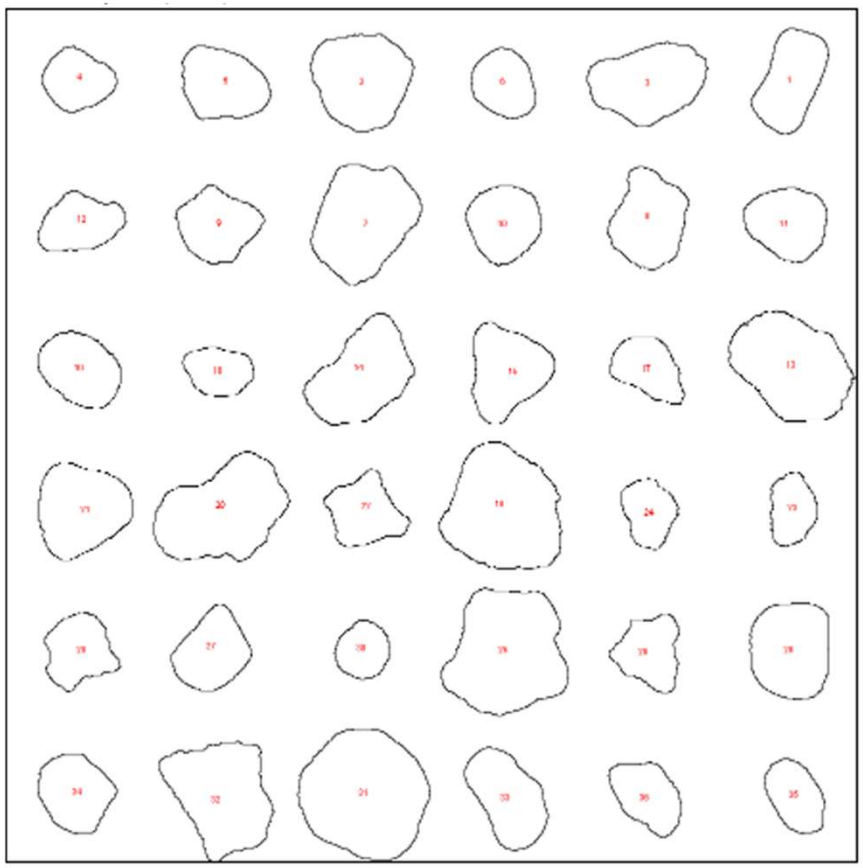
This is the original sand image. As I processed the image using ImageJ, I converted it to grayscale and then to 8-bit, to eliminate the color information and to reduce the complexity of the image, making it easier to manipulate for feature extraction. I then applied thresholding to the image in order to separate the stone from the background to be able to extract features from the cells without interference from the background.

BINARY AND INVERTED SAND IMAGE



This is the resulting thresholded binary and inverted image that shows a clear separation between the stones and the background. We also noted that the inverted image provided better contrast between the cells and the background. Here, it is evident that the image has been simplified and the objects we we wish to measure have been highlighted.

MEASURED FEATURES SAND IMAGE



Using ImageJ's Analyze Particles function, I extracted different characteristics of the image's cells. As seen from the side, the resulting image's cells were labeled with their respective feature measurement. This allowed us to readily identify and quantify the size, shape, and texture of each individual stone in the image. The selected characteristics, such as area, perimeter, and circularity, were especially pertinent to our analysis because they helped us determine the uniformity of the size and shape of the sand image's stones. [the table is displayed on the next slide]

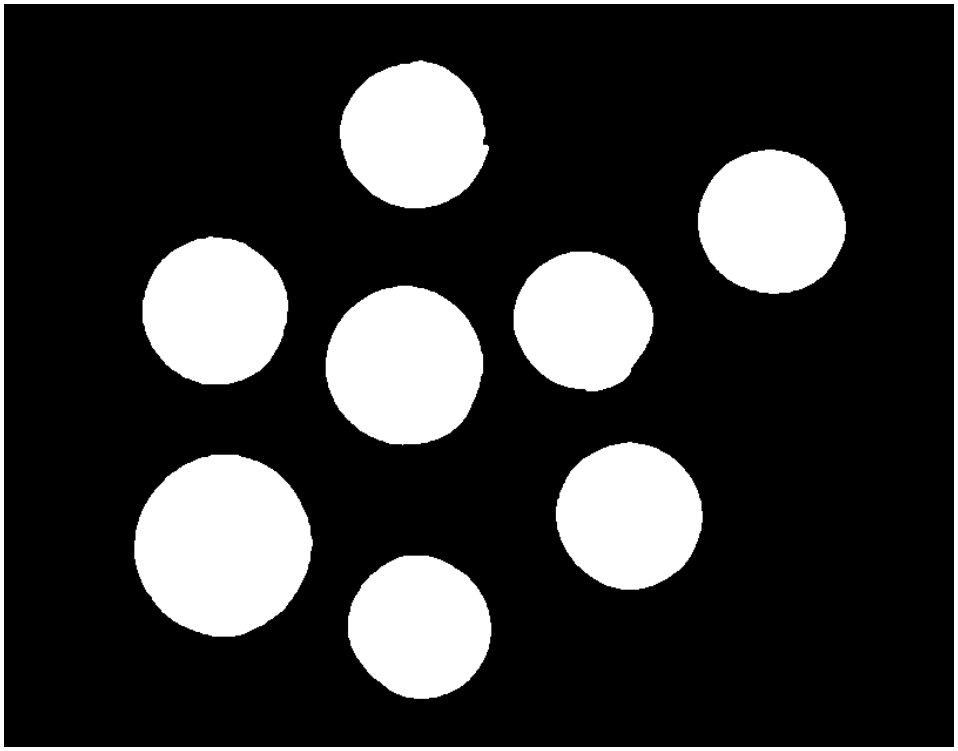
	Area	X	Y	Perim.	Feret	%Area	FeretX	FeretY	FeretAngl	MinFeret
1	5550	817.663	73.076	311.12	110.766	100	809	129	83.26	59.437
2	8118	369.559	72.362	349.605	110.802	100	332	30	126.56	101.762
3	7590	668.913	74.991	355.848	126.89	100	605	75	6.789	80.559
4	3650	73.195	72.703	233.664	78.518	100	36	68	173.418	64.498
5	5388	225.191	76.879	291.078	99.81	100	182	54	155.746	76.289
6	3674	518.251	76.72	229.865	75.802	100	504	43	120.964	63.927
7	9847	371.822	219.19	392.416	132.257	100	357	287	69.647	100.176
8	6120	669.57	218.689	317.019	108.503	100	658	163	99.549	77.553
9	4897	219.226	224.009	277.362	93.193	100	175	215	176.309	75.517
10	4808	518.318	221.645	264.25	84.723	100	511	266	78.425	76.593
11	5008	814.025	221.459	271.907	89.471	100	769	206	154.867	76.211
12	4061	75.816	222.315	261.765	95.52	100	33	243	19.573	62.395
13	10336	818.3	371.294	411.345	137.201	100	760	334	143.297	99.749
14	8010	370.058	379.917	368.517	129.294	100	337	432	61.849	81.22
15	6108	521.564	375.819	318.777	106.794	100	501	325	96.992	85.482
16	5023	75.947	374.359	271.907	92.914	100	35	351	145.968	69.559
17	3606	668.508	373.564	245.622	89.196	100	643	344	132.274	58.419
18	2873	220.617	376.048	210.409	76.158	100	183	365	166.329	50.978
19	12398	517.556	521.799	441.103	145.962	100	488	455	121.839	121.355
20	10724	224.279	522.8	430.659	146.986	100	152	545	13.374	100.845
21	7354	77.218	519.977	332.291	105.551	100	44	564	41.543	96.326
22	4364	372.915	522.872	279.563	93.408	100	330	510	164.476	75.502
23	2866	818.994	520.303	217.966	79.31	100	806	558	76.139	49
24	3036	669.417	523.271	221.037	75.71	100	661	489	102.2	56.639
25	12779	521.312	669.577	458.617	143.283	100	456	706	40.471	128.528
26	7053	817.745	666.528	318.208	105.119	100	796	621	115.346	82
27	4844	213.596	668.488	272.434	93.145	100	201	709	75.069	67.565
28	4220	74.589	667.46	267.806	85.165	100	62	710	74.332	72.912
29	3968	670.242	668.959	265.179	85.959	100	651	635	119.249	72.402
30	2625	371.004	667.107	194.309	62.129	100	368	697	86.309	56.569
31	14023	372.784	817.268	449.245	144.003	100	343	754	116.387	129.594
32	9688	223.535	818.11	419.889	137.637	100	158	783	144.462	103.87
33	5839	521.981	820.767	312.09	113.719	100	496	769	113.86	67.978
34	4843	70.706	815.354	266.978	88.323	100	46	780	120.63	73.539
35	3417	822.233	819.117	231.622	85.604	100	797	786	127.405	51.743
36	3954	667.793	818.932	253.765	92.849	100	631	789	131.07	59.508

FEATURE MEASUREMENTS

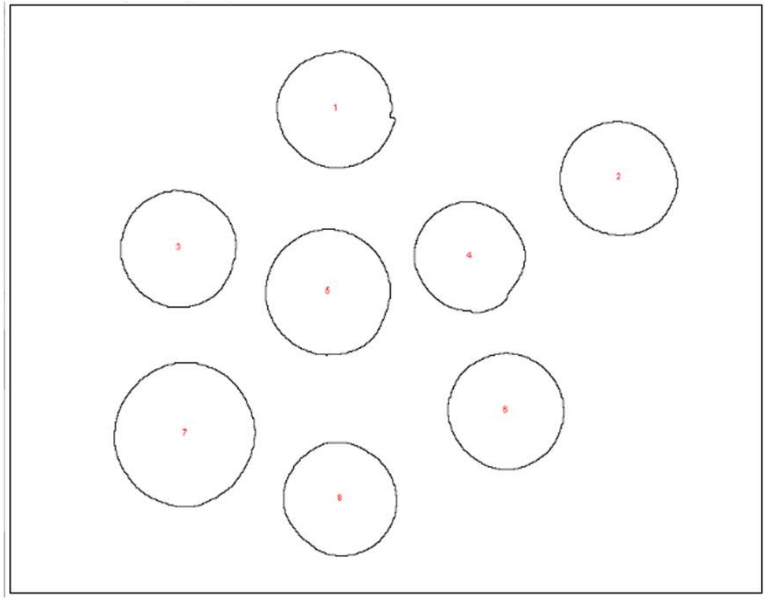
This table provides a concise overview of the extracted information. It provides the numerical values for each designated feature from the analysis. The data in the table can be readily manipulated and analyzed to obtain additional insight into the characteristics of the stones in the image of sand. The area measurement indicates the size of each stone, while the perimeter measurement can be used to determine its shape factor. The utmost diameter of a stone can be determined using the Feret measurement, which can provide insight into its overall shape.

EXTRA CHALLENGE!

Here, a collection of variously shaped and textured coins were photographed by me against a simple background. Basically, I just repeated all the process I did on the sand image. But the catch here is that, to accurately gauge the properties of the coins, I have included a scale bar in the image. I placed a 1 cm scale bar (ruler to be exact) next to the coins and photographed them against a plain background. I then utilized ImageJ to extract the properties of each coin from the image.



This is the resulting thresholded binary and inverted image that shows a clear separation between the coins and the background. It is clearly visible that the image was simplified and the objects we are interested in measuring were highlighted.



	Area	X	Y	Perim.	Feret	%Area	FeretX	FeretY	FeretAngl	MinFeret
1	4.33	6.588	2.113	7.853	2.431	100	286	103	170.172	2.321
2	4.278	12.331	3.51	7.737	2.407	100	593	168	164.548	2.309
3	4.33	3.395	4.934	7.775	2.401	100	174	198	98.13	2.339
4	3.862	9.305	5.093	7.355	2.298	100	456	223	125.647	2.181
5	5.046	6.436	5.815	8.397	2.588	100	310	248	120.677	2.524
6	4.31	10.048	8.229	7.768	2.386	100	482	398	140.774	2.334
7	6.461	3.519	8.701	9.516	2.956	100	177	539	81.56	2.826
8	4.09	6.682	10.015	7.548	2.348	100	336	471	105.376	2.239

This is similar to the sand image with the exception that I used a precise measurement or scalebar instead of an arbitrary one. By including a scale in the image, we were able to measure the size and shape of each coin precisely. The measured features provided insightful information about the diameter, thickness, and overall shape of each coin. This method can be used to analyze and compare coins of various shapes and characteristics, making it a useful instrument for both researchers and coin collectors.

REFLECTION

This was the simplest task, and hence the one I enjoyed the most. I enjoy activities like this because I am able to clearly follow the instructions and get the desired outcome. I particularly like the extra challenge owhere I assembled coins. However, taking a picture of the coins is the most challenging part of this task for me. I struggled to get an image with uniform illumination that would allow for effective masking. I did it, though, by making efficient use of available resources. I also struggled with how to explain the information I got, but I succeeded. So, I guess I'd give myself a perfect score of 10 out of 10. <33

REFERENCES

[1]https://www.mygreatlearning.com/blog/feature-extraction-in-image-processing/#:~:text=Feature%20extraction%20is%20a%20part,a%20large%20number%20of%20variables.
[2] Lab manual