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Geometrical Analysis of White Blood Cells by Using Image Segmentation Algorithm

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Abstract: The technique behind image analysis is based on machine learning. In order for the software to recognize specific irregularities, it doesn't matter what field of medicine (or other industry) we're thinking about. The way AI learns differs dramatically from how humans learn. It makes use of enormous image databases that the software must interpret and analyze. In the present work, geometrical features of White Blood Cells such Area, Perimeter, Orientation, and Equivalent Diameter are calculated by using Image Segmentation approach.
Keywords: Image Segmentation; White Blood Cells; Image Processing; Machine Learning; Artificial Intelligence; Healthcare

I. INTRODUCTION

Using sample data or prior knowledge, machine learning is the process of programming computers to maximize a performance criterion. We have a model that has been developed up to a certain point, and learning is the application of a computer program to maximize the model's parameters using training data or prior knowledge. The model may be descriptive to learn from the data or predictive to make future predictions. How to build computer programs that gradually get better with experience is a topic of research in the field of machine learning [1-5]. Tens of millions of compounds need to go through a series of tests in order to manufacture or find a new medicine, which is an expensive and time-consuming process. One and only one could produce a usable medication.

The lengthy multi-step process can be sped up in one or more of these processes using machine learning [6-10]. The field of personalized medicine has enormous development potential in the future, and machine learning may be key in identifying the types of genetic markers and genes that are responsive to a given therapy or medication. As it allows for improved disease assessment, customized medication or treatment based on a person's health information combined with analytics is a popular study topic. Another data flood may be beneficial for treatment efficacy with the rise in sensor-integrated technology and mobile applications with advanced monitoring system and health-measurement capabilities. Health optimization is made possible by personalized care, which also lowers overall healthcare expenses [11-15].

Machine Learning also finds application in manufacturing sectors for defects identification and material properties optimization [16-22]. Medical professionals all across the world are inundated with data of every description, which they must gather, handle, and analyze.

Image Processing approach is finding a wide range of applications [31-35]. As individuals, they are limited in their abilities and prone to weariness, which is bad for both their health and their capability to care for patients. In the healthcare industry, medical photographs make up about 90% of the data.

The amount of data that needs to be analyzed is growing along with the demand for medical imaging. It's crucial to keep in mind that machine learning-based solutions can and, in some instances, already have outperformed human doctors in terms of diagnosis accuracy. Of course, there will always be a need for some degree of expert oversight. When dealing with photos that are defective, partial, or otherwise of poor quality, the software can occasionally suffer. At that point, a human doctor's expertise and the capacity to view an image without turning it to ones and zeros may be required [23-30].

II. EXPERIMENTAL PROCEDURE

In the recent work, the Python programming has been developed for image segmentation purpose which was executed on SPYDER platform. The approach to image segmentation is based on a topological interpretation of the boundaries of the image. The closure process aids in filling in tiny cracks or tiny dark spots on the foreground objects. Morphological dilatation fills in small holes in the objects and increases object visibility. The Euclidean distance formula is used to calculate the distance transform.

A distance matrix is created once these distance values are computed for each and every pixel in a picture. It serves as a watershed transform input.

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Figure 1 shows the input image of White Blood Cells which will be subjected to the image segmentation algorithm.

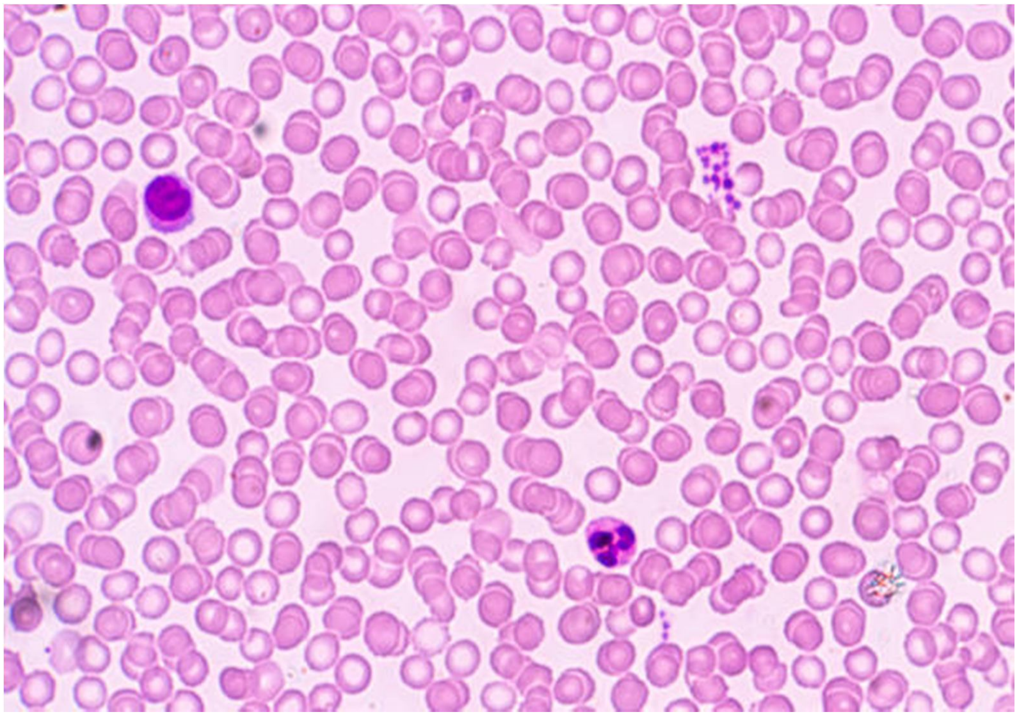

Figure 1: White Blood Cells Microscope Image

The reference Python code for the subjected algorithm is shown below:

```
# SEGMENTATION
import numpy as np
import cv2
from matplotlib import pyplot as plt
img = cv2.imread(r'C33P1thinF_IMG_20150619_114756a_cell_181.png')
b,g,r = cv2.split(img)
rgb_img = cv2.merge([r,g,b])
gray = cv2.cvtColor(img,cv2.COLOR_BGR2GRAY)
ret, thresh = cv2.threshold(gray,0,255,cv2.THRESH_BINARY_INV+cv2.THRESH_OTSU)
plt.subplot(211),plt.imshow(closing, 'gray')
plt.title("morphologyEx:Closing:2x2"), plt.xticks([]), plt.yticks([])
plt.subplot(212),plt.imshow(sure_bg, 'gray')
plt.imsave(r'dilation.png',sure_bg)
plt.title("Dilation"), plt.xticks([]), plt.yticks([])
plt.tight_layout()
plt.show()
```

```
plt.subplot(211),plt.imshow(dist_transform, 'gray')
plt.title("Distance Transform"), plt.xticks([]), plt.yticks([])
plt.subplot(212),plt.imshow(sure_fg, 'gray')
plt.title("Thresholding"), plt.xticks([]), plt.yticks([])
plt.tight_layout()
plt.show()
```

III. RESULTS AND DISCUSSION

Picture segmentation entails breaking an image down into a number of pixel-rich sections that are each represented by a mask or labeled image. We can analyze only the key portions of an image by segmenting it rather than processing the whole thing. In contrast to classifiers, which typically use a single encoder network, most image segmentation models in computer vision use an encoder-decoder network.

Figure 2 shows the segmented image of the white blood cell image and Table 1 shows the geometrical parameters used to define these cells.

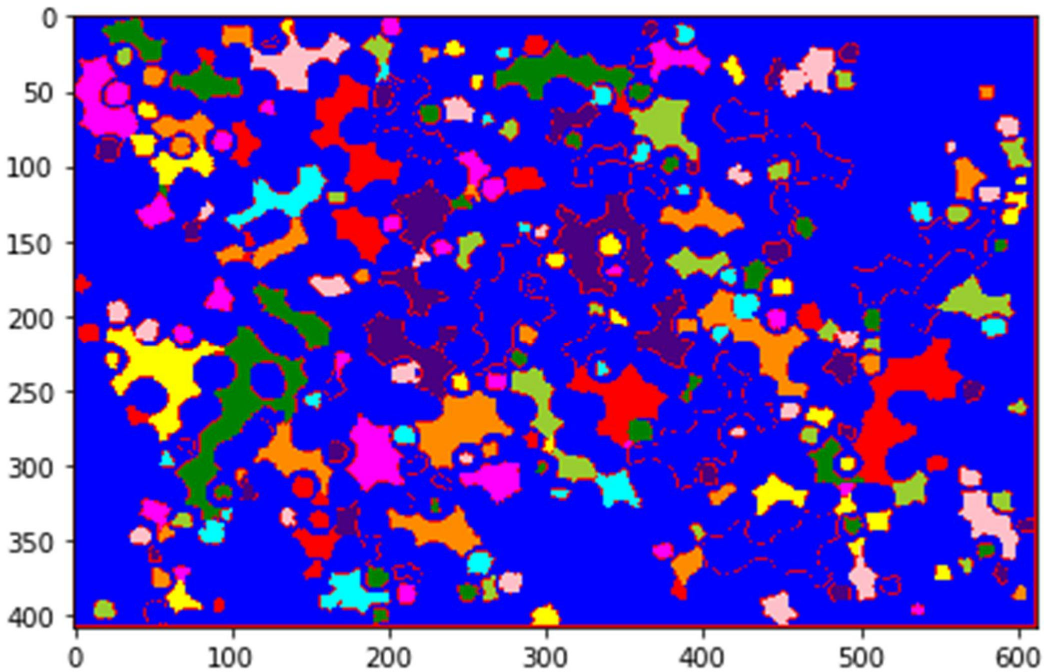

Figure 2: Segmented image of White Blood Cells

The encoder transforms the input into a latent space representation, which the decoder transforms into segment maps, or, more precisely, maps indicating the positions of each object in the image. One of the simplest techniques for segmenting images is thresholding, which establishes a threshold for categorizing pixels into two groups. The threshold value determines which pixels are set to 1 and which pixels are set to 0. Pixels with values below the threshold value are set to 0. Thus, the image undergoes a process known as binarization in which it is transformed into a binary map. When the difference in pixel values between the two target classes is quite great, image thresholding is highly helpful since it is simple to select an average value as the threshold. When binarizing a picture, threshold is frequently employed to enable the employment of additional, binary-only algorithms like contour detection and identification.

Table 1: Obtained Results for Image Segmentation

Grain #	Area	equivalent_diameter	orientation	MajorAxisLength	MinorAxisLength	Perimeter	MinIntensity	MeanIntensity	MaxIntensity
1	40313.75	226.5592	-86.5197	366.4697	244.3068	10375.38	26	187.5385	254
2	12.5	3.989423	-16.7172	5.013444	3.549842	13.36396	221	238.12	250
3	27.5	5.91727	14.61433	6.524303	5.517493	19.77817	180	221.9364	238
4	128.25	12.77861	57.55738	21.36487	9.52316	59.5594	183	234.3645	249

5	15	4.370194	-51.8828	4.603842	4.269683	14.15685	213	232.4	242
6	49.75	7.958873	87.1888	10.61013	6.758335	30.6066	218	236.7487	249
7	28.25	5.997418	6.409693	6.861229	5.508213	20.48528	190	228.7965	239
8	248.25	17.77869	-73.5625	30.61481	15.58574	104.1513	212	236.1631	250
9	48.5	7.858252	46.90055	9.267156	7.400012	31.2132	210	233.8505	245
10	31.5	6.333012	-80.3133	6.97432	5.862567	20.07107	185	220.5	235
11	7.25	3.038254	-75.819	4.879077	2.131152	10.34619	219	229.3793	236
12	20.5	5.108954	76.9909	5.620377	4.833732	16.77817	200	229.1585	243
13	114.75	12.08736	85.43971	21.44607	10.15126	62.85534	211	235.8235	250
14	342.25	20.87501	89.91384	45.25056	13.36606	126.2965	208	234.7166	251
15	24.5	5.585192	-52.2997	6.246855	5.073935	17.77817	201	224.0306	238
16	16.75	4.618091	82.20408	5.560907	4.56569	16.86396	222	237.6716	248
17	11.75	3.867889	-74.1508	4.125164	3.665105	11.53553	205	230.4255	242
18	104	11.50725	2.22244	14.78831	9.92207	46.23097	201	234.5024	248
19	20.5	5.108954	-17.2041	5.946613	4.420366	16.07107	196	226.2927	236
20	16.5	4.583498	53.45127	6.076332	3.622213	16.19239	214	235.8333	249
21	30.75	6.257165	-72.7752	7.132449	5.805494	23.31371	157	210.8862	243
22	31.25	6.307831	24.47449	9.695111	4.573575	24.84924	214	236.864	249
23	262	18.26441	23.08956	31.34189	15.43937	94.22235	209	232.8683	247
24	141.75	13.43435	81.35781	21.56137	9.718689	62.37006	212	234.3598	247
25	26.25	5.781223	-22.8273	10.21916	3.553977	23.02082	215	237.419	249
26	33.25	6.506552	-76.499	6.924228	6.175373	20.89949	201	228.218	239
27	13.75	4.184142	-12.9516	6.001737	3.259617	15.67462	210	234.2182	244

28	53.75	8.272643	-47.1824	9.34455	7.652943	30.05635	156	214.3209	236
29	24	5.527906	29.42692	6.639078	5.136199	20.57107	196	221.0521	238
30	195.25	15.76705	-29.3814	27.39234	11.74929	82.28732	184	233.5109	249
31	260.25	18.20331	26.78432	34.80895	18.10859	119.897	210	234.8348	248
32	13.25	4.107362	-24.1921	4.891308	3.639651	13.65685	200	215.4528	224
33	43	7.399277	-41.9691	7.835882	7.035527	23.48528	193	218.814	237
34	28.75	6.050259	-89.8364	6.56379	5.709375	19.89949	196	226	236
35	32.5	6.432751	-14.0582	7.637598	5.474168	21.07107	187	222.1769	236
36	12.75	4.02912	-40.719	4.564416	3.940106	14.44975	189	212.9804	224
37	29.25	6.102643	53.18205	6.520251	6.090788	20.96751	180	216.1795	233
38	54	8.29186	57.26432	9.999262	7.455027	33.4528	217	235.963	246
39	229	17.07548	45.15596	22.75205	16.16675	81.13351	207	235.3352	251
40	17.25	4.686511	26.6684	5.609159	4.565338	16.88173	208	232.8406	244
41	144	13.54055	70.72903	17.49112	11.30449	53.85229	189	234.6528	250
42	23.5	5.470021	59.47292	6.127201	5.03862	18.36396	185	221.6383	241
43	14.75	4.333622	31.56589	4.914604	4.142612	14.36396	218	236.5085	247
44	33.25	6.506552	81.32548	6.780398	6.399029	22.38173	204	228.4211	240
45	90.25	10.7196	-63.0984	19.28615	8.199797	51.97361	205	234.1551	250
46	100	11.28379	88.74597	20.84885	8.354498	55.52691	210	234.4075	249
47	8.25	3.241022	-45	3.550501	3.109274	9.949747	207	224.0303	231
48	35.5	6.723095	70.70376	7.288546	6.293922	22.98528	184	219.169	240
49	23.5	5.470021	-13.2796	6.395976	4.982227	18.89949	222	236.4787	247
50	60.25	8.758578	0.219967	14.88387	7.177956	41.92031	202	234.7593	248

IV. CONCLUSION

Medical digital image processing can increase the quality of the image and lessen the impact of noise. Images that have been processed can clearly communicate the image's pathological and medical information as well as the ailment that is being focused on. The use of digital images is essential on a daily basis.

The handling of images with a computer is referred to as medical imaging processing. This processing entails a wide range of methods and actions, including image acquisition, archiving, presentation, and communication. The image is a function that denotes a measure of the properties of an observed sight, such as illumination or color. The advantages of digital photos include quick and inexpensive processing, simple transmission and storage, immediate quality assessment, many copies while maintaining quality, quick and inexpensive reproduction, and flexible manipulation. Digital photos' drawbacks include copyright infringement, the inability to resize while maintaining quality, the necessity for high-capacity memory, and the requirement for a quicker processor for modification.

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