CS 4650 - Digital Image Processing

Homework 4: Counting Individual Objects

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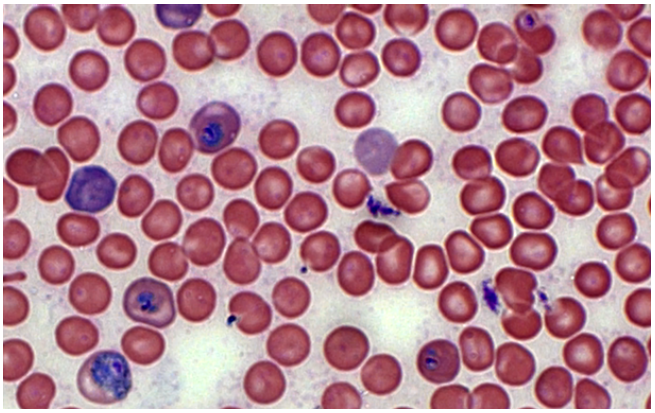
Abstract

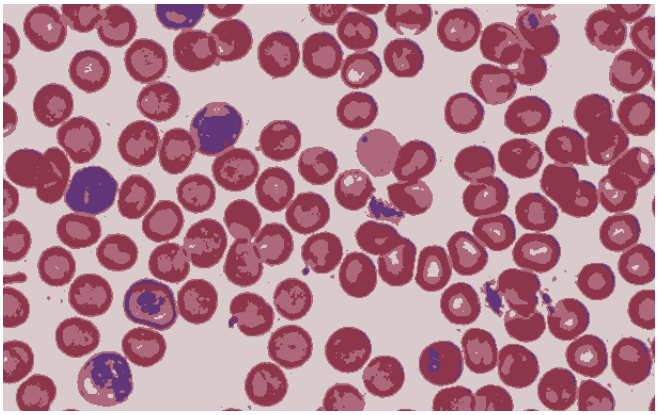
The main goal of this assignment was to divide an image of many malaria cells by utilizing Watershed Segmentation. This resulted in each cell receiving a unique label, thus distinguishing each object in the image from the others.

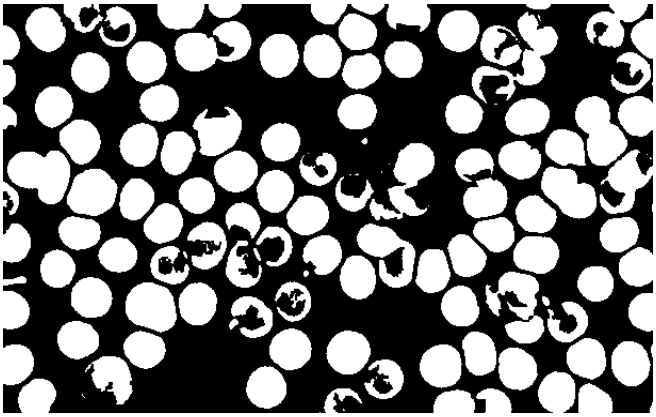
Introduction

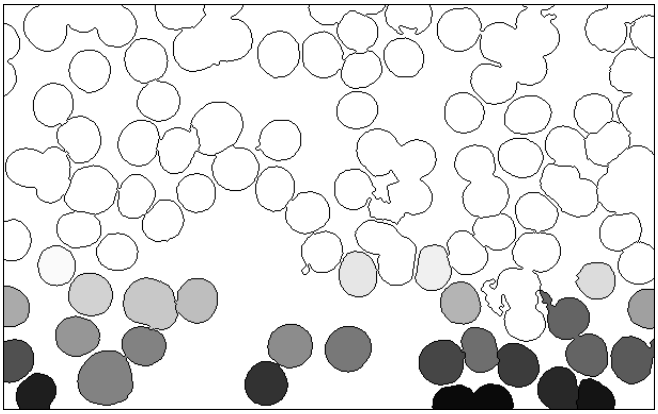
The malaria image underwent significant changes throughout the course of this experiment. First, it went through K-Means Segmentation, yielding a more simplistic colorized version to be used. Afterwards, the image was binarized, distinguishing the foreground from the background. A Distance Transform of the image was then created, further narrowing down the foreground into small areas of focus, which was then binarized again. Markers were drawn from this to create boundaries within the image through which the Watershed Segmentation algorithm could separate each cell. Lastly, each cell was counted, designated a label, and the mean color and area were calculated.

Experiments and Results

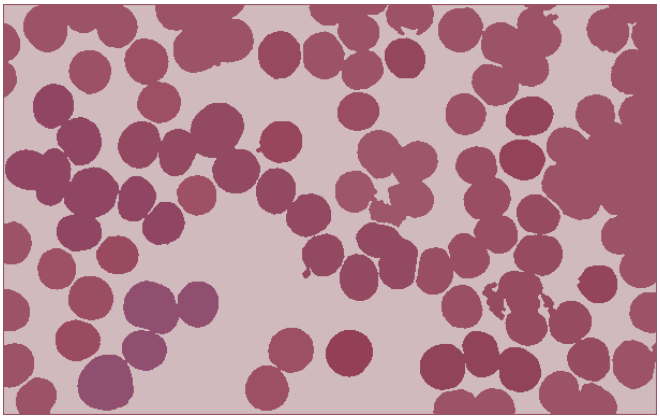

(1)


(2)


(3)



(4)



(5)

```
Cell 1 Area: 48127 pixels.
Cell 1 Mean Color(BGR): 103 82 156
Cell 2 Area: 1394 pixels.
Cell 2 Mean Color(BGR): 95 73 151
Cell 3 Area: 1135 pixels.
Cell 3 Mean Color(BGR): 94 70 148
Cell 4 Area: 2586 pixels.
Cell 4 Mean Color(BGR): 100 80 157
Cell 5 Area: 1248 pixels.
Cell 5 Mean Color(BGR): 102 81 157
Cell 6 Area: 10336 pixels.
Cell 6 Mean Color(BGR): 98 70 144
Cell 7 Area: 1111 pixels.
Cell 7 Mean Color(BGR): 98 76 153
Cell 8 Area: 1151 pixels.
Cell 8 Mean Color(BGR): 103 81 156
Cell 9 Area: 1302 pixels.
Cell 9 Mean Color(BGR): 91 68 148
Cell 10 Area: 13273 pixels.
Cell 10 Mean Color(BGR): 98 73 148
Cell 11 Area: 1255 pixels.
Cell 11 Mean Color(BGR): 92 70 151
Cell 12 Area: 5402 pixels.
Cell 12 Mean Color(BGR): 108 86 158
Cell 13 Area: 1277 pixels.
Cell 13 Mean Color(BGR): 88 66 148
Cell 14 Area: 5905 pixels.
Cell 14 Mean Color(BGR): 99 78 154
Cell 15 Area: 1088 pixels.
Cell 15 Mean Color(BGR): 101 81 158
Cell 16 Area: 7906 pixels.
Cell 16 Mean Color(BGR): 98 75 150
Cell 17 Area: 1108 pixels.
Cell 17 Mean Color(BGR): 95 74 154
Cell 18 Area: 1088 pixels.
Cell 18 Mean Color(BGR): 100 80 158
Cell 19 Area: 1033 pixels.
Cell 19 Mean Color(BGR): 93 69 148
Cell 20 Area: 1367 pixels.
Cell 20 Mean Color(BGR): 97 77 155
Cell 21 Area: 6681 pixels.
Cell 21 Mean Color(BGR): 111 79 145
Cell 22 Area: 1218 pixels.
Cell 22 Mean Color(BGR): 100 79 155
Cell 23 Area: 1260 pixels.
Cell 23 Mean Color(BGR): 96 75 155
Cell 24 Area: 2734 pixels.
Cell 24 Mean Color(BGR): 99 79 157
Cell 25 Area: 1493 pixels.
Cell 25 Mean Color(BGR): 86 64 147
Cell 26 Area: 3990 pixels.
Cell 26 Mean Color(BGR): 92 67 146
```

(6)

(1) Original Input Image

(2) K-Means Segmentation Result

(3) Foreground Mask

(4) Watershed Boundaries

(5) Mean Color Image

(6) Cell Area and Mean Color Output

After running this program with many parameter tweaks, I wasn't able to distinguish every cell present in the input image from each other. This skewed the resulting output image, and identifying the infected cells was impossible since they had all been assimilated into other cell groups. The total number of cells found by this program was 26, though this number is lower than the actual number of cells since many got spliced together.

Conclusions

Watershed Segmentation has proved to be a powerful tool in segmenting images, and leaves the possibility for nearly endless possible visual representations of its results. Though not perfectly executed in this example, it will be interesting to see what else it has to offer through further experimentation.

References

https://docs.opencv.org/3.4/index.html

https://umsystem.instructure.com/courses/113149/files/14428161?module_item_id=5410799

https://umsystem.instructure.com/courses/113149/files/14080364?module_item_id=5365853