PROBLEM 1

MY FUNCTIONS

- **mybinarize** (image, peakStepLength, peakStepHeight, histSmoothSize) – Calculates histogram, histogram smoothing, threshold and binary image from image.
- **myhist** (image) – Calculates histogram of a grayscale image.
- **myhistsmoothing** (histogram, histSmoothSize) – Performs smoothing of a histogram by input smoothing window size.
- **mythresh** (histogram, peakStepLength, peakStepHeight) – Calculates threshold. peakStepLength and peakStepHeight are utilized to get peaks in assumed Gaussian distributions.
- **mysmoothing** (image, openWindowSize, closeWindowSize, type) – Performs morphological operations on the image on the type 'open-clos' or 'clos-open'. The openWindowSize & closeWindowSize are input for open/close window sizes 3x3 or 5x5.
- **myerode** (binaryimage, erodeWindowSize) – Erosion
- **mydilate** (binaryimage, dilateWindowSize) – Dilation
- **myclose** (binaryimage, closeWindowSize) – Close operation
- **myopen** (binaryimage, openWindowSize) – Open operation
- **mylabel** (image) – Labels the blobs.
- **mycentroid** (binaryimage, labelimage, labeltable) – Creates centroid in the binary image from labelimage and labeltable. Centroids are marked with RED CROSS.
- **mylabel2rgb** (labelimage, labelcount) – Creates colored blobs from labeled image.

RESULTS OF PROBLEM 1A

Analysis: Thresholding Method

Function **mybinarize** creates binary image from a grayscale image. It also returns the calculated histogram, histogram smoothing and threshold value. Along with grayscale image, the function also takes input 'peakStepLength' & 'peakStepHeight' for finding peaks in the assumed Gaussian distribution and 'histSmoothSize' as window for histogram smoothing.

The 'Intermodal' approach for thresholding assumes a bimodal histogram, where it is iteratively smoothed using a running average of size 3, until there are only two local maxima. The thresholding function **mythresh** also works on this assumption that the histogram is a sum of two Gaussian

Distribution. Before passing the histogram to **mythresh** it is smoothened with function **myhistsmoothing**. For the example shown below, the smoothing window size is 5.

However, all the sample input images have extremely unequal peaks and some with a broad & flat valley. These images are unsuitable for this method. Further to avoid multiple iteration at this stage, only one smoothing was done using a running average of 5. Then **mythresh** takes help of function **mypeaks** to determine peaks in the histogram and performs a weighted average of two peaks (first and last one, if mypeaks returns more than two). If only normal average is taken, then the result is far from the expected one and only few objects are identified in the binary image (for 2nd and 3rd images). The results are compared below:

Comparison on Different Thresholding Approach

Image	Threshold Values calculated by different Methods			
	Intermodal with **one** iteration for smoothing and normal average	Otsu	Intermodal with weighted average	Matlab
cell-1.png	110	130	148	131
cell-2_n.tif	176	193	208	193
cell-3_n.tif	187	201	214	201

Output

Following are the outputs of hw1_1a where the input image is processed and displayed:

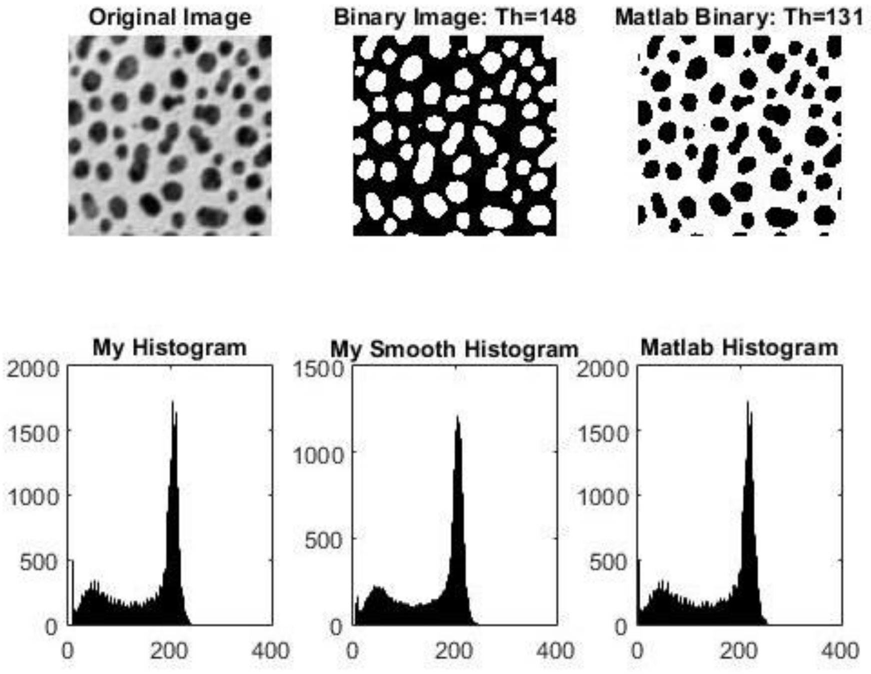


Figure 1.1: Result of hw1_1a('cells-1.png')

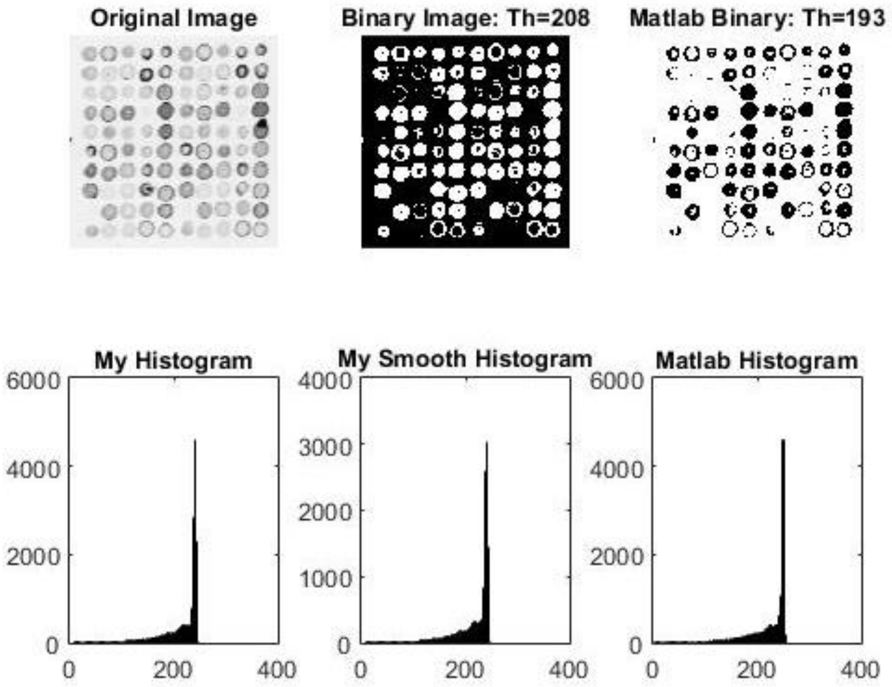


Figure 1.2: Result of hw1_1a('cells-2_n.tif')

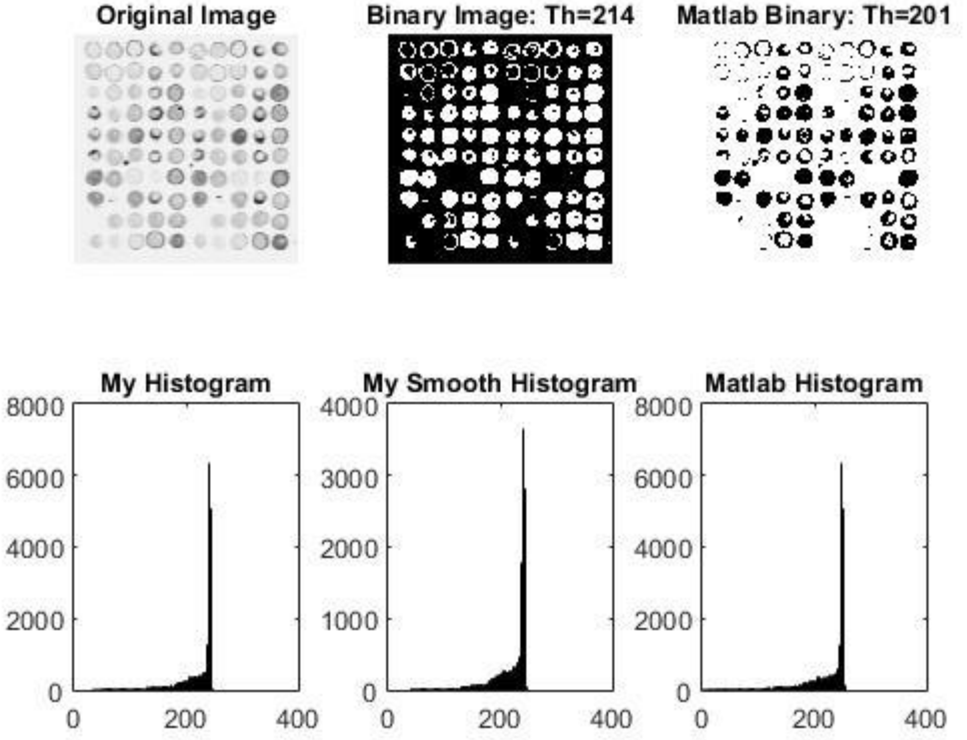


Figure 1.3: Result of hw1_1a('cells-3_n.tif')

RESULTS OF PROBLEM 1B

Description

Function **mysmoothing** performs morphological operations on the image on the type ‘open-clos’ or ‘clos-open’. The openWindowSize & closeWindowSize are input for open/close window sizes 3x3 or 5x5.

Output

Following are the outputs of hw1_2a where the input image is processed and displayed, both CLOS-OPEN and OPEN-CLOS morphological operations are done using 3x3 window (only **ONE** iteration):

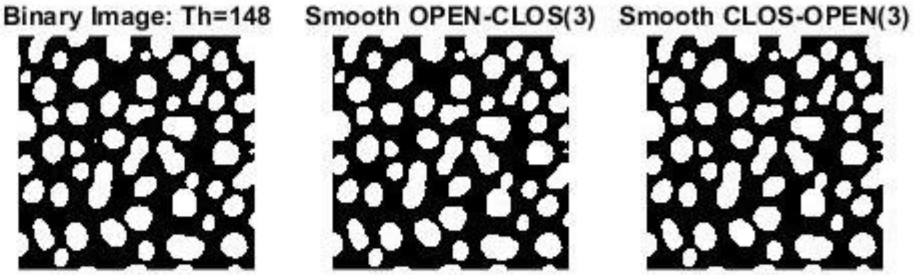


Figure 2.1: Result of hw1_1b(‘cells-1.png’)

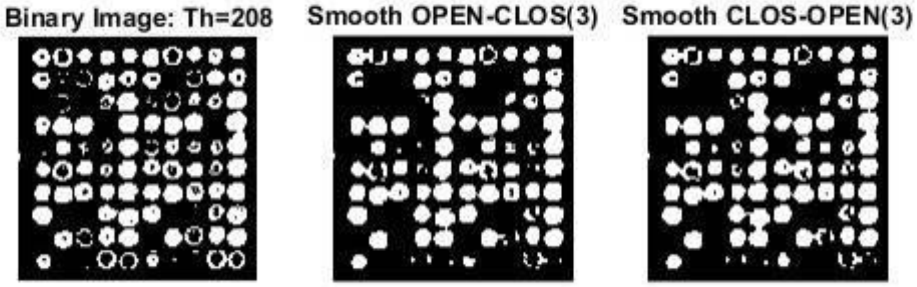


Figure 2.2: Result of hw1_1b(‘cells-2_n.tif’)

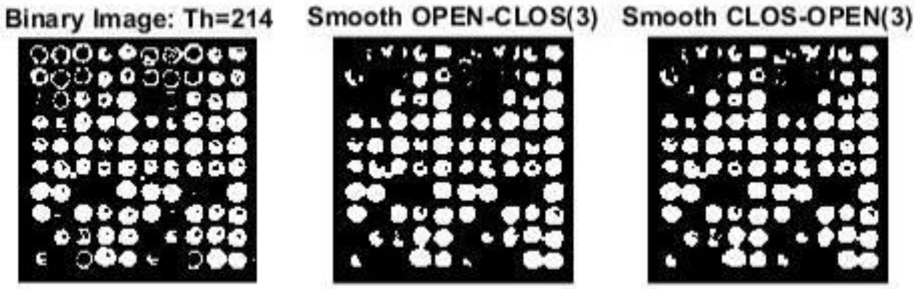


Figure 2.3: Result of hw1_1b(‘cells-3_n.tif’)

RESULTS OF PROBLEM 1C

Method: Blob Coloring

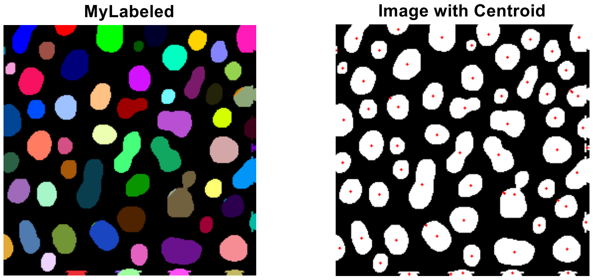
Function **mylabel** performs blobcoloring of any image based on an 8-connected neighborhood (3 x 3 window). It also returns label-table and number of total blobs.

Then labeled image is processed with function **mycentroid**, which returns image with centroids (marked red) and area & centroid positions for each blob.

Function **mylabel2rgb** takes labeled image as input and returns a RGB image with each of the blobs identified in different color.

Output

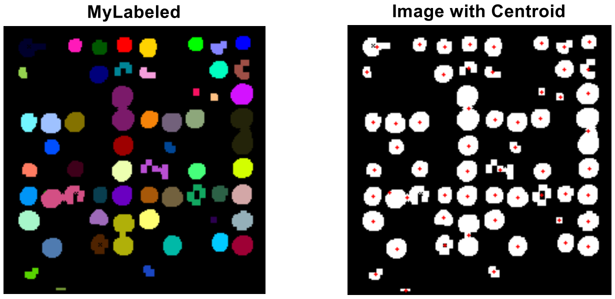
Following are the outputs of hw1_1c where the input image is processed and displayed:



MyLabeled

Image with Centroid

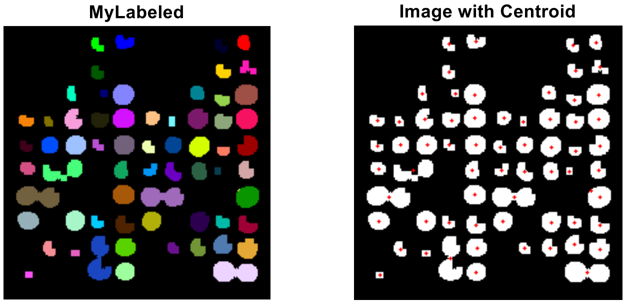
Figure 3.1: Result of hw1_1b('cells-1.png')



MyLabeled

Image with Centroid

Figure 3.2: Result of hw1_1c('cells-2_n.tif')



MyLabeled

Image with Centroid

Figure 3.3: Result of hw1_1c('cells-3_n.tif')

RESULTS OF PROBLEM 1D

Description

Function **main** reads an image and generates a binary image using funciton **mybinarize**. Next function **mysmoothing** is used to eliminate small regions and fill holes in larger regions. Function **mylabel** is used for blob-coloring. Function **mycentroid** identifies the area and centroid positions. Then a report on statistics (cells having less than 15 pixel area are ignored) are generated on remaining cells (Cell Number, Area, Location, Total Count). Function **mylabel2rgb** is used to color the blobs uniquely.

Finally, the main function displays the original input image, the binary image, the smoothed image, and the final cell labeled image. It also returns total blobs and area & centroid of each blob. Following are the outputs of main function:

Output

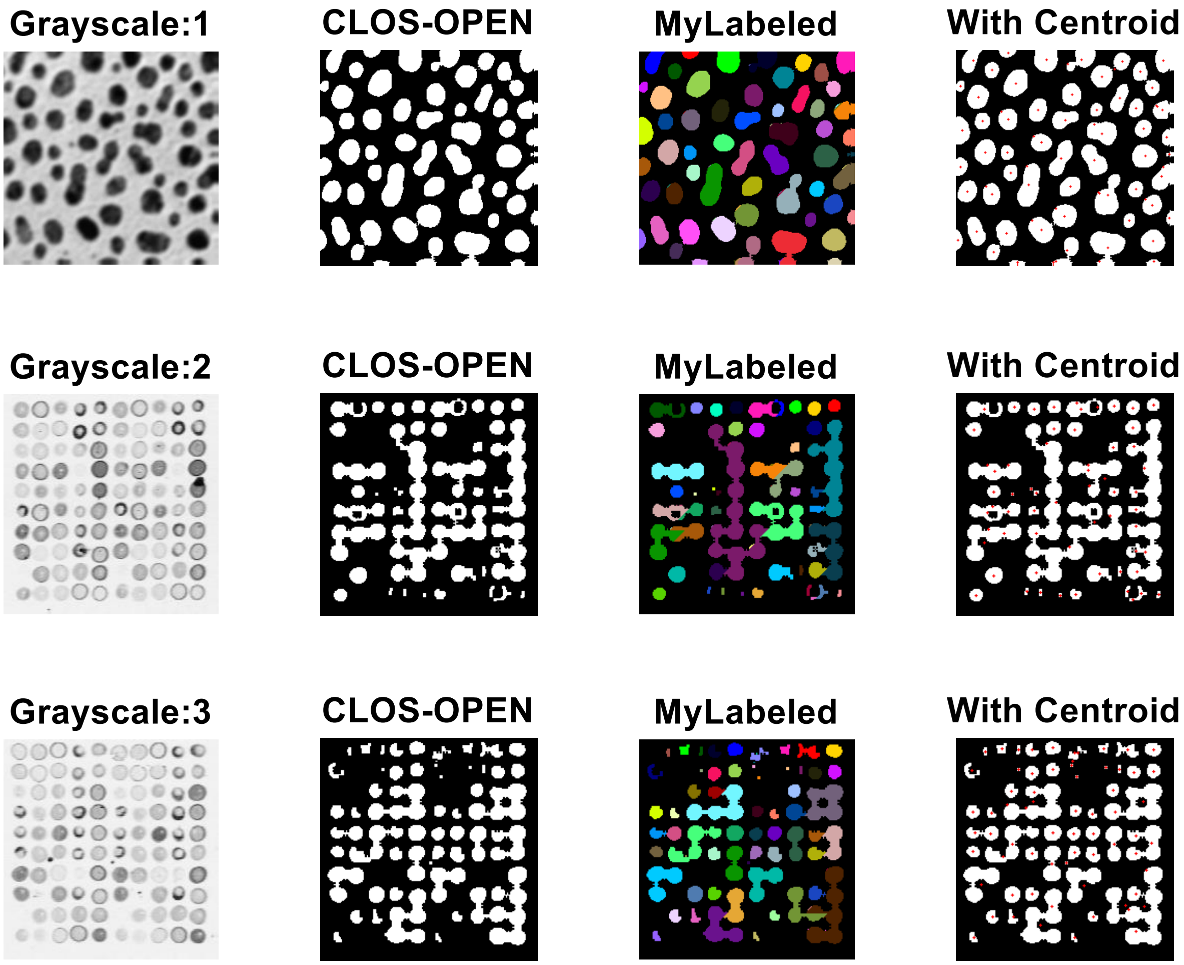


Figure 3.4: Result of main

Report

[blob no: area (positionX, positonY)]

Image: cells-1.png	Image: cells-2_n.tif	Image: cells-3_n.tif
Total Blob: 59	Total Blob: 44	Total Blob: 54
1:476 (16,24)	1:66 (17,140)	1:156 (13,97)
2:207 (7,65)	2:121 (15,194)	2:179 (15,169)
3:701 (15,110)	3:123 (16,156)	3:74 (14,48)
4:582 (15,151)	4:137 (17,98)	4:105 (15,77)
5:499 (16,247)	5:290 (19,124)	5:70 (14,146)
6:315 (17,199)	6:144 (18,174)	6:166 (15,194)
7:254 (27,46)	7:334 (19,31)	7:29 (15,64)
8:308 (29,220)	8:112 (17,60)	8:91 (18,121)
9:32 (28,2)	9:132 (19,79)	9:27 (17,32)
10:529 (35,175)	10:1442 (76,185)	10:96 (35,19)
11:695 (43,74)	11:170 (37,174)	11:137 (34,97)
12:260 (48,234)	12:160 (38,98)	12:147 (36,194)
13:110 (46,9)	13:167 (39,21)	13:24 (34,161)
14:483 (56,140)	14:172 (39,118)	14:140 (38,77)
15:439 (60,196)	15:2756 (109,100)	15:130 (37,175)
16:563 (59,30)	16:77 (56,155)	16:128 (55,57)
17:455 (74,100)	17:412 (86,147)	17:899 (65,78)
18:298 (72,215)	18:362 (78,131)	18:130 (54,155)
19:344 (74,246)	19:648 (79,41)	19:912 (65,184)
20:19 (70,240)	20:128 (99,40)	20:137 (56,79)
21:181 (74,169)	21:77 (99,177)	21:225 (75,157)
22:449 (85,65)	22:73 (99,156)	22:132 (75,20)
23:479 (86,132)	23:21 (100,81)	23:103 (74,119)
24:285 (87,35)	24:1062 (128,137)	24:64 (76,38)
25:541 (98,11)	25:174 (118,54)	25:63 (77,135)
26:320 (96,224)	26:307 (119,34)	26:709 (106,58)
27:736 (102,175)	27:70 (117,79)	27:213 (95,97)
28:192 (106,251)	28:80 (116,177)	28:450 (105,192)
29:401 (112,104)	29:897 (157,186)	29:157 (96,37)
30:582 (124,38)	30:337 (139,50)	30:155 (96,136)
31:663 (131,127)	31:560 (148,31)	31:382 (106,156)
32:699 (133,166)	32:126 (156,177)	32:111 (95,22)
33:652 (128,226)	33:187 (176,178)	33:127 (96,117)
34:213 (124,64)	34:198 (177,81)	34:119 (98,177)
35:24 (126,254)	35:269 (178,142)	35:110 (113,20)
36:301 (141,9)	36:34 (176,162)	36:427 (125,96)
37:496 (152,245)	37:217 (180,40)	37:124 (114,118)
38:963 (162,89)	38:36 (195,169)	38:124 (115,77)
39:259 (148,68)	39:69 (197,182)	39:160 (116,136)
40:894 (174,182)	40:21 (195,72)	40:158 (115,177)
41:449 (164,138)	41:126 (199,23)	41:652 (145,28)
42:456 (170,17)	42:21 (196,85)	42:1326 (166,185)
43:272 (167,215)	43:84 (198,119)	43:639 (146,127)

Image: cells-1.png	Image: cells-2_n.tif	Image: cells-3_n.tif
Total Blob: 59	Total Blob: 44	Total Blob: 54
44:418 (173,46) 45:16 (172,172) 46:420 (186,234) 47:622 (199,131) 48:79 (201,254) 49:187 (204,207) 50:531 (217,28) 51:669 (215,104) 52:592 (219,63) 53:224 (227,6) 54:606 (228,235) 55:1035 (236,182) 56:436 (239,132) 57:248 (241,48) 58:63 (252,236) 59:59 (253,76)	44:23 (198,199)	44:199 (155,58) 45:155 (154,177) 46:133 (154,77) 47:514 (165,167) 48:453 (166,96) 49:694 (184,85) 50:78 (176,59) 51:112 (176,39) 52:77 (176,136) 53:59 (196,21) 54:35 (196,118)

PROBLEM 2

MY FUNCTIONS

- **myhisteq** (image) – Performs histogram equalization of image.
- **myhisteqtriag** (image) – Performs histogram shaping based on a triangle shaped distribution.
- **myhisteqgaussian** (image, mu, sigma)– Performs histogram shaping based on a Gaussian distribution.

RESULTS OF PROBLEM 2A

Description

Function **myhisteq** computes the histogram equalized image.

Output

Following are the outputs of hw1_2a computes the histogram of the original input image and perform histogram equalization. It shows original image, its histogram, the equalized image and its histogram:

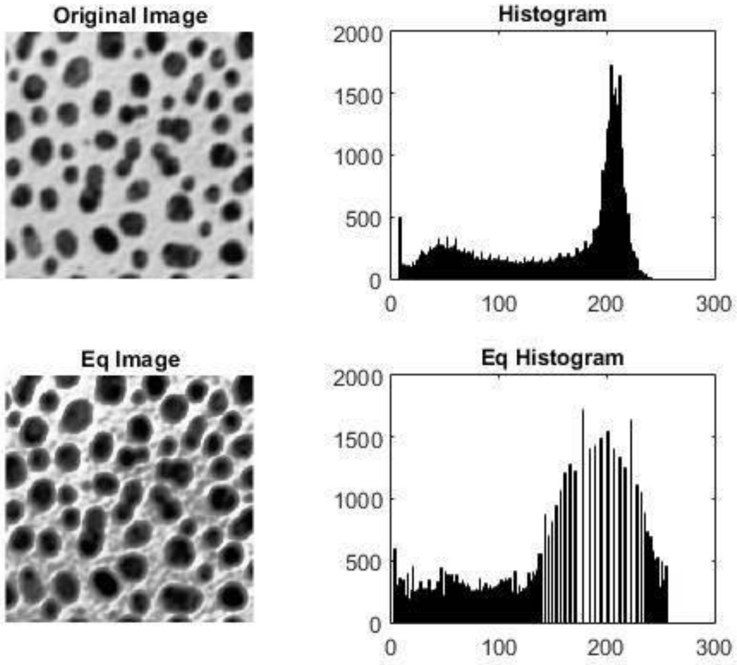


Figure 2.1: Result of hw1_2a('cells-1.png')

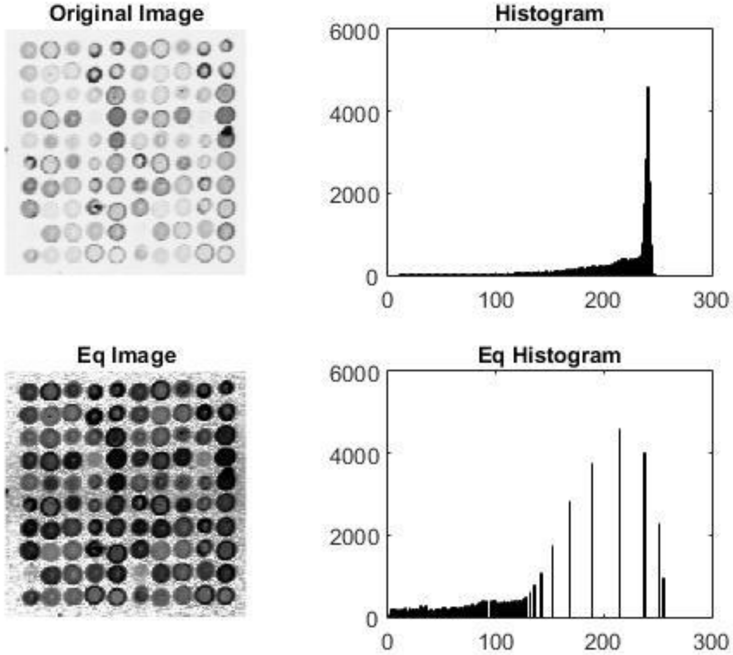


Figure 2.2: Result of hw1_2a('cells-2_.tif')

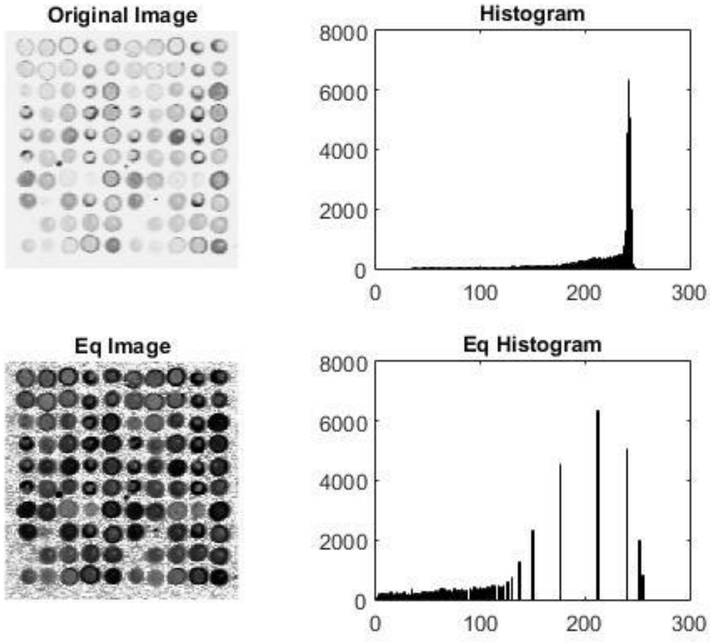


Figure 2.3: Result of hw1_2a('cells-3_n.tif')

RESULTS OF PROBLEM 2B

Description

The functions **histeqtriag** and **histeqgaussian** shape an input image based on triangle shaped distribution and a Gaussian distribution (respectively). Both distributions are centered at 128. The function **histeqgaussian** can utilize a user-defined standard deviation. Matlab library function **`pdf`** and **`pd2`** were used to create the triangular and Gaussian dristributions.

Output

Following are the outputs of hw1_2b for each input image, showing the original image, its histogram, user defined shaping histogram, the shaped image and its histogram. Standard deviation was taken **μ=128** and **σ = 20**.

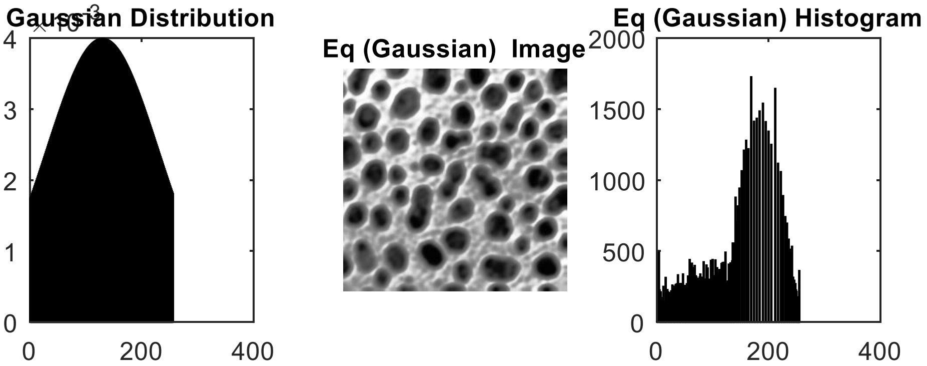


Figure 2.4: Result of hw1_2b('cells-1.png', ‘gaussian’)

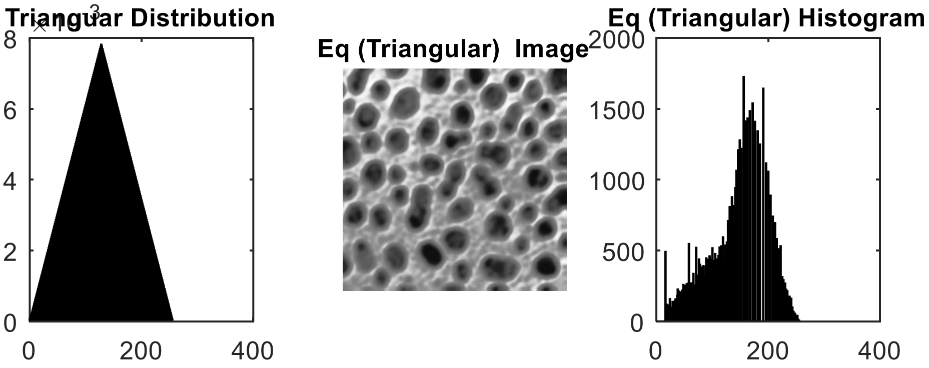


Figure 2.5: Result of hw1_2b('cells-1.png', ‘triangular’)

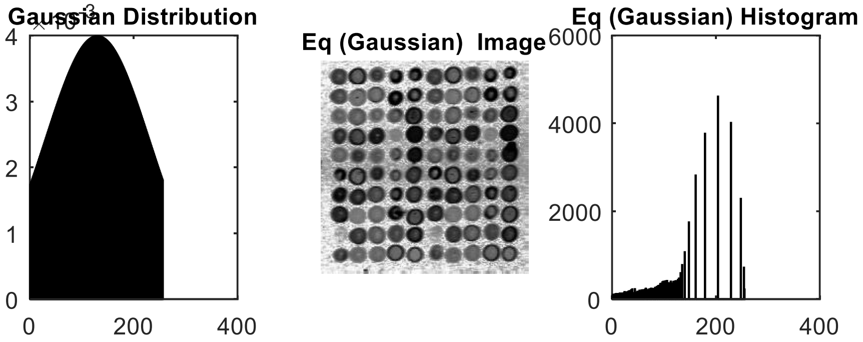


Figure 2.6: Result of hw1_2b('cells-2_n.tif, 'gaussian)

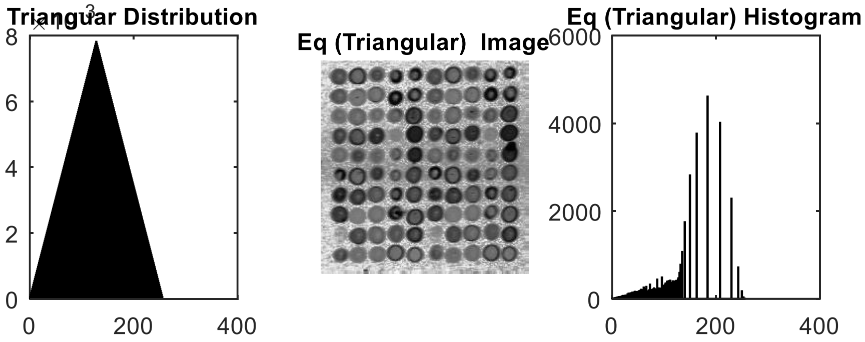


Figure 2.7: Result of hw1_2b('cells-2_n.tif, 'triangular')

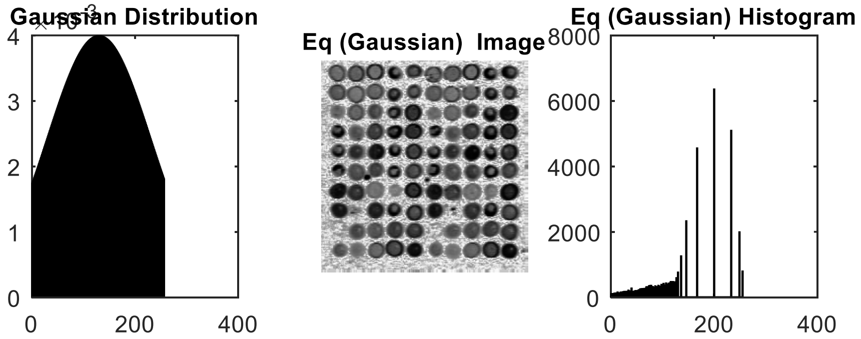


Figure 2.8: Result of hw1_2b('cells-3_n.tif, 'gaussian)

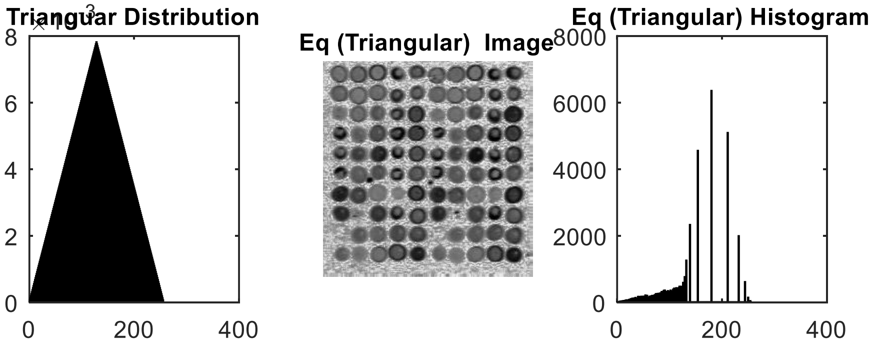


Figure 2.9 : Result of hw1_2b('cells-3_n.tif, 'triangular')

RESULTS OF PROBLEM 2C

Description

The main program of Problem 1d was re-run for histogram shaped images as input (equalized, triangle shaped, and Gaussian shaped). Results of identifying blob counts are given below:

	Total Blobs (Open-Close Window)			
Image	**1d (main)**	**Equalized**	**Gaussian Shaped**	**Triangular Shaped**
cells-1.png	59 (3,3)	56 (3,3)	59 (3,3)	59 (3,3)
cells-2_n.tif	44 (3,3)	57 (3,3)	65 (3,3)	87 (3,3)
cells-3_n.tif	52 (3,3)	65 (0,0)	51 (0,0)	89 (0,0)
		89* (3,3)	89* (3,3)	46* (3,3)

* During morphological operation of histogram equitized 3rd image, only one OPEN-CLOS operation doesn’t give good output. The process returns 552 blobs. As such separately calling myerode and mydilate in following manner produces better output (Figure 2.19):

```
mydilate(mydilate(myerode(myerode(binimage,5),3),3),5);
```

Analysis

Though the Open-Close or Close-Open window-sizes were not same across same operations for all images, but it was kept same for each image. It’s because different image may respond to one operation in different manner. To process each of the images we have to change the parameter and set it accordingly to get a better result. In this case, the image cells-3_n.tif couldn’t be processed with same OPEN CLOSE window sizes for equalized or Gaussian shaping. Customized erosion and dilation showed better result (Figure 2.13). However, in case of triangular shaping, the cells-3_n.tif showed better results (Figure 2.19).

Output

Following are the outputs of hw1_2c for each input image, showing the equalized image, binary, user defined shaping histogram, the shaped image and its histogram.

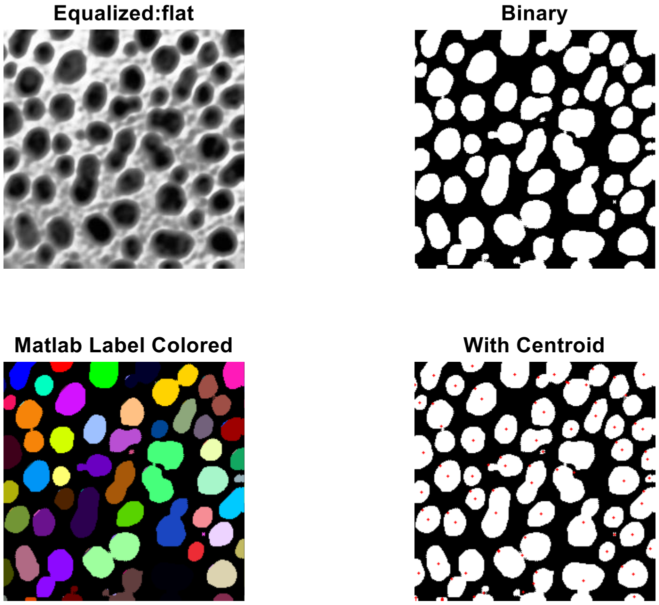
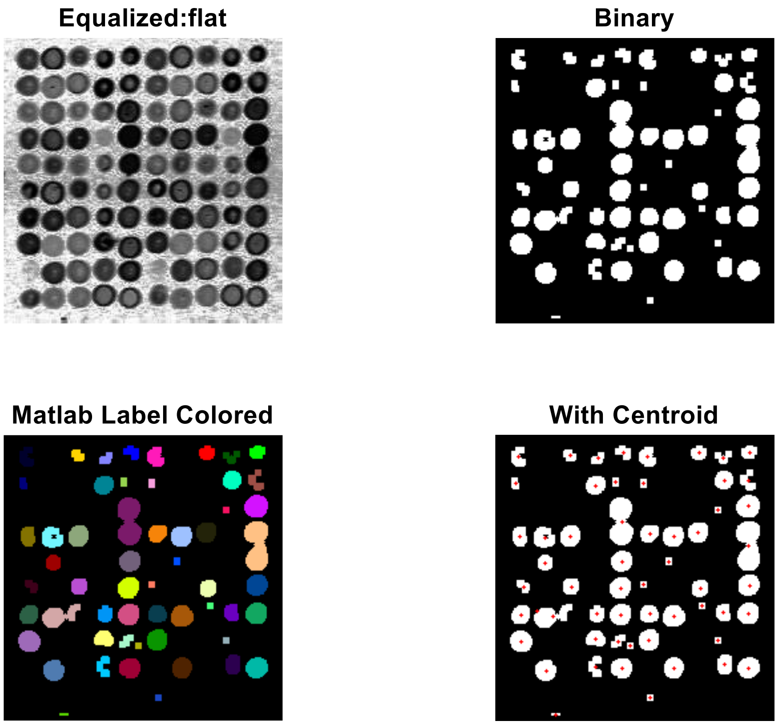


Figure 2.10: Result of hw1_2c('cells-1.png', 'equalized',3,3)

Blobs (total blob: 56) [blob no: area (positionX, positonY)]

```
1:585 (17,23)          15:1087 (71,31)        29:852 (131,127)       43:1623 (208,117)
2:264 (7,64)           16:589 (74,100)        30:311 (124,64)        44:122 (201,253)
3:826 (16,109)         17:404 (72,215)        31:813 (129,225)       45:286 (204,207)
4:719 (16,151)         18:473 (74,245)        32:64 (126,252)        46:720 (217,28)
5:575 (16,246)         19:273 (74,169)        33:371 (141,10)        47:16 (204,92)
6:1062 (27,185)        20:580 (86,65)         34:1170 (163,89)       48:1111 (227,57)
7:764 (38,227)         21:629 (86,132)        35:602 (153,244)       49:306 (227,7)
8:349 (28,46)          22:648 (99,12)         36:372 (148,67)        50:747 (228,235)
9:66 (27,3)            23:429 (96,223)        37:1149 (173,182)      51:1255 (235,182)
10:846 (42,74)         24:1836 (120,172)      38:611 (164,137)       52:656 (238,129)
11:15 (31,67)          25:255 (106,250)       39:593 (170,17)        53:148 (248,76)
12:187 (46,8)          26:21 (98,139)         40:384 (168,214)       54:94 (252,236)
13:607 (56,140)        27:586 (113,99)        41:558 (173,46)        55:20 (253,4)
14:585 (60,195)        28:727 (124,38)        42:543 (186,234)       56:22 (254,32)
```



Equalized:flat

Binary

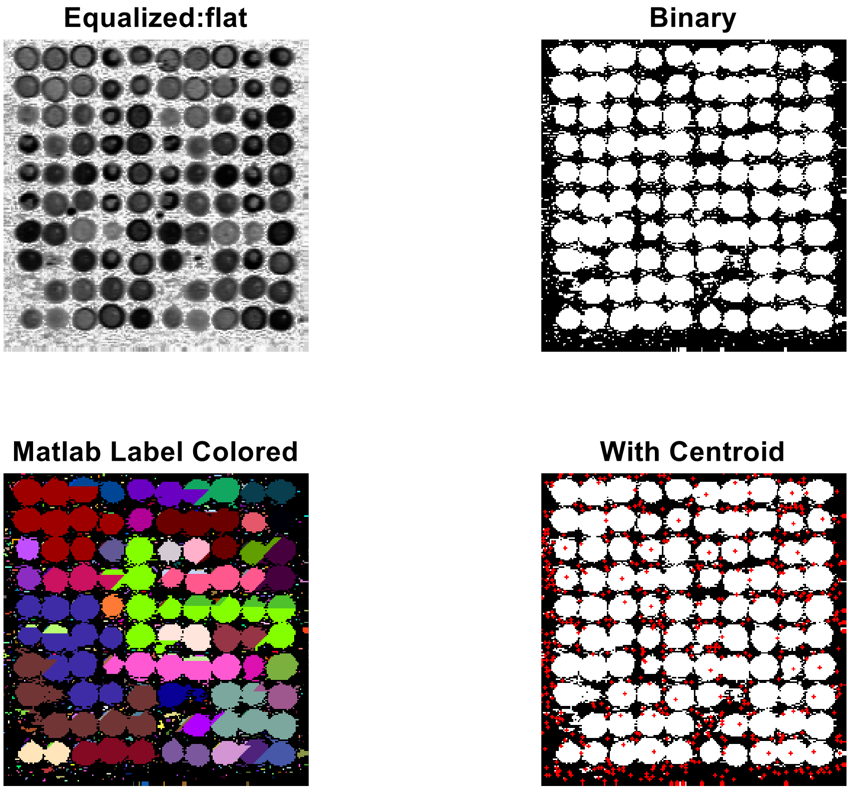
Matlab Label Colored

With Centroid

Figure 2.11: Result of hw1_2c('cells-2_n.tif', 'equalized',3,3)

Blobs (Total-65) [blob no: area (positionX, positonY)]

```
1:116 (15,194)       18:175 (40,78)       35:133 (116,60)      52:220 (158,22)
2:135 (17,98)        19:246 (56,193)      36:216 (118,97)      53:24 (154,179)
3:114 (17,156)       20:509 (68,97)       37:91 (117,136)      54:139 (158,193)
4:130 (18,174)       21:31 (55,81)        38:171 (119,27)      55:56 (157,172)
5:168 (19,21)        22:15 (54,157)       39:145 (118,157)     56:189 (160,98)
6:101 (17,59)        23:85 (58,174)       40:57 (120,45)       57:158 (176,175)
7:175 (19,118)       24:199 (76,156)      41:143 (137,156)     58:161 (177,79)
8:25 (16,143)        25:531 (86,193)      42:217 (137,193)     59:199 (178,139)
9:55 (20,35)         26:157 (77,119)      43:391 (139,49)      60:214 (178,193)
10:46 (20,45)        27:377 (79,32)       44:211 (138,97)      61:202 (178,98)
11:131 (19,79)       28:207 (79,59)       45:143 (136,175)     62:210 (180,40)
12:41 (19,131)       29:207 (79,137)      46:170 (138,22)      63:108 (199,23)
13:168 (37,194)      30:208 (98,98)       47:129 (137,79)      64:16 (196,85)
14:166 (37,174)      31:108 (97,136)      48:157 (138,118)     65:60 (198,119)
15:135 (38,98)       32:117 (99,41)       49:225 (139,137)
16:98 (39,20)        33:216 (116,193)     50:168 (156,79)
17:135 (39,119)      34:182 (118,123)     51:206 (157,119)
```



Equalized:flat

Binary

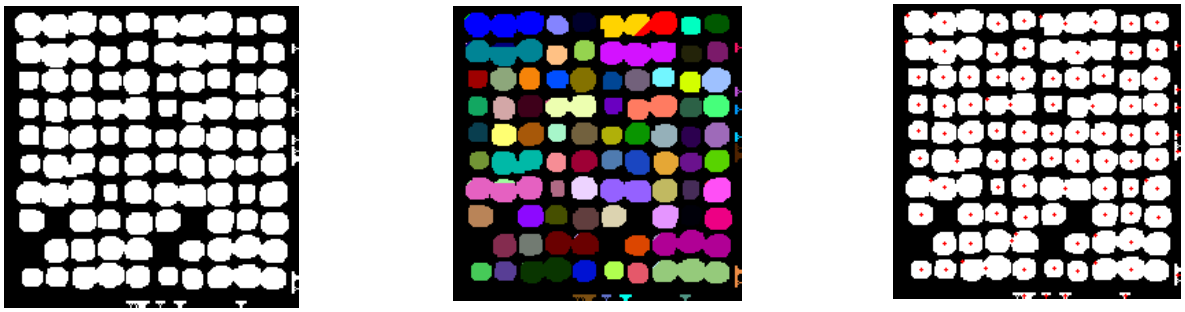
Matlab Label Colored

With Centroid

Figure 2.12: Result of hw1_2c('cells-3_n.tif', 'equalized',0,0)

Blobs (Total-65) [blob no: area (positionX, positonY)]

```
1:2359 (35,47)        14:237 (56,136)       27:2185 (154,60)      40:27 (170,119)
2:294 (14,67)         15:256 (57,179)       28:1237 (138,119)     41:27 (175,127)
3:454 (16,146)        16:185 (57,118)       29:18 (132,74)        42:15 (176,111)
4:621 (17,116)        17:654 (75,58)        30:61 (129,127)       43:22 (179,20)
5:445 (16,185)        18:213 (74,20)        31:323 (136,194)      44:329 (194,190)
6:228 (34,196)        19:845 (76,146)       32:193 (137,176)      45:826 (194,80)
7:222 (35,97)         20:43 (71,127)        33:1344 (166,176)     46:408 (195,128)
8:1071 (46,137)       21:2662 (126,48)      34:333 (156,190)      47:213 (195,174)
9:187 (37,176)        22:187 (94,78)        35:29 (158,95)        48:412 (195,30)
10:2554 (86,137)      23:361 (91,165)       36:350 (156,126)      49:296 (195,159)
11:623 (65,190)       24:454 (115,127)      37:17 (169,80)        50:26 (195,208)
12:199 (54,19)        25:471 (116,165)      38:18 (167,16)        51:20 (206,33)
13:209 (55,78)        26:93 (112,28)        39:252 (175,139)
```



Binary

Colored

Centroids

Figure 2.13: Result of custom erosion and dilation operation of equalized Cells-3_n.tif

Blobs (Total – 95) [blob no: area (positionX, positonY)]

```
1:15 (39,851)           25:57 (174,207)         49:116 (48,528)         73:157 (98,270)
2:15 (149,350)          26:64 (209,17)          50:115 (97,257)         74:157 (195,281)
3:16 (127,443)          27:75 (58,262)          51:114 (117,187)        75:175 (175,816)
4:15 (194,217)          28:75 (87,478)          52:116 (136,280)        76:174 (88,543)
5:16 (78,187)           29:76 (147,496)         53:115 (194,252)        77:169 (91,3)
6:16 (175,170)          30:75 (193,269)         54:114 (21,158)         78:170 (149,7)
7:36 (39,765)           31:75 (20,177)          55:116 (157,255)        79:176 (39,252)
8:30 (29,51)            32:76 (39,232)          56:116 (77,172)         80:176 (58,248)
9:34 (97,198)           33:71 (70,4)            57:116 (175,194)        81:176 (136,230)
10:29 (11,1)            34:75 (118,145)         58:135 (39,777)         82:194 (69,543)
11:37 (136,790)         35:76 (175,205)         59:134 (97,278)         83:195 (175,789)
12:35 (194,200)         36:77 (209,17)          60:130 (29,37)          84:195 (97,234)
13:32 (209,17)          37:94 (20,178)          61:136 (194,310)        85:190 (149,5)
14:38 (77,186)          38:95 (58,272)          62:136 (127,543)        86:195 (40,197)
15:37 (175,165)         39:95 (97,266)          63:136 (156,267)        87:189 (52,1)
16:55 (38,267)          40:95 (136,251)         64:130 (186,3)          88:194 (119,165)
17:55 (57,214)          41:96 (194,278)         65:135 (78,112)         89:195 (22,178)
18:56 (96,283)          42:96 (39,256)          66:136 (175,155)        90:196 (136,200)
19:54 (155,204)         43:94 (77,154)          67:155 (22,261)         91:199 (209,43)
20:56 (193,309)         44:96 (155,274)         68:155 (58,271)         92:214 (97,51)
21:56 (136,249)         45:96 (117,173)         69:154 (77,200)         93:214 (113,17)
22:55 (20,171)          46:97 (175,186)         70:155 (119,252)        94:214 (127,26)
23:55 (78,185)          47:97 (209,17)          71:155 (156,285)        95:214 (171,22)
24:56 (118,164)         48:109 (209,41)         72:154 (175,198)
```

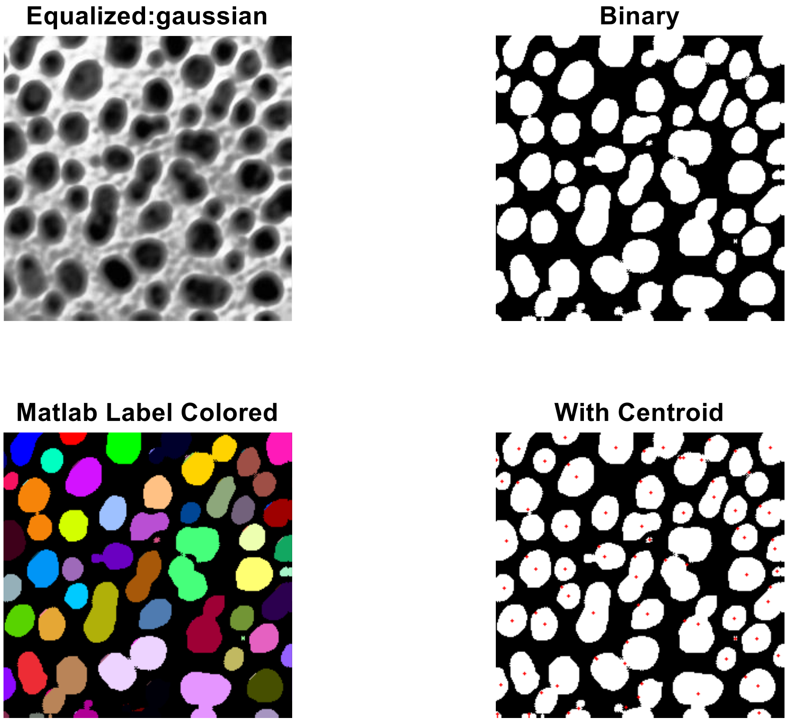
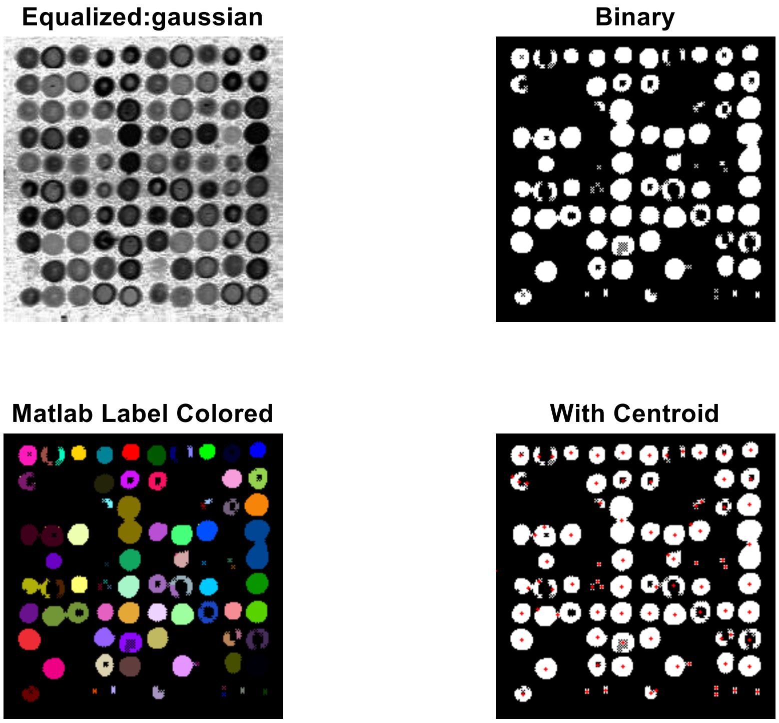


Figure 2.14: Result of hw1_2c('cells-1.png','gaussian',3,3)

Blobs (Total-59) [blob no: area (positionX, positonY)]

```
1:589 (17,23)            4:725 (16,151)           7:778 (38,227)           10:19 (25,169)
2:266 (7,64)             5:577 (16,246)           8:352 (28,46)            11:850 (42,74)
3:829 (16,109)           6:1061 (27,185)          9:69 (27,3)              12:15 (31,67)
```

```
13:187 (46,8)            25:1867 (120,172)         37:603 (153,244)         49:16 (204,92)
14:621 (56,140)          26:261 (106,250)          38:372 (148,67)          50:1124 (228,57)
15:592 (60,196)          27:21 (98,139)            39:1156 (173,182)        51:308 (227,7)
16:1095 (71,31)          28:593 (113,99)           40:612 (164,137)         52:753 (228,235)
17:593 (74,100)          29:732 (124,38)           41:600 (170,17)          53:1262 (235,182)
18:405 (72,215)          30:15 (113,30)            42:386 (168,214)         54:651 (238,129)
19:477 (74,245)          31:856 (131,127)          43:560 (173,46)          55:152 (248,76)
20:275 (74,169)          32:313 (124,64)           44:549 (186,234)         56:20 (247,118)
21:583 (86,65)           33:817 (129,225)          45:1632 (208,117)        57:95 (252,236)
22:639 (86,132)          34:64 (126,252)           46:124 (201,253)         58:22 (253,4)
23:651 (99,12)           35:375 (141,10)           47:291 (204,207)         59:26 (253,32)
24:433 (96,223)          36:1177 (163,89)          48:728 (217,28)
```


Equalized:gaussian

Binary

Matlab Label Colored

With Centroid

Figure 2.15: Result of hw1_2c('cells-2_n.tif','gaussian',3,3)

Blobs (Total-65) [blob no: area (positionX, positonY)]

```
1:116 (15,194)         18:175 (40,78)        35:133 (116,60)        52:220 (158,22)
2:135 (17,98)          19:246 (56,193)       36:216 (118,97)        53:24 (154,179)
3:114 (17,156)         20:509 (68,97)        37:91 (117,136)        54:139 (158,193)
4:130 (18,174)         21:31 (55,81)         38:171 (119,27)        55:56 (157,172)
5:168 (19,21)          22:15 (54,157)        39:145 (118,157)       56:189 (160,98)
6:101 (17,59)          23:85 (58,174)        40:57 (120,45)         57:158 (176,175)
7:175 (19,118)         24:199 (76,156)       41:143 (137,156)       58:161 (177,79)
8:25 (16,143)          25:531 (86,193)       42:217 (137,193)       59:199 (178,139)
9:55 (20,35)           26:157 (77,119)       43:391 (139,49)        60:214 (178,193)
10:46 (20,45)          27:377 (79,32)        44:211 (138,97)        61:202 (178,98)
11:131 (19,79)         28:207 (79,59)        45:143 (136,175)       62:210 (180,40)
12:41 (19,131)         29:207 (79,137)       46:170 (138,22)        63:108 (199,23)
13:168 (37,194)        30:208 (98,98)        47:129 (137,79)        64:16 (196,85)
14:166 (37,174)        31:108 (97,136)       48:157 (138,118)       65:60 (198,119)
15:135 (38,98)         32:117 (99,41)        49:225 (139,137)
16:98 (39,20)          33:216 (116,193)      50:168 (156,79)
17:135 (39,119)        34:182 (118,123)      51:206 (157,119)
```

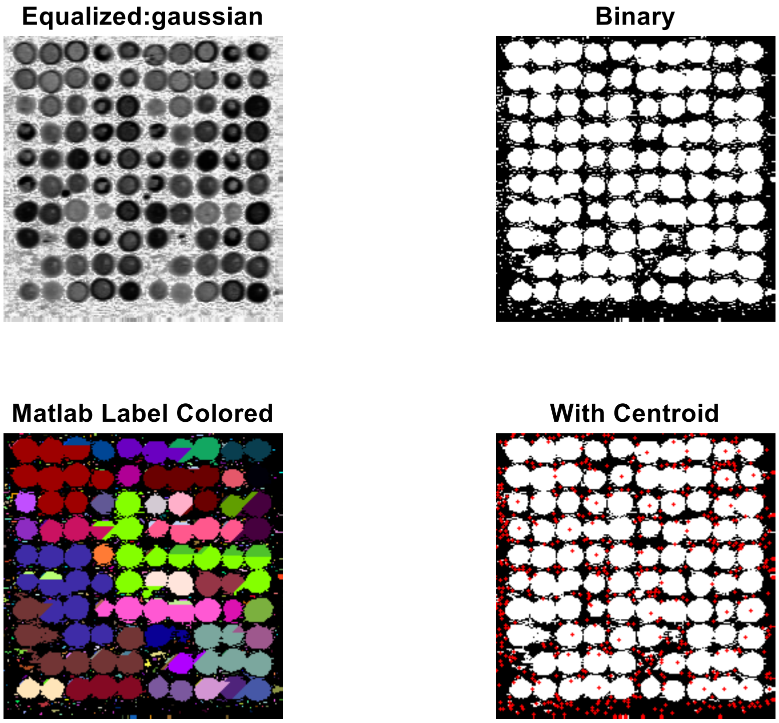


Figure 2.16: Result of hw1_2c('cells-3_n.tif','gaussian',0,0)

Blobs (Total-51) [blob no: area (positionX, positonY)]

```
1:2359 (35,47)          14:237 (56,136)         27:2185 (154,60)        40:27 (170,119)
2:294 (14,67)           15:256 (57,179)         28:1237 (138,119)       41:27 (175,127)
3:454 (16,146)          16:185 (57,118)         29:18 (132,74)          42:15 (176,111)
4:621 (17,116)          17:654 (75,58)          30:61 (129,127)         43:22 (179,20)
5:445 (16,185)          18:213 (74,20)          31:323 (136,194)        44:329 (194,190)
6:228 (34,196)          19:845 (76,146)         32:193 (137,176)        45:826 (194,80)
7:222 (35,97)           20:43 (71,127)          33:1344 (166,176)       46:408 (195,128)
8:1071 (46,137)         21:2662 (126,48)        34:333 (156,190)        47:213 (195,174)
9:187 (37,176)          22:187 (94,78)          35:29 (158,95)          48:412 (195,30)
10:2554 (86,137)        23:361 (91,165)         36:350 (156,126)        49:296 (195,159)
11:623 (65,190)         24:454 (115,127)        37:17 (169,80)          50:26 (195,208)
12:199 (54,19)          25:471 (116,165)        38:18 (167,16)          51:20 (206,33)
13:209 (55,78)          26:93 (112,28)          39:252 (175,139)
```

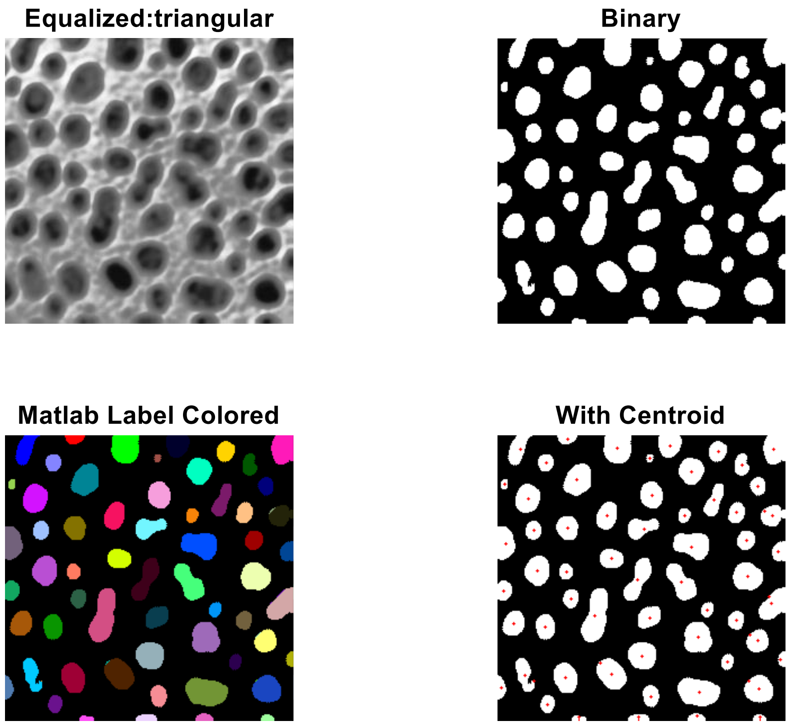
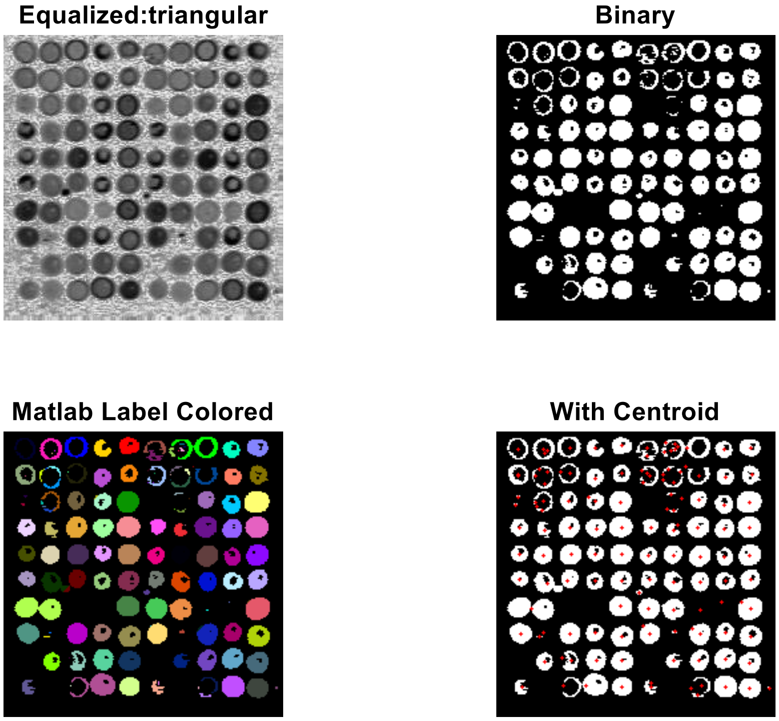


Figure 2.17: Result of hw1_2c('cells-1.png','triangular',3,3)

Blobs (Total-59) [blob no: area (positionX, positonY)]

```
1:357 (15,23)         16:310 (60,195)       31:525 (128,225)      46:48 (202,254)
2:149 (6,65)          17:358 (74,100)       32:140 (124,64)       47:126 (204,207)
3:595 (14,109)        18:219 (71,215)       33:525 (133,166)      48:313 (216,27)
4:385 (12,156)        19:286 (74,247)       34:221 (141,8)        49:539 (215,104)
5:435 (15,248)        20:116 (74,169)       35:413 (152,246)      50:454 (218,63)
6:234 (17,199)        21:335 (85,65)        36:780 (163,89)       51:171 (227,6)
7:201 (29,220)        22:356 (86,133)       37:188 (148,68)       52:494 (228,235)
8:175 (27,46)         23:192 (87,35)        38:120 (158,189)      53:743 (231,182)
9:38 (23,138)         24:444 (99,10)        39:322 (165,138)      54:226 (235,139)
10:419 (35,175)       25:223 (96,224)       40:345 (170,17)       55:162 (242,47)
11:539 (42,73)        26:590 (102,175)      41:192 (167,215)      56:58 (252,180)
12:177 (48,234)       27:146 (106,252)      42:312 (173,45)       57:63 (253,128)
13:49 (46,9)          28:299 (112,104)      43:560 (182,181)      58:36 (253,236)
14:386 (56,140)       29:463 (123,38)       44:313 (185,234)      59:28 (253,75))
15:450 (59,30)        30:497 (131,127)      45:500 (199,131)
```



Equalized:triangular

Binary

Matlab Label Colored

With Centroid

Figure 2.18: Result of hw1_2c('cells-2_n.tif','triangular',3,3)

Blobs (Total-70) [blob no: area (positionX, positonY)]

```
1:121 (15,194)       19:44 (56,80)        37:194 (119,28)      55:63 (156,172)
2:129 (16,156)       20:123 (58,174)      38:33 (117,172)      56:231 (158,194)
3:139 (17,99)        21:203 (76,156)      39:24 (115,178)      57:441 (169,98)
4:117 (18,136)       22:388 (78,128)      40:74 (119,44)       58:171 (176,175)
5:144 (18,174)       23:397 (79,32)       41:152 (118,157)     59:187 (177,79)
6:323 (19,31)        24:212 (79,59)       42:46 (117,79)       60:260 (178,142)
7:115 (17,60)        25:212 (98,98)       43:212 (137,157)     61:221 (178,193)
8:185 (19,117)       26:130 (97,136)      44:221 (137,193)     62:26 (176,162)
9:134 (19,79)        27:128 (99,40)       45:430 (139,49)      63:217 (180,40)
10:182 (37,194)      28:80 (98,156)       46:218 (138,97)      64:32 (197,170)
11:170 (37,174)      29:59 (99,176)       47:146 (136,175)     65:40 (197,182)
12:147 (38,98)       30:18 (100,58)       48:178 (138,22)      66:32 (196,72)
13:155 (39,21)       31:17 (100,81)       49:140 (138,79)      67:127 (199,23)
14:172 (39,118)      32:222 (116,193)     50:400 (139,128)     68:19 (196,85)
15:180 (40,78)       33:243 (118,123)     51:174 (156,79)      69:86 (198,119)
16:783 (76,193)      34:142 (116,59)      52:213 (157,119)     70:22 (198,199)
17:519 (68,97)       35:223 (118,97)      53:30 (153,179)
18:81 (56,156)       36:97 (118,137)      54:226 (158,22)
```

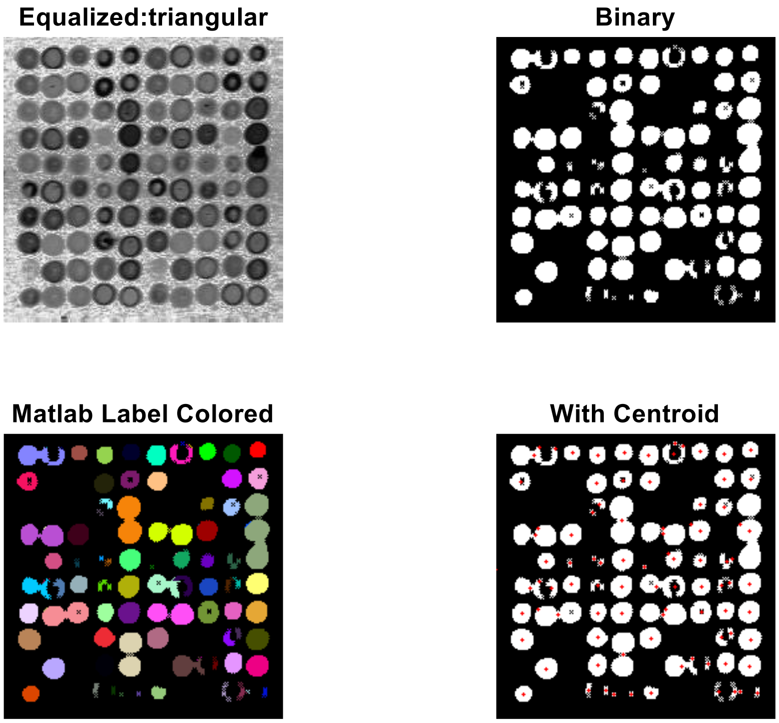


Figure 2.19: Result of hw1_2c('cells-3_n.tif','gaussian',0,0)

Blobs (Total-89) [blob no: area (positionX, positonY)]

```
1:118 (15,58)        24:124 (55,57)       47:206 (97,156)      70:143 (154,175)
2:149 (13,97)        25:224 (56,96)       48:121 (96,117)      71:125 (154,77)
3:207 (15,146)       26:130 (54,155)      49:116 (97,174)      72:201 (157,97)
4:81 (16,19)         27:253 (56,193)      50:159 (115,56)      73:200 (157,194)
5:113 (16,38)        28:112 (55,77)       51:171 (114,194)     74:195 (174,175)
6:104 (15,77)        29:141 (58,174)      52:111 (114,20)      75:191 (175,78)
7:157 (15,194)       30:198 (75,58)       53:180 (115,97)      76:164 (175,155)
8:56 (15,116)        31:226 (75,97)       54:114 (114,118)     77:101 (175,59)
9:115 (16,174)       32:211 (75,154)      55:155 (116,136)     78:196 (175,97)
10:20 (18,129)       33:228 (75,193)      56:183 (117,41)      79:120 (176,39)
11:48 (21,116)       34:128 (75,20)       57:106 (115,77)      80:206 (177,193)
12:72 (34,58)        35:166 (76,78)       58:156 (116,156)     81:86 (175,136)
13:118 (35,19)       36:107 (75,119)      59:129 (115,175)     82:302 (194,70)
14:113 (34,97)       37:168 (76,174)      60:15 (124,110)      83:232 (195,175)
15:139 (35,195)      38:75 (77,39)        61:218 (134,96)      84:174 (195,97)
16:20 (33,41)        39:66 (77,136)       62:416 (136,29)      85:36 (194,157)
17:71 (36,118)       40:202 (95,59)       63:205 (136,117)     86:200 (196,193)
18:81 (36,155)       41:213 (95,97)       64:254 (136,194)     87:71 (195,22)
19:136 (38,77)       42:216 (96,193)      65:199 (137,136)     88:51 (195,119)
20:125 (37,175)      43:109 (95,20)       66:200 (155,21)      89:15 (201,154)
21:36 (41,136)       44:156 (96,38)       67:200 (155,58)
22:33 (42,39)        45:109 (95,77)       68:186 (155,118)
23:48 (55,38)        46:154 (96,136)      69:196 (155,156)
```