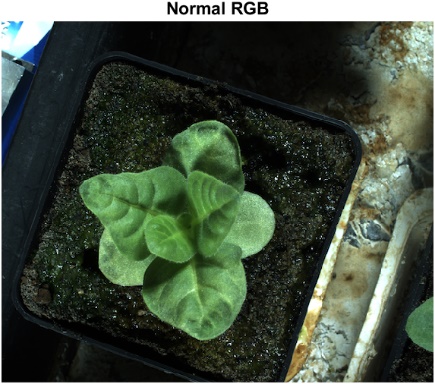
**Introduction to Image Processing (COMP2032) Coursework Report**

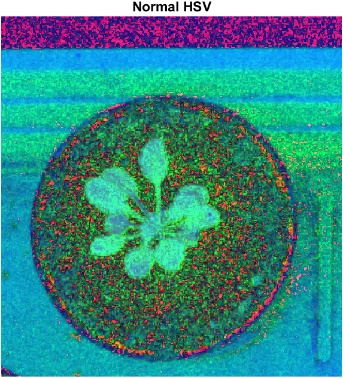
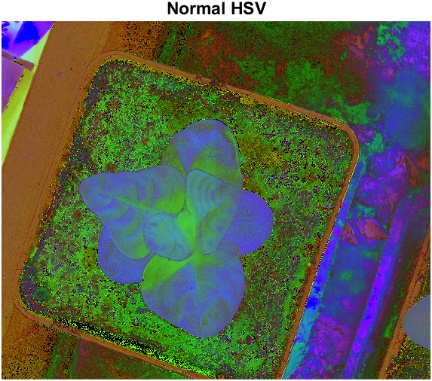
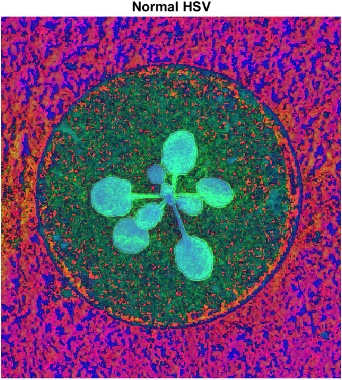
|  |  |
| --- | --- |
| Objective | Detect and Segment Leaf |
| Date | 24/03/2022 |
| Student Name | Tan Zhun Xian |
| Module Convenor | Tissa Chandesa |

**Introduction**

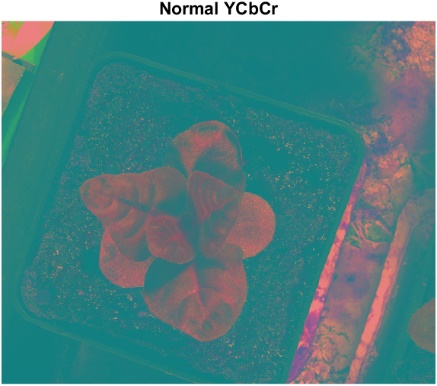
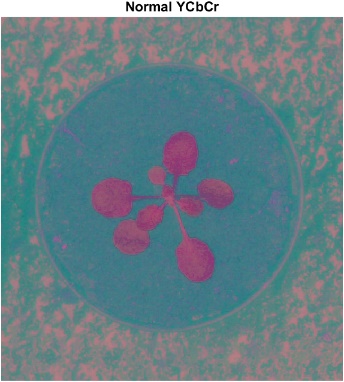
* *The images in the document will be displayed in rows of 3.*
* *The images are arranged in the order plant001.png, plant002.png and plant003.png.*
* *Below are the images used displayed in RGB, HSV and YCbCr.*
  + *RGB*

**

* *HSV*

**

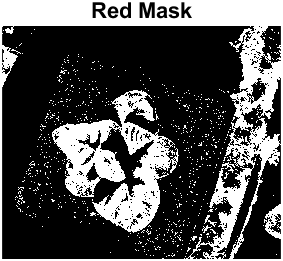
* *YCbCr*

**

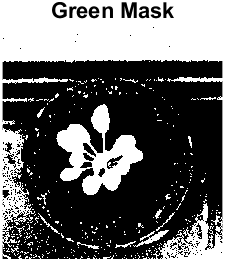
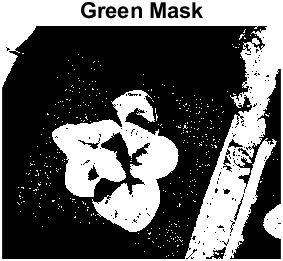
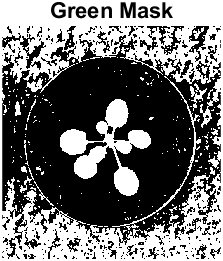
**Pre-processing technique(s)**

**Masking**

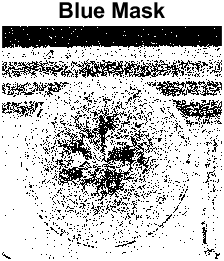
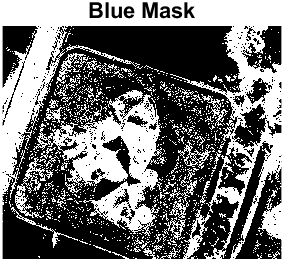
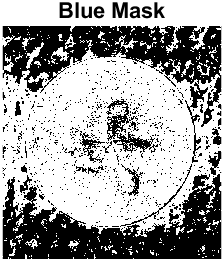
* *Using the RGB, HSV and YCbCr colour spaces, we can construct some masks to only cover the green leaves.*
* *First, we have the RGB masks*
  + *Red Mask (red > 70 & red < 140)*

**

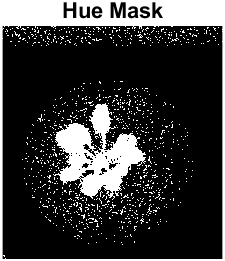
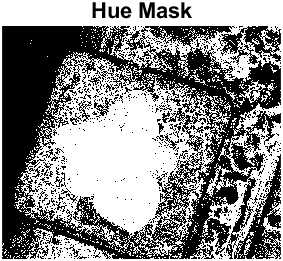
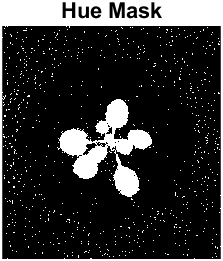
* *Although the plant can be seen in the first image, the plant cannot be clearly seen in the second image while the third image has large pieces of the plant missing. So, this mask is discarded.*
  + *Green Mask (green > 100)*

**

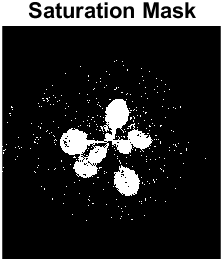
* + *Although the plant can clearly be seen in the first and second image, the third image has large pieces of the plant missing. So, this mask is discarded.*
  + *Blue Mask (blue > 30 & blue < 100)*

**

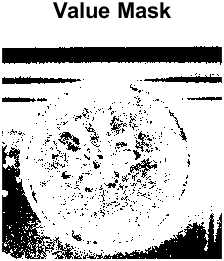
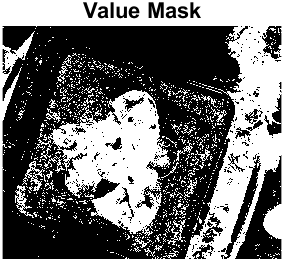
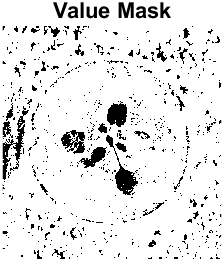
* *The plant cannot be seen clearly in all 3 images. So, this mask is discarded.*
* *Then, we have the HSV masks*
  + *Hue Mask (hue >= 0.2 & hue <= 0.35)*

**

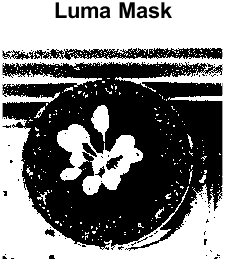
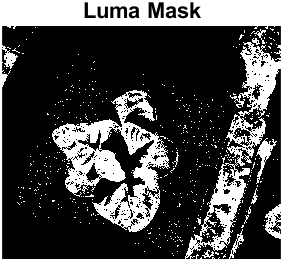
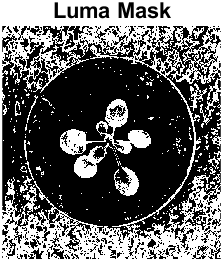
* *Although the main plant can clearly be seen in all 3 images. The side plant to the right in the third image cannot be seen clearly. So, this mask is discarded.*
  + *Saturation Mask (saturation >= 0.6)*

**

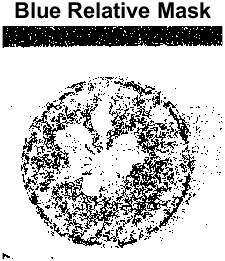
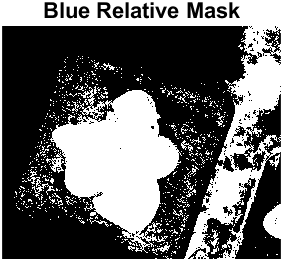
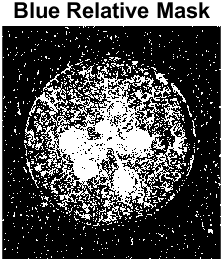
* + *The plant in the first and second image can be seen quite clearly. However, the plant in the third image is almost fully blocked. So, this mask is discarded.*
  + *Value Mask (value >= 0.2 & value <= 0.7)*

**

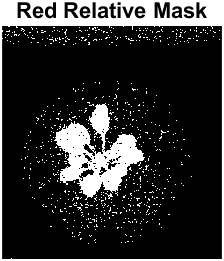
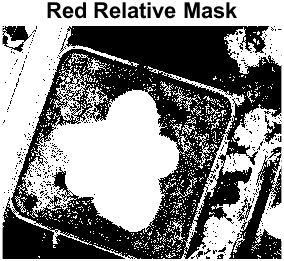
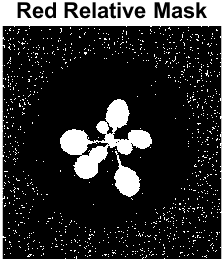
* *The plants cannot be seen clearly in any of the 3 images. So, this mask is discarded.*
* *Then, we have the YCbCr masks*
  + *Luma Mask (luma >= 100 & luma <= 150)*

**

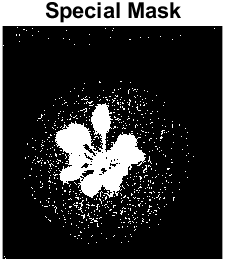
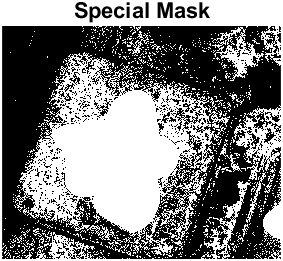
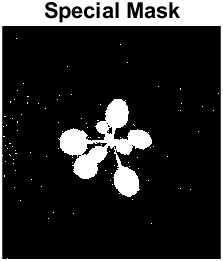
* *Although the plant in the image can be seen clearly, the other 2 images have large pieces of the plant missing. So, the mask is discarded.*
  + *Blue Relative Mask (blueRelative >= 60 & blueRelative <= 121)*

**

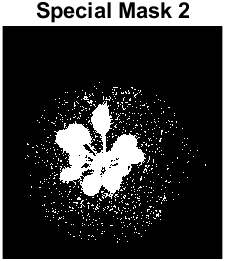
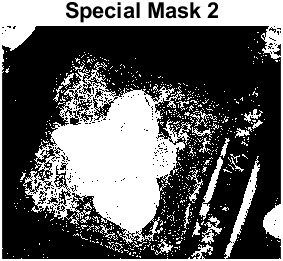
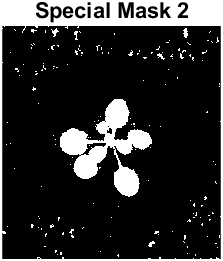
* + *The plants in all 3 images can be seen. Although there is a lot of noise in the first 2 images, it will be removed by the other masks. So, this mask is chosen.*
  + *Red Relative Mask (redRelative >= 100 & redRelative <= 125)*

**

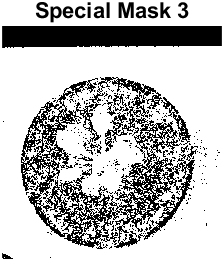
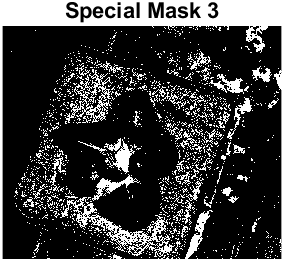
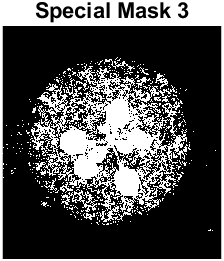
* + *The plant in all 3 images can be seen clearly. Although there is a lot of noise in the third image, it will be removed by the other masks. So, this mask is chosen.*
* *Finally, we have the special masks*
  + *Special Mask 1 (green > 1.1 \* red & green > 1.1 \* blue)*

**

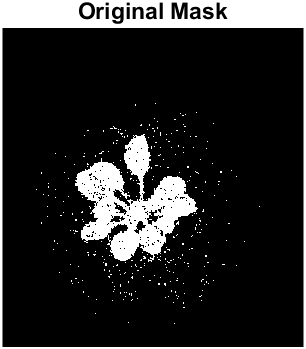
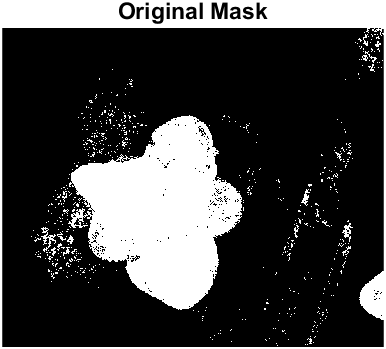
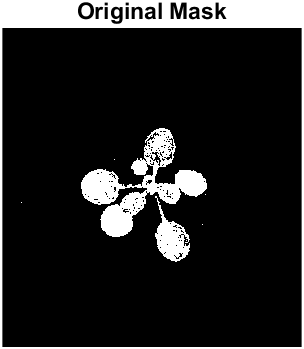
* + *The plant in all 3 images can be seen clearly. Although there is a lot of noise in the third image, it will be removed by the other masks. So, this mask is chosen.*
  + *Special Mask 2 (green > (red + blue) / 1.4)*

**

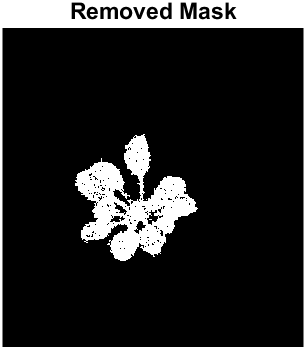
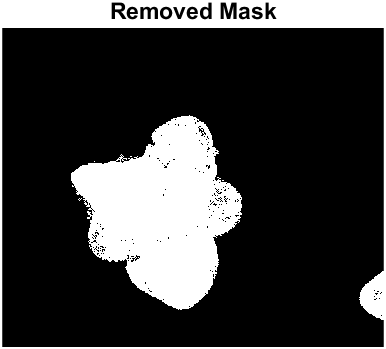
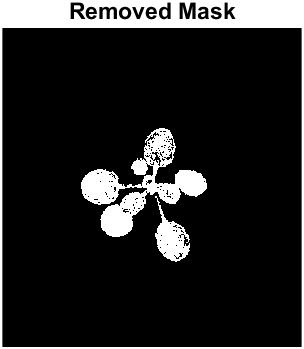
* + *The plant in all 3 images can be seen clearly. Although there is a lot of noise in the third image, it will be removed by the other masks. So, this mask is chosen.*
  + *Special Mask 3 (red > 1.5 \* blue)*

**

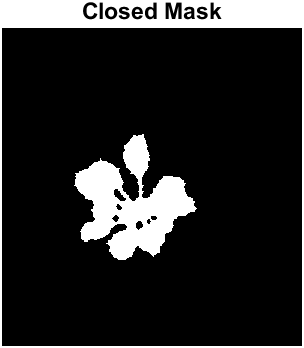
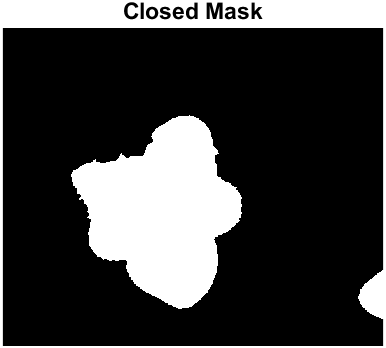
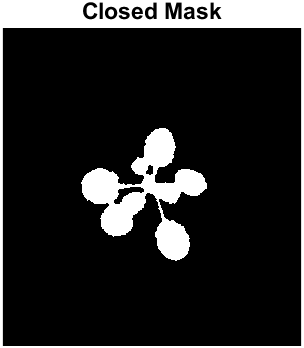
* *The plants in the first 2 images can be seen. However, the plant in the third images is almost fully blocked. So, this mask is discarded.*
* *In the end, the combination of Special Mask 1, Special Mask 2, Blue Relative Mask and Red Relative Mask was found to produce the best mask for separating the leaves from the original image.*
  + *Combined Mask*

**

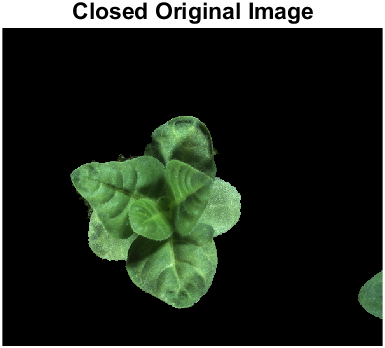
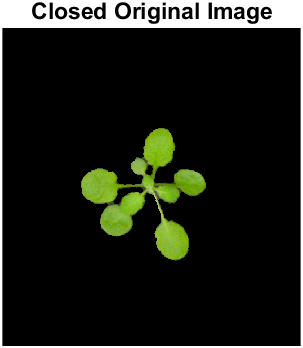
* *As you can see, the mask is quite dirty. We clean up the mask below*
  + *Mask treated with bwareaopen (originalMask,400)*

**

* + *Mask treated with imclose (originalMask,* *strel ('disk',4))*

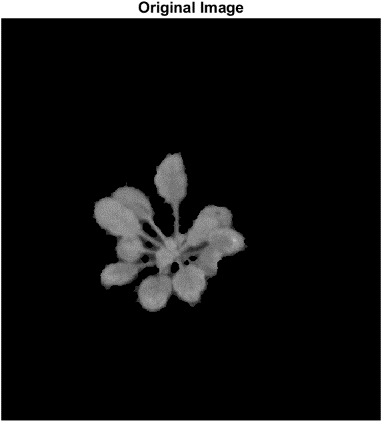
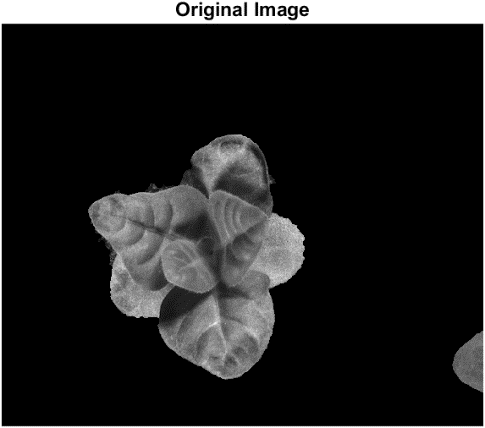
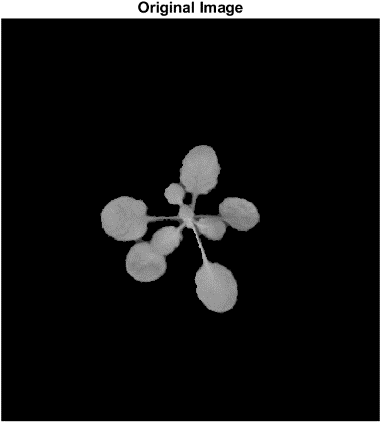
**

* *Now, the mask is mostly clean and ready for further segmentation*
  + *Mask overlayed on original image*

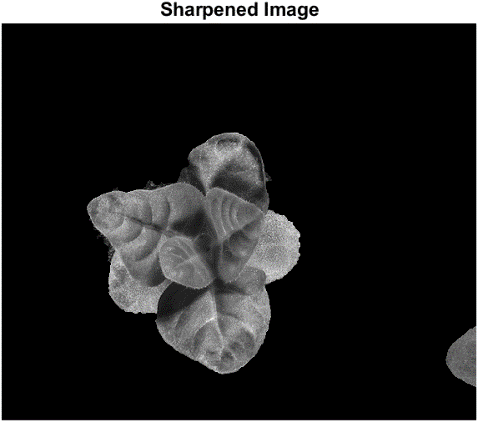
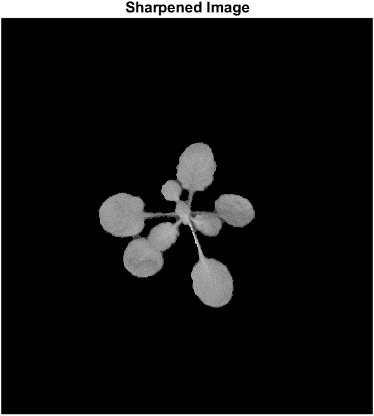
**

**Unsharp Masking**

* *First, convert the images to grayscale with rgb2gray (originalImage)*
  + *Grayscale images*

**

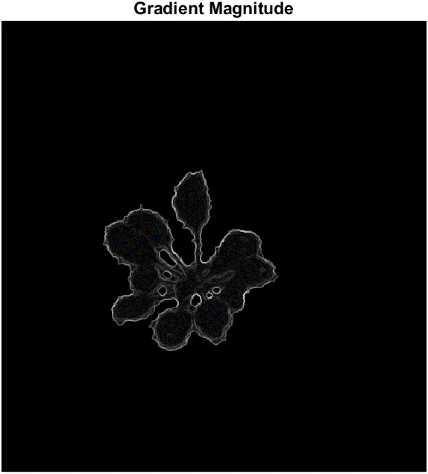
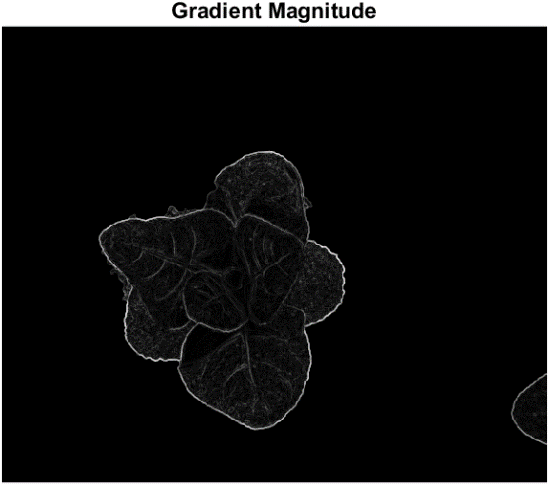
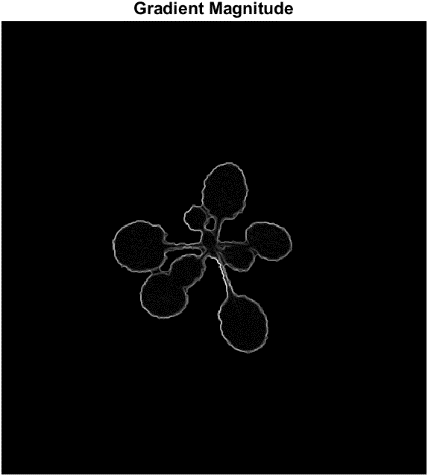
* *Now, apply imsharpen (grayScaleImage,'Radius',0.5,'Amount',1.5)*
  + *Sharpened images*

**

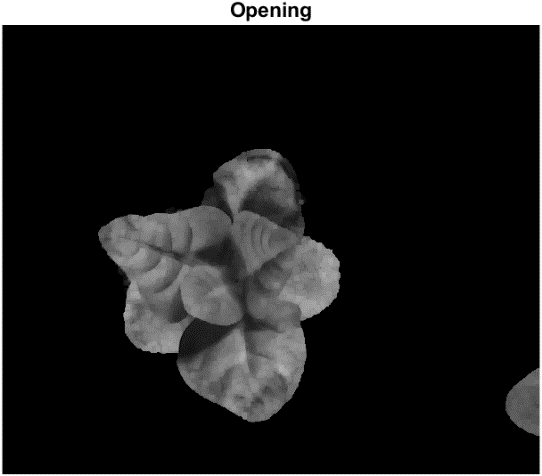
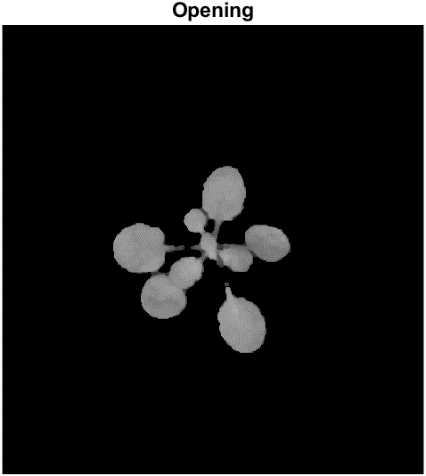
**Segmentation Technique**

**Watershed Segmentation**

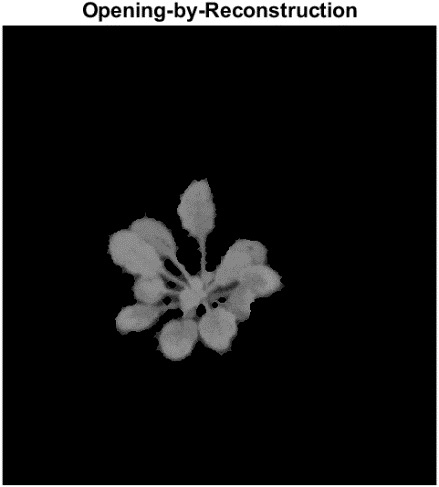
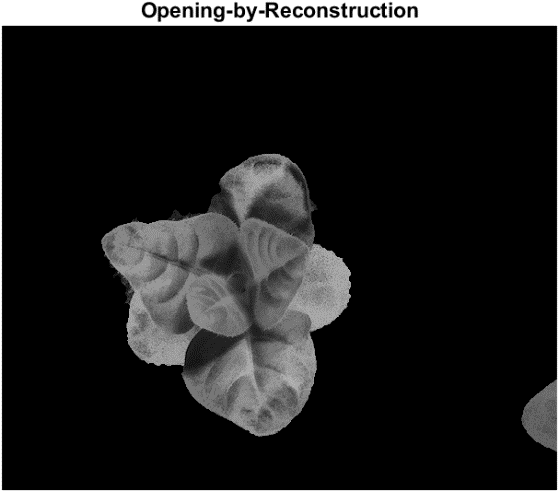
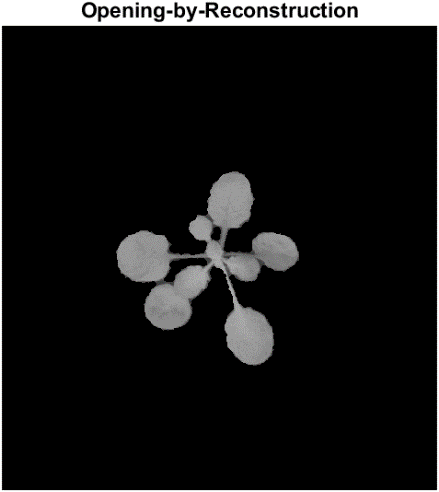
* *First, we get the gradient magnitude with imgradient (Image)*
  + *Gradient magnitude*

**

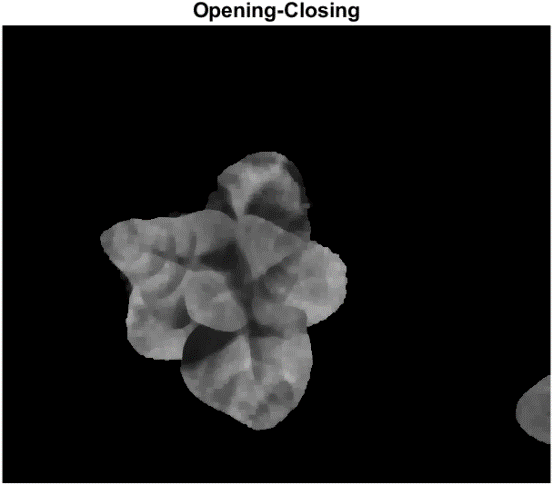
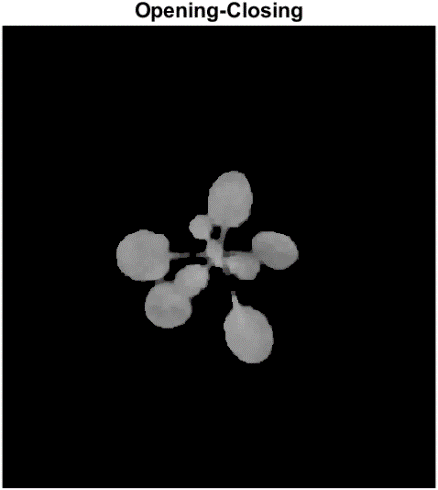
* *Then, we apply imopen (I,* *strel ('disk',3))*
  + *Opening*

**

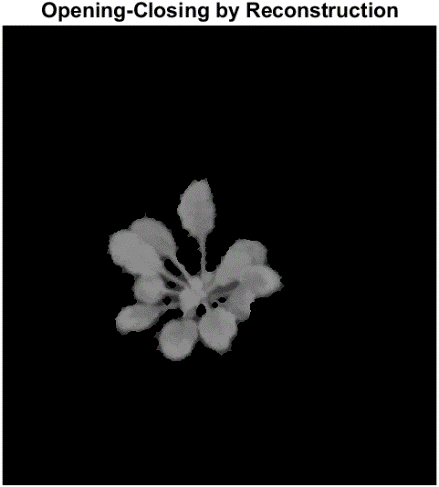
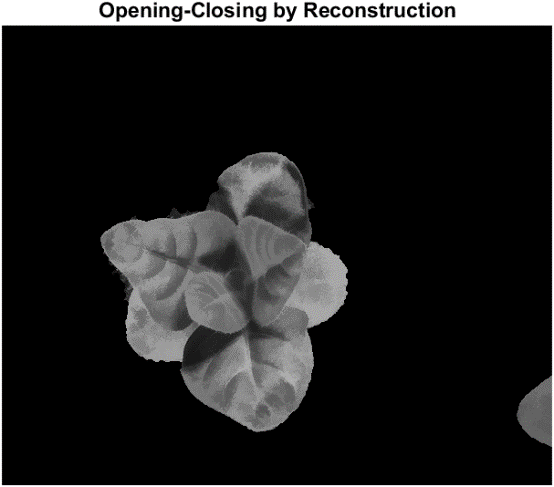
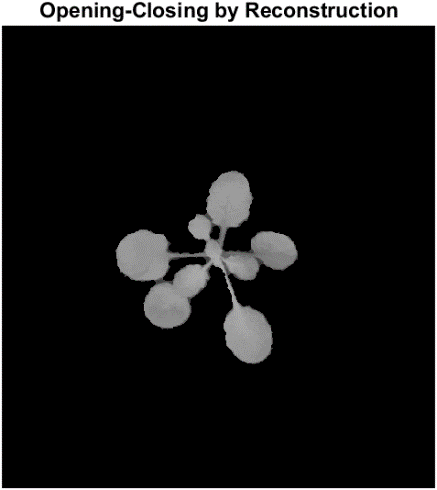
* *Then, we apply imreconstruct(Ie,I)*
  + *Opening-by-Reconstruction*

**

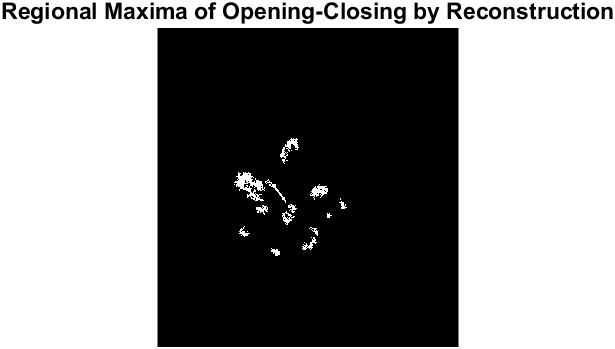
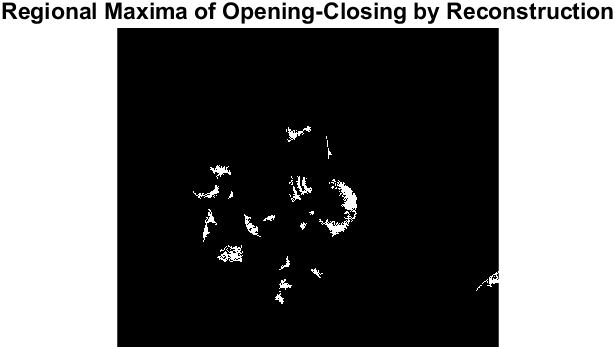
* *Then, we apply imclose(Io,se)*
  + *Opening-Closing*

**

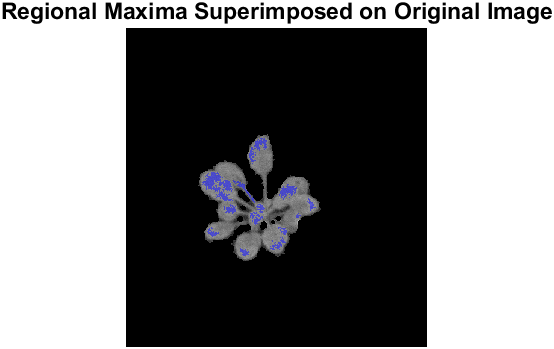
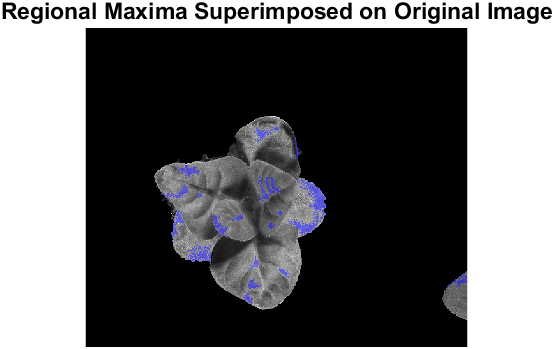
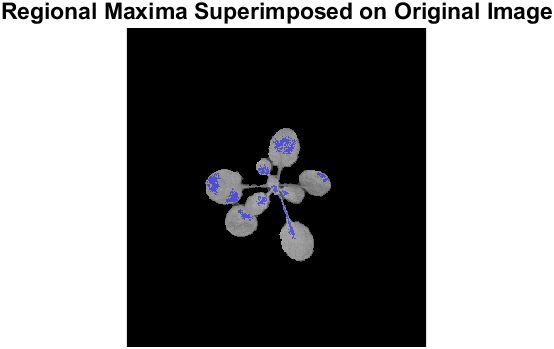
* *imreconstruct(imcomplement(Iobrd),imcomplement(Iobr))*
  + *Opening-Closing by Reconstruction*

**

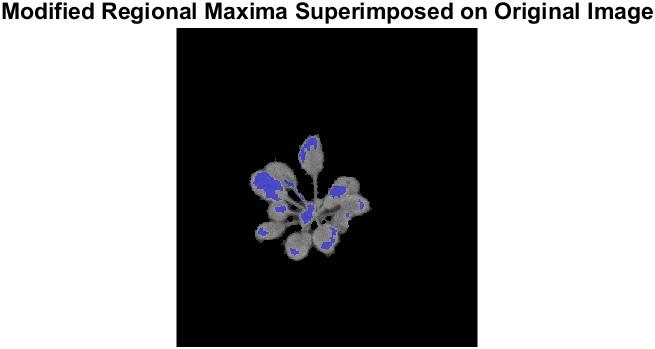
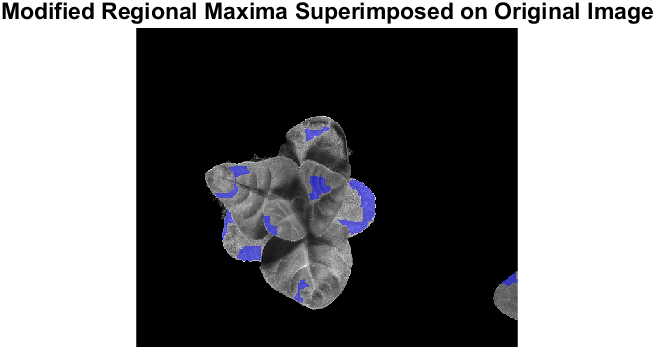
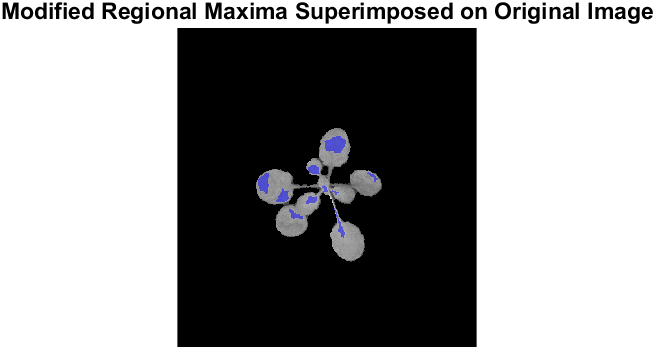
* *imregionalmax(Iobrcbr)*
  + *Regional Maxima of Opening-Closing by Reconstruction*

****

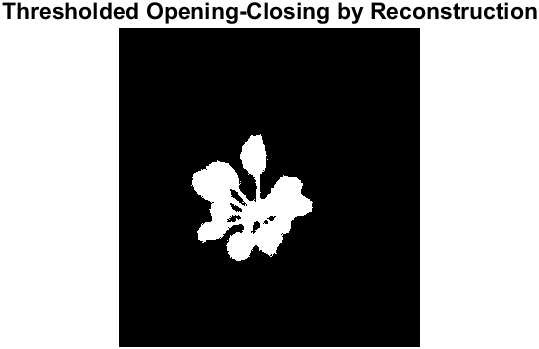
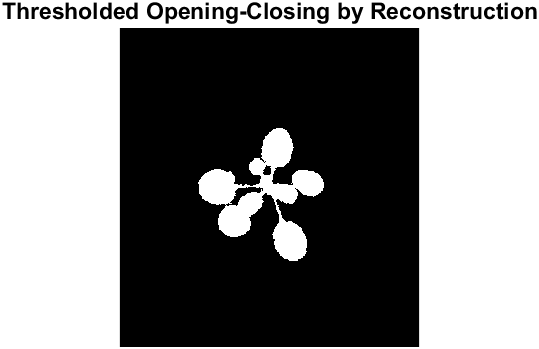
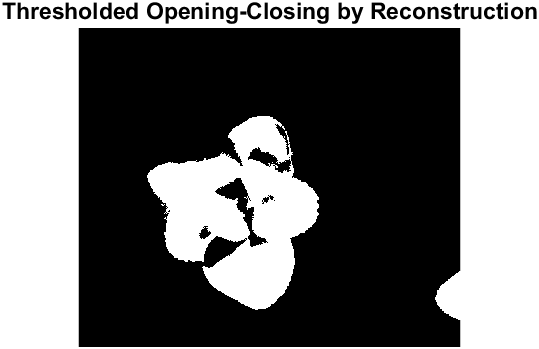
* + *Regional Maxima Superimposed on Original Image*

**

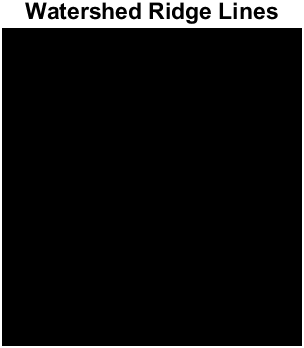
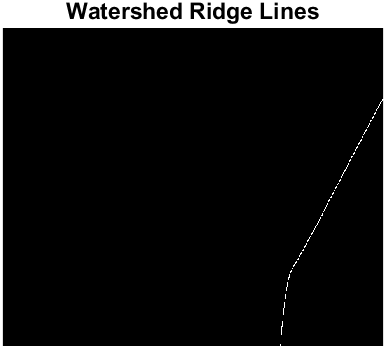
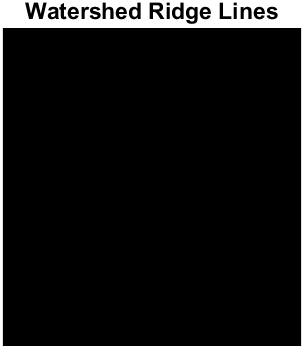
* *Then, we modify the maxima*
  + *Modified Regional Maxima Superimposed on Original Image*

**

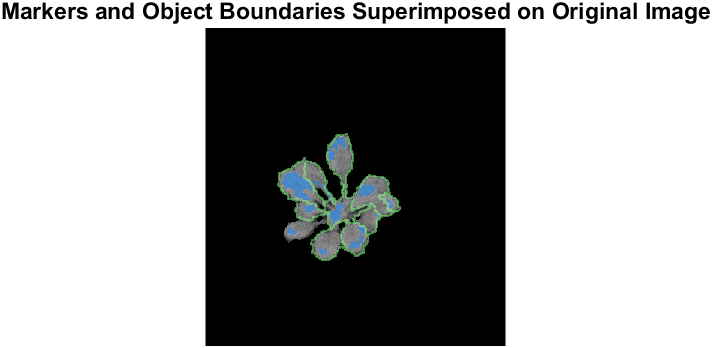
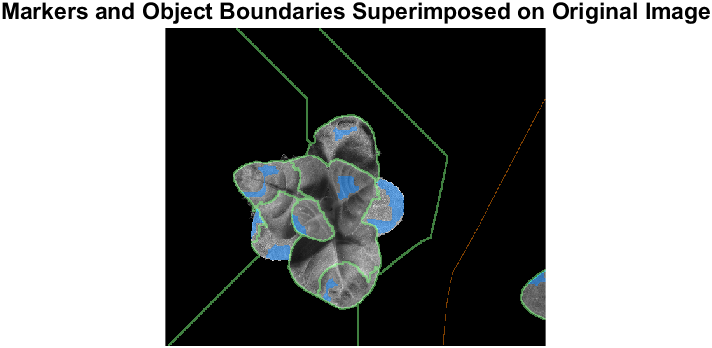
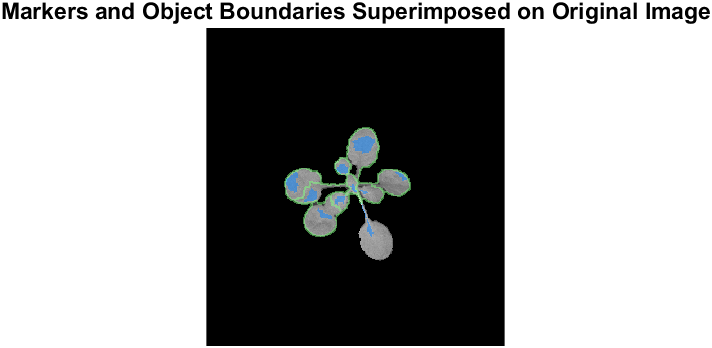
* *imbinarize(Iobrcbr)*
  + *Thresholded Opening-Closing by Reconstruction*

**

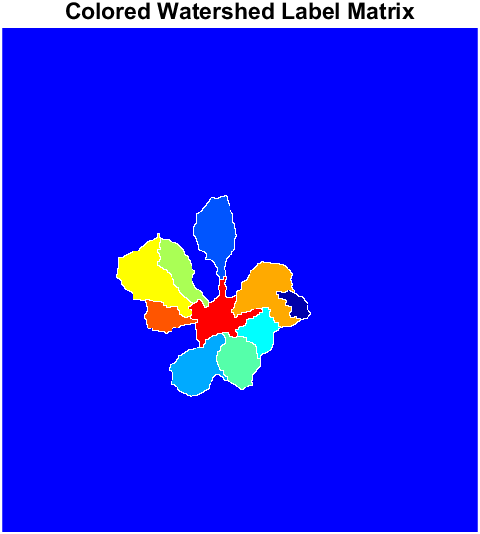
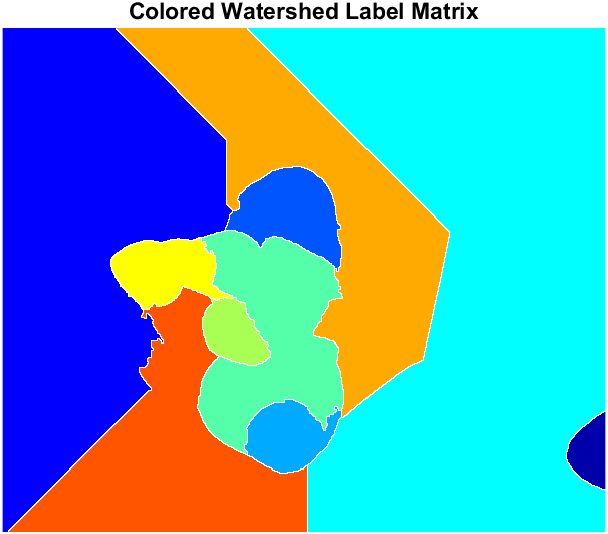
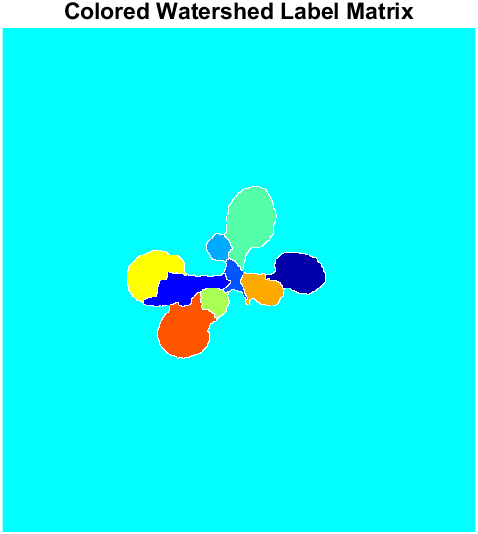
* *bwdist(bw)*
  + *Watershed Ridge Lines*

**

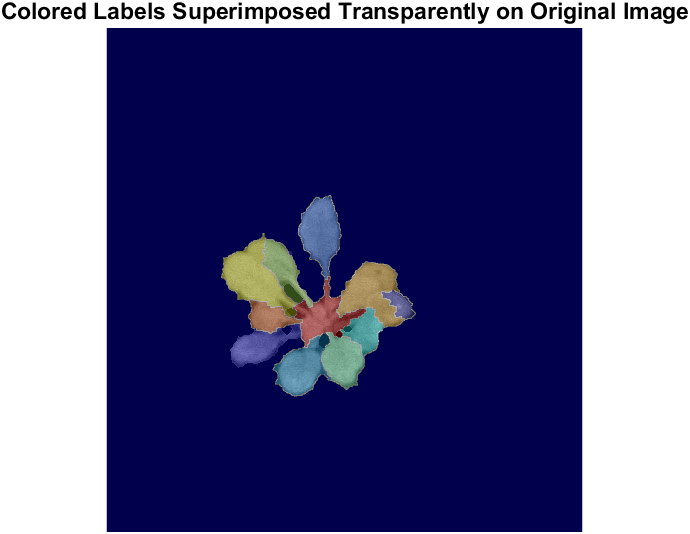
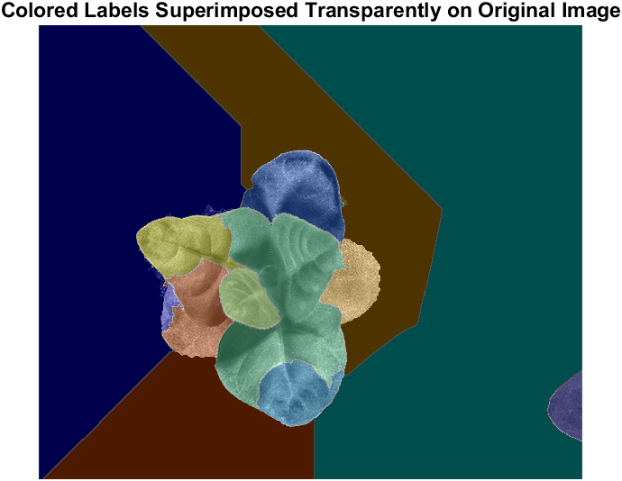
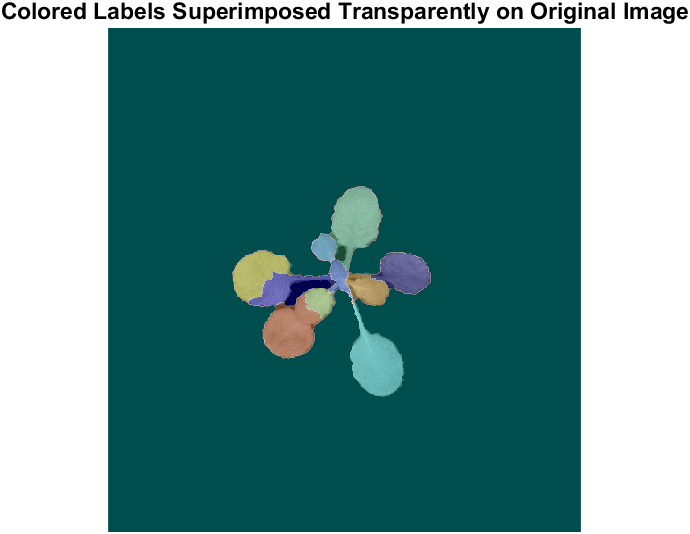
* *labels = imdilate (L==0, ones (3,3)) + 2\*bgm + 3\*fgm4*
  + *Markers and Object Boundaries Superimposed on Original Image*

**

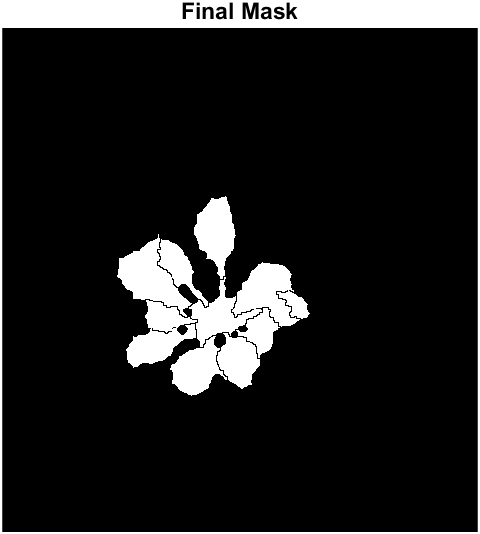
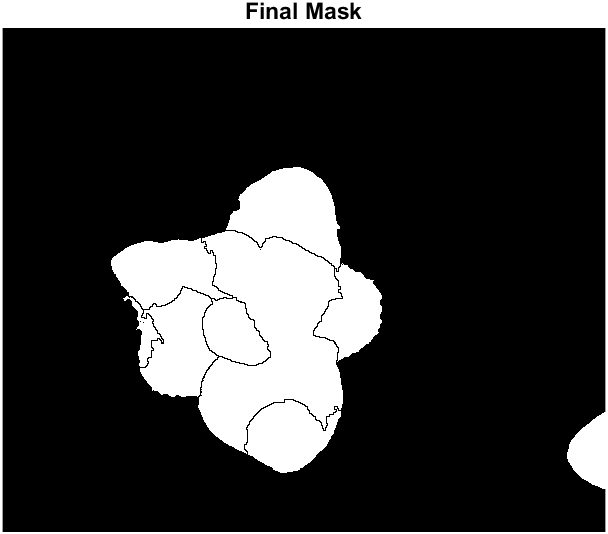
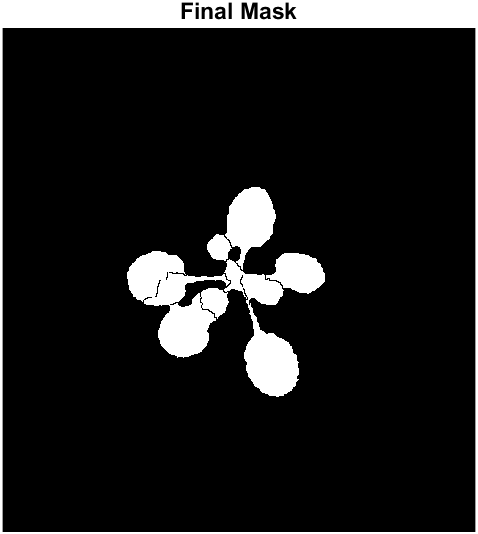
* *label2rgb(L,'jet','w','shuffle')*
  + *Colored Watershed Label Matrix*

**

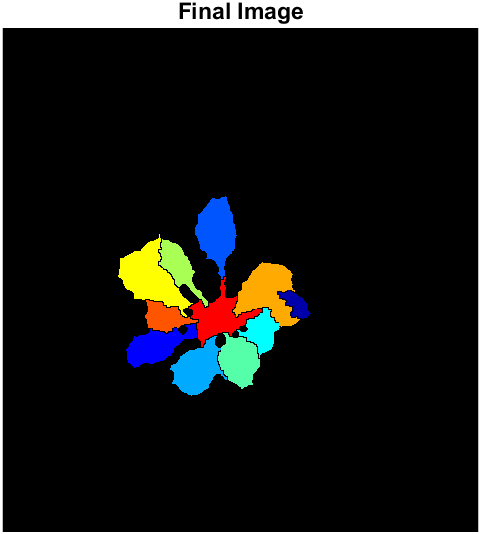
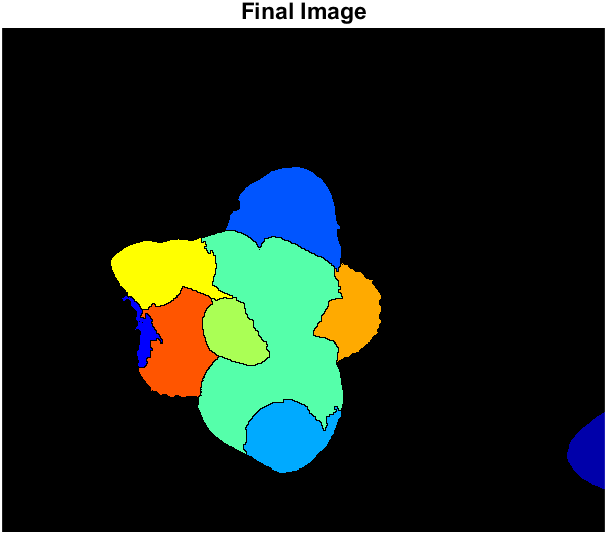
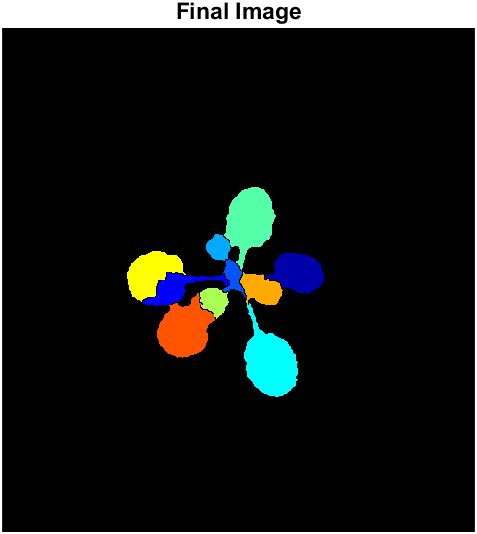
* + *Colored Labels Superimposed Transparently on Original Image*

**

* *Now, we create the final mask for the final image*
  + *Final Mask*

**

* *Now, we have the final image*
  + *Final Images*

**