Robotics and Computer Vision 2
University of Southern Denmark
Spring 2019

Steven Nygaard Hansen
Syddansk Universitet
steha14@student.sdu.dk

Chris Bruun Mikkelsen
Syddansk Universitet
chmik13@student.sdu.dk

I. Introduction

The goal for this project is to detect pumpkins in a field. To do this, it is necessary to segment the pumpkins in the picture and use a method to calculate the amount of pumpkins in the field. The input image that was segmented and counted the pumpkins in, was the DJI_0237.JPG.

II. Exercise 1

Annotate some pumpkins in a test image and extract information about the average pumpkin color in the annotated pixels. Specify both mean value and standard variation. Use the following two color spaces: RGB and CieLAB.

In this exercise the goal is to annotate some pumpkins and extract the mean and standard deviation of these pumpkins. The mean and standard deviation should be found for both the RGB image space and the CieLAB image space.
An image of three manually arbitrarily selected pumpkins have been created, these are the ones in which the standard deviation and mean are calculated, these can be seen in figure 1.
The RGB and LAB means and standard deviations and be seen in table 1 and 2 respectively.

	R	G	B
Mean	170.70	94.27	30.31
Std dev	20.17	22.87	15.67

Table 1. The mean and standard deviation of the Red, Green and Blue of the pumpkins seen in image 1

	L	A	B
Mean	122.41	154.57	175.34
Std dev	20.62	4.42	4.38

Table 2. The mean and standard deviation of the Lightness, A and B of the pumpkins seen in image 1

III. Exercise 2

Segment the orange pumpkins from the background using color information. Experiment with the following methods:

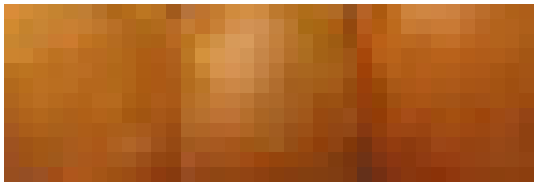

Figure 1. Three arbitrary selected pumpkins

- **Segmentation using RGB values**
- **Segmentation using CieLAB values: The segmentation is seen in figure 3**
- **Histogram backprojection**
- **Distance in RGB space to a reference color**

The RGB segmentation binary image can be seen in figure 2. The white dots describes the possible position of a pumpkin.
The segmentation is found using the the pumpkins in figure 1 as a reference, the means and standard deviations is used from this image, to find a match.
The CieLAB segmentation is much the same as in the RGB case, only difference is that the image is converted to LAB image space, and then the mean and standard deviations are taken from this.
The backprojection is done by first taking a reference of what we want to find in the image, after that the reference is converted to HSV image space, and a histogram is created of this. This is then overlaid on top of the original image. The pixels which match, is then segmented. The result can be seen in figure 4.

The distance in RGB space is found using equation 1, where R is the reference and O is the observation.
Looking at figure 5, one should notice that; the darker the spot, the smaller the euclidean distance, which means that there is a more likely chance that the dark spots are actually pumpkins.

$$dist(R,O) = \sqrt{(r_R - r_O)^2 + (g_R - g_O)^2 + (b_R - b_O)^2} \tag{1}$$

The result can be seen in figure 5.

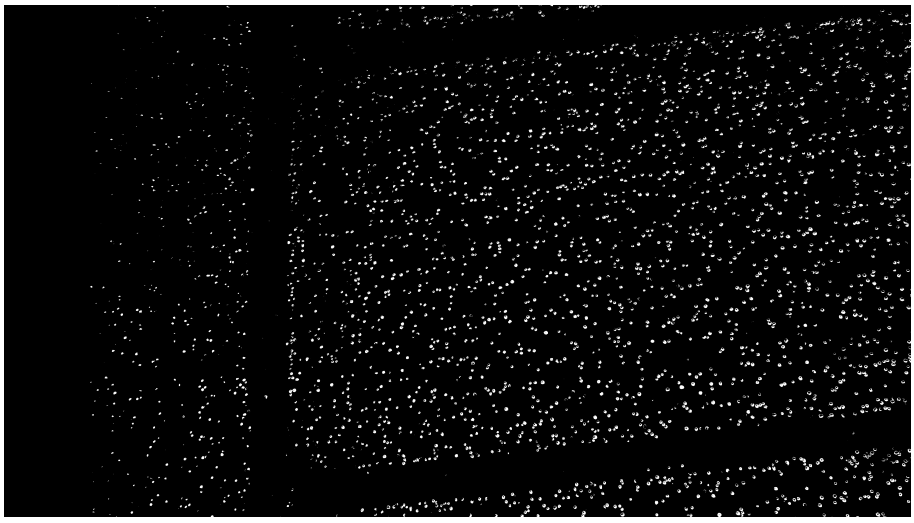

Figure 2. The segmented RGB binary image, the white spots are possible pumpkins

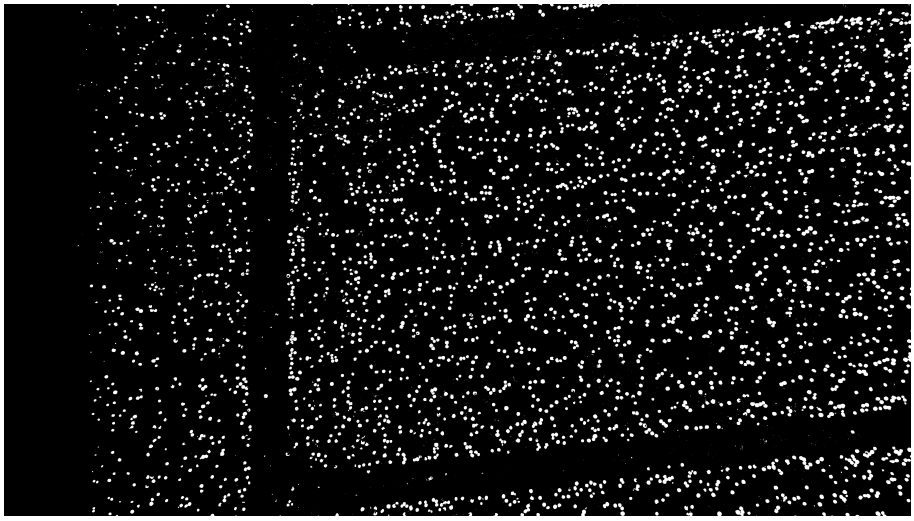

Figure 3. The segmented LAB binary image, white spots are possible pumpkins

IV. Exercise 3

Choose one segmentation method to use for the rest of the mini-project. Count the number of orange blobs in the segmented image.

In this project, the *cieLAB* segmentation method was chosen, this is due to the good results it produced when a segmentation of the original image is done.

To count the orange blobs in the image, the contours of the segmented binary image is found, and the number of contours are then counted. The number of blobs found is **5351**, this is shown in figure 6.

i. Conclusion

Looking at the image 6, it is clear that some form of filtering is needed to remove noise. This is what the next section is about.

V. Exercise 4

Filter the segmented image to remove noise.

To filter, first a morph open [1] (erosion followed by dilation) filter was used with a kernel size of 5. This is followed by median blur [2], to remove the last noise. This gives the good results shown in exercise 5.

VI. Exercise 5

Count the number of orange blobs in the segmented image.

Counting the blobs after the filtering results in figure 7. Then there is no noise left and the pumpkins are marked.

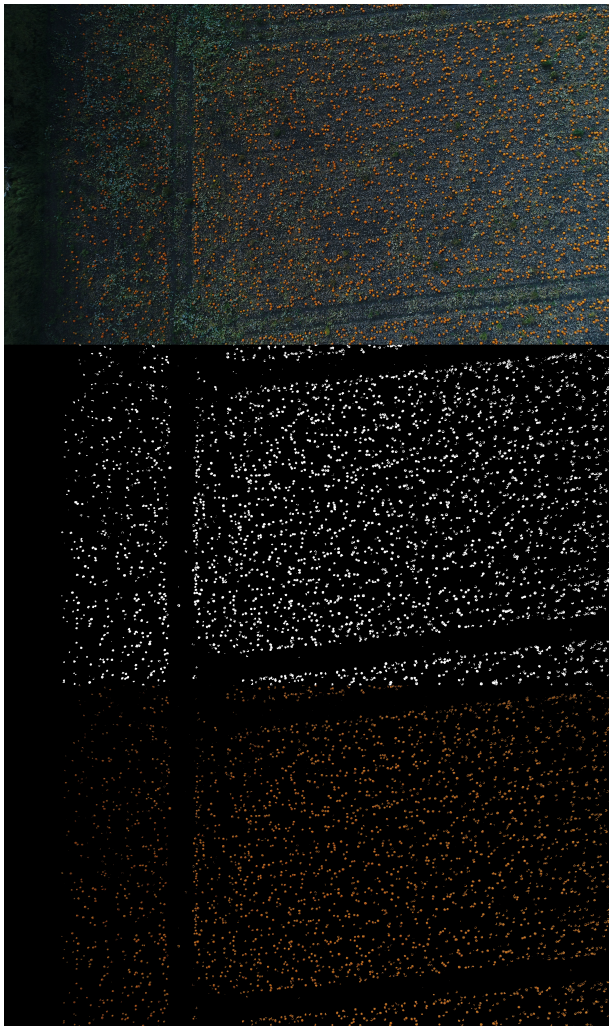

Figure 4. The backprojected image, this used the figure 1 as a reference for finding pumpkins

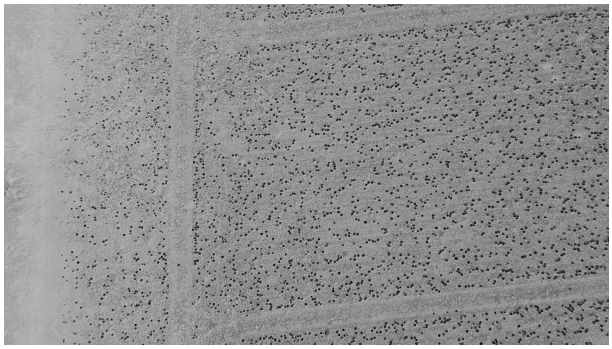

Figure 5. Image where the distance in RGB space is used as a segmentation method

i. Conclusion

There is a problem when the pumpkins are to the left of the image, there it is not illuminated enough. Also some of the pumpkins in the image is predominantly green, which is a problem, since these would preferably also be detected. All green objects in the image is detected. And since a lot of leaves and other weeds is in the way of

Figure 6. LAB marked image, without filtering

Figure 7. LAB segmented image with filtering

the pumpkins, all pumpkins cannot be segmented and therefore not counted either.

VII. Exercise 6

Determine GSD and size of the image field. What isthe average number of pumpkins per area?

It was assumed that an average pumpkin is approximately 20 cm in diameter. From the image of the pumpkin field used in the exercises, a line was drawn across a pumpkin which was thought to be an average pumpkin in the field and this showed to be approximately 22 pixels. Therefore the GSD of the image was estimated to be 10mm/pixel. The calculation can be seen in equation 2.

$$20px = 200mm \Rightarrow 1px = 10mm \tag{2}$$

When knowing this, it is possible to find the width of the image taken by the drone. The calculation can be seen in 3. The pixel width of the image was found and when knowing this, it is just a simple multiplication to find the

actual width of what can be seen in the image. The width was found to be approximately 54m as can be seen in equation 3.

$$w = 10mm \cdot 5472px = 54720mm \approx 54m \tag{3}$$

From this, the diagonal can be derived from Pythagoras' theorem. When knowing the width of a pixel, it is assumed the height of the image to be 30m since the image is 5472x3078 pixel. From this the diagonal is calculated as seen in equation 4.

$$d = \sqrt{54^2 + 30^2} = 61m \tag{4}$$

The average number of pumpkin per square meters was found by taking the amount of pumpkins which was found in the image and dividing by the area of the field in the image. The calculation can be seen in equation 5.

$$Pumpkins - per - m^2 = 2723/1620 = 1.68 \tag{5}$$

VIII. Exercise 7

Mark the located pumpkins in the input image. This step is for debugging purposes and to convince others that you have counted the pumpkins accurately.

To mark the images, as done in exercise three and five, the contours are being passed to *cv2.drawContours* function.

IX. Exercise 8 / Discussion

Reflect on whether the developed system is ready to help a farmer with the task of estimating the number of pumpkins in a field.

The system can be used to count most of the ripe pumpkins. With that, meaning the orange pumpkins in the field, since the image has been segmented using colours. At the moment there are issues with getting the orange pumpkins in the darker/shadowed parts of the field. This is due to the colours of the pumpkins in this area are quite darker than the three reference pumpkins. So the result will be improved if the field is better lit.

The reason the system does not find every pumpkin in the field is also because some of the pumpkins have leafs and other obstacles on top of them or they have more green than orange in them. These obstacles and discolourations then leaves the system unable to find them because of its way of finding the pumpkins. Also some of the pumpkins are clustered and it was not possible to separate these into single pumpkins.

There might be a better way of finding a reference than taking the three reference pumpkin samples and thus getting a more precise result.

Overall the farmer would be a able to get a good estimate of how many pumpkins there are in the field, although he might be positively surprised since the system does not find all of the pumpkins.

References

[1] OpenCV, "Morphological transformations," 2014.

[2] OpenCV, "Image filtering," 2014.