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CS4053: Computer Vision
Assignment 1 - Glue
Report

Assignment specification

"Develop a program to check bottles of glue and determine if there is a label on each bottle.. You must compute the Precision, Recall, Accuracy, Specificity and F1 measure for your system."

High Level Description

My chosen method for solving this problem was to use the standard deviation function on separate RGB channels for a large portion of the label area of each bottle in turn. I used what domain knowledge I could gather for selecting this area of each bottle; as a result, this was a 90x40 pixel area, of which the offset between bottles was 125 pixels. A threshold value was deduced from the first 2 images of the set which I call my "test data". I have assumed that I know the bottles with labels and the ones with no labels in these images, and use the data gathered to construct the threshold value. On the remaining images I deduce whether or not or the bottle has a label by getting the average standard deviation of the three channels of the image and checking whether or not the value is lower or higher than the threshold; equal to or higher, the bottle has a label, or lower, no label. in the process I also draw an output histogram for visual inspection of the data of the image, as well as the original image itself.

Sample Output Images

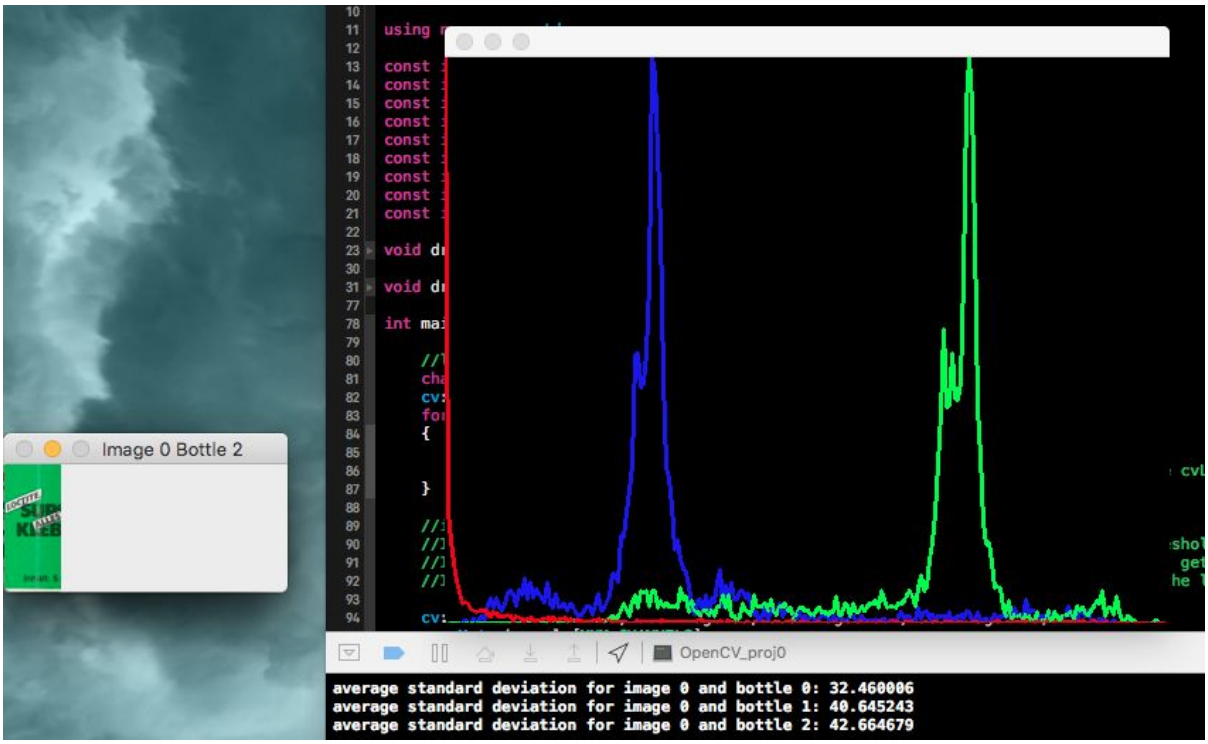
Image 0 Bottle 2
OpenCV_proj0
average standard deviation for image 0 and bottle 0: 32.460006
average standard deviation for image 0 and bottle 1: 40.645243
average standard deviation for image 0 and bottle 2: 42.664679

Fig. 1

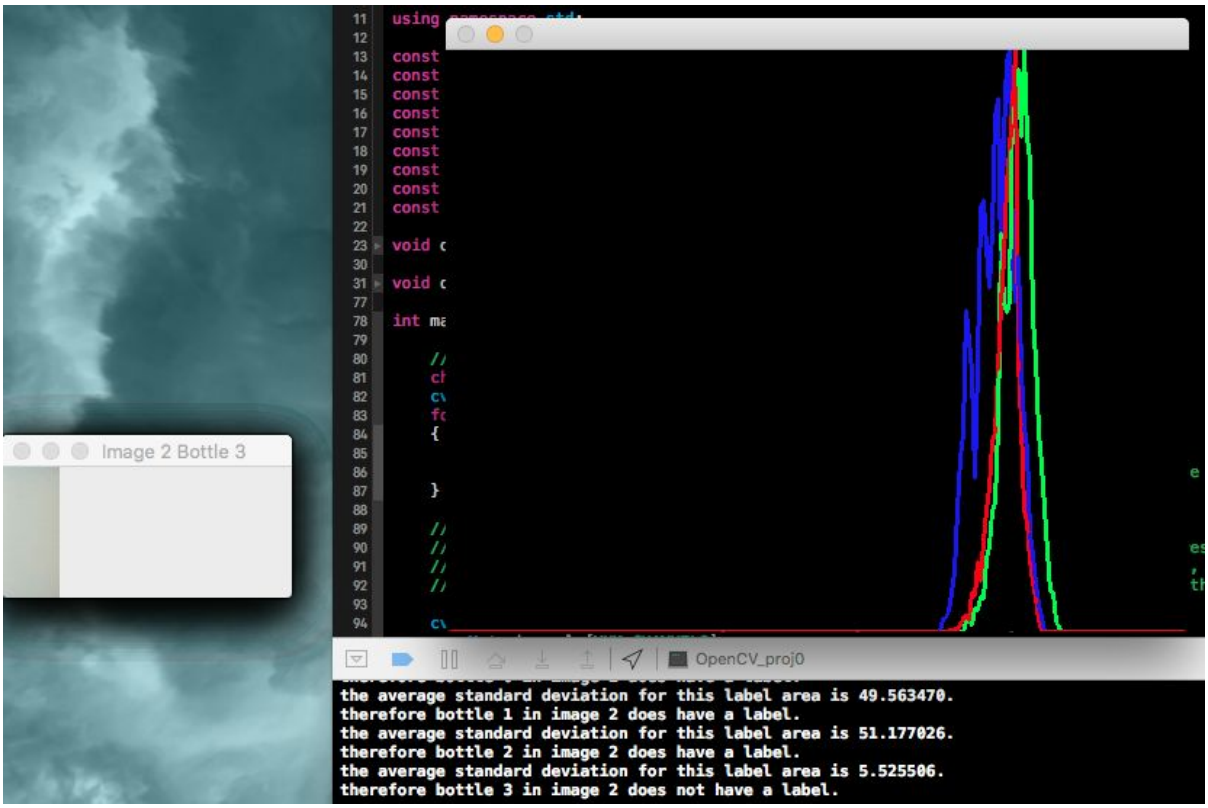
Image 2 Bottle 3
OpenCV_proj0
the average standard deviation for this label area is 49.563470.
therefore bottle 1 in image 2 does have a label.
the average standard deviation for this label area is 51.177026.
therefore bottle 2 in image 2 does have a label.
the average standard deviation for this label area is 5.525506.
therefore bottle 3 in image 2 does not have a label.

Fig. 2

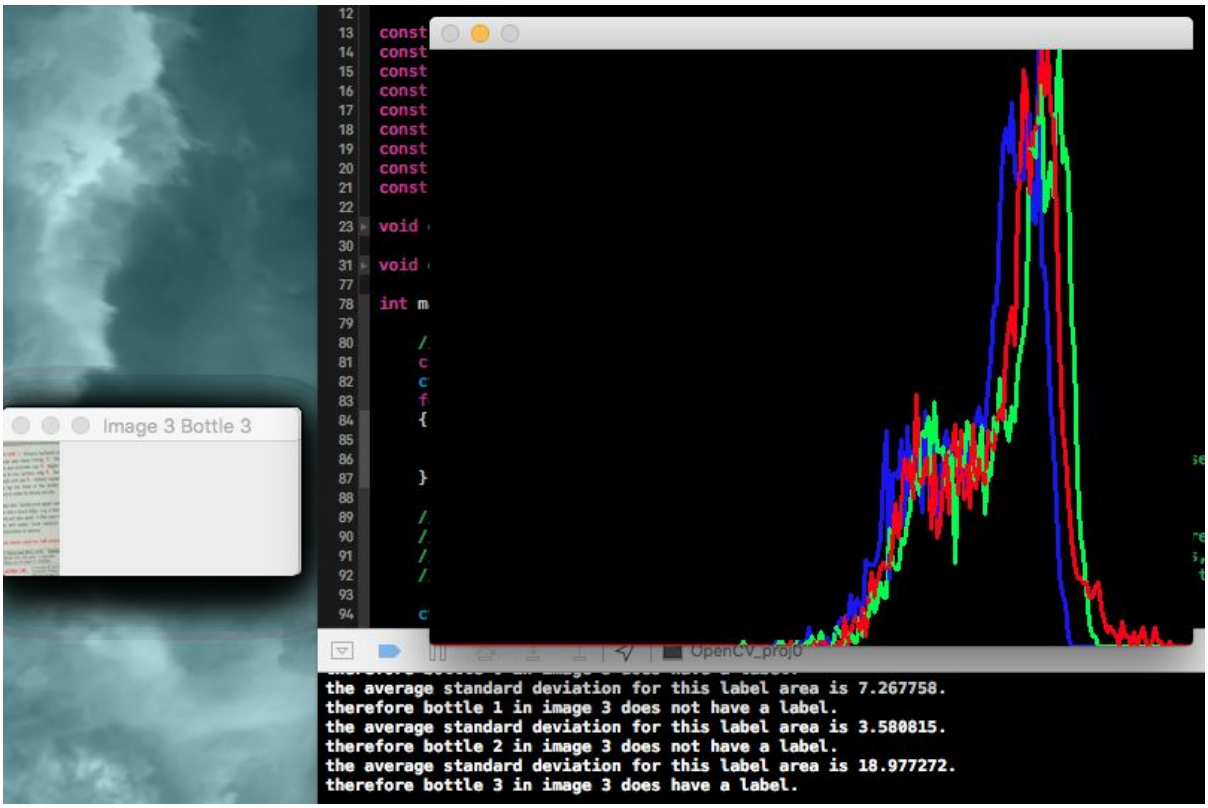

Fig. 3

Figure 1 shows a sample image output where we have a label on the bottle. We can see that the values for each channel spike in different areas, giving a high standard deviation and a strong likelihood of a label being present.

Figure 2 shows an example of an image where no label is present. We can see from the histogram that all of the channels values accumulate and spike around a single area, with very little if any values elsewhere.

Finally, Figure 3 shows us an image of a bottle with a label where the standard deviation is close to the threshold (this image is discussed more below). we can see that although the values accumulate over a relatively narrow area there is some variation in the ~180 range, likely due to the red text that is present in the image.

Metrics

No. = number of label areas checked.
No. of True Positives (TP): 22
No. of False Positives (FP): 0

No. of True Negatives(TN): 8
No. of False Negatives(FN): 0

Recall = TP/(TP+FN) = 1
Precision = TP/(TP+FP) = 1
Accuracy = TP+TN/(TotalSamples) = 1
Specificity = TN/(FP+TN) = 1

F1 = 2 * ((Precision * Recall)/(Precision+Recall)) = 1.

Observations

I think that the standard deviation method over separate channels is an almost ideal way of solving this problem. The fact that I can specify an exact region of a front facing bottle, of which a bottle with no label has very similar values across all channels is testament to this. There are, however, some drawbacks, and while having worked under all cases presented, will not work in every imaginable case within the domain. Firstly, it is based on a label having varying values in each channel. The worst case of this would be where we have a label on a bottle that is one uniform colour; in this case there will be false negatives. I don't think this can be solved with the current channels I am using and a conversion to HLS values may give a more accurate result in this case.

In other cases, we may have labels with just text on them, where this text is one colour; the standard deviation value will be higher here but still low by comparison, and may well fall below the threshold range. In Fig. 3 this text problem arose, however the red colour on some of the text raised the standard deviation value just above my threshold. An obvious remedy to this problem would be to use more test data to get a more accurate threshold value.

Another possible problem case is that of the offset of the bottles. The problem domain we have indicates that the offset is constant but in a real world scenario this certainly may not be the case 100% of the time. As a result my method of deducing the label area will not work and another method will have to be implemented; perhaps a template matching method with several different images of label areas with no label (to deal with lighting etc.) as test data.