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Project 3

ENPM 673
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Buoy Detection

To prepare the data we have used the OpenCV function **cv2.setMouseCallback**. We have defined mouse click event as 6 clicks to create a circle. Anytime mouse is clicked eight time event happens. We have converted the region of interest for each colour into an array of co-ordinates and saved it for each frame in a pickle file.

Modelling the likelihood for a color as a gaussian is beneficial because a little light variation generally makes the colors spread out in an ellipsoid form, i.e., the actual color is in the middle and color deviates from the center in all directions resembling an ellipse. This is the major reasons why a simple gaussian model works so well for color segmentation.However, there might be cases when the colors may not be bounded well by an ellipsoid. In such cases,a sum of gaussians is taken. The formula is:

$$p(C_l \mid x) = \sum_{i=1}^{k} \pi_i * N * (x, \mu_i, \sum) \tag{1}$$

Here, π_i, μ_i and $\sum_i$ respectively define the scaling factor, mean and co-variance of the kth gaussian.

Histogram

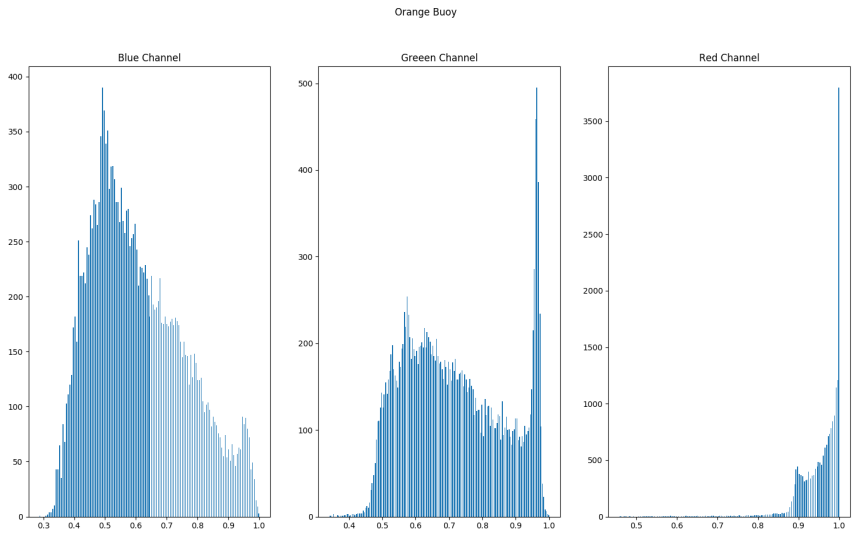

Figure 1: Average Histogram for Orange color

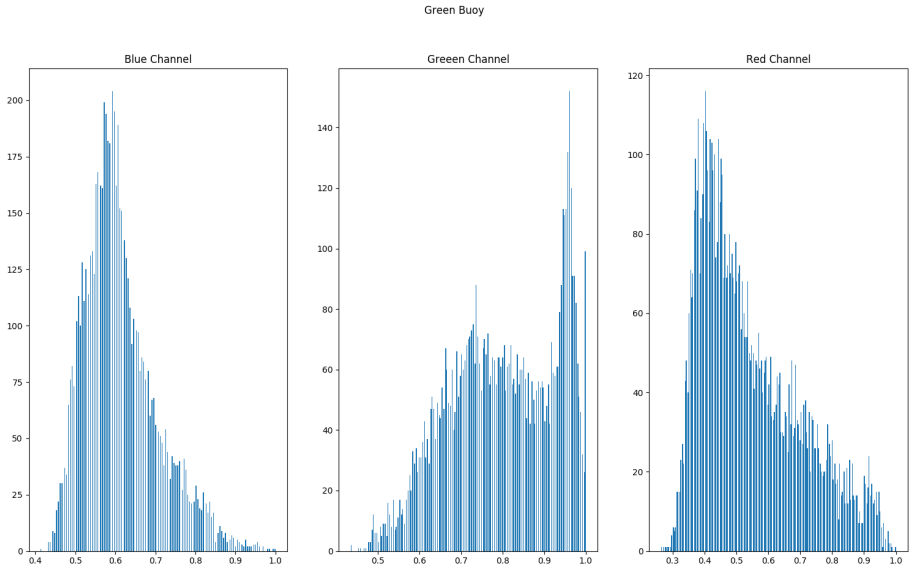

Figure 2: Average Histogram for Green color

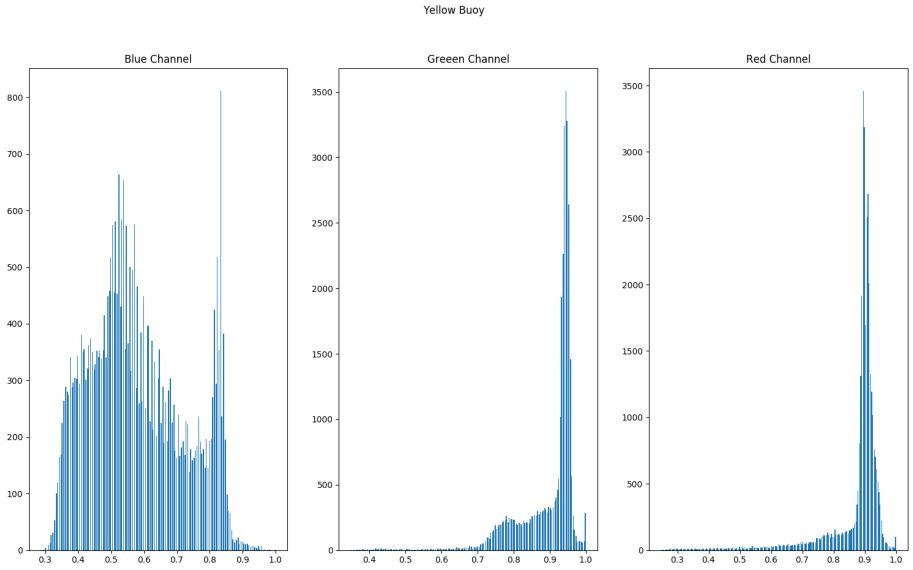

Figure 3: Average Histogram for Yellow color

The process used to find our above Parameters are:

Initialization:Randomly choose π_i, μ_i and $\sum_i$
Alternate until convergence:

1. Estimation E-step: Expectation maximization for mixture models consists of two steps. It consists of calculating the expectation of the component assignments C_k for each data point given the model parameters π_i, μ_i and $\sum_i$.

Training results

After implementing E-step, the training model Gaussian for the buoy is as shown below. In Figure 4-6 the gaussian is a combination of green and red channel along x-y axis and Probability along its z-axis.

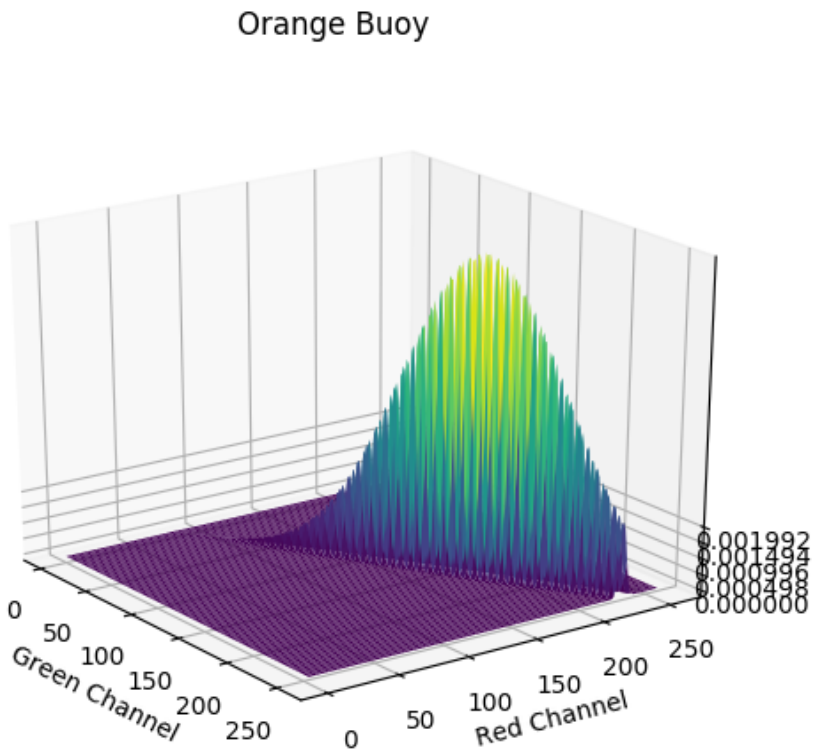

Figure 4: Gaussian for orange color

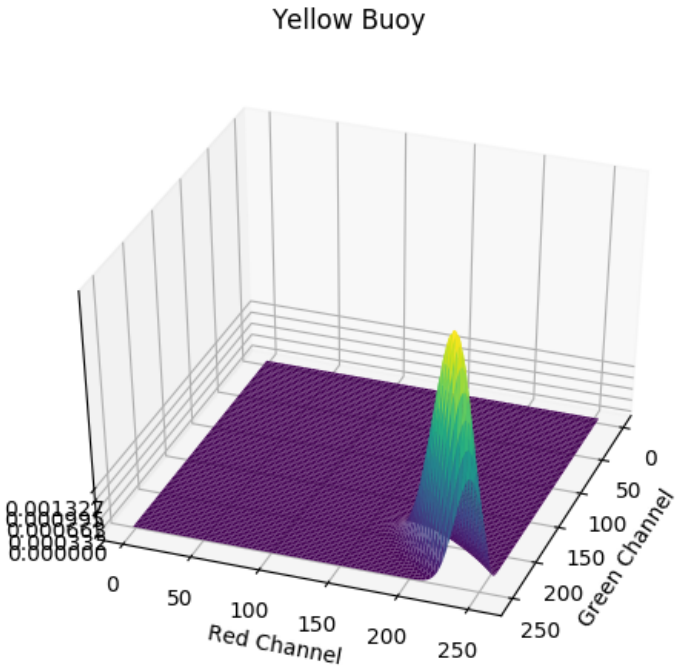

Figure 5: Gaussian for Yellow color

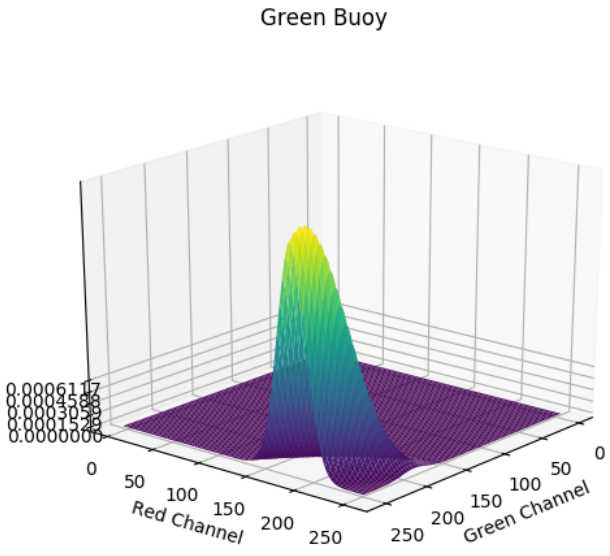

Figure 6: Gaussian for Green color

2. Maximation M-step: The second step is known as the maximization step or M step, which consists of maximizing the expectations calculated in the E step with respect to the model parameters. This step consists of updating the values π_i, μ_i and $\sum_i$.

The 2 steps are repeated until covergence.
Convergence is defined as $\sum_i \parallel \mu_i^{t+1} \mu_i^t \parallel \leq \tau$ where i denotes the cluster number, t denotes the iteration number and is some user defined threshold.Thus, by alternating between which values are assumed fixed, or known, maximum likelihood estimates of the non-fixed values can be calculated in an efficient manner.
Finally, we estimated the parameters for our model and on substituting the value in equation1 we can identity pixels which will of of specific color.

0.1 Buoy Detection

After we estimated the parameters for our model we are finally able to create N 3D Gaussian mixture model for each colour.1. GMM takes in RGB values as inputs for each pixel and outputs the probability for that pixel to be a specific color. Using Histogram for visualizing, we are able to estimate thresholding values for each color.Further using the color histogram peaks dimension[D] for individual color is determined.
A sample orangel buoy detected after training with Dimension 2,and Number of Gaussian 7.

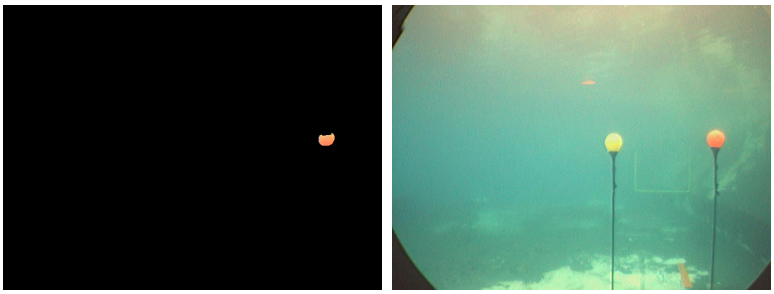

Figure 7: Orange Buoy Detected for Frame 100

NOTE

To run the code follow the README file. All the videos are available on our drive. Follow this link