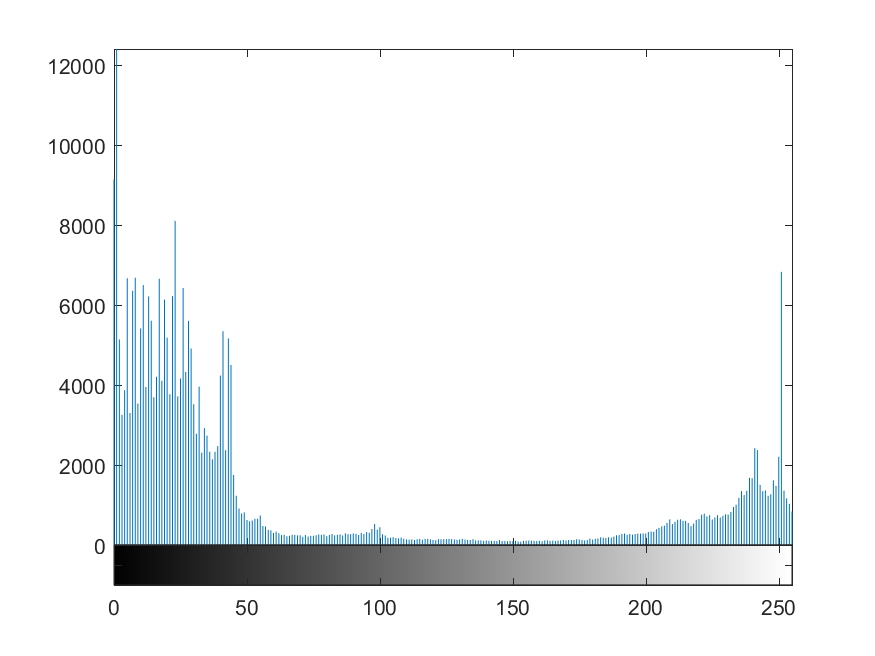
**Image Segmentation (EN 2550)**

Niruhan Viswarupan



Histogram of the Image

1. Thresholding

Method: Input image is converted into grayscale image. Every pixel of the gray image is visited and is the value is above a threshold it is passed into the output.

Code snippet:

for i=1:h

for j=1:w

if (imGray(i, j) > threshold)

thresholdedImGray(i, j) = imGray(i, j);

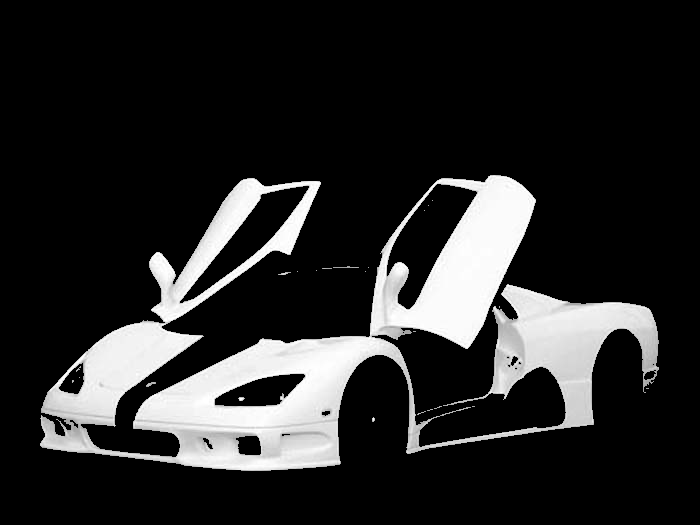
end

end

end



Original Image



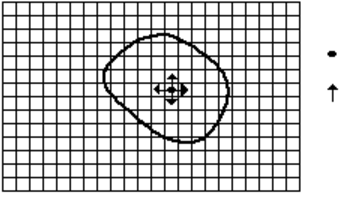
After Thresholding with 150

Result:

Analysis: This simple technique is powerful but only works when there is a good intensity variation between object of interest and background. The histogram of the image used is as follows. Note that it has two peaks separated by a valley. Around intensity of 150 the valley is minimum. So choosing 150 as threshold will result in a clearly segmented image.

2. Region Growing

Method: Select a seed pixel and pass it to the output. Then check its adjacent 4 pixels and if their intensities differ from the seed’s by less than a stipulated threshold then recursively call regionGrow function on the adjacent pixels.

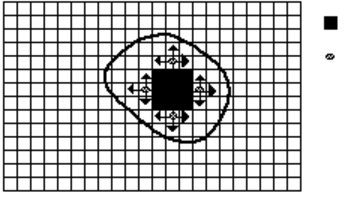


Seed Pixel

Direction of growth

Start Growing a Region

Grown Pixel



Pixels being considered

Growing Process after a few Iterations

Code Snippet:

if (x-1>0)

if (abs(image(x, y)-image(x-1,y))<threshold)

%output(x-1,y)=-2;

newSeed = [x-1, y];

regionGrow(newSeed, image, threshold);

end

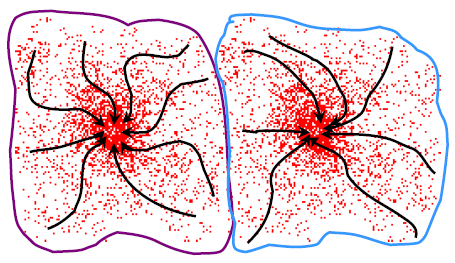
end

Result:

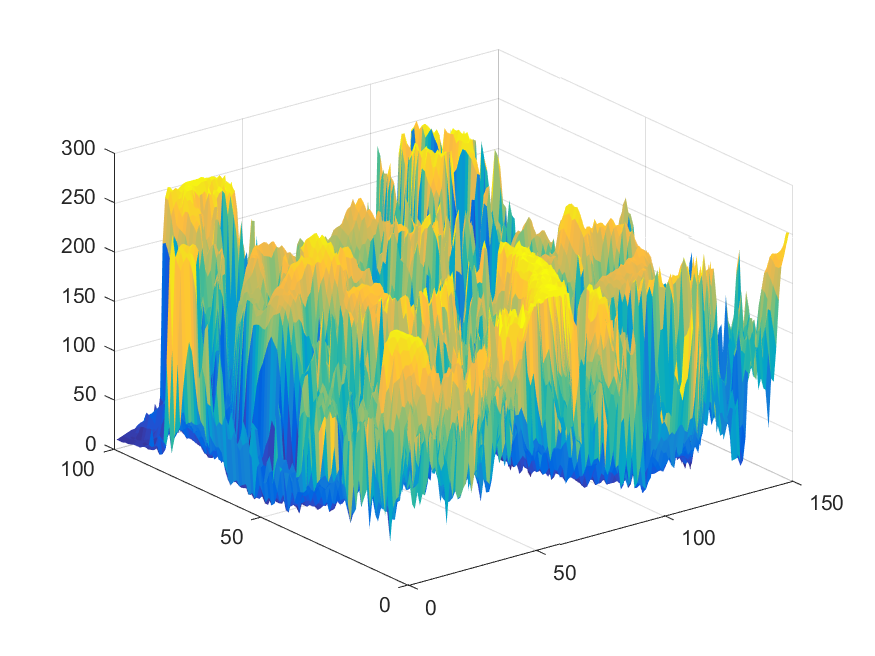


Original Image

Analysis: Note that when using a single seed the dark regions inside the object of interest are not passed onto the output. We could eliminate it by selecting multiple seeds. Note the depressions inside the red circle in the following image.



Finding Attracting Basins by Mean Shift Clustering in 2D



3D Plot of Intensities of the Input Image



Region Grown with One Seed (Threshold = 20)

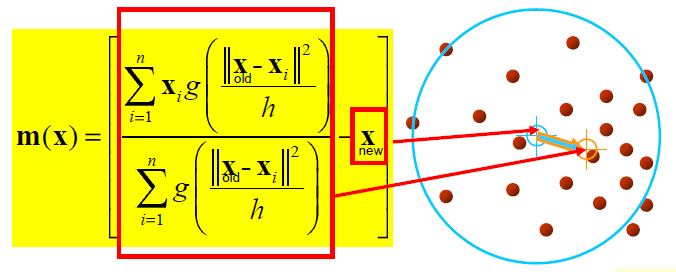


With Multiple Seeds at Dark Regions in The face

3. Mean Shift

Method: The input RGB image is converted to CIELUV color space because clustering in RGB will result in radical color shifts. Mean shift clustering is done on a 5D space containing 3 dimensions from LUV and 2 spatial dimensions of the image using the following kernel.

Where, p = dimensionality of range (for LUV p = 3) hs = spatial parameter, hr = range parameter, C = normalization constant, xs = spatial part of x and xr = range part of x. For k(x) Epanachikov profile (kE) or truncated normal (kN) profile gives satisfactory performance.



Calculating Mean Shift in 2D

The mean shift filtering algorithm: Let xi and zi, I = 1,…..,n, be the d-dimensional input and filtered image pixel.

1. Set j = 1 and yi,1 = xi
2. Compute yi,j+1 until convergence y = yi,c using,

Where,

1. Assign

The mean shift segmentation algorithm:

1. Run mean shift filtering on all data points and find convergence point zi
2. Cluster the data points y grouping zi which are closer than hs in the spatial domain and hr in the range domain.
3. For each I = 1,…,n, assign
4. Optional: Eliminate clusters containing less than M pixels.

Code Snippet:

for i = 1:length(clusterMemberCell)

X(clusterMemberCell {i},:) = repmat(clusterCenter(:,i)',size(clusterMemberCell {i},2),1);

end

if norm(mean-prevMean) < stopAt

addTo = 0;

for cN = 1:amountofClusters

distance = norm(mean-clusterCent(:,cN));

if distance < bw/2

addTo = cN;

break;

end

end

if addTo > 0

clusterCent(:,addTo) = 0.5\*(mean+clusterCent(:,addTo));

preference(addTo,:) = preference(addTo,:) + thispreference;

else %its a new cluster

amountofClusters = amountofClusters+1;

clusterCent(:,amountofClusters) = mean;

preference(amountofClusters,:) = thispreference;

end

break;

end

Result:



Original Image



Mean Shift Segmented using bw = 0.1 (NumClust = 119)



Mean Shift Segmented using bw = 0.3 (NumClust = 6)

Analysis: The advantages of mean shift segmentation are just two parameters used and the number of modes are found automatically.

Note: For certain parts of the assignment images not provided were used because certain carefully selected images could give very meaningful outputs for the operations.

References:

1. “Image segmentation” at https://en.wikipedia.org/wiki/Image\_segmentation
2. “Image segmentation” at http://homes.di.unimi.it/ferrari/ImgProc2011\_12/EI2011\_12\_16\_segmentation\_double.pdf
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4. “Segmentation - Mean-Shift Algorithm” at http://robot-develop.org/wp-content/uploads/2012/03/seg3.pdf
5. “Image Segmentation using Mean Shift explained” at http://stackoverflow.com/questions/4831813/image-segmentation-using-mean-shift-explained
6. “Mean Shift Clustering” at https://www.youtube.com/watch?v=Evc53OaDTFc
7. “Mean Shift: A Robust Approach Towards Feature Space Analysis” by D.Comaniciu and P.Meer on IEEE Transactions on Pattern Analysis and Machine Intelligence
8. “k-means, mean-shift and normalized-cut segmentation” at https://in.mathworks.com/matlabcentral/fileexchange/52698-k-means--mean-shift-and-normalized-cut-segmentation