LAB1: Color Image Segmentation using EM Algorithm

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1 Introduction

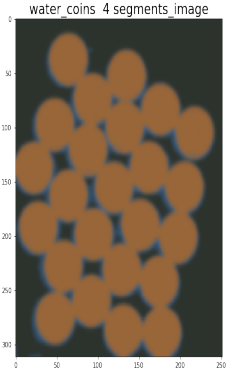
This Assignment deals with Color Image Segmentation using Expectation Maximization Algorithm . Expectation Maximization Algorithm is an unsupervised Machine Learning Algorithm which involves two 2 steps - E Step and M-Step . E step means that we assign labels to the data points (as the labels are not already assigned in case of unsupervised algorithms). In M-Step we calculate the parameters of the distribution ,like mean and std. deviation in case of Gaussian Distribution, with the help of the labels assigned to the data points during the E-Step. We iterate over the E-Step and M-step until our results converge .
Image Segmentation refers to the partitioning images into a number of segments or parts based on the similarity and differences in terms of a number of characteristics like intensity , colors , edges etc.
In this assignment we implement Image Segmentation using EM Algorithm by segmenting a set of images into a number of segments. We show the results obtained and analyse them to get important inferences and observations .

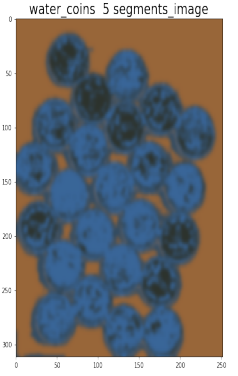
2 Results

We use 3 images for our purpose . For every image , we try to segment it into 2,3,4 and 5 segments.


water_coins_2 segments_image

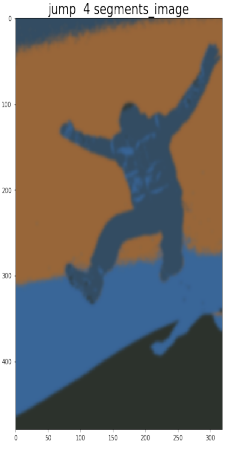

water_coins_3 segments_image


water_coins_4 segments_image

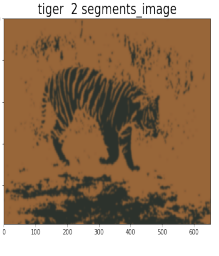

water_coins_5 segments_image

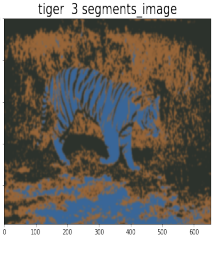

jump_2 segments_image

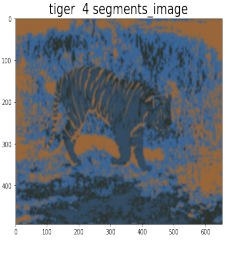

jump_3 segments_image

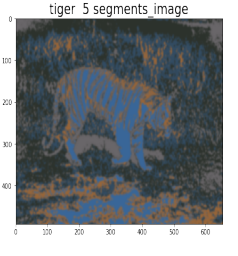

jump_4 segments_image


jump_5 segments_image


tiger_2 segments_image


tiger_3 segments_image


tiger_4 segments_image


tiger_5 segments_image

3 Observations

WATER_COINS Image

-> For two segments of the image , the coins shown in black are separated from its background which is in brown. Thus the EM algorithm segments the image into 2 distinguishable parts in case of 2_segment image of Water_coins.

->For 3 and 4 segments images , some of the coins edges are also detected . For 4 segment image the edges detected are more prominent than the 3 segment image .

-> When the number of segments are 5 , then some of the features printed on the coins , the stamps etc are also detected and distinguished from the rest of the image .

JUMP Image

->For the jump image , when the number of segments are 2 , then only the white snow and blue skies are identified as 2 different objects and distinguished from each other.

->When number of segments are 3 , then the sky is further segmented into 2 parts- one denoting the light blue color present in the image near the snow region and the another dark blue part of the sky present at the top of the image. The person is still not clearly segmented in segmentation with 3 parts.

->When the number of segments are 4 , then the person can be distinguished clearly along with the snow region , light color sky region and dark color sky region. Around the top left corner of the image , the color is really dark as compared the other regions , which is somewhat identified partially as can be seen in the top left corner .

-> Finally when the number of segments are increased to 5 , then along with the segments that were clearly identified in the 4_segment image , some extra dark color regions which are present around the top left corner of the image and some of the clothes of the person are also identified clearly.

TIGER Image

->When the number of segments are 2 , then mostly the tiger and some brown patch of land which are largely of the same color are separated from the rest of the surroundings which are mostly green grass. Thus tiger is identified in case of two segments .

->When the number of segments are increased to 3 ,the green grass in the surroundings and the strips on the tiger are also identified along with the previously obtained segments.

->When the number of segments becomes 4 , then the brown portions in the green grass ,strips on the tiger , and water body is also identified in addition to the previously identified portions.

->On further increase in number of segments to 5 some minute differences which were earlier not considered are also considered and the regions of images with very less differences are also identified as distinct.

Best Segments

-> According to the analysis of the output images of different segments for the above images we can conclude that 3 segments best partition the 'water_coin' image , 5 seg-

ments best partition the 'jump' image and 3/4 segments best partition the 'tiger' image .

-> The EM Algorithm takes the number of segments as input and iterates at most 20 times between E-step and M-step until the segments converge to particular values within the specified or accepted error of convergence.As the segments converge , the iteration cycle breaks and the final segments are formed .
->For any number of segments given as input, the EM algorithm finds the segments with maximum differences in features with respect to each other.