IMAGE SEGMENTATION

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1   Abstract

Gaussian Mixture models are use in the segmentation of image is an important field of image processing and pattern recognition. In this project "Image Segmentation" using Gaussian mixture model we model the original image using GMM and transforms segmentation problem into maximum likelihood parameter estimation by expectation-maximization popularly known as EM algorithm.

2   Introduction

Image segmentation is a method in which a digital image is divided into various segment which is very useful in further processing of image. There are various method in which an image can be segmented. Such as i.Thresholding Segmentation, ii.Edge-Based Segmentation, iii.Region-Based Segmentation, iv.Clustering-Based Segmentation and many more Here I am using Gaussian Mixture Model (GMM), which is a very flexible tool for image segmentation. GMM is a widely used tool for the background subtraction and the the moving objects detection. GMM assumes that there are a certain number of Gaussian distributions, and each of these distribution represent a cluster. Hence, a Gaussian Mixture Model tends to group the data points belonging to single distribution together. In simple Gaussian Mixture Models are probabilistic models and use the soft clustering approach for distributing the different clusters unlike k-means clustering where it uses hard assignments of data points in circular fashion.

3   Solution

The Gaussian Mixture Model is an unsupervised models and it involves mixture of multiple Gaussian distribution here in GMM we consider variance that is width of the bell shape curve. The following assumptions and algorithms have been used in order to do the project.

3.1   Assumptions

The fundamental assumption is the user must know the number of component of given image (in .jpg format). Here number of component of an image implies the number of segment an image can be segmented. The result and analysis section can give clear insight.

3.2 Algorithms used

I am using Gaussian Mixture Model Algorithm.
One dimensional Gaussian distribution given as:-

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/2\sigma^2}$$

where μ - mean and σ is variance

$$X \sim \mathcal{N}(\mu,\, \sigma^2)\,.$$

For multivariate, let say n variate Gaussian distribution. Let there are k cluster (for simplicity we already assumed that the number of clusters are known), so μ and $\sum$ is estimated for each k, where $\sum$ is covariance matrix of n x n. After all the mathematcal work we can see that the parameters cannot be estimated in closed form. Where Expectation Maximization (EM) algorithm benefited.
The Expectation-Maximization is an iteritive way to find maximum likelihood estimates for mode parameters when the data is incomplete or has some missing point or some hidden variables.

1. EM choose some random values for the missing data points and estimates a new set of data.

2. The two basic steps of EM algorithm

   i E-step or Expectation step or Estimation step

   ii M-step or Maximization step

4 Results and analysis

The output image for various different image has been shown below.

Figure 1: (a) Tiger-mask0 (b)Tiger-mask1 (c) Tiger-Segmented

And for the another image of rose is given below
For the cat image if number of component is taken two then the segmented image is as shown below

Figure 2: (a) Rose Mask 0 (b)Rose Mask 1 (c) Rose Segmented

Figure 3: (a) Cat Mask 0 (b) Cat Mask 1 (c) Cat Segmented

The above cat image can be segmented for three component, which can be easily seen on the Github page output sections.

5   Conclusion

In this project the Gaussian Mixture Model used which work nicely for various type of of images. I have experiment with different types of images one common thing was observed for two and three component it segment vary nicely and for more number of component choosing component is very critical than its gives require output. Here it is based on division into homogeneous clusters in which positive side is fuzzy uses partial membership therefore more useful for real problems. And disadvantage is determining membership function is not easy. We can various other method for image segmentation such as watershed method which is based on topological interpretation, results are more stable here. Also we can PDE Based Method, based on the working of differential equations, this method is fastest method.

6   Project Github page

For the detail explaination and source code where output for different image has been shown, click to following link for Github page.
`https://github.com/Anuranjan055/IMAGE-SEGMETATION.git`

Bibliography

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