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Converting Color Real Image to Cartoon Image Using Non-Parametric Mean-Shift Technique

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Abstract

This paper focuses on using mean-shift technique to convert real color image to cartoon image which is necessary for more image processing application such as segmentation, edge detection, recognition ..etc from divide the original image to many regions window "clusters" without any prior knowledge about these regions in each find the center cluster value which considered the density of some color in this cluster and then modification all neighbor pixel in this region to this value **K-Nearest-Neighbor** which used in clustering operation where all pixels in this region be in the same color without gradual. Implementation this search by using Java ™ 6 update 7 from Sun Microsystems,Inc.

الخلاصة

في هذا البحث تم إستعمال تقنية non-parametric mean shift لتَحويل صورةِ ذات الالوان الحقيقيةِ إلى صورة كارتونيةِ التي تعتبر ضروريةُ في تطبيقات معالجة الصور مثل التقسيمِ، تحديد الحوافِ، تمييز الصور. . الخ. مِنْ المعالجاتِ،تعمل هذه التقنية على اساس تقسيم الصورة الى عدة مناطق وبدون معرفة سابقة عن اي معلومات عن تلك المناطق وفي كل منطقة تحدد قيمة نقطة مركز التي تعتبر كثافة للون معين ومن ثم تعديل كل قيم نقاط المجاورة في تلك المنطقة الى هذه القيمة تم استخدام طريقة **K-Nearest-Neighbor** في عملية العنقدة وبذلك تكون قيم جميع نقاط هذه المنطقة ذات قيمة وبالتالي تكون جميع نقاط المنطقة ذات لون واحد بدون تدرج وبتطبيقها على كل مناطق الصورة يتم الحصول على صورة كارتونية للصورة الاصلية . تم برمجة هذا البحث باستخدام لغة جافا .

1.Introduction

Mean-Shift technique is a non-parametric technique which does not require prior knowledge of the number of clusters, and does not constrain the shape of the clusters. The mean-shift procedure consists of two steps: the estimation of the gradient of the density function, and the utilization of the results to form clusters. The gradient of the density function is estimated by a nonparametric density estimator [1]. Then starting from each sample point,the mean-shift procedure iteratively finds a path along the gradient direction away from the valleys and towards the nearest peak[2,3] (clustering) to access to cartoon form for this input real color image from type (*.jpg)

2.Mean-Shift Technique :

mean-shift analysis in which step we would estimate Probability Density Function (PDF) and Gradient (Mean-shift Vector)to define modes[4](the centers of the regions of high concentration) second step mean-shift clustering to grouping the pixels to these centers of clusters.

2.1 Kernel Density Estimation[1,2]:

The feature spaces employed in low-level vision task are more often characterized by very irregular data clusters whose number and shapes are not available .this strongly suggests that non-parametric approach which provides reliable detection of the local maxima of the underlying density, i.e. ,the modes, should be employed for analysis. To compute kernel density estimation which considered is the most popular non-parametric density estimation technique using normal kernel, since for low to medium data sizes,normal kernel estimation is a good practical choice; it is simple ,and for kernels the estimate is asymptotically unbiased,consistent in a mean-square sense and uniformaly consistent in probability.

The equaition which used in compute Kernel density esitimation as follows :

Given n data points (image pixels) in dimension space x=1,2,3,…,n,the multivariate kernel density estimator with K(x) and window bandwidth h,is given by:

$$\hat{f}(x) = \frac{1}{nh^d}\sum_{i=0}^{n} K\left(\frac{x-x_i}{h}\right) \quad \text{.....(1)}$$

The kernel function has the following properties:

$$\int_{R^d} K(x)dx = 1\ (normalized);$$

$$\int_{R^d} xK(x)dx = 0\ (symmetric);$$

The normal kernel used in this research compute by :

$$K(x) = (2\pi)^{-d/2}\exp\left(-\frac{1}{2}||x||^2\right) \quad \text{.....(2)}$$

Therefore ,the kernel density estimator when use normal kernel can

$$\hat{f}_{h,k}(x) = \frac{c_{k,d}}{nh^d}\sum_{i=0}^{n} K\left|\left|\frac{x-xi}{h}\right|\right|^2 \quad \text{.....(3)}$$

2.1.2 Density Gradient Estimation(mean-shift vector)

In this step Compute mean shift vector , we estimate the gradient (mean-shift vector) for the analysis of the modes of the data set. The modes are feature space with the underlying PDF is to find located among the zeros of the gradient.

The gradient estimator can obtained by[1,2,3] :

By defining profile of the new window :

$$g(x) = -k(x)$$

and this new kernel can be written as follows :

$$G(x) = g(\| x \|)$$

Then the mean shift vector can obtain by :

$$m(x) = \frac{\sum_{i=1}^{n} xig\left(\left|\frac{x-xi}{h}\right|^2\right)}{\sum_{i=1}^{n} g\left(\left|\frac{x-xi}{h}\right|^2\right)} - x \quad \text{.....(4)}$$

Where h is a number of points in kernel window.

From above it can be seen that at certain x the gradient is proportional to the mean shift vector , thus the mean shift vector always points to the maximum increase of density, i.e , it moves towards the modes.

The mean shift analysis procedure for certain x within a data set can be successively obtained by :

Step 1: Compute the mean-shift vector by equation (4).

Step 2 : Translate the kernel window K by m(x) and re-compute the weighted mean.

Step 3 : Stop the iteration if the gradient is close to zero.

The recursive formula for the weighted mean is :

If y1 is the initial value , the translation of window center can be obtain by:

$$yj+1 = m(yj) + yj = \frac{\sum_{i=1}^{n} xig\left(\left|\frac{yj-xi}{h}\right|^2\right)}{\sum_{i=1}^{n} g\left(\left|\frac{yj-xi}{h}\right|^2\right)} \quad \text{.....(5)}$$

2.2 Mean shift clustering [5] :

Non parametric cluster analysis use the modes of underlying probability density to define the cluster centers and the valleys in the density to define the boundaries separating the clusters. The

Clustering Problem given a set of data points $\{\mathbf{x}_i\}$ in a d-dimensional Euclidean space R^d, assign a label l_i to each point $\mathbf{x}_i$, based on proximity to high density regions in the space.

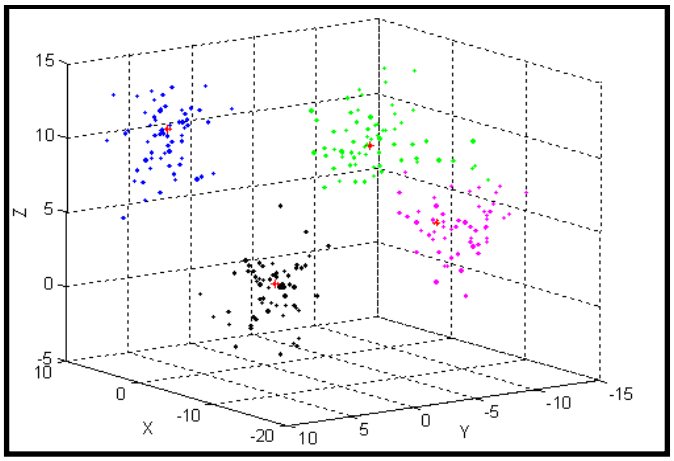

Figure (1) d-dimensional Euclidean space

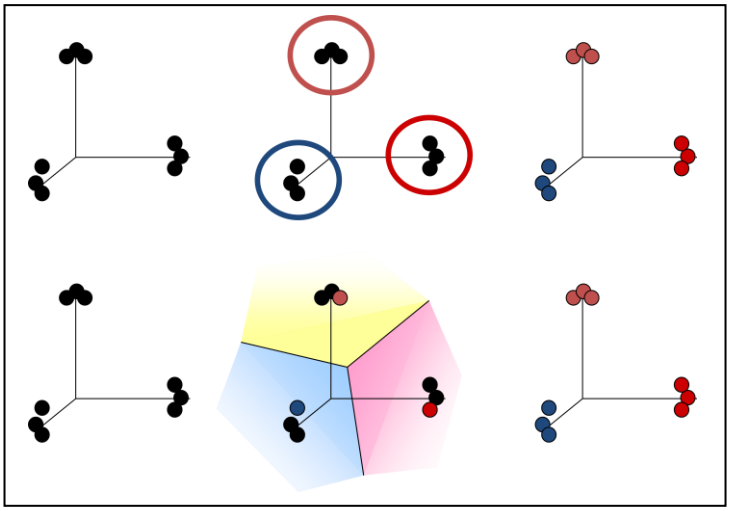

Figure (2) Grouping data in clusters

3.Algorithm mean shift technique proposed in this search

Input :*.jpg type color image.
Output :*.jpg cartoon image.
Start the algorithm :

Step 1: Input **spatial radius** which refer to number of pixels in window is randomly selected from the data on the basis on selected it is that the range difference between any two neighbors should be large than certain value. And input **color distance** which mean the number of clusters for pixels in one window .

Step 2 : Convert image file into matrix of two dimension N*N (called image pixel).from it choose sample set[x1,x2,……,xn],n<h ,h is a number of points in kernel window.

Step 3 : Compute kernel density by using equation(1) for each sample set all the data are chosen to be training set and after applying mean shift procedure the center candidates of cluster are defines.

Step 4 : Compute mean shift vector to find modes by using equation (4)

Step 5 : Derive cluster center from equation(5) clustering these points: since each data point associated with certain sample set convergence to the candidate according to the K-Nearest-Neighbor(k=1 in our case).after converging and grouping the center candidates belong to certain

cluster center (condition stop when gradient is close to zero) which can be used to assign the value to the corresponding data set.

Step 6 : End .

After application this algorithm we obtain on cartoon image from type (*.jpg) for entered real color image.

4. The practical side for search

the following figure show the interface :

Figure (3) General Interface

from button "**Select your image"** we load the image which be manipulated to converted it to cartoon image using mean shift technique The button "**Open Image**" open new window for opining the selected image which is explain in figure (4)

Figure (4) manipulated image using mean shift technique

this form contain from two important buttons first buttom **Start Mean Shift Algorithm** when press on this button appear box dialog to enter the spatial radius and color distance which show in figure (5)

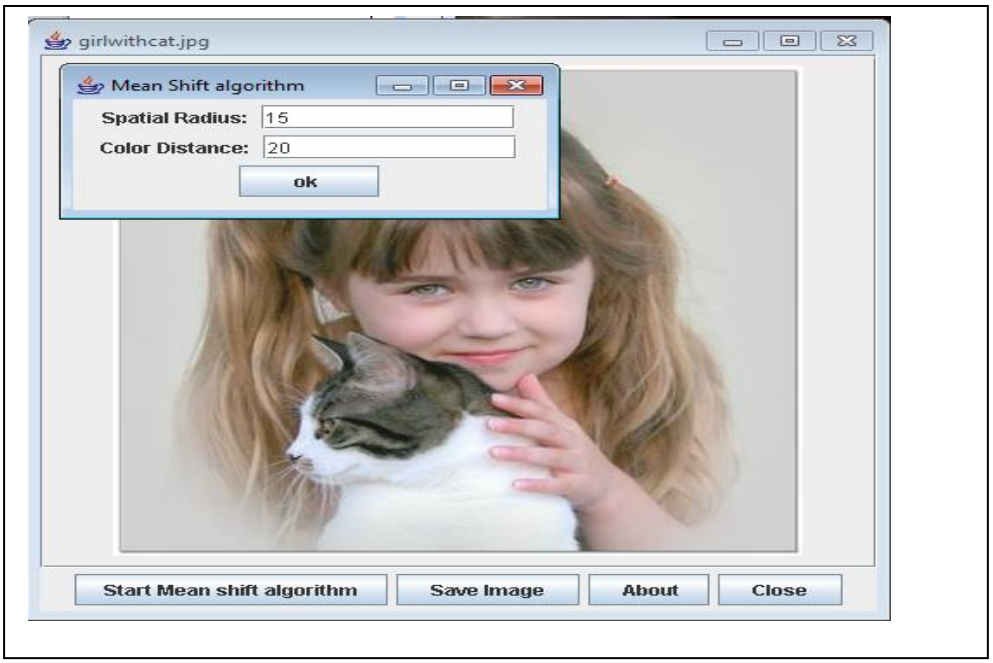

Figure (5) Form select Spatial Radius and Color Distance parameters

After enter the values for these parameters the execution on this image begin which may be take several minute to complete execution depends on values for spatial radius and color distance and quality of image and then show the resulted image in cartoon form and then press button Save image to save the resulted image in type of *.**jpg** extension this illustrated in figure (6)

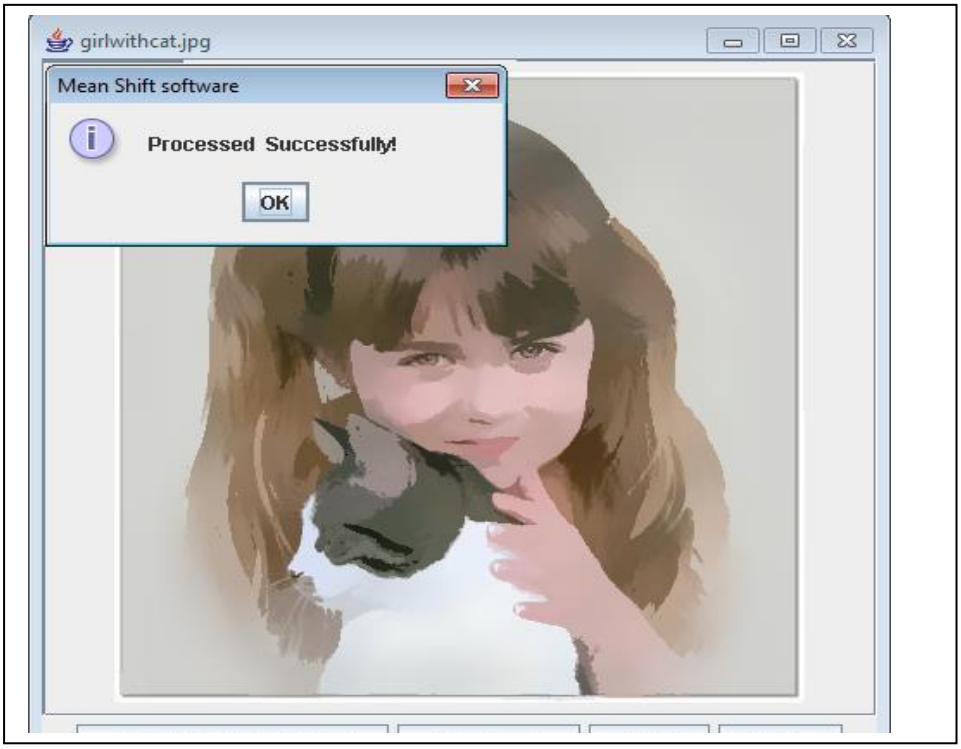

Figure (6) Resulted Image after complete execution of mean shift algorithm

Experiments

Group 1 : the following images converted by mean-shift technique

with spatial radius =7 and color distance = 20:

Spatial radius = 7

Spatial radius = 15

Spatial radius = 30

Using spatial radius = 3 distance color = 10

Group 2 : using different image with color distance = 20 with different spatial radius

Original image

Spatial radius = 7

Spatial radius =15

Spatial radius = 30

Using spatial radius = 3 distance color = 10

Group 4 : take another image different form other in the colors with using same spatial radius which using with other images

Orginal image

Spatial radius = 7

Spatial radius = 15

Spatial radius = 30

Using spatial radius = 3 distance color = 10

Group 5 :the following images converted by using color distance color = 30 with different spatial radius

Original image

Spatial radius = 7

Spatial radius = 15

Spatial radius = 30

Using spatial radius = 3 distance color = 10

5. Discussion :

from experiments we found that the image resulted which represent the cartoon copy image for original image the accuracy of the conversion depend on the selection of spatial radius and color distance furthermore on the quality and density of colors in original image .from experiments we found that the best result we obtain on it when the value of spatial radius between 15 -30 and the value of color distance=20 this is depend on the nature of image . the worst result (this mean the image resulted is cretin and losing in the objects which found in original image) when the value of spatial radius<=5 and the value of color distance <=10. Therefore, the result of this technique depend on nature of image(quality of color , objects in an image and the values of color distance and spatial radius.

6.Conclusion :

1-- mode detection which means the converge procedure are attracted by stationary. Therefore, the points through mean shift process will adaptively reach the corresponding mode.

2- The selection the best values for spatial radius and color distance to obtain the accuracy in the result and a good separation for objects in image it is be from experiments where not be able to found the constant values for these variable for all images. Where select value for one image give a good result and when applying these values on other image that not give the same result with one image. And that is recognize is the mean shift technique is non-parametric technique which does not require prior knowledge of the number of clusters, and does not constrain the shape of the cluster.

3- From experiments we found that when the values of color distance<=10 and spatial radius<=5 the resulted image is to be slantwise to be cretin and it losing more objects in the image when these images have the same properties about the quality of colors , number of colors in images and number of objects in these images.

4- We must select the values for spatial radius and color distance which justify that as possible not losing the objects in the image when clustering and grouping the data set to be assigned to the certain color cluster (center cluster).

References:

[1] Changjiang Yang, Ramani Duraiswami, Daniel DeMenthon and Larry Davis ,“ Mean-Shift analysis using Quasi-Newton Methods”
University of Maryland, College Park, MD 20742,1997

[2] Comaniciu, D. & Meer, P., “Mean shift Analysis and Applications”, IEEE Int. Conf. Computer Vision, pp. 1197-1203, 1999.

[3] Roberto Rodríguez and Ana G. Suarez ,” A new algorithm for
image segmentation by using iteratively the mean shift filtering”, Digital Signal Proce Digital Signal Processing Group No. 551 , La Habana, 2006

[4] Benjamin Gorry, Zezhi Chen, Kevin Hammond, Andy Wallace, and Greg Michaelson, ” Using Mean-Shift Tracking Algorithms for Real-TimeTracking of Moving Images on an Autonomous Vehicle Testbed Platform”Digital Signal Proce Digital Signal Processing Group No. 451 , 2003

[5] Comaniciu D, Meer P , “Mean Shift: A Robust Approach toward Feature Space Analysis”, IEEE Transaction on Pattern Analysis and Machine Intell. Vol. 24 (5), No. 551 ,2006