Mean Shift 알고리즘을 활용한 경계선 검출의 발전

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Progress of Edge Detection Using Mean Shift Algorithm

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요 약

영상에서의 경계선 추출은 원 영상의 노이즈에 의해 크게 영향을 받는다. 따라서 먼저 그 노이즈들을 제거할만한 어떤 방법들이 필요하다. Mean Shift 알고리즘은 이러한 목적에 부합되는 유연한 함수로서, 별로 중요하지 않은 정보와 민감한 노이즈 부분을 점점 제거하는데 알맞다. 여기서는 Canny 알고리즘을 사용하여 중점으로 하는 영상에서의 윤곽선을 찾아낸다. 그리고 테스트 하고 이전의 유일한 Canny 알고리즘 보다 결과가 좋음을 알아낸다.

키워드

Edge Detection, Noise, Mean Shift Algorithm, Canny Algorithm

Ⅰ. Introduction

Regular detection algorithm considers the contour is the lightness or brightness discontinuous result. Majority edge detection algorithms adopt the rectangle window data weight average in order to assume the gradient vector of discrete region. The approach mentioned in this paper base on region density estimation, and regards the different value of density as the metrics of edge detection. However, if just do like this will involve some noise points, and increase useless calculation work. So before the Canny algorithm processing the input image, use Mean Shift cluster method to smooth the image ahead of time. This additional procedure can not only find out the precise edge information effectively and efficiently, but also eliminate the not important information and noise influent.

Ⅱ. Related Work

Edge detection is a tool in image processing aim at identifying points in a digital image at which the image brightness changes sharply or more formally has discontinuities. Majority the methods detect edges by first computing a measure of edge strength, usually a first order derivative expression such as the gradient magnitude [1], and then searching for local directional maxima of the gradient magnitude using a computed estimate of the local orientation of the edge, usually the gradient direction.

Ⅲ. Mean Shift and Progress

Generally speaking, the Mean Shift algorithm is an iteration process which can find out cluster centers. Its basic idea like this, move a shift window on the gradient direction of the

feature space, starting at a randomly selected point. The convergence point of the shift window center is a cluster center; hence its kernel that the significant features of the image represent high density regions in the features space of the image and the highest density regions correspond to cluster centers. In recent years, this method is widely used in computer vision field [5].

Suppose x is d-dimensional Euclidean metric, { $x_i, 1 \le i \le n$ }is the isolated identically distributed sample set, $k(x)$ is kernel function, h is radius bandwidth, then the kernel density estimator definition of x becomes the well-known expression

$$f(x) = \frac{1}{nh^d} \sum_{i=1}^{n} K(\frac{x - x_i}{h})$$,and the kernel function usually used is Epanechnikov kernel[6];

$$K_\varepsilon(x) = \begin{cases} (2c_d)^{-1}(d+2)(1+x^T x) & \|x^T x\| \le 1 \\ 0 & otherwise \end{cases}$$,

and the Gaussian kernel function

$$K_G(x) = (2\pi)^{-d/2} \exp(-\frac{1}{2}\|x\|^2)$$.

After a succession of calculation, getthe kernel density assumption

$$\hat{\nabla} f_{h,k}(x) = \frac{2c_{k,d}}{nh^{d+2}} [\sum_{i=1}^{n} g(\left\|\frac{x - x_i}{h}\right\|^2)] \bullet \left[\frac{\sum_{i=1}^{n} x_i g(\left\|\frac{x - x_i}{h}\right\|^2)}{\sum_{i=1}^{n} g\left\|\frac{x - x_i}{h}\right\|^2} - x \right]$$,

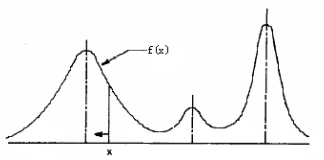
and the vector of Mean Shift is

$$M_h(x) = \frac{\sum_{i=1}^{n} x_i g(\left\|\frac{x - x_i}{h}\right\|^2)}{\sum_{i=1}^{n} g(\left\|\frac{x - x_i}{h}\right\|^2)} - x$$,

and from it can make out the Mean Shift iteration function is

$$y_{j+1} = \frac{\sum_{i-1}^{n} x_i g(\left\|\frac{x - x_i}{h}\right\|^2)}{\sum_{i=1}^{n} g(\left\|\frac{x - x_i}{h}\right\|^2)}$$ [7].

From the above description of relationship between Mean Shift and probability density function, we make it clear that the Mean Shift algorithm is an adaptive search method that can find peak along the rise of gradient, illustrate in the followed figure:



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if the data set $\{x_i, i = 1,...n\}$ obey the probability density function, given a original point, Mean Shift algorithm will move step by step, finally converge at the first peak.

This method can be used for smoothing image, define one image as p dimensional vector on two-dimensional lattice, every point of lattice stand for a pixel, $p = 1$ indicate this image is a gray image, $p = 3$ indicate it is chromatic image, $p > 3$ indicate it is a more spectrum image, the coordinate of point in the lattice denote the space information of image. We consider all the space and color information together, combine $p+2$ dimensional vector $x = (x^s, x^r)$,where x^s denote the coordinate of point in the lattice, x^r denote the p dimensionalvectorfeatures.Weusekernelfunction K_{h_s,h_r} assume the distribution of x , K_{h_s,h_r} has the following format,

$$K_{h_s,h_r} = \frac{C}{h_s^2 h_r^p} k\left(\left\|\frac{x^s}{h_s}\right\|^2\right) k\left(\left\|\frac{x^r}{h_r}\right\|^2\right)$$,

where h_s, h_r decide the smooth definition, and c is a normalized constant.

We use x_i and z_i , $i = 1,2,...n$ indicate the original and undergone processed image respectively. The steps of Mean Shift algorithm application are as follow:

Firstly, initialized $j = 1$,andmake $y_{i,1} = x_i$

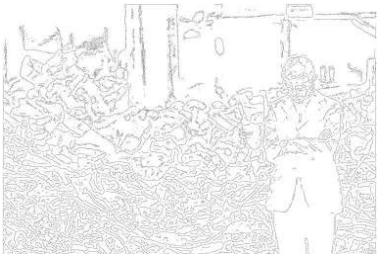
Secondly, use Mean Shift algorithm to calculate $y_{i,j+1}$ till convergence. Make the result as $y_{i,c}$.

Thirdly, evaluate $z_i = \left(x_i^s, y_{i,c}^r\right)$

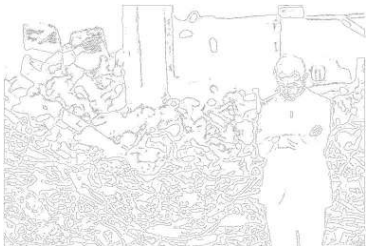
Ⅳ. Experiment

Take experiment to compare the original Canny edge detector with the improved Canny which has Mean Shift procedure in advance, the different is obvious:

The original image



The result just use Canny algorithm, where σ =0.4, L_{ratio} =0.4, H_{ratio} =0.8;



The result use Mean Shift smooth and Canny edge detector, where h_s =32, h_r =16;

Ⅴ. Conclusion

This paper presented a method can improve the original Canny algorithm for edge detection. The Mean Shift algorithm can find the cluster centers through iteration process depend on the gradient density, so add this ahead of the Canny procedure can eliminate the noise points who will influent the edge detection. In contrast, this smooth step will fade out some significant inner information more or less as the compensation of blurring image, which is the trait of Mean Shift algorithm.

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