Zernike moment based image blurring for detecting object boundary

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Abstract—In order to segment object shape, object features edge detection techniques are widely used. A dominant edges detection poses many challenges such as intensity variations inside object, degradation due to noise, spurious edges caused due to noise .There are lots of edge detection techniques are available such as prewitt, sobel ,canny. Problem with prewitt,sobel edge detection is that ,these are mask based edge detectors and doesn't reveal delicate edges. On the contrary canny edge detector can control a lot of edges to be detected. This is possible due to multiple stages introduced in canny,particulary LOG (laplacian of Gaussian) and non-maximal suppression. This allows to detect less detailed and prominent edges also. For object boundary detection, at many places [1] canny edge detector is used. The problem with canny is if variance of it,is changes to higher side only prominent edges are detected with some loss of edge information at certain places. For lower variance of canny, it introduces too many spurious edges leaving a complexity behind for object boundary detection

In this paper, various images were studied as example of micro-part image. A edge detection method based on property of Gaussian blurred edge is proposed. Firstly the 5x5 kernel is derived for image. The values of kernels are updated iteratively based on the Zernike moments response to sub block of an image.

Keywords—Blurring, Canny edge detection, Edge detection,Sub pixel edge detection, Zernike moments.

I.INTRODUCTION

There are many edge detection techniques have been developed and studied, among which these methods are broadly classified into pixel-level and subpixel-level edge detection. Early edge detection methods employed local operators to approximately compute the first derivative of gray level gradient of an image in the spatial domain. The locations of local maximum of the first derivative are considered to be edge points. Prewitt and Sobel operators are examples of thegradient-based edge detectors [1,2]. Marr and Hildreth [3] proposed the Laplacian of Gaussian (LOG) operator foredge detection, which uses Gaussian function for image smoothing, then calculates the second derivative, the zero crossing points are considered to be edge points. Canny presented an optimal edge detector, especially for two-dimensional image. Canny operator can give the edge information of both intensity and direction [4]. All methods mentioned above are of pixel-level edge detection, capable of detecting edge fast but of low precision.

II.PRINCIPLE OF EDGE DETECTION METHOD

Figure1 shows the overall edge detection model and effect of blurring on edge detection .As shown in figure 1,an edge detector blocks are shown. An edge detection output is impacted by blurring process and preprocessing steps which normally uses gradient of blurred image. As shown in figure, and are the pixels gradients used by further processing steps. The mask which is used to blur the image is given by

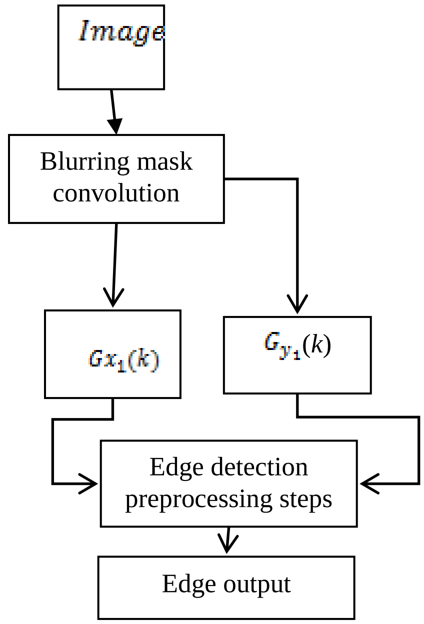


Figure 1: Block diagram of edge detection

$$C_{(x,y)} = e^{-(x^2+y^2)/(2\pi} \quad (1)$$

The proposed method uses mask using 2nd order Zernike moments. This mask is computed iteratively and values are updated based on image contents.[3]. The mask which is used in figure 1,is used to blurr the image. In proposed approach we have modified this mask to compute based on Zernike moments.

Zernike moment [2] of order n and repetition m can be expressed as

$$A_{n,m} = \frac{n+1}{\pi} \iint f(x,y) V_{nm}^{*}(\rho,\Theta) dxdy \quad (2)$$

Here n, m=0, ±1,…; (n+1)/ π is a normalization factor and it is ignored in future discussion; f(x, y) is the image function defined in coordinate system; V*nm(ρ , θ) is complex conjugate function of Vnm(ρ , θ) which is the kernel of

$$R_{nm}(\rho) = \sum_{s=0}^{(n-|m|)/2} \frac{(-1)^s (n-s)!\, \rho^{n-2s}}{s!\left(\frac{n+|m|}{2}-s\right)!\left(\frac{n-|m|}{2}-s\right)!}$$

Where $R_{nm}(\rho\ )$ is radial polynomial definedas

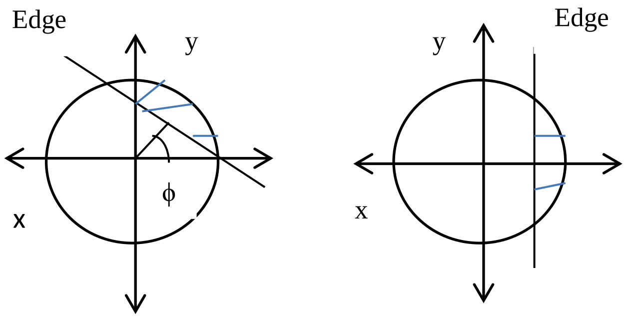
$$V_{nm}(\rho,\Theta) = R_{nm}(\rho) e^{jm\Theta} \quad (3)$$

An important feature of Zernike moments is that it is rotation invariant. This is expressed by following equation.

$$A'_{nm} = A_{nm} e^{-jm\phi} \; (4)$$

III.Designing kernel mask using Zernike moments

The mask coefficients values should change according to contrasts and intensity changes in image. As shown in figure 2



(a)Original image with edge (b) rotated image edge

Figure 2:Rotation angle ϕ to be estimated using Zernike moments

As shown in figure 2 a sample image and its corresponding rotated part is shown. In proposed approach every sub block of size 10x10 is treated as an image block, where apparent angle at which intensity change(edge) is detected. The rotation angle

Φ is computed using following equation.

$$\phi = arctan\left(\frac{Im(A_{11})}{Re(A_{11})}\right) \qquad (5)$$

Where A_{11} is computed on image sub-block using [2]. With the [2],it can be shown that sub-pixel positions ,with the help of x and y positions in sub block image can be computed using

$$\begin{bmatrix} X_s \\ Y_s \end{bmatrix} = \begin{bmatrix} X \\ Y \end{bmatrix} + \frac{2l}{N}\begin{bmatrix} \cos\phi \\ \sin\phi \end{bmatrix} \qquad (5)$$

$$\text{Where } l = \frac{A_{20}}{A_{11}'} \qquad (6)$$

N is the number of horizontal or vertical size of the mask. In proposed approach N = 10.

IV.PSEUDO CODE TO COMPUTE MASK

Init: n,m,blkSize ,Mask

forrowX=1:blkSize:Row

forcolY=1:blkSize:Col

```
subBlockImage=Image(rowX: rowX+ blkSize-1,colY:colY+blkSize-1);
        [ Mag11, Phase11] =Zernikmoment(subBlockImage,2,1);
        [ Mag, Phase] = Zernikmoment(subBlockImage,n,m);
          sci= Phase *pi/180;
          el= Mag / Mag11;
          Xsp=X+2*el*cos(sci)/blsize;
          Ysp=Y+2*el*sin(sci)/blsize;
          Mask=sqrt(Xsp.*Xsp+Ysp.*Ysp);
          Mask=Mask/sum(Mask(:));
        end
        end
```

In proposed approach as described in pseudo code, mask is computed iteratively and same is convolved with input image from which it is derived.

V.Results

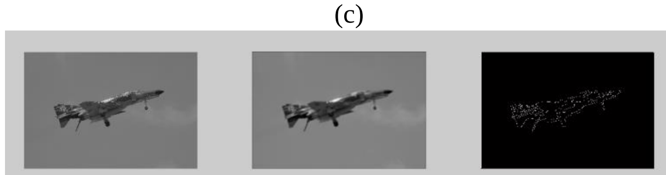
To test the algorithm, different sample images were used to apply blurr mask and canny edge detector *(threshold = 0.2, variance =2.2)*,is used to compute the boundary of images.

Results shows that, this technique of image specific blurring helps to accurately locate the image boundary. The results are shown in figure 3

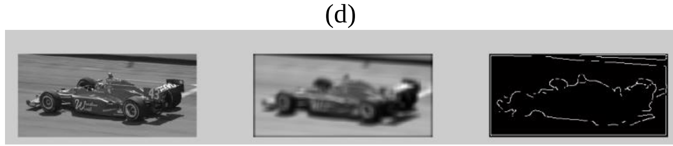
(a)

(b)

(c)



(d)



(e)

(f)

Figure -3,results of edge detection post blurring,(blksize =10,n=2,m=2 for zernike) a)lena b)moving object c)static Object d)plane e)racecar (f)car

VI.CONCLUSION

The proposed algorithm ran on different publicly available images. The results shows that Zernike based blurring, helps to detectboundary edges of object, which otherwise would have introduced spurious edges at some places. This method Can give better results than other edge preserving techniques since contents of blurring masks are decided according to image contents.

VII.REFERENCES

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