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Spatial Adaptive Filter for Object Boundary Identification in an Image

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ABSTRACT:

Segmentation is the process of partitioning the image into its constituent parts in order to be used in image understanding and visualization. Edge based segmentation detects the edges of various objects based on gradients. Filter/Mask processing finds vital role in various edge detecting techniques. The choice of the mask and the response of the mask help in identifying various components and segment it from the image. An algorithm has been proposed that uses a mask of varying size with the mask co-efficients computed based on the intensity of the pixels local to the mask resulting in a binary pattern. With the response of the pixel at the center of the mask and a threshold, the boundary of different objects are identified for further operations. A comparative analysis has also been shown by considering traditional edge detection methods.

KEYWORDS: Segmentation, Threshold, Adaptive Filters, Local Binary Pattern (LBP)

1. INTRODUCTION

Image processing techniques are largely application domain specific. Institutions and Business Organizations conduct various events round the year and hence the image acquisition activity has been increased extensively. The events are generally documented for future reference. In the present days, the images have become integral part of documents. Thus the image data collected at source must automatically be preprocessed, efficiently tagged and maintained as an archive. To tag these images, each image must be segmented based on the image content by extracting required features and then be classified using the event context and stored in an image archive. The archive could then be used to retrieve[2] information for preparing various documents. It would also aid in various fields such as surveillance, forensics and person or object identification related to crime.

The paper is organized as follows: Section 2 presents the literature survey of the related topics. Section 3 presents the proposed algorithm, Section 4discusses the experimental results of an event data set and Section 5 concludes with scope of the work.

2. RELATED WORK

Image content can be described as a composition of visual and semantic content. Visual content itself may be general or specific to a domain. Color, texture and shape fall under general visual content. The low-level features such as color, shape and texture alone may not be sufficient for segmenting[1] the images. Different feature elements of an image emphasize different properties. The importance of these features may vary from one application to another. Global approaches are at times not adequate and do not provide sufficient details on images with specific objects. In region based systems an image is represented as a collection of regions. The feature descriptors are then extracted from each object instead of the global image. Thus for better results a combination of global features and region based feature descriptors could be extracted and used in segmentation[5] and classification[3][4].

Edge based and Region based models are common in image segmentation. The application of partial derivatives (gradients) has a prominent role in edge based image segmentation. On the other hand Region based models avoid the derivatives of image intensity and hence are generally robust. Image segmentation provides a natural dimensional reduction from the spatial resolution of the image to a much smaller set of spatially compact and relatively homogeneous regions. The homogeneity of a region, in general include object boundaries[6][8] and hence could be used in object detection. One of the measures that is used to measure homogeneity of a region is texture. The Local Binary Pattern[7] (LBP) operator is a simple but very efficient method of analyzing texture. It was originally used as a complementary measure for local image contrast. The first of its kind used 8-neibhours of the pixel with the central pixel as its threshold. The response R of the LBP is computed by multiplying the thresholded values with weights given to the corresponding pixels, and summing up the result. The original definition was extended to arbitrary circular neighborhoods and later a number of extensions have been developed. Except for random noise in the image, the brightness level at a particular point in an image is highly dependent on the brightness levels of neighboring points.

Pixel based segmentation segments the image based on gray level values without considering any contextual information, Region based segmentation uses neighborhood pixel values, on the other hand Edge based segmentation forms contours by detecting and linking edges. The proposed method uses a neighborhood approach to detect object boundaries with the edge thickness based on the defined neighborhood.

3. PROPOSED WORK

Segmentation methods using edge detection techniques using spatial filters such as Roberts, Prewitt, Sobel and Canny are suitable for images where the image content is minimal and does not contain more detail. For the application domain introduced in this paper, the individual objects need to be clearly distinguished from one another. The proposed method detects object boundaries with absolute distinction from one another. The thickness of the boundary is solely based on the filter size.

The process flow of the proposed work is depicted in the following figure 1.

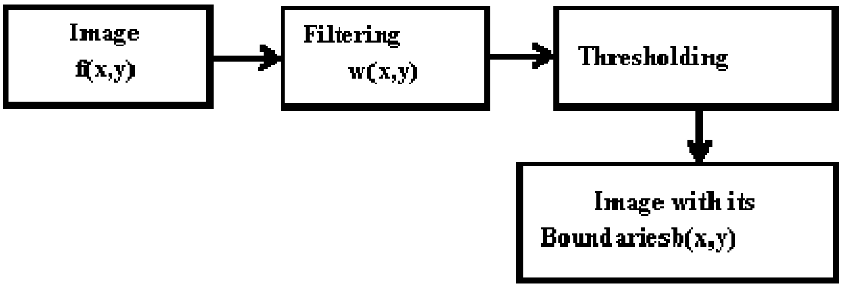

Figure 1: Process flow

3.1 Filtering:

Spatial filters or mask processing in image processing is to obtain the response(R) at an image location by considering the neighborhood surrounding that location. Let I be an image of size M x Nwith f(x, y) as the gray intensity of a pixel at the location (x, y). Let W be a filter of size n with its center at (0, 0). The co-efficient w(i, j) of the mask dynamically change based on the distance measure. It is adaptive to the gray values of the image pixels under the filter region. For each pixel location (u, v) of the image under the mask the distance D is calculated as described below:

$$pval = f(x, y)$$
$$D(u,v) = abs\ (f(u,v) - pval)$$
$$If\ (D(u,v) < e)\ then$$
$$w(u,v) = 0$$
$$else$$
$$w(u,v) = 1$$

where e is the gray level limit. The response R at (x, y) is: $R(x, y) = \sum_{i=-(n-1)/2}^{(n-1)/2} \sum_{j=-(n-1)/2}^{(n-1)/2} w(i, j)$

The response is the Local Binary Pattern surrounding the pixel at the center of the mask. The maximum value of the response being n*n.

3.2 Thresholding:
A binary image b is obtained by thresholding the response at each pixel. The threshold T used for this operation that gives optimal result is: $T = 2*(n-1) - 1$ .Hence:

$if\ R(x,y) > T\ then$

$\quad b(x,y) = 0$

$else$

$\quad b(x,y) = 1$

The binary image thus obtained defines clear boundaries of the objects that are present in the image. The binary image can further be processed by restoring the color values in the complement of the Binary image by assigning the corresponding RGB values of the original image to all the non-zero pixels. The resulting RGB image with clear boundaries is processed further using region growing technique to detect various objects of interest.
The Algorithm 1 enlists the procedure described:

*Algorithm*1

Function **Boundary Detection (Image I, filter size n, gray limit e, Image b)**

Begin

Convert image I to its grayscale image f

Create a filter w of size n by n

for each pixel (x,y) *in the gray scale image do*

Initialize the response at (x,y), $R(x,y)$ *to zero*

Assign $f(x,y)$ *to pval*

Place the center of the filter at location (x,y)

for each co−ordinate (u,v) *of the filter do*

Compute $D(u,v) = f(u,v) - pval$

$if\ \left(\left(D(u,v) < e\ and\ D(u,v) > 0\right)\ or\ D(u,v) < 0\right)\ then$

$w(u,v) = 0$

$else$

$w(u,v) = 1$

end

Compute $R(x,y) = R(x,y) + w(x,y)$

end

$if\ (\ R(x,y)\ > (2*(n-1)-1))\ then$

$b(x,y) = 0$

$else$

$b(x,y) = 1$

end

end

End Function

4. EXPERIMENTAL RESULTS

An image set of an event organized in an organization has been considered. The image set consists of indoor/outdoor images, image with people of interest, presentations and various objects that describe the scene that could relate to the event context. Each image has been reduced to $1/5^{th}$ of its original size to ease the processing. Redundant images and noisy images are eliminated from the image set during pre-processing using structural similarity index. The resulting images in the image set are converted to gray scale images for processing.

The size of the square adaptive filter has been assumed to be 9. The image pixels that fall outside the filter boundaries are managed by the traditional techniques namely, padding with zeros or with the neighboring pixel values that surround the image border. Figure 1 shows a random image from the image set.

Figure 1: Resized Image

The gray values of a portion of the image in figure 1 is shown in table 1.

Table 1: Gray levels (6, 146) to (20, 155)

152	151	152	151	152	150	151	152	150	150
151	152	152	151	150	149	149	148	146	144
149	149	148	146	143	139	139	133	129	128
143	139	138	132	125	119	114	106	98	94
135	124	117	107	96	86	76	67	60	55
99	86	81	69	56	49	44	40	37	35
56	53	50	45	38	35	34	34	34	32
39	38	36	34	34	35	33	33	33	33
34	33	33	34	34	34	33	32	31	32
33	32	32	33	33	33	33	32	31	31
32	33	32	32	34	34	32	32	30	29
32	33	34	32	33	34	33	31	30	29
32	33	34	34	34	35	34	31	30	30
33	34	34	36	38	38	35	33	30	29
37	37	36	35	37	37	37	34	31	29

The adaptive filter of size 9x9 with its associated weights w(u, v) when the filter center is placed at pixel location (u, v)=(11, 150) where the gray level is 56 is given in Table 2.

Table 2: Filter with the weights when it is placed at location (11, 150)

1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	0
1	1	1	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

The response R(x, y) at (11, 150) when e = 10 is given by R(11, 150) = 39. The threshold T = 2*(n-1) – 1 = 15. The boundary image is obtained by assigning:

$$B(x,y) = 0 \quad when\ R(x,y) > T$$
$$1 \quad otherwise$$

Thus B(11, 150) = 0. The boundary image corresponding to the resized image in figure 1 is shown in Figure 2, Figure 3, Figure 4 with the filter size of 9 and e=10, filter size of 7 and e=10, filter size 9 and e=20 respectively.

Figure 2: Boundary Image with n= 9 & e=10

Figure 3: Boundary Image with n= 7 & e=10

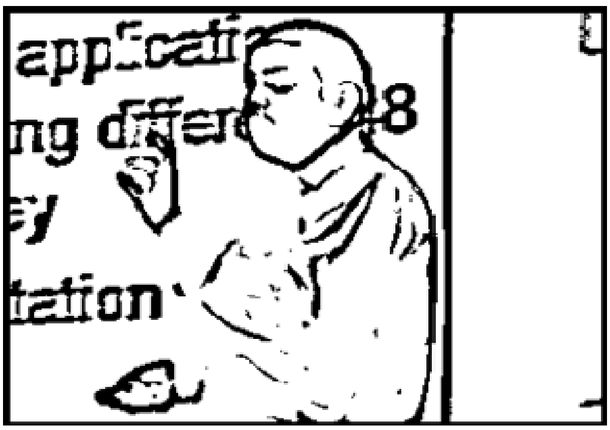

Figure 4: Boundary Image with n= 9 & e=20

The adaptive spatial filter thus identifies object boundaries with clear distinction of objects present in an image including the text boundaries. This could further be used in identifying specific objects using object templates.
The image shown in figure1with its edges detected using Roberts, Prewitt, Sobel and Canny filters are shown in figure 5, figure 6, figure 7 and figure 8 respectively.

Figure 5: Edge image using 'Roberts' filter

Figure 6: Edge image using 'Prewitt' filter

Figure 7: Edge image using 'Sobel' filter

Figure 8: Edge image using ‘Canny’ filter

5. CONCLUSION

The simple spatial adaptive filter based only on the gray levels in the local region surrounding the pixel finds the object boundaries by reducing the computational cost. The color components within the boundary regions with the region growing technique would further lead to segmentation of the objects and its identification. This technique finds its application in various areas such as surveillance, forensics, text processing and image mining.

6. REFERENCES

[1] Andy Tsai, Anthony Yezzi, Jr., Member, IEEE, and Alan S. Willsky, “Curve Evolution Implementation of the Mumford–Shah Functional for Image Segmentation, Denoising, Interpolation, and Magnification”, IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 10, NO. 8, AUGUST 2001.

[2] A.Kannan, V.Mohan, N.Anbazhagan, “ Image Clustering and Retrieval using Image Mining Techniques”, IEEE International Conference on Computational Intelligence and Computing Research, 2010.

[3] Hanumanthappa. M, S. Regina Lourdhu Suganthi, “Content Based Classification using Object Identification”, International Journal of Combined Research & Development (IJCRD) eISSN: 2321-225X;pISSN:2321-2241 Volume: 4; Issue: 6; June-2015.

[4] Kun-Che Lu And Don-Lin Yang, “Image Processing and Image Mining using Decision Trees”, Journal Of Information Science And Engineering 25, 989-1003, 2009.

[5] Kyungnam Kim, Thanarat H. Chalidabhongse, David Harwood, Larry Davis, “Real-time foreground–background segmentation using codebook model”, Elsevier, 2005.

[6] Le Lu, Gregory Hager, "Dynamic Foreground/Background Extraction from Images and Videos using Random Patches", Advances in Neural Information Processing Systems, 2006, 929--936.

[7] Matti Pietikäinen, Abdenour Hadid, Guoying Zhao, Timo Ahon, "Local Binary Patterns for Still Images", Chapter 2, Sringer, Vol 40, pp 13-47.

[8] Takumi Uemura, Gou Koutaki, Keiichi Uchimura, "Image Segmentation based on edge detection using boundary code", International Journal of Innovative Computing, Information and control, Vol 7, No.10, 2011, 6073-6083.