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Object Detection Strategies: Survey

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Abstract: Object detection is important task in image processing and computer vision. To identify objects in images or pictures, objects have various features. Objects have various features in the form of feature vectors. Feature vector are being extracted for the object detection. There are ways for detection objects that are texture, colour and shape. Texture is the surface of the object. Texture based object detection is further divided in sub types texture segmentation, region based, edge based. In order to shape is most stable and explanative way for object detection. Further shape is divided in two subtypes region based and contour based. In this contour based is more used because these methods are invariant to rotation scaling and transposition invariant of the object. All the ways and its subtypes are discussed in this paper. Object detection is being used in many applications robot navigation, augmented reality, CBIR.

Keywords: Object detection, Computer vision, Texture, Colour, Shape, Contour, CBIR

I. INTRODUCTION

With the fast development of image processing technology and its wide applications in robot vision and automation, augmented reality, character recognition, shape matching algorithms become a hot focus on object recognition, defect detection, robot navigation . Typically, images in a database are retrieved or detected based on either textual information or content information [1]. Early retrieval techniques were based on textual illustration of images. Images were first illustrated with text and then searched based on their textual tags. However, text-based techniques have many limitations, including their reliance on manual illustration, which is a very difficult process for large data sets. Furthermore, the rich content typically found in images and the subjectivity of the human perception make the task of describing images using words a difficult if not impossible task. To overcome these difficulties, for the similarity between the two objects, various features like colours, textures and shape is being used [2]. Shape is the inherence characteristics of an object in the image and it is the important character used for the object recognition. So it is significant for the object recognition based on shape. Shape can be expressed by contour or the region occupied by the object.

II. TYPES OF OBJECT DETECTION

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A. Object Detection Using Texture

Texture is that inborn property of all surfaces that describes visual patterns and contains important information about its arrangement. In short, texture describes the distinctive physical composition of a surface [3]. Since an image is made up of pixels, texture can be defined as an entity consisting of mutually related pixels and group of pixels. This group of pixels is called as texture primitives or texture elements (texels) [4]. Hence, texture based techniques can be applied only on a group of pixel and not a single pixel. There is no visible inter-object part-wise correspondence for texture based objects. These objects are better described by their texture than the geometric structure of reliably detectable part. Buildings, roads, trees and skies are texture based objects. Sometimes when we are using color based segmentation shadow is detected as a different object. But if we use texture based object detection technique shadow can be completely eliminated [5]. Texture is a prominent and crucial feature for content based image retrieval applications, image shape identification and image segmentation through pattern recognition and similarity matching. Periodicity, scalability, coarseness, inherent direction and pattern complexity are considered as the most perceptually distinct properties of texture [6]. Texture depends on the distribution of intensity over the image rather than being defined for a separate pixel.

Texture is an important feature for content based image retrieval applications, image shape identification and image segmentation through pattern recognition and similarity matching. Many texture based feature extraction methods are possible. Gray level co occurrence matrix, Gabor filters, Haar filters, Daubechies filters etc are the methods of the texture [7]. A fusion of two or more above mentioned techniques can also be used to get better results. The texture of

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object in the image can be detected using the different techniques like texture segmentation, region based and edge based detection. Figure shows different texture images.

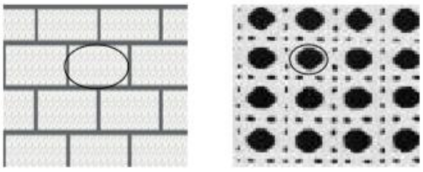

Fig.1 Different texture images [7]

1) Texture Segmentation: Segmentation identifies the differences between particularly interesting and non interesting objects as well as distinguishing foreground from background content. Partitioning an image into a small number of homogeneous regions highlights important features, allowing a user to analyze the image more easily. Image segmentation methods should be divided into region based vs. edge-based methods [8]. In order to identify possibilities for acquisition of scene information by digital images, an analysis of the principle features of these images is required. In this regard, textures are the only possibility to derive information from imagery, besides the grey or color values and structural features. Texture-based segmentation seems to be an adequate approach, because of the panchromatic images. For this reason, texture analysis methods were used in the beginning of digital image processing. Single texture features are unsuitable for texture segmentation, caused by different viewing and illumination conditions as well as shadows, etc. Gabor filters can be applied to many image-processing applications, such as texture segmentation, document analysis, edge detection, retina identification and image representation. A 2D Gabor filter is a Gaussian kernel function modulated by a sinusoidal plane wave. A two dimensional Gabor function g(x, y) is defined as:

$$g(x,y)=\frac{1}{2\pi\sigma_x\sigma_y}\exp[-\frac{1}{2}\left\{\frac{x^2}{\sigma^2 x}+\frac{x^y}{\sigma^2 y}\right\}+2\pi j W_x] \quad [8]$$

2) Region Based: In this, image is divided into different clusters based on various parameters like the color, brightness etc. Each pixel is assigned to be a particular cluster based on color and brightness. Texture can be detected with the help of the clusters in the image [9]. Figure 2 shows example of region based object.

Fig.2 Example of region based techniques [9]

3) Edge Based: Edges contain some of the most useful information in an image. We may use edges to measure the size of objects in an image; to isolate particular objects from their background; to recognize or classify objects. There are a large number of edges finding algorithms in existence. Edges are region boundaries and they are closely related, since there is often a sharp adjustment in intensity at the region boundaries [8]. Figure 3 shows the edge based example of object. Edge detection techniques have therefore been used as the base of another segmentation technique. The edges should be identified by edge detection are often disconnected. To segment an object from an image however, one needs closed region boundaries. The desired edges are the boundaries between such objects. Segmentation methods can also be applied to edges obtained from edge detectors. The different edge detection methods used are Sobel, Prewitt, Roberts, Canny, LoG, EM algorithm, OSTU algorithm and Genetic Algorithm or FPGA method is also used for edge detection. It consists of five functional blocks, namely interface,interlacer, Memory, Operator and 5. Control unit [10]. These kernels can then be combined together to find the absolute magnitude of the gradient at each point. The gradient magnitude is given by:

$$|G|=\sqrt{G_x^2+G_y^2} \quad [8]$$

An Edge in an image is a significant local change in the image intensity, usually associated with a discontinuity in the image intensity. The three steps in Edge detection process are Filtering, Enhancement and Detection. Filtering of the images is meant by removing the noise such as salt and pepper noise, impulse noise and Gaussian noise. Enhancement

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prominently detects pixels where there is a significant change in local intensity values. This usually obtained by computing the gradient magnitude. Detection: Many points in an image have a nonzero value for the gradient, and not all of these points are edges for a particular application, using this edge is to be detected. Thresholding is used for the detecting edge points.

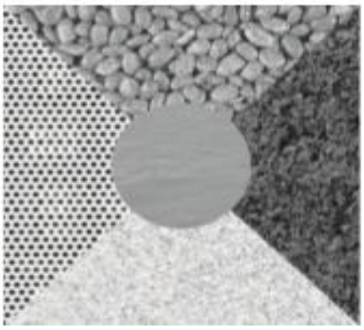

Fig. Example of edge based techniques [9]

B. Colour Based Object Detection

Colour is relatively constant than the other features like shape, texture under viewpoint changes and it is easy to be acquired. Although colour is not always appropriate for detecting and tracking objects, but the low computational cost of the algorithms proposed that colour is suitable feature. Sebastian et al. [11] proposed Genetic Hybrid Optimization & Search of Parameters (GHOSP) algorithm to detect object and track the objects using colour information. Multidimensional observations are taken from RGB colour images which contain object to be learnt are to be used by GHOSP algorithm. They consider each colour component separately and sample the intensities of pixels that are belonging to three gray level images in order to define a reasonable set of symbols. Hence intensity values (v) ranges from 0 to 255 that are converted into symbol(s) using the following formula:

$$s = \frac{v.M_r - 1}{255} \quad [7]$$

Where M_r is the number of possible symbols

From this sampling, three component vectors are to be obtained which will be used as input in the GHOSP algorithm. This method is unable to perform correctly when the tracked object size is too small. In this case, the learning phase cannot be performed correctly due to the lack of learning data. Zhenjun et al. [12] used combined feature set which is built using colour histogram (HC) bins and gradient orientation histogram (HOG) bins considering the colour and contour representation of an object for object detection. The combined feature set is the evolvement of colour, edge orientation histograms and SIFT descriptors. Colour histogram defines a colour histogram (HC) of 48 dimensions for both the object and its background. In each colour component in RGB colour space, 16 dimensions of histogram features are calculated. This method would be work only if the background has the similar colour.

C. Object Detection using Shape

The study of shape includes two aspects, shape representation and shape matching [13]. The former one is to extract salient shape information from image by defining effective shape descriptors. The latter one is to match shapes to calculate their similarity between their descriptions. Shape is the more promising and stable. Shape plays an important role to allow humans to recognize and classify objects. Shape matching is very critical issue in computer vision, which has been widely used in many applications such as object recognition [14], character recognition [15], shape evolution [16], medical image and protein analysis [17], robot navigation [18] and topology analysis in sensor networks [19], which look similar to humans, are often very different when measured with geometric transformation and nonlinear deformations. Compared to geometric transformations, nonlinear deformations are much challenging for shape similarity measures [20].Shape similarity measure is useful for shape based retrieval in image database should be an accord with our visual perception. [21]. the comparison of the shape with the colour and texture, shape is more descriptive on larger images. Shape matching methods further divided into two subtypes region based and contour based methods. In region based methods include information about the internal region and contour based methods capture the information on contour only.

1) Region Based Matching: Region based methods aim to capture information not only from the boundary but also from the region of the shape. Grid based method[22] is example of the region based method this is illustrated in figure 4.This approach places grid over the canonical version, that is normalized with the respect to rotation, scale of the shape. After that grid is transformed into binary feature vector with the same length as number of tiles in grid Ones indicate that the corresponding grid tiles touch the shape and zeros that indicate the tiles are completely outside the

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shape. This method does not capture the texture information. Region-based techniques often use moment descriptors to describe shapes. These descriptors include geometrical moments, Zernike moments, pseudo-Zernike moments, Legendre moments Although region-based approaches are global in nature and can be applied to generic shapes, they fail to distinguish between objects that are similar.

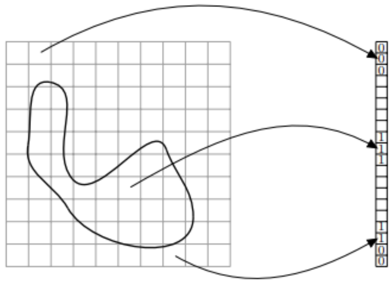

Fig. 3 Example of Region based matching [22]

2) Contour Based Matching: Contour is boundary of the object having same intensity. Contour is simply as curve joining all the continuous points having same intensity. The contours are useful tool for shape analysis, object detection and object recognition. Contour based methods only account for the information given by contour itself. A simple contour based object detection method is shape context (SC)[23].In this method, set of line segment vectors between one sample point and all the other sample points on contour are used to characterise the spatial distribution of the points and then tactical histogram is obtained by discrediting the vectors using log polar system. The SC method contains rich information and performs well on rigid objects but it is sensitive to articulated deformation and lacks of contour point sequence information. To overcome these problems inner-distance shape context (IDSC) method [24] is used for object detection. It uses inner-distance between contour points. It has strong ability to describe non-rigid articulated objects. It fails in recognising the objects that contain complex interior information. Another local descriptor method is distance a set [25] is used for the object detection. This method calculates the distance set of sample point on contour to several points adjacent to it as local descriptor. This method considers only local feature while ignoring global one, which results in low recognition accuracy. Another contour based method is height function [26]. In this first calculate the heights of each sample point using that function. Height functions consist not only the height value of every sample point, but also the order of sample points along the shape contour. The proposed method is very simple, it achieves excellent retrieval results.

A new MCMC method is used for the shape matching that match two shape contours where both of them only have subsets of contour segments involved in matching. It can also well handle the non-rigid deformation between the matched shape contours. It out performs the ‘Elastic matching, Shape context’. Another contour based object detection method is dominant set computation. In this method [27] first finding dominant sets in weighted graphs. The nodes of the graph are pairs composed of model contour parts and image edge fragments, and the weights between nodes are based on shape similarity. Because of high consistency between correct correspondences, the correct matching corresponds to a dominant set of the graph. Consequently, when a dominant set is determined, it provides a selection of correct correspondences. As the proposed method is able to get all the dominant sets, it can detect multiple objects in image in one pass. This approach is purely based on shape, it also determine an optimal scale of target object without a common enumeration of all possible scale. A new method for the object detection is Contour Analysis (CA) [28]. In this method two descriptors are used that is Autocorrelation function (ACF) and inter correlation function. Shape matching can be achieved by matching their descriptors that are ACF and ICF which are scale, rotation and transposition invariant. It has high computational efficiency. Two shapes of the two objects are same only if their inter correlation functions are the same.ICF of the two contours is:

$$\tau(m)=(\Gamma,N^{(m)}) \text{ , where } m=0,\text{-------}, k\text{-}1 \qquad []$$

Where $N^{(m)}$ = a contour received from N cycle shift by its EV on m of elements.

Values obtained from inter correlation function show contours Γ and N is how much similar if to shift starting point N on m positions. ICF is defined on all set of integral numbers but as cycle shift on k leads to initial contour. Thus the ICF is periodic with phase k. The values of ICF function limits from 0 to k-1. Maximum Norm among the values of ICF is’

$$\tau_{max} = \max\left[\frac{\tau(m)}{|\Gamma||N|}\right], \text{ where } m=0, \text{-----}, k\text{-}1$$

From thisτ_{max} measure of similarity of the two contours that are invariant totransposition, scaling, rotation and starting point shift.

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Table I Comparison between methods of object detection

Object Computational Method	Computational Time	Accuracy	Comments
Texture Based	High	High	Textures can't be matched largely invariant to lighting conditions
Colour Based	High	High	Delivers expenditure of added computation time with improved quality.
Shape Based	Low	Moderate to High	object categories are better described by their shape than texture, colour

III. CONCLUSION

In this paper we discussed objects are being detected by features like texture, colour and shape and different types of these features are to be discussed. There are pros and cons for every method. The results depend on various factors like template size, pixel distribution, colour; brightness etc. Texture is the surface of the object. Texture based object detection is further divided in sub types texture segmentation, region based, edge based. Shape is very descriptive feature than the other ones feature. Further shape matching methods can be divided into two types region based and contour based, but contour is more efficient than region because contour effectively represent the object. Hence now days contour is being used for object detection by calculating the similarity between the shapes. Hence shape matching algorithms are being used in many applications like robot navigation, surveillance, protein synthesis.

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