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Shape Analysis and Recognition Based on Oversegmentation Technique

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Abstract*: *Shape recognition plays an important role in machine vision applications. This paper represents a modified shape recognition algorithm to predict the shapes of different objects using over segmentation technique. This algorithm predicts the different shapes of objects based on two parameters corners, and the dimensions (length, breadth) of a particular object in a prediction table. Obviously, the boundary of shape is an important property in shape representation and description. In proposed method, the boundaries of various objects are extracted using some morphological operations. Then the feature extraction process is then applied on the detected shapes. Finally for shape recognition we will match the features of the current object with the preloaded features in the database or we can say training set for recognition. Also profiling of the algorithm is done to measure the execution time. With the help of the mathematical relation it can predict the accuracy of algorithm execution.

***Index Terms-* geometrical shapes, morphological operations, over segmentation, shape recognition.**

I. INTRODUCTION

Shape recognition represents a very important computer vision domain, consisting of recognizing image objects, based on their shape information. While supervised shape recognition classifies image objects by comparing them with some registered shape templates, unsupervised shape recognition groups a set of objects in several clusters, based on their shape similarity. A successful shape recognition approach requires a robust shape descriptor, representing a measure that captures the shape features in a concise manner and is invariant to all geometric transformations. Shape analysis approaches are divided into two main categories: region-based and contour based methods [7].

The shape of an object is a classic and effective feature of the object which has a significant role in object recognition. There are a number of visual information aspects and among them object recognition certainly has wide range of applications in robotics, fingerprint analysis, handwriting mapping, face recognition, remote sensors and so [2]. Object recognition is one of the common problems featured in most computer vision applications. An object recognition system finds objects in the real world from an image of the world, using object models which are known a priori. Multiple visual cues like shape, color, texture are used to describe shapes. My work aims to develop a simple and fast method of object recognition. The effective recognition algorithm should be less complicated and more accurate.

In image processing, feature extraction is a special form of dimensionality reduction. When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant (much data, but not much information) then the input data will be transformed into a reduced representation set of features also named feature vector. Transforming the input data into the set of features is called feature extraction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input.

Morphology is a broad set of image processing operations that process images based on shapes. Morphological operations apply a structuring element to an input image, creating an output image of the same size.

The most basic morphological operations are dilation and erosion. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. The number of pixels added or removed from the objects in an image depends on the size and shape of the structuring element used to process the image.

The shape of the object represents a group of pixels which is referring to an image. To design a robust recognition system, careful attention to the definition of pattern classes, pattern representation, sensing environment, feature extraction and selection, cluster analysis, classifier design and learning, selection of training and test samples and performance evaluation is inevitable.

II. PRIOR WORK

Most approaches to shape matching, find a transformation that gives a factor of dissimilarity between two shapes. The extent of this dissimilarity decides whether we have a match. People have used various properties like curvature, contour to describe shape boundaries. Shape matching has also been implemented using various feature-based and brightness based methods. Feature based methods are often used for silhouette images. The feature being Characteristic of the object is used in content based matching approaches. In eigenvector or modal matching based approaches, sample points are transformed into a mass-spring damper equation and the vibrations are used to estimate matching [10]. PCA was successfully used for faces to create a dimensionally reduced mean shape that was used for matching shapes.

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A novel feature extraction technique, which uses a non-rigid representation adaptable to the shape. This technique employs a deformable grid based on the computation of geometrical centroids that follows a region partitioning algorithm. A new effective shape descriptor, chord context, for shape description image retrieval is used for shape recognition. For a shape, the chord context describes a frequency distribution of chord lengths with different orientations and this method is unaffected by translation, rotation and scaling. Another approach to shape matching was computing skeletal framework of the object that is used as a descriptor for matching [11]. Shape context is a novel approach in shape descriptor. They are simple to compute yet are rich descriptors of the shape boundary.

III. PROBLEM FORMULATION

A. Algorithm without oversegmentation

In the proposed algorithm the shapes of the different objects are being saved in .bmp file as shown in figure 1 (a). Using this algorithm, the shape of objects circle, square, rectangle can be recognized as shown in figure 1 (b) only if the objects are distinct from each other.

If the two or three objects are merged as shown in figure 1 (c), as we can see circle and rectangle, square and rectangle shapes are touching each other .Therefore it can be seen that without using oversegmentation scheme this algorithm can't predict the shape of merged objects as shown in figure 1 (d).This process can't distinguish the shape of irregular images in which two or three objects are merged with each other to form a complete image.

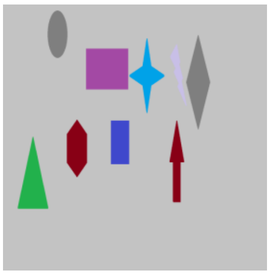


Fig.1 (a) Input Image containing objects

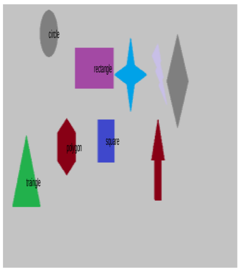


Fig.1(b)Output Image

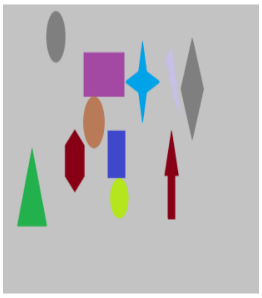


Fig.1(c) Input Image containing objects

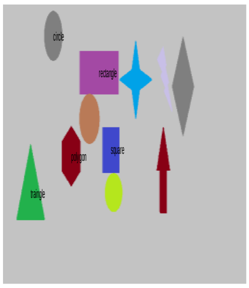


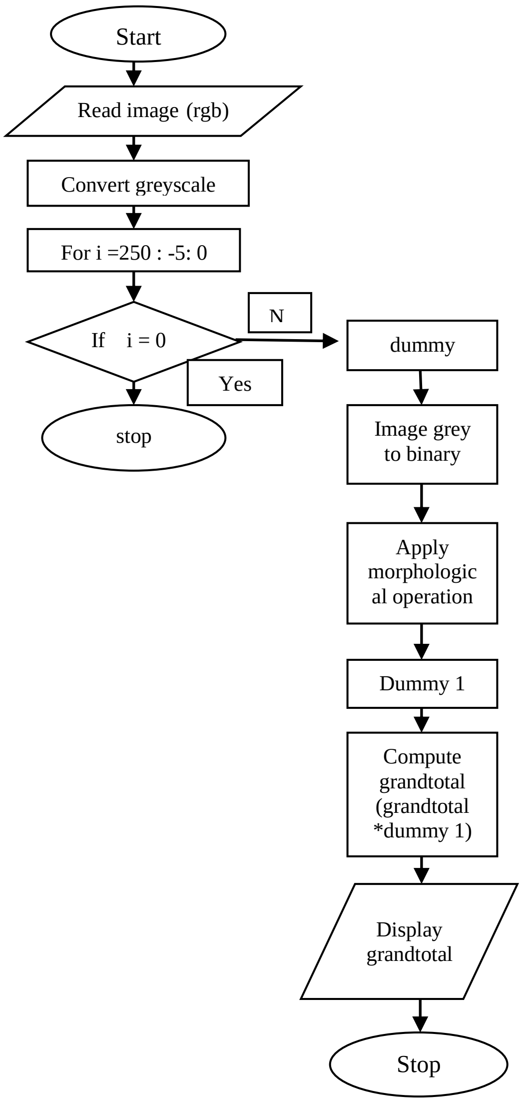
Fig.1 (d) Output Image

B. Algorithm using oversegmentation

Over segmentation is the method by which the objects to be segmented from the background of an image is fractured into subcomponents. The proposed method is trying to reduce the over segmentation and segment some overlapping areas to extract the boundaries of various objects within the image. Our new algorithm detects the shapes in the following cases when (i) There are distinct objects in the given image. (ii) The objects are touching in the given image. (iii) The objects are overlapping in the given image. (iv)One object is contained in the other in the given image.

The shapes of the different objects are being saved in bmp file. This is the very basic way to test and verify our algorithm to predict the shape of the different objects. Oversegmentation concept is used in this algorithm for predicting the shape of different objects like circle, square, triangle, rectangle, polygon when they are merged with one another. The images in which objects having the slightly different colour intensity from the background and the objects in the image are not evenly recognized by the human vision .In this case oversegmentation is used to predict the objects.

IV. FLOW CHART OF OVERSEGMENTATION



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PROCEDURE STEPS

1. Firstly read the rgb image. Then convert the rgb image to gray scale image (img1).
2. Create a new image named grand_ total of the same size as the image (gray colour img1) and convert the grand_total image to a binary image.
3. Store the threshold value (Th). Using a thresholding technique convert the grayscale image to a binary image until the Th=0. Thresholding is used to create a binary image from gray scale image.
4. Then the binary image is processed using morphological operations. After creating the binary image (named dummy), use the NOT operation on the binary image to create another image named (~ dummy). Multiply this image (~dummy) with grayscale image (img1) that multiplication will be elementary multiplication.
5. The morphological erosion operation is applied to binary image (named dummy). Using erosion operation the size of the objects gets reduced. If the objects are attached to each other then by using morphological erosion operation these objects can be separated from one another.
6. After the erosion operation, the result is placed in dummy1.Then OR operation of grand_total image is done with the dummy1 image. If Th=0 then the process is stopped.

V. ALGORITHM IMPLEMENTATION

A. Oversegmentation Technique

For the purpose of shape recognition of different objects, firstly the boundaries are extracted using segmentation scheme. Then features of the objects are extracted using fuzzy logic operations and it is based on morphological commands.

Thresholding technique is used to convert the image from grayscale images to binary .During the thresholding process, individual pixels in an image are marked as "object" pixels if their value is greater than some threshold value and as “background" pixels otherwise. Typically, an object pixel is given a value of “1” while a background pixel is given a value of “0.” Finally, a binary image is created by colouring each pixel white or black, depending on a pixel's label.

Erosion and dilation are the two basic operators in the area of mathematical morphology. Erosion is applied to binary images to erode away the boundaries of regions of foreground pixels. Thus areas of foreground pixels shrink in size, and holes within those areas become larger.

For performing the morphological operation take the structuring element.

se = strel('disk',1);

dummy1=imerode (dummy,se);

Disk shaped structuring element used in it. For example 'disk', 1 means the diameter of objects will be reduced according to this value. For eroding an image, imerode function is used.

The imerode function accepts two primary arguments.

- The input image to be processed (binary image).
- A structuring element object, returned by the strel function.

B. Analysis and Labelling of objects

In this algorithm when the objects are being segmented from each other, the final stage is to identify the shape of the objects. For the shape recognition of the circle, triangle, square, rectangle and polygon use the prediction table in which two parameter dimensions (length, breadth) and corners are defined. The properties like sensitivity factor and corners of the objects are needed to predict the shapes of varying objects.

[lablednum]=bwlabel(grand_total);

S = regionprops (labeled, 'centroid');

centroids = cat(1, s.Centroid);

Then with these mathematical parameters, objects of input image are matched with the preloaded features of the objects in the database or we can say training set and thus we can recognize the shape of the objects.

Table. I Prediction Tables used to distinguish objects

CIRCLE	TRIANGLE	SQUARE	RECTANGLE	POLYGON
➢ Number of corners = 0 ➢ Absolute difference b/w length and breadth < 25	➢ Number of corners = 3 ➢ Sensitivity Factor = 0.24	➢ Number of corners = 4 ➢ Absolute difference b/w length and breadth < 10	➢ Number of corners = 4 ➢ Absolute difference b/w length and breadth > 10	➢ Number of corners > 4 ➢ Absolute difference b/w length and breadth < 10

(a) For recognizing the shapes when objects are touching and contained in each other.

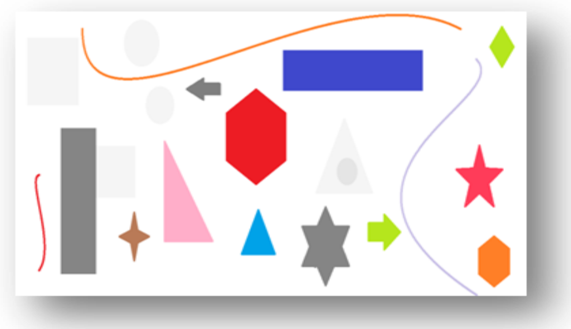

Fig. a (I): Input image

Without oversegmentation the shapes of distinct objects can be predicted but the shapes of the merged objects can’t be predicted. In this figure a (I) rectangle and square are touching each other where an object i.e. circle is contained in the triangle. By using oversegmentation concept, the shapes of these objects are segmented and can be predicted. The output is shown in fig. a (II), a (III).

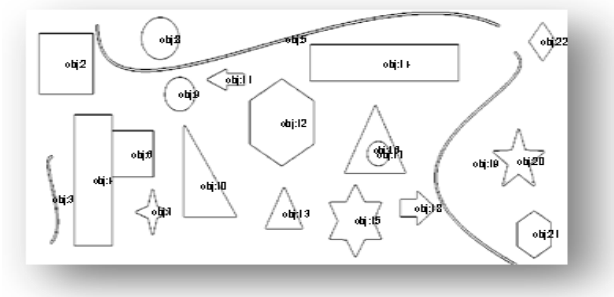

Fig. a (II) showing the segmented objects containing in the image

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In this figure a (II), the output of figure a (I) is shown where this algorithm extracts the boundary of each object. Merged objects are identified by extracting the boundaries of objects. After this feature extraction process is used.

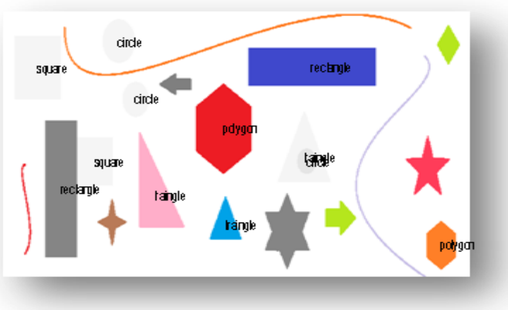

Fig. a (III) showing the predicted shapes of Objects

For the shape recognition of objects match the features of the objects with the predefined data in prediction table. The objects whose shapes are predicted are shown in figure a (III). It also solves the problem stated in the problem statement, where the rectangle and square are merged with each other.

(b) For recognizing the shapes of objects which are not recognized by human vision

From the above mentioned technique, the objects which are merging together can be predicted. But the same algorithm can be used to predict those objects which are not recognized by the human vision. In the figure b (I), a number of distinct objects are present in it which is difficult to visualize by human. These objects are having the slightly different colour intensity from the background so it is not visualized by human vision. Figure b (I) input image containing objects whose shape is to be predicted. The results are shown in figure b (II) and figure b (III).

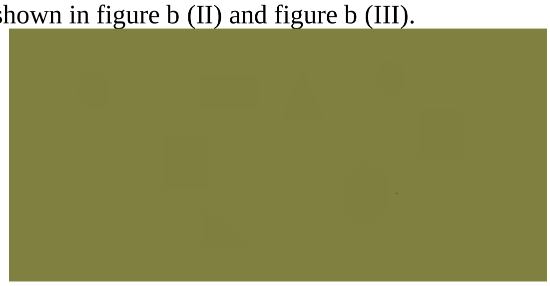

Fig. b (I) Input images containing the Objects

Using oversegmentation scheme the shapes of those objects are predicted that are not recognized by human vision. Figure b (II) is showing the individual shapes of objects that are present within the image without the colour intensity.

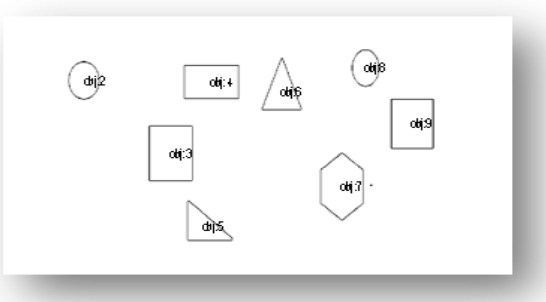

Fig. b (II) shows the objects that are not recognized by human vision in the above image

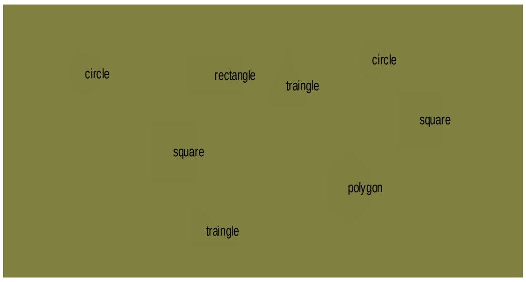

Fig. b (III) Image shows recognized shape of objects

From figure b((III) this algorithm extracts the boundary of objects that are present in the image b (I).And now all the objects can be seen in the image. Because of the change in colour intensity of objects from its background, the objects seems to be merged in the image but for predicting the shape of objects, match the features of objects in the image b (II) with the predefined data in the prediction table. The predicted shapes of the objects are shown in figure b (III).

VI. EXECUTION TIME OF ALGORITHM

We have performed numerous experiments using the described shape recognition approach. The proposed technique is tested on different image categories and satisfactory results have been obtained.

This algorithm also computes the execution time for predicting the shape of different objects. This figure 2 shows that how much time is taken by the algorithm for predicting the shapes of different objects. Execution time of the algorithm (sec.) is determined with respect to the size of images (MB). The execution time depends on the size of the image and number of objects present in the image.

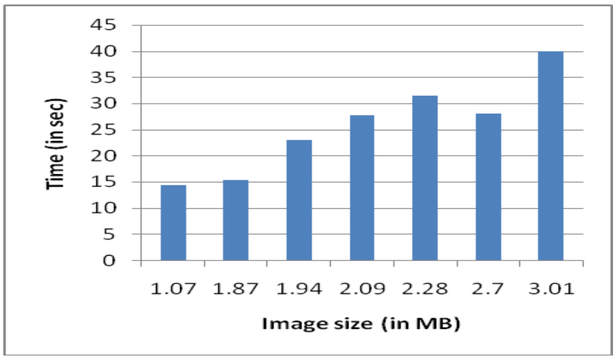

Fig.2

The image size of 1.07 MB takes 14.29 sec for execution. The image size of 1.87 MB takes 15.26 sec. for execution. The image size of 1.94 MB takes 23.04 sec for execution. The image size of 2.09 MB takes 27.76 sec for execution. The image size of 2.28 MB takes 31.46 sec for execution

In the above mentioned graph we can see the image having a size of 2.70 MB takes less time for execution in comparison to the image size 2.28 MB although the image size is more because of the size of 2.28 MB having 17 objects present in the image and image size of 2.70 MB having 14 objects present in the image. From this we conclude that the execution time most probably depends on the number of objects contained in the image.

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VII. ACCURACY

The accuracy of the proposed shape recognition algorithm to predict the shapes of different objects depends on false detection and true detection of objects in the given image.

Table. II Accuracy

Images	False detection of objects (FD)	True detection of objects (TD)	No. of objects present in the image	Recognition rate
Image 1	2	11	13	84.61%
Image2	4	12	16	75%
Image3	0	11	11	100%
Image 4	3	13	16	81.25%
Image 5	1	10	11	90.90%

Accuracy is calculated as =

$$\sum_{i=1}^{n} \frac{\Sigma TD \times 100}{\Sigma FD + \Sigma TD}$$

Where, i= Image 1.
TD= True detection of objects in the image.
FD= False detection of objects in the image.
n= Total number of images.

A high recognition rate, of approximately 86.55%, is achieved by our method. It represents a better rate that those of many other object recognition approaches. The accuracy of this algorithm is 86.55%.

VIII. CONCLUSION

A shape recognition technique using feature matching scheme has been presented in this paper. As we have mentioned in the introduction, our article has focused on object shape recognition, and not on the image object detection issue, therefore by integrating the method of oversegmentation with the shape recognition technique we have predicted the various shapes like circle, polygon, triangle ,square and rectangle.

The identification of the proper number of shape clusters automatizes the classification method, which represents a very important thing. That means our recognition technique can be used successfully for very large sets of images, containing a high number of shapes.

The execution time for different size of images is also evaluated. With use of the above mentioned mathematical formula it has predicted accuracy of the algorithm it gives a satisfactory result .Therefore our shape recognition approach is very useful in some important computer vision application areas, such as shape-based indexing of large image databases and object retrieval from these databases. The performed experiments, producing a satisfactory recognition rate, prove the effectiveness of the proposed technique.

IX. FUTURE WORK

With the use of this shape recognition approach we have successfully predicted various shapes of the objects but to improve the recognition rate and reducing the process complexity represent some task of our future work in the shape analysis domain and to deal with overlapping objects and by making the changes in the colour intensity.

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