Shape Prediction Linear Algorithm Using Fuzzy

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***Abstract*— The goal of the proposed method is to develop shape prediction algorithm using fuzzy that is computationally fast and invariant. To predict the overlapping and joined shapes accurately, a method of shape prediction based on erosion and over segmentation is used to estimate values for dependent variables from previously unseen predictor values based on the variation in an underlying learning data set.**

Keywords- Shape prediction; Shape recognition; Feature extraction.

I. INTRODUCTION

Shape prediction represents an important domain of recognizing image objects, based on their shape information.[1] The Prediction of the original shape by efficient and accurate algorithm for connected or overlapping objects in an image leads to the decreased algorithm execution time and elapsed time. Each image contains up to several hundred objects, which were manually arranged not to overlap or touch each other. The algorithm is divided into two stages. In the first stage multiple thresh-holding values for the image are defined. Over segmentation and erosion is applied on binary image to erode away the boundaries of regions of foreground pixels.[9] And in the second stage features of the current object whose user is going to predict the shape are matched with the preloaded features in data set.[7] The equivalence distance to which the current object matched in data set is considered.

A. Morphology

The term Morphology refers to 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. In a morphological operation, the value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors. By choosing the size and shape of the neighborhood, you can construct a morphological operation that is sensitive to specific shapes in the input image.[2] Morphological operations affect the structure or shape of an object. All these operations are applied on binary images.

B. Structuring Element

Structuring element consists of matrix of 0's and 1's. Its size is smaller than the image and its origin identifies the pixel to be processed. The structuring element used for processing the images under prediction is disk shaped.[10]

If A and B be two sets in Z^2 then,

$$A \oplus B = \{ \mid (B)_z \cap A \neq \phi \}$$

Where A is image and B is the structural element.

C. Morphological Operations

The two principal morphological operations are dilation and erosion.

1) *Dilation*

Dilation allows objects to expand, potentially filling in small holes and connecting disjoint objects. Structural element of S is applied to all pixels of binary image. Every time the origin of the structural element is combined with a single binary pixel, the entire structural element is wrapped and subsequent alteration of the corresponding pixels of binary image.[3] The results of logical addition are written into the output binary image, which was originally initialized to zero.

$$A \oplus B = \{Z \mid [(B)_z \cap A] \, \varepsilon \, A \}$$

2) *Erosion*

Erosion shrinks objects by etching away (eroding) their boundaries. When using erosion structural element also passes through all pixels of the image.[4] If at a certain position every single pixel structuring element coincides with a single pixel binary image, then the logical disjunction of the central pixel structuring element with the corresponding pixel in the output image.

The method of erosion for prediction of overlapping and connecting images is specially used in this algorithm to increase the efficiency and improve execution time.

$$A \oplus B = \{Z \mid [(B)_z \, \varepsilon A]$$

Where A is an image and B is structuring element in Z^2.

D. Fuzzy Logic

A fuzzy system is represented by if-then rules in the form:

$$\text{If } i_1 \text{ is } vi_{1,1} \text{ and } \cdots \text{ and } i_m \text{ is } vi_{m,1}$$

$$\text{then } o_1 \text{ is } vo_{1,1} \text{ and } \cdots \text{ and } o_n \text{ is } vo_{n,1}$$

Where m is input and n is output, r is fuzzy rules in the system. The rules r defines the fuzzy rules which is an exponential function of the number of the inputs *i* and the number of linguistic values *l* taken by input.

$r = l^i$

If a fuzzy system has n inputs and single output then its fuzzy rules can be of the form:

$$\text{If } X_1 \text{ is } A_{1j} \text{ and } X_2 \text{ is } A_{2j} \cdots \text{ and } Xm \text{ is } A_{jm}$$
$$\text{then } Y \text{ is } B_j$$

E. Dataset

It is a collection of data elements. The following name/value pairs are used when a dataset is constructed:

1. VarNames: This gives the variables with the specified variable names.

{name_1,...,name_m}

2. ObsNames: This gives the n observations in A with the specified observation names.

{name_1,...,name_n}

II. Operational Stages

The techniques to estimate values for dependent variables from previously unseen predictor values based on the variation in an underlying learning database are used to predict the objects in the shape.

Main focus of work is to predict the shape by defining morphological operation which describes all boundary points of a shape. Development and Prediction of the shape by efficient, accurate, computationally fast and invariant algorithm for connected or overlapping objects in an image is the main consideration so that execution time and elapsed time is decreased.[6]

F. Basic Steps

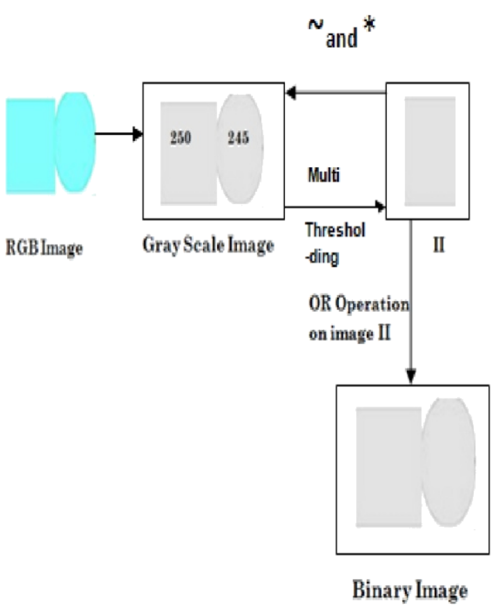

Figure1: Basic Steps Levels of algorithm are as under,

Level 1

1. Read Image: First step is to read the RGB image and convert that image to gray scale image by defining multi-thresholding.
2. Over segmentation: Next step is to do over-segmentation and convert the image to binary image.
3. Erosion: Apply erosion on binary image to erode away the boundaries of regions of foreground pixels (*i.e.* white pixels). Thus areas of foreground pixels shrink in size, and holes within those areas become larger.[5]
4. Feature finding: Find the features and edges for the current image that will be done with the help of fuzzy logic operations and will be loaded into memory for use whenever it is needed.

Level 2

The features of the current object whose user is going to predict the shape are matched with the preloaded features in data set. The equivalence distance to which the current object matched in our data set is considered.

III. Shape Prediction: The Algorithm

The detailed algorithm is described as,

1. Read an RGB image.

I= r(x,y), g(x,y), and b(x,y), a collection of image functions.

2. Convert an RGB image to a gray scale image.

J = rgb2gray (I)

Where J and I represents gray scale and rgb image

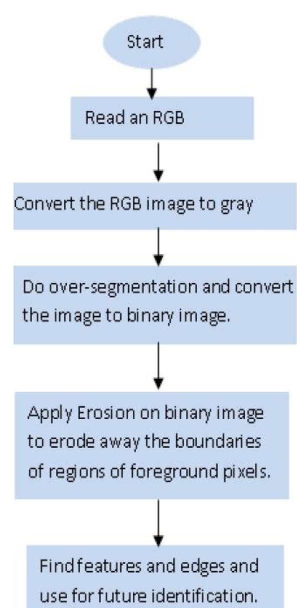

Figure2: Operating Stages for Level 1

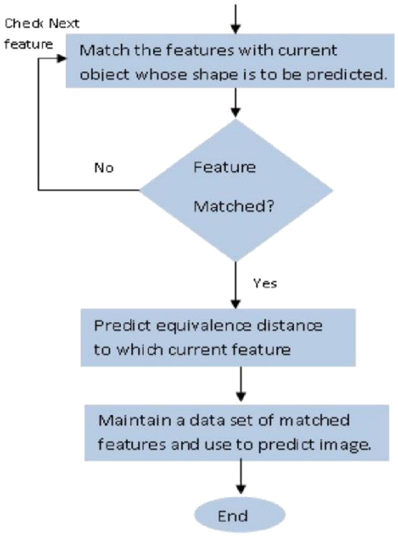

Figure3: Operating Stages for Level 2

3. Reduction to the information to make the processing of the visual data by defining threshold value.[8]

a) Defining Threshold value:

A new threshold is created that is the average of m_1 and m_2

$T' = (m_1 + m_2)/2$

where, m_1 *= average value of* G_1,

m_2 *= average value of* G_2 *and* G_1

$=\{f(m,n):f(m,n)>T\}$ *(object pixels)*

$G_2 = \{f(m,n):f(m,n)<= T\}$ *(background pixels)*

f(m,n) is the value of the pixel located in the m^{th} *column,* n^{th} *row.*

b) Defining a structural element:

SE = strel(shape, parameters)

4. Apply Erosion on binary image.
5. Find features and edges.
6. Predict equivalence distance to which current feature matches. The minimum value among all predicted values is considered.
   $d = \sqrt{(x - a)^2 + (y - b)^2}$ $z = min(d)$

where z is the minimum value and x represents the predicted values.

7. Establishment of the Prediction Table *prtbl* by using fuzzy method.
8. Use table *prtbl* for future identification and Match the features with current object whose shape is to be predicted.

Table1: Table prtbl for the predicted time values

Objects/Image	Predicted Time				
	Circle	*Triangle*	*Rectangle*	*Polygon*	*Eclipse*
10	5.77	5.22	5.28	6.18	5.43
13	9.60	8.85	8.36	9.16	8.54
13	7.86	7.21	7.22	8.18	7.50
15	8.76	8.32	8.19	9.52	8.24
15	9.13	8.60	8.62	9.72	8.75
15	8.62	8.09	8.01	21.76	8.18
16	9.96	9.13	9.19	18.86	9.47
17	11.18	9.99	9.94	11.40	10.35
17	10.54	18.64	9.59	26.01	9.99
22	13.94	29.49	23.20	33.50	13.24
692	60.35	190.99	185.02	189.41	199.66

The predicted time values Table1 above shows the predicted values for time which may vary depending upon input images and number of objects per image.

IV. RESULTS

For the purpose of testing the Shape Prediction algorithm, different input values are considered.

1. Output surface for circle:

Output surface of image with values for circle by taking Number of objects on x-axis and Time taken on the y-axis.

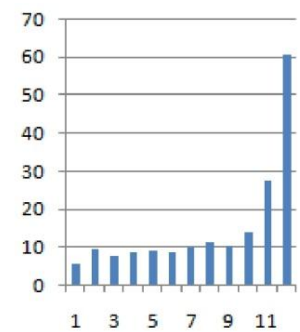

Figure4: Output surface for circle

This output surface shows the variation in the values of circle predicted in all the images. The predicted values vary as the number of objects in the image increases.

2. Output surface for eclipse:

Output surface of image with values for eclipse by taking Number of objects on x-axis and Time taken on the y-axis.

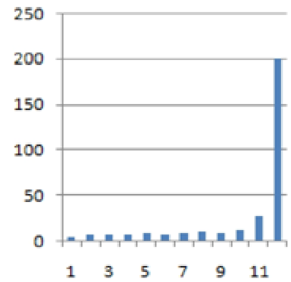

Figure5: Output surface for eclipse

This output surface shows the variation in the values of eclipse predicted in all the images. The predicted values vary as the number of objects in the image increases.

3. Output surface for polygon:

Output surface of image with values for polygon by taking Number of objects on x-axis and Time taken on the y-axis.

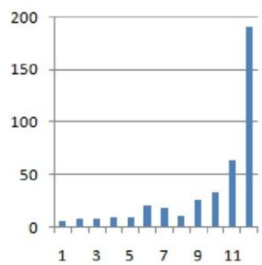

Figure6: Output surface for polygon

This output surface shows the variation in the values of polygon predicted in all the images. The predicted values vary as the number of objects in the image increases.

4. Output surface for rectangle:

Output surface of image with values for rectangle by taking Number of objects on x-axis and Time taken on the y-axis.

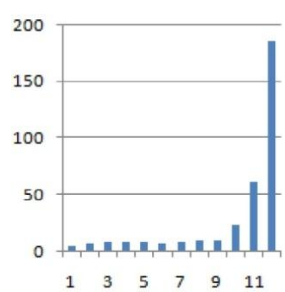

Figure7: Output surface for rectangle

This output surface shows the variation in the values of rectangle predicted in all the images. The predicted values vary as the number of objects in the image increases.

5. Output surface for triangle:

Output surface of image with values for rectangle by taking Number of objects on x-axis and Time taken on the y-axis.

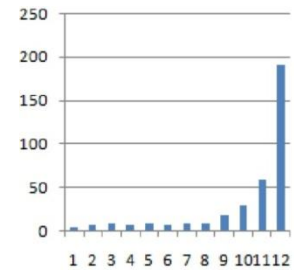

Figure8: Output surface for triangle

This output surface shows the variation in the values of triangle predicted in all the images. The predicted values vary as the number of objects in the image increases.

6. Combined output surface for values of Circle, Eclipse, Polygon, Rectangle and Triangle:

The number of objects per image can be any; here the considered objects per image are 5.

Output surface of image with values for all objects as combined image by taking number of objects on x-axis and time taken on the y-axis.

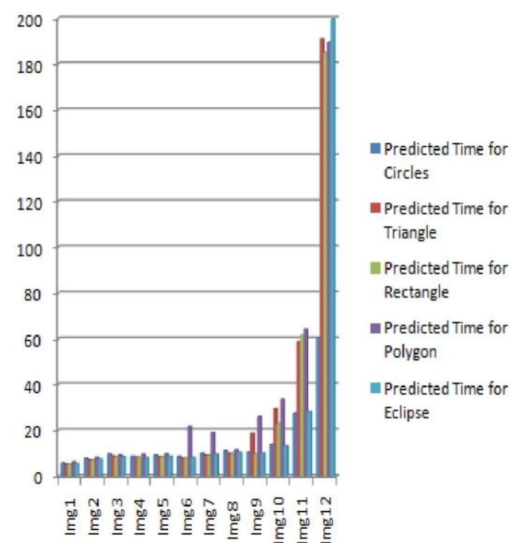

Figure 9: time taken and number of objects recognized

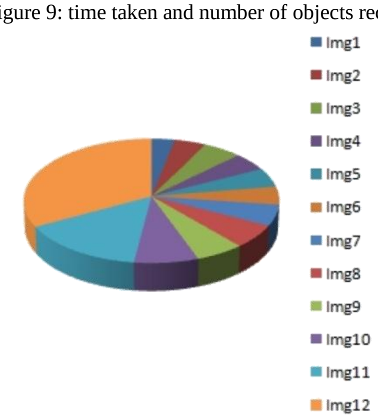

Figure10: Pie chart representation for Combined output surface

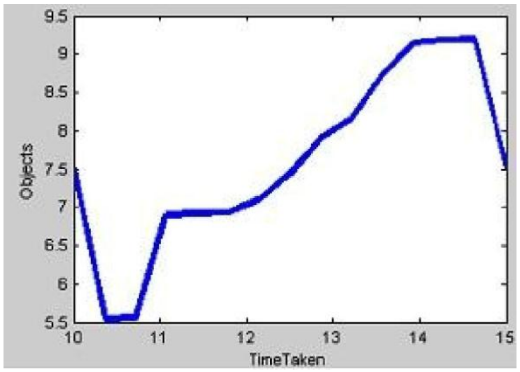

Figure11: Output surface of time taken and number of objects recognized by defining fuzzy rules

V. EXPERIMENTAL RESULT

Technique used to extract characteristics in order to get the prediction characteristic of different shapes. 12 samples are extracted randomly for each of the five kinds of shape to work out the statistical distribution rule of the characteristic value. The image quality measures like PSNR, MSE etc. are used to find the correct recognition values for objects of image and at last the predicted values used to get the recognizable results, as shown in table 2. It can be seen that the correct recognizable rates of eclipse, triangular, rectangle and circular shapes all exceed 90%, and the total correct recognizable rate amount to 94.5%. Table2 gives the recognizable results of shape prediction based on fuzzy method.

Table2 The recognizable results of shape prediction based on fuzzy method

Correct recognition number	Correct recognition rate (%)	Total recognition rate (%)
4.9	95	94.50
4.7	95	
4.8	95	
7.1	93	

VI. FUTURE SCOPE

In this paper, the shape prediction method based on fuzzy is proposed. This method efficiently recognizes the different individual and overlapping objects. The utilization of proposed method could be in robotics, in which robots are used to predict the objects which could remain unpredicted from human. Image definition can be done to define the image based on characteristics of objects predicted.

This recognizable prediction method based on fuzzy can reflect different shapes objectively and correctly, so the total automatically recognizable rate arrives at 94.50%.

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