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Recognition of Overlapped 2D Geometrical Objects

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Abstract— In this paper the main focus is to study the techniques to detect or recognize the geometrical objects which are overlapped or merged with each other and to find out the best possible way to determine their respective shapes. Object detection is the process or technique of finding occurrence of real-world objects such as faces, objects, bicycles, and buildings in images or videos. Algorithms used for object detection typically use extracted features and learning algorithms to detect instances of an object division. It is commonly used in different applications such as image retrieval, security and automated vehicle parking systems. In meantime there are various different techniques available to detect object of a particular geometric shape from 2D images. But they are not much reliable techniques that identify features of objects of an image and recognize the object having geometric shape like circle, square, rectangle and triangle and other shapes. Object detection plays an important role in image processing, It helps in to identify any particular object .Object detection is basically used to identify an individual object from number of objects in an image. The proposed system includes a new algorithm to separate the touching and overlapping circles edges based on the radius range. Initial attempt include finding circles by increasing detection sensitivity and final step, include finding the dark and bright circle edges by lowering the values of edge threshold.

Keywords- *shape detection, radius range, edge thresholding, contrast sensitivity, circle recognition*

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I.INTRODUCTION

As we developing technology changes rapidly. New methods are being employed in industrial manufacture and inspection every day. Earlier there was a time when manual labor was in much demand in the industries for jobs like packaging, inspection. This was a repetitive process. Now it is the need of time for automated machines to take over these simple jobs and make them more efficient in every manner. Today the sensors are one of the most important parts of automation industry and for our lives. They provide output for the controllers to take action based upon the inputs received [2].Various kinds of sensors like humidity sensor, infrared, ultrasonic sensor, camera etc. are easily available in markets for individual use. High precision is a must for better feedback of these sensors. Cameras are being used for Image Processing which finds tremendous application in the field of automation industry. It captures the images or streams live video and then they are being processed as per the needs of those applications [2].

Before trying to understand the concept of object recognition and detection the very first thing is to understand the concept of an image. Images are actually a two-dimensional signal and it can be represented mathematically as F(x, y) where x and y are the two coordinates, vertically and horizontally. Basically, the particular point i.e. F(x, y) is the value of the pixel. The basic term which includes in an image is a pixel i.e. a smallest element found in an image and the point F(x, y) represents the particular value of that pixel. Pixel can store a value that is proportional to the intensity of the light at a particular location. As image is a two dimensional visual signal, we can describe signal as the quantitative measurable item over the space and time. Thus, it can be one-dimensional, two-dimensional, three-dimensional or higher dimensional too and can be discrete or analog [5].

Images plays very crucial role in human perception .Vision is the most advanced feature in human senses. Human are bound to optical band of electromagnetic spectrum but this is not crucial in the case of imaging machines, as imaging machines can spread almost the total electromagnetic spectrum (radio waves to gamma waves). The images generated by the sources can also be supervised by this. These consists electron microscopy and computer generated images and ultrasound. So, because of the above reasons we can grow many applications in various fields. [4].This paper consists following processes.

A. IMAGE PREPROCESSING

The preprocessing method is used to modifying the image for Best matching to their reference image. Noise removal is the one of the prior preprocessing techniques. For noise removal a number of methods are Mean filter, Gaussian filter, median filter, etc. The Gaussian filter has been used for noise removal. The Gaussian smoothing filter is very good filtering for removing noise in an image [6]. The zero mean Gaussian function in one dimension is

$$g(x) = e^{\frac{-x^2}{2\sigma^2}}$$

When the Gaussian is spread parameter sigma figures the width of the Gaussian. For image processing, the zero mean 2 dimension discrete Gaussian function is

$$g(i,j) = e^{\frac{-(i^2+j^2)}{2\sigma^2}}$$

B. RADIUS RANGE

To search for the circles we need to find out the radius range. So, that we can detect their centers. An easy way to find the relevant radius range is to use the interactive tool `imtool` to get an approx. estimation of the radii of various objects presented in an image.

C. SENSITIVITY FACTOR

Sensitivity which can be used to handle this internal threshold and the sensitivity of the algorithm. A higher Sensitivity value concludes the detection threshold lower and directs to recognize more circles. This is very similar to the sensitivity control systems on the motion detectors which used in home security systems. Overlapping object boundaries are usually challenging scenarios for object detection in an image.

D. EDGE THRESHOLD

The 'Edge Threshold' parameter handles how *high* the gradient value at a pixel has to be before it is considered an edge pixel and included in computation process. A high value will allow only the strong edges (higher gradient values) to be included, whereas a low value is more permissive and includes even the weaker edges (lower gradient values) in computation process. In case of the missing yellow circles, since the contrast is very low, some of the edge pixels are expected to have low gradient values. Therefore, lower the 'Edge Threshold' parameter to ensure that the most of the edge pixels for the yellow circle are included in computation process.

II.EXISTING TECHNIQUES

A number of techniques which are available to detect or recognize the overlapped circular objects in an image include Hough transform, feature extraction, segmentation, morphological operations and many more.

The **circle Hough Transform** is a feature extraction technique for detecting or recognizing circles. The main aim of the technique is to detect circles in imperfect image. The circles are generated by "voting" in the Hough parameter space and then select the local maxima in an accumulator matrix. In a 2-D space, a circle can by described by:

$$(x-a)^2 + (y-b)^2 = r^2$$

Where (a,b) is the center and r is the radius of the circle. If a two dimensional point (x, y) is fixed, then the parameters can be found according to the given equation. The parameter space would be 3-D, (a, b, r). And all the respective parameters that satisfying (x, y) would lie on the surface of an inverted right-angled cone whose apex is at (x, y, 0). In the three dimensional space, the circle parameters can be recognized by the intersection of many conic surfaces that are defined by points on the two dimensional circle [8].

Feature extraction is a specific form of dimensionality reduction. When the input data to an algorithm is too large to be refined and it is uncertain to be notoriously redundant then the input data will be converted into a reduced representation set of features also named as feature vector. Altering the input data into the set of features is called feature extraction. If the features extracted are wisely chosen it is expected that the features set will extract the significant information from the input data in order to accomplish the desired task using this reduced representation instead of the full size input [7].

Image segmentation is the method of isolating an image into various parts. Segmentation refers to the process of partitioning a digital image into the different segments (set of pixels as known as super pixels). The goal of segmentation is basically segment an image into something that is more meaningful and easier to analyze [3].This is usually used to recognize objects or extra relevant information in digital images. The following categories are used:

Threshold based segmentation: It is basically used to segment an image on the basis of their threshold value. Thresholding methods replace each pixel in an image with a black pixel if the image intensity $I_{i,j}$ is less than some fixed constant T (that is, $I_{i,j} < T$), or a white pixel if the image intensity is greater than that constant [3].

Edge based segmentation: The edge-based segmentation can simplify the study by considerably minimizing the amount of pixels from an image to be processed, while still preserving adequate object structures. It is also used to find the object boundaries and then locate the object itself by filling them.

Region based segmentation: Region growing is a easy region-based image segmentation method. It is also classified as a pixel-based image segmentation technique since it involves the selection of initial seed points. These approaches to segmentation determine neighboring pixels of initial starting points and determine whether the pixel neighbors should be added to the region.

Clustering Techniques: Clustering is basically used where the gray-level samples are clustered in two parts as background and foreground (object), or alternately are modeled as a combination of two Gaussians.
Here, we use threshold based segmentation to find the threshold value to divide an image into two parts contain low contrast and high contrast regions.

Morphology is a wide set of image processing process that measure images based on their shapes. Morphological operations apply a standard element to an input image, to generate an output image of the same size as input. The most basic morphological operations are erosion, dilation, open and close. Dilation adds extra pixels to the edges of objects in an image, while erosion removes extra pixels on object edges. The number of pixels added or removed from the objects boundaries in an image relatively depends on the size of the standard element used to measure the image [4].

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III.PROPOSED ALGORITHM

The proposed method basically works to detect the edges of circular objects which are merged with each other in an image. It basically determines the radius range for searching circles. The algorithm is explaining to detect the different radius range of overlapped circles present in an image. If the circles present in an image are of different contrasts then we apply the contrast sensitivity technique to detect all the 'Dark' or 'Bright' circles The steps of presented algorithm are:

1. Firstly, initialize an image. Then apply preprocessing technique.
2. Determine the radius range for every circle present in an image
3. Find all the circles present in that radius range.
4. Now increase the sensitivity factor to determine all the circles of high or low contrasts.
5. Draw the edges around the circles.
6. Find out the edges of all dark or bright circles present in an image by lower the 'Edge Threshold' parameter to ensure that the most of the edge pixels are included in computation.

IV.EXPERIMENT AND RESULT DISCUSSION

To verify the efficiency of the method, in the present paper for detecting the shapes and edges of merged or overlapped circles.

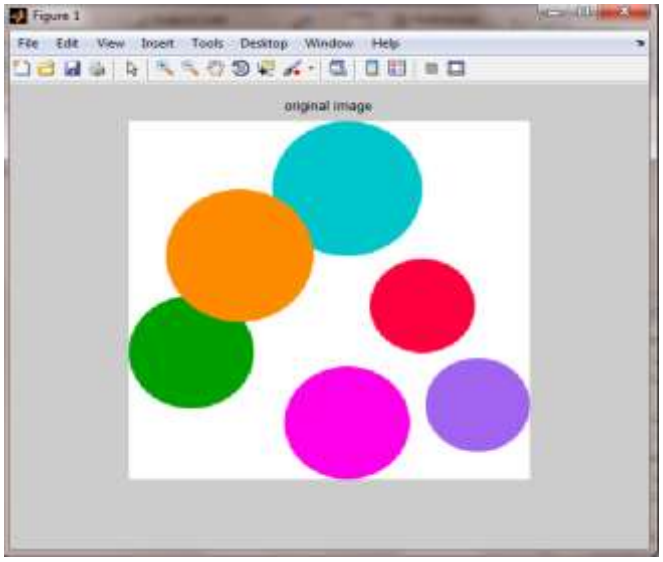

Figure 1. Original Image

As we have seen in figure 1, this is the original overlapped image of circles. In which we have to detect or recognize their respective edges in which they are merged together.

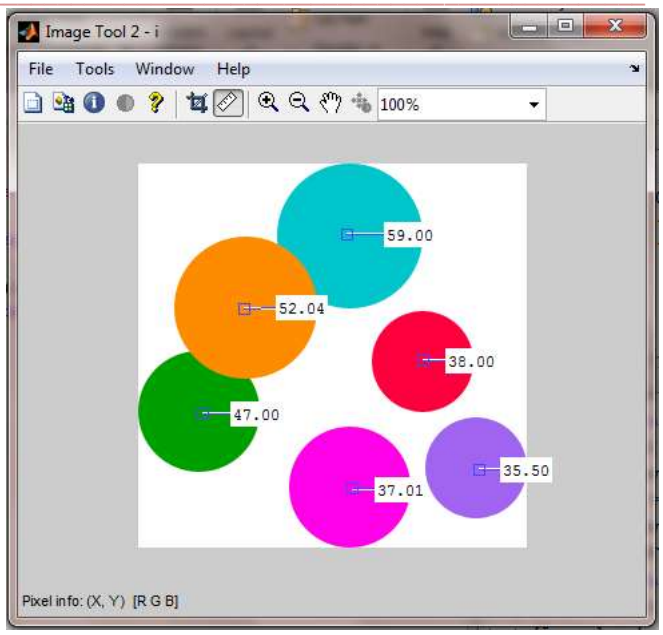

Figure 2. Radius range of every circle

As above figure 2, mentioned the radius range of every circle presented in an image. The command which is used to find out the circles needs a radius range to search for the circles. An easy way to find out the appropriate radius range is to use the interactive tool to get an approximate estimate of the radii of various objects present in that image.

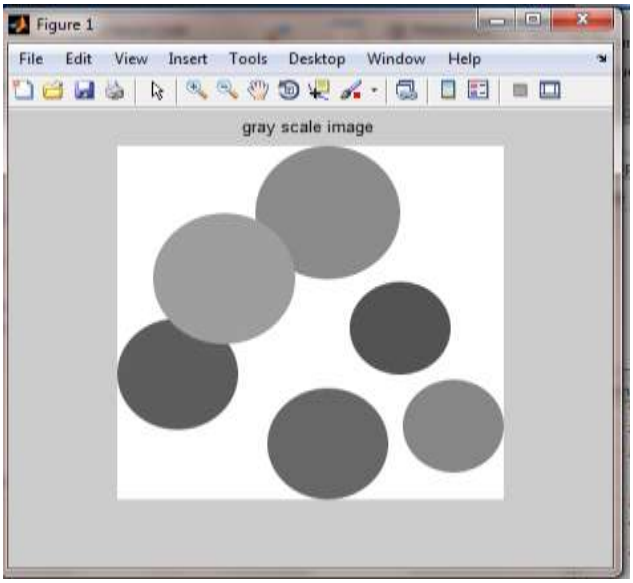

Figure 3. Gray scale Image

As shown in figure 2, this is the gray scale image to detect whether the objects are brighter or darker than their respective backgrounds.

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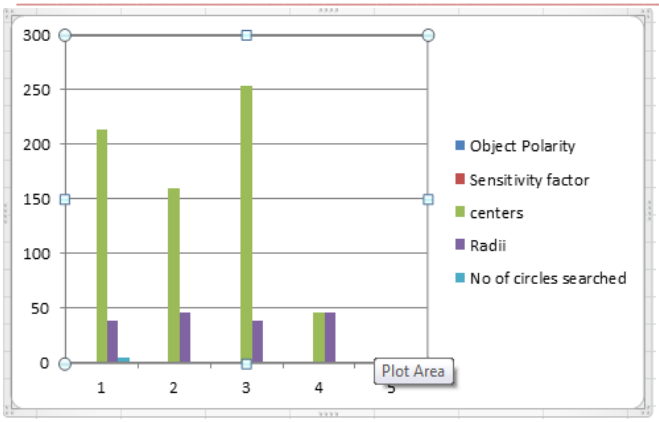

Figure 4. Bargraph of showing no of circles found when sensitivity factor is 0

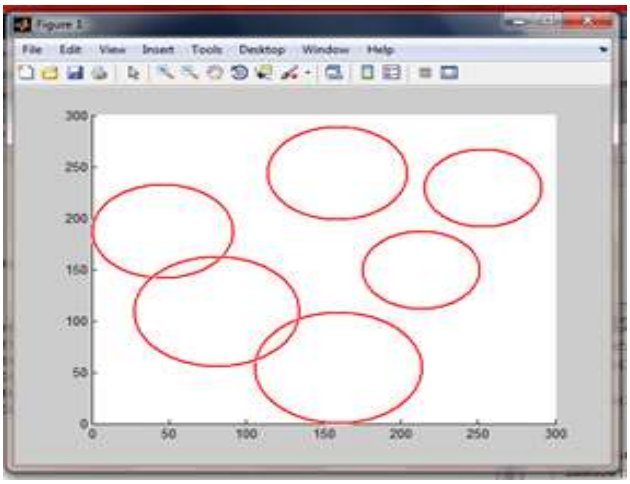

Figure 5. Circle boundaries

As in figure 4, here the function is used to draw the boundaries of overlapped circles present in an image. The circle centers and their radii seem to match well on every object.

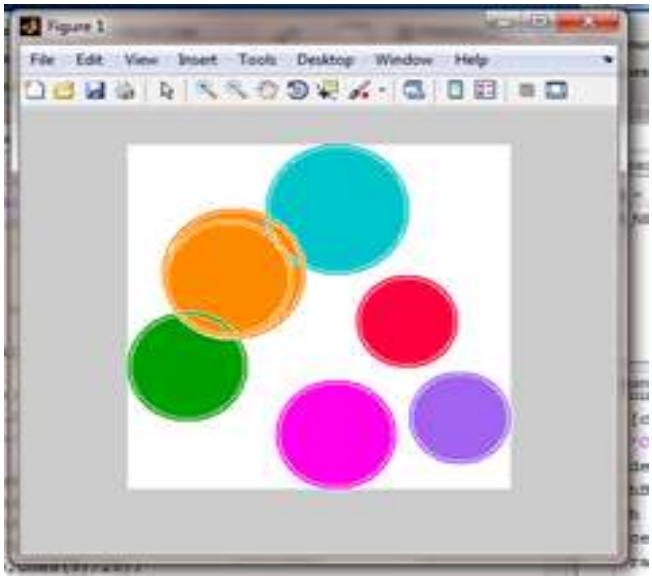

Figure 6. Proposed Method Image

In figure 6,the Proposed method shows the result where method is detecting all the circles at the Sensitivity of 0.95.here we are lowering the 'Edge Threshold' parameters to ensure that the most of the edge pixels for the yellow circle are included in computation. All the circles are finally detected successfully.

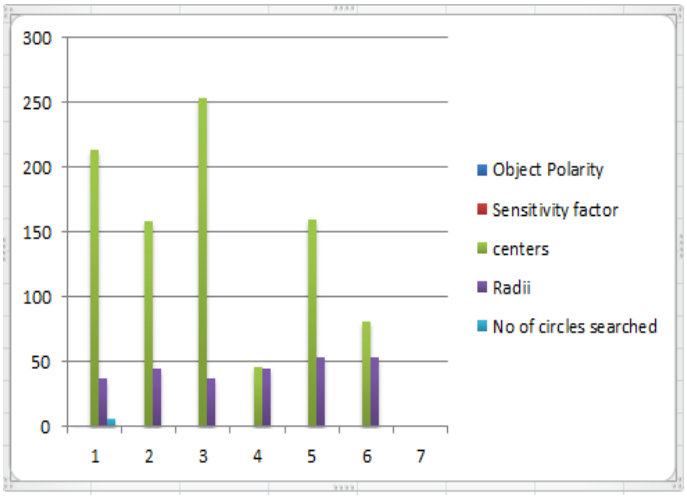

Figure 6. Bar graph of showing no of circles found when sensitivity factor is 0.9

Table 1. Object polarity, sensitivity factor, centers and radii of circles, no of searched circle edges.

Object Polarity	Sensitivity factor	centers	Radii	No of circles searched
'Dark'	0	213.4955 149.4936 159.0090 243.9905 253.4933 229.5005 45.8653 187.1740	38.0031 45.4705 37.9695 45.5190	4
'Dark'	0.9	213.4955 149.4936 159.0095 243.8795 253.4933 229.5005 45.9923 187.0060 159.7261 54.6200 81.0822 109.0318	38.0031 45.4705 37.9695 45.5190 53.9823 53.5790	6
'Bright'	0.95	6	2	6

The Table 1 shows the result of the proposed method, in which it includes the object polarity, their sensitivity factors, centers and radii of the following overlapped circle and finally it searched the no of circles present in an original image.

V.CONCLUSION AND FUTURE WORK

In the proposed paper we are predicting and recognizing the overlapped circles boundaries. Object shape prediction and recognition is used to detect an individual object from a series of objects in an image .The proposed system includes a new algorithm to separate the touching and overlapping circles edges based on their radius range. In future work, algorithm can used on other images to predict the boundaries of the various shapes like circle, polygon, triangle, square and rectangle.

VI. REFERENCES

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