OBJECT IDENTIFICATION USING FOVEAL EXPLORATION

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Abstract— In human vision, interpretation is the main phase which analyses the small instantaneous image projected onto the foveal region in eye. Human eyes analyzes the object using different features like edges, corners etc. An edge can be defined as the sharp change in intensity or brightness. Edges can occur on the boundary of the objects and in between the objects. Human eyes are more attracted to corners than edges. It provides an important cue factor to the object identification. Boundary forms the outline of an object from which we can easily interpret the object. From these three cue factors the shape details of an object can be identified in an intelligent manner. Unlike the normal image processing where the whole image is fed as input, the work uses foveal images. A sequence of foveal exploration leads to the object identification

Keywords— Boundary Tracing, Corner, Edge, Extrapolation, Eight pixel connectedness, Fovea, Sobel.

INTRODUCTION

Human vision is an extremely powerful information processing system that facilitates our interaction with the surrounding world. Optic nerve transmits the image captured by eyes to brain. Optic nerve terminates on the lateral geniculate nucleus (LGN), which is the first relay in the brain's visual pathways. The lateral geniculate nucleus then project to the primary visual cortex, their main target. Here brain begins to reconstitute the image from the retina. The main pre processing step in any object identification systems are feature extraction. Likewise, in brain also this process happens.The actual process of feature extraction happens at the lateral-geniculate nucleus of the brain. This early level processing in human vision consists of both attentive and pre-attentive stages. In the pre-attentive stage only pop out features are detected. These are the local regions of the image which present some form of spatial discontinuity. In the attentive stage relationships between these features are found and grouping takes place. Objects are primarily characterized by distinctive shape. Shape is commonly defined in terms of the set of contours that describe the boundary of the object. Human visual system performs edge detection very efficiently. Visual image search actually progresses through foveal exploration. Through foveal exploration the whole image is interpreted. This interpretation process builds through extracting the features like edge [4], boundary, corners [2] etc.

Edge detection [11], [12] is one of the fundamental steps in object analysis and recognition. The edge detected image can provide information regarding the shape of the object. A corner can also be defined as points for which there are two dominant and different edge directions in a local neighbourhood of the point. By using both the edge and corner information we can easily identify the object. Contours can also help to explain the shape of the object. So combining the information from these areas the efficiency of the system can be improved.

The ultimate goal is to extract the shape of the object of interest. Unlike the normal image processing where the whole input image is fed as input, the system uses the foveated exploration. In foveated exploration, a small portion, that is 2 to 5 degree foveal region, is used to fill the clear picture of the object under consideration and from that region the features are extracted

LITERATURE SURVEY

Canny J (1986) proposed a computational approach for finding the edges of object efficiently [1]. This algorithm uses a bilateral filtering for smoothening the edges. This process helps in covering up the noise without losing the information content. Then it adaptively finds the low and high threshold values using OTSU method. The algorithm mainly consists of three steps. They are smoothing process using a Gaussian filter, calculating the gradient magnitude and direction and finally non maximum suppression.

Sobel I (1990) proposed an important method based on gradient values [3].The Sobel operator performs a 2-D spatial gradient measurement on an image and emphasizes regions of high spatial gradient that are edges. Typically it is used to find the approximate absolute gradient magnitude at each point in an input gray scale image.

Je De Vries (2005) introduced a novel artificial intelligence approach to object recognition [5]. Its main emphasis is on its neural elements that allow the system to learn to recognise objects about which it has no prior information. The main concepts include edge extraction algorithm to find the edge pixels in the image. The edge detection tool used is the SUSAN. The edge it produces are more solid and better connected, this will be helpful in extracting the shape of whole image. Using these edge pixels, create the contours of the shapes. In final step the shapes are extracted. Using the shape different descriptors is identified.

Wu et al (2007) described the system based on the behaviour of biological receptive fields and the human visual system [6]. A network model based on spiking neurons is proposed to detect edges in a visual image. It consists of 3 layers in which first layer represent photonic receptors where each pixel corresponds to each receptor. Intermediate layer is composed of four types of neurons corresponding to four different receptive fields respectively. The firing rate map of the output layer forms an edge graphic corresponding to the input image.

Arnow T L et al (2007) proposed a new approach to find corners in images that combine foveated edge detection and curvature calculation with the saccadic placement of foveal fixations [7]. Each saccade moves the fovea to a location of high curvature combined with high edge gradient. Edges are located using a canny edge detector with the spatial constant that increases with eccentricity. Then they computed a factor called corner strength which is a product of curvature and gradient. An inhibition factor is used to avoid visits to the regions which are previously visited. A long saccade moves the fovea to the unexplored areas of the image.

Shabab.W et al. (2009**)** they proposed a modified 2D Chain Algorithm that can be applied to color images [8]. The segmented object is used to derive the chain code [9] in the image. The proposed algorithm implements a 4 connectivity rule but differs by the fact that it is concentrated much on the position of each pixel. After necessary initializations the input image is dealt with a row wise and column wise manner suing the 4 connectivity manner. By the end of the computations the coordinates of the corners will be available. It sis found valid for shapes composed of triangular, rectangular and hexagonal shapes and the results demonstrated it could extract the coordinates of the shapes.

Reddy P R et al (2012) proposed various stopping criterions for boundary tracing algorithms [10]. The main contour tracing algorithms include square tracing, Moore Neighbour Hood tracing, radial sweep, and Theo Pavlidis algorithms. The first two algorithms are easy to implement and are frequently used. Upon analyzing the algorithms the selection of stopping criterion is important in case of all algorithms. Considering the ease of implementation and selection of stopping criterion Moore Neighbourhood algorithm found more efficient. It uses eight neighbourhood connectivity for boundary tracing.

OBJECTIVE OF THE PROJECT

The main objective of the project is to identify the shape of the object through foveal exploration. Main focus required is to the concept of both the foveal exploration and extraction of the shape. Based on the literature survey, various approaches are found for the extraction of shape. To meet the requirements of the project the following steps are adapted for foveated edge detection. As initial step a foveal region will be selected. For that region edge extraction is performed. In the edge detected image contour following will be initialised at the first non zero pixel. Contour following forms the method for foveal exploration. The trend of the contour will decide the next foveal region. The work aims at extracting the shape information with the minimum error or single pixel accuracy.

PROPOSED METHODOLOGY

The foveal colour image is fed as input to the system. As an initial step the input in the RGB format is converted to gray scale image. Then shape extraction is done using edge detection. This step facilitates the boundary tracing. Boundary tracing is done on the binary image. After completing the tracing in the foveal image, trend of the contour will decide the next fixation. Finally the concept of extrapolation is used to find the positional information that is, the position where high curvature point occurs

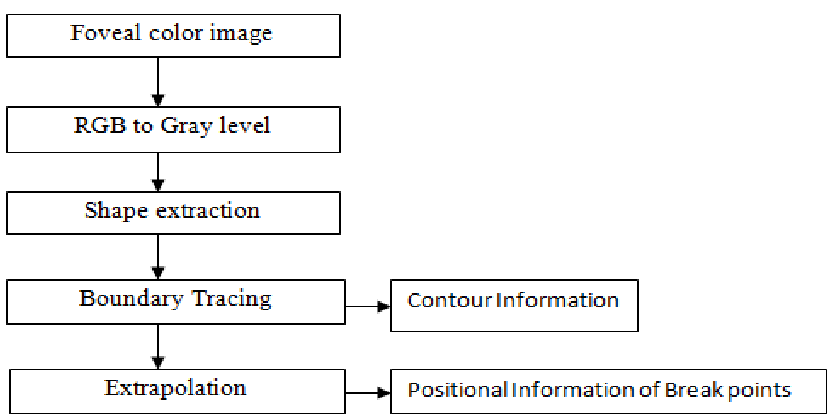

Figure 1: Methodology for the system

RGB TO GRAY SCALE CONVERSION

When converting an RGB image to grayscale, take the RGB values for each pixel and make output a single value reflecting the brightness of that pixel. One of the methods is to take the average of the contribution from each channel: (R+B+C)/3.

THRESHOLDING

Thresholding is a process of converting a grayscale input image to a bi-level image by using an optimal threshold. The aim of thresholding is to extract those pixels from any image which represent an object.

ALGORITHM USED FOR EDGE DETECTION

The Sobel operator is used in image processing, particularly within edge extraction algorithms [4]. The Sobel operator performs a 2-D spatial gradient measurement on an image and so emphasizes regions of high spatial frequency that correspond to edges. The Sobel edge detector uses two masks, vertical and horizontal. Each direction of Sobel masks is applied to an image, and two new images are created. One shows the vertical response and the other shows the horizontal response. Two responses are combined to form a single image. The purpose is to determine the existence and location of edges in an image.

The properties of derivative mask are:

- Each mask should contain opposite sign.
- Sum of each mask should be equal to zero.
- More weight means implies more edge detection.

The operator uses two 3×3 kernels which are convolved with the original image to calculate approximations of the derivatives - one for horizontal changes, and one for vertical changes.

Let us consider f(x, y) is the image grayscale distribution and G is the edge of the image gradient value and G*x* and G_y are two images which at each point contain the horizontal and vertical derivative approximations, the calculations are as follows:

$$G_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} * f(x, y)$$

$$G_y = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} * f(x, y)$$

where *here denotes the 2-dimensional convolution operation. The *x*-coordinate is defined here as increasing in the "right"-direction, and the *y*-coordinate is defined as increasing in the "down"-direction. At each point in the image, the resulting gradient approximations can be combined to give the gradient magnitude, using:

$$G=\sqrt{Gx^2 + Gy^2} \qquad (1)$$

Using this information, we can also calculate the gradient's direction:

$$\theta=\arctan(G_y/G_x) \qquad (2)$$

Sobel masks have better noise suppression characteristics and make them preferable because it is an important issue when dealing with the derivatives. Sobel operator is suitable for FPGA implementation. The quality of the Sobel edge detector is adequate enough to be used in numerous applications.

ALGORITHM USED FOR BOUNDARY TRACING

Contour Tracing also known as border following or boundary following; is a technique that is applied to digital images in order to extract their boundary. Contour tracing [10] is one of main pre processing methods done on digital images in order to extract information about their general shape. Once the contour of a given object is obtained, its different characteristics will be examined and used as features .Therefore, correct extraction of the contour will produce more accurate features which will increase the chances of correctly classifying a given pattern. The contour pixels are generally a small subset of the total number of pixels representing a pattern. Therefore, the amount of calculation is greatly reduced when we run feature extracting algorithms on the contour instead of on the whole pattern. In conclusion, contour tracing is often a major contributor to the efficiency of the feature extraction process -an essential process in the field of pattern recognition.

The following algorithm gives output as an ordered sequence of points. The Moore neighborhood of a pixel, NP, is the set of 8 pixels which share a vertex or edge with that pixel. These pixels are namely pixels NP1, NP2, NP3, N P4, N P5, N P6, NP7 and NP8.

	NP1	NP2	NP3	
	NP8	NP	NP4	
	NP7	NP6	NP5	

Figure 2: Moore Neighborhood

Given a digital pattern i.e. a group of black pixels and white pixels; locate a boundary pixel and declare it as the "start" pixel. Locating a "start" pixel can be done in a number of ways; it can start at the bottom left corner, scan each column of pixels from the bottom going upwards -starting from the leftmost column and proceeding to the right- until get a black pixel. Then declare that pixel as the "start" pixel. Without loss of generality, we will extract the contour by going around the pattern in a clockwise direction. The general idea is: every time we hit a boundary pixel, backtrack i.e. go back to the white pixel you were previously standing on, then, go around that pixel in a clockwise direction, visiting each pixel in its Moore neighborhood, until you hit a black pixel. The algorithm terminates when the start pixel is visited for a second time. The boundary pixels walked over will be the contour of the pattern.

HIGH CURVATURE POINT SELECTION

The output obtained from the boundary tracing will be a set of pixel coordinate values. By using this information we have to find the high curvature points or the break points, since the output from the gray scale image gave only wrong results. The main challenge is to find the break points. For this purpose a manual analysis is being done. From that some abrupt change is found out. To find the same abrupt change, the concept of extrapolation is found suitable.

Extrapolation is the process of taking data values at points x_1, ..., x_n, and approximating a value outside the range of the given points. This is most commonly experienced when an incoming signal is sampled periodically and that data are used to approximate the next data point. The same concept is used to find the high curvature points from the pixel coordinates. The pixel coordinate values are analyzed using the concept of extrapolation.

SIMULATION RESULTS

The following figures show the simulation output in MATLAB using simple shapes. In order to start with the simulation to show the foveal fixations the object segment is divided into 4 foveal regions. In the foveal regions the steps detailed in the methodology is done. The result found successful.

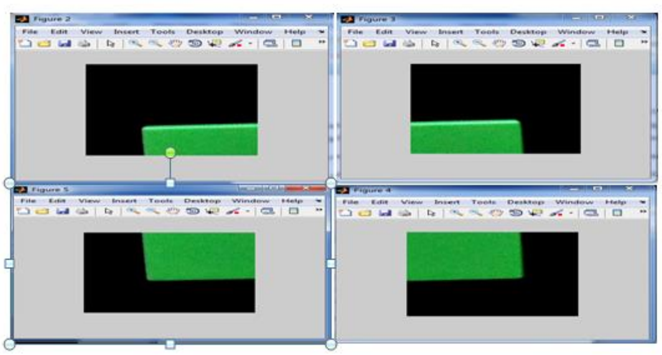

Figure 3: A square divided into four foveal regions

In the foveal images the tracing starts and the trend of the contour will decide the next foveal fixation. This continued till the object was completely detected. This results in the contour information of the object.
The fig 4 below shows the pixel coordinates of a rectangle.
Break points are also shown.

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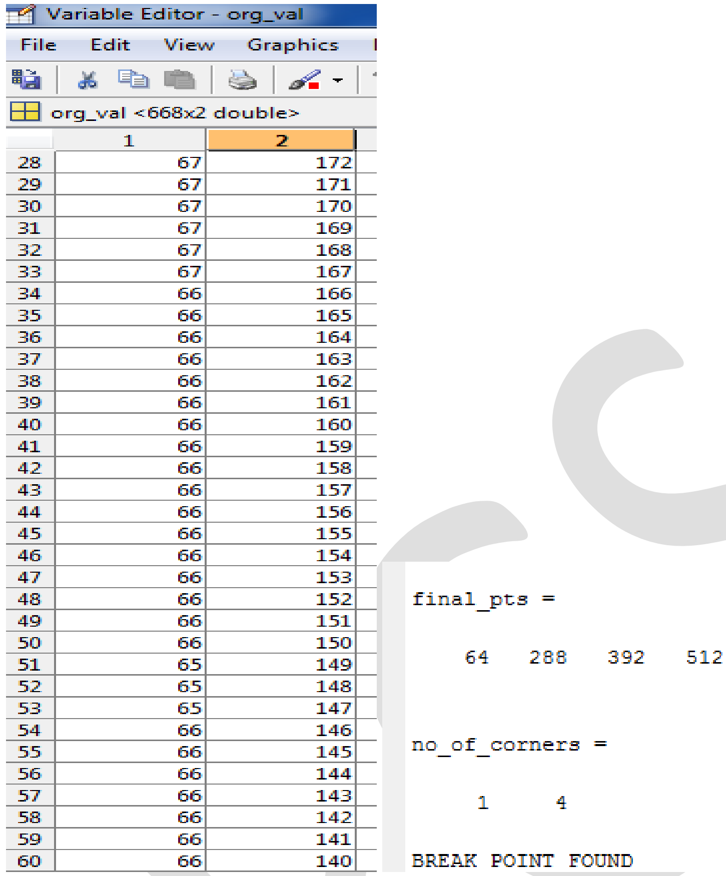

Variable Editor - org_val

File Edit View Graphics

org_val <668x2 double>

	1	2
28	67	172
29	67	171
30	67	170
31	67	169
32	67	168
33	67	167
34	66	166
35	66	165
36	66	164
37	66	163
38	66	162
39	66	161
40	66	160
41	66	159
42	66	158
43	66	157
44	66	156
45	66	155
46	66	154
47	66	153
48	66	152
49	66	151
50	66	150
51	65	149
52	65	148
53	65	147
54	66	146
55	66	145
56	66	144
57	66	143
58	66	142
59	66	141
60	66	140

```
final_pts =

    64   288   392   512

no_of_corners =

     1     4

BREAK POINT FOUND
```

Figure 4: Contour information and break points for rectangle

The next object taken into consideration was the circle. Fig 5 shows the foveal regions for the circle. Fig 6 shows the pixel coordinates and since the circle has got infinite corner point's initial and final points is taken. By plotting the pixel coordinates the object can be re created.

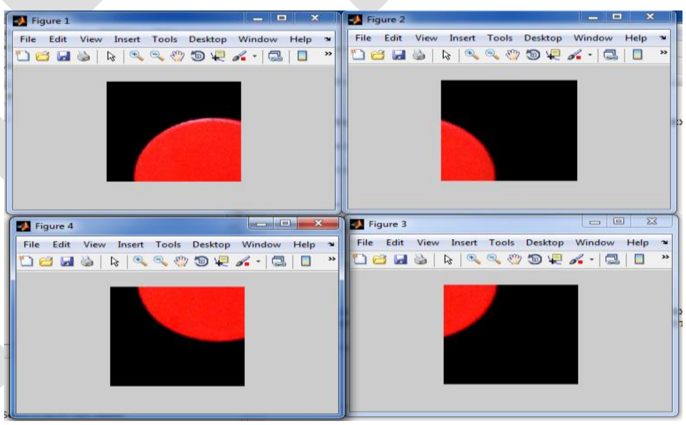

Figure 5: A circle divided into four foveal regions

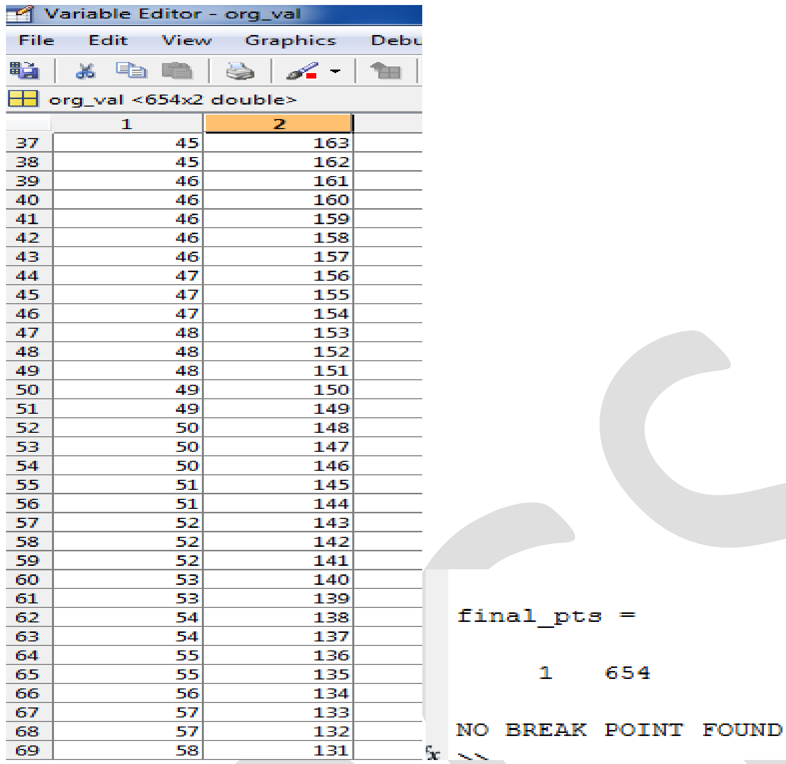

Figure 6: Contour information and break points of Circle

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CONCLUSION

By using the ideas perceived from the literature survey, the work uses three different concepts for simulating the system requirements. These include edge detection, contour tracing and high curvature point selection. The work was successfully completed on a database which consists of basic shapes like rectangle, square, triangle, circle and ellipse.

REFERENCES:

[1] J. Canny "A computational Approach for edge detection" IEEE Transactions on pattern analysis and machine intelligence, November, 1986.

[2] C.Harris and M. Stephens, "A combined corner and edge detector", In Proceedings of Alvey vision conference, pp. 147-151, 1988.

[3] SOBEL, I., An Isotropic 3×3 Gradient Operator, Machine Vision for Three – Dimensional Scenes, Freeman, H., Academic Press, pp. 376-379, 1990.

[4] R. Gonzalez and R. Woods "Digital Image processing", Addison-Wesley Publishing Company, 1992, pp 518-548

[5] Je De Vries "Object Recognition: A Shape based Approach using Artificial Neural Networks", 2005

[6] Qing Xiang Wu, Martin McGinnity, Liam Maguire, Ammar Belatreche, and Brendan Glackin "Edge Detection based on spiking neural network model", In Proceedings of Third International Conference on Intelligent Computing (ICIC), pp. 26–34, August 2007.

[7] Thomas L. Arnow and Alan C. Bovik. "Foveated Visual search for Corners " In Proceedings of IEEE transactions on Image Processing, pp.813-23, March, 2007.

[8] Walid Shabab,Hazem Al-Otum and Farouq Al-Ghoul."A Modified 2D Chain Algorithm for Object Segmentation and Contour Tracing", The International Arab Journal of Information Technology, July 2009.

[9] R.S. Vaddi, K.R. Anne,L.N.P .Boggavarapu and H.D. Vankayalapati."Contour Detection using Freeman Chain Code and Approximation Methods for the Real Time Object Detection", Asian Journal of Computer Science and Information Technology, pp. 15-17, 2011.

[10] P.Rajashekar Reddy, V.Amarnadh, Mekala Bhaskar "Evaluation of Stopping Criterion in Contour Tracing Algorithms", International Journal of Computer Science and Information Technologies, pp.3888-3894, 2012.

[11] Abid, Sabeur, Farhat Fnaiech, and Ezzeddine Ben Braiek. "A novel neural network approach for image edge detection." *In Proceedings of International Conference on Electrical Engineering and Software Applications (ICEESA)*, pp. 1-6. IEEE, March 2013.

[12] Chunting Qiu and Jing Wu. "A New method for edge detection in digital images", *In Proceedings of Ninth International conference on Natural Computation, IEEE*,pp.1234-1238, July 2013