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ECD + AHE: Edge and Corner Detection in Complex Lighting Environment by Image Enhancement Techniques

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Abstract
In this paper we focused on edge and corner detection area. Its aims to designing a reliable framework to assist edge, and corner of an object in image. As we know in present stage there are some area where we need to find the corners point those are related to Object recognition, Aeronautics, and depth reasoning. In these type of application there is need of some device which will detect the corner points using Harris corner detector and fast processing unit which is not possible by pure accurate unit so for reduction of those issue in work we need to present a Novel algorithm which involve both Edge & Corner detection with 3D map representation. Our approach (ECD + AHE), based on 2D qualitative edge profile fitting and edge consistency, will produce one continuous edge from an initial point. The goal of this work is to use edge continuity metrics to improve the detection of salient edges and corners of the foreground object in images.

Keywords: Sub pixel, Harris algorithm, corner detection.

I. INTRODUCTION

In image processing **e**dge detection mainly used for detecting and extracting the boundary features in a digital image [15]. The detection has done at the place where the image illumination changes suddenly and at the place where there will be discontinuities. Therefore, implementing edge detection algorithm on any image may significantly reduce the quantity of information to be processed and also removes the undesirable information [8]. Many edge detection techniques come into existence. These detection methods different in smooth out filters that are connected for ascertaining slope appraises in the X and Y axis.
The development of the edge detection methods based on some factors like good detection, minimal response, good localization edge detection method can be apply on gray sale images and colored images [8]. The fundamental distinction between a gray scale image and a color image is, the pixel in a grayscale image is a scalar valued function where as in color image, a pixel is considered as a vector valued function as it consists of color components (RGB). Due to this, vector valued techniques are preferred for edge detection in color images [11]. This representation of gray scale variation in 1D.

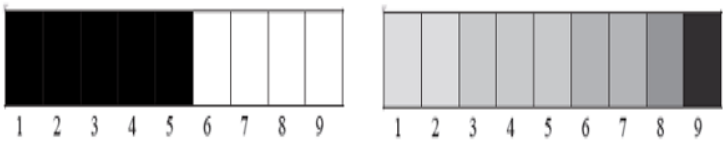


Fig. 1 Intensity variations in one dimensional image information

The corners of an object play a significant role in shape representation and analysis. Corners in an image are the points that demonstrate a strong two-dimensional intensity change, and are subsequently well recognized from neighboring points. It is desirable for a corner detector to fulfill various criteria. Every single genuine corner ought to be detected and no false corners ought to be recognized.
Applications: There are many applications where we have to use corner detection processor and those applications are: Face Recognition, Object Recognition and tracking, Compression, Medical image processing, Terrain Maps.

The reason of detecting sharp changes in image brightness is to capture significant occasions and changes in properties of the world. The objective is decomposed into three smaller objectives which can be achieved separately. Our first objective is to deal with the problem of color image. The second objective is to detection of edge and corner from complex environment with ECD + AHE. The third, also the most ambitious, objective is to be able to detect edge and corner at same time with 3D map of images reliably under completely unconstrained environments.

II. LITRATURE REVIEW

This although the major focus of this work on two tasks: Edge detection and corner detection for the sake of completeness for object in an image. This section addresses recent developments in various related methods of Edge and corner detection separately in images using the image processing [14].

Jianzhong He1 et al. [2] proposed a "Bi-Directional Cascade Network" for edge detection. They likewise presented a Scale Enhancement Module (SEM) which is utilized to create multi-scale features [13], by utilizing CNNs or explicitly fusing multi-scale edge maps. The methodology work with various layers and distinguish edges that are all around outlined by their scales. Learning scale committed layers additionally result in compact network with a small amount of parameters. They evaluate method on three datasets, i.e., NYUDv2, and Multi cue [17], BSDS500.

SmaranikaSubhasini et al. [5] presented a review, various monochrome edge detection techniques and color edge detection techniques were analyzed and compared. Some normally utilized first derivative edge operators and second subsidiary edge operators, for example, Roberts, Sobel [18], Prewitt, Compass, Laplacian of Gaussian (LoG), Canny [16], Marr-Hildreth and Haralick are talked about here and afterward the methods are additionally reached out to vector-valued techniques . In the next part some recent techniques used for color edge detection were presented. In the last section of the review, discussion of mathematical properties.

M. D. Almadhoun et al. [6] they work for Improving and measuring color edge detection algorithm in RGB color space: an enhancement of Dutta &Choudhari algorithm. An analysis of complexity, execution time and number of fundamental activities is appeared with correlation with Canny and Sobel edge detectors. The limitation of this method is the proposed algorithm needs more execution time than Sobel.

P. Dollár et al. [7] They presents a comparative study on color edge detection by utilizing various methodologies like Sobel, the Laplace, the Mexican hat operator, different realization of the Cumani operator and the Alshatti-Lambert operator. Additionally it shows an effective algorithm for implementing Cumani and Alshatti-lambert operator. Improved result is shown by using Gaussian masks with larger standard deviations instead of 3×3 mask.

Yang Qiao, et al. [9] they proposed "a sub-pixel corner detection based on improved Harris algorithm" that is improved version of Harris algorithm. According to the two basic conditions of demand of sub pixel positioning technology, first, target is not an isolated single point that has some geometric characteristics of the gray; secondly, they know the specific location of target positioning datum point.

SonamSaluja, et al. [10] presented a study of edge based image segmentation methods which provide insight into most widely used edge detection techniques of Gradient-based and Laplacian based edge detection. They also described Sobel, Robert, Prewitt, LoG, Canny detection methods. The gradient based methodologies, for example, the Prewitt have a drawback of being extremely sensitive to noise. Canny edge detection algorithm is less delicate to noise however computationally increasingly costly are contrasted with Robert's, Sobel, and Prewitt. Notwithstanding, the Canny edge detection approach performs better than every one of these operators almost under all situations.

G.T. Shrivakshan, et al. [11] in this paper they managed Gradient-based and Laplacian based edge detection techniques are compared and contextual investigation of distinguishing a shark fish type. This algorithm is important to give an errorless solution that is versatile to the diverse noise levels of these images to help in identifying the substantial image substance created by noise. Although Laplacian does the better for some features, it still suffers from mis mapping some of the lines

XintingGao, et al. [12] proposed "a novel corner location strategy for gray level images dependent on log-Gabor wavelet change (WT)" that perform decomposition at multi scales and along multi orientations. The magnitude of the decomposition are detailed into the second moment framework. Compared and the most well-known Harris detector [9], SUSAN detector and the as of late distributed detector- Gabor wavelet change based detector, the strategy demonstrates great limitation and single reaction to the higher request corner structures. The localization is improved by utilizing the optimal localization property of the log-Gabor WT.

III. PROPOSED APPROACH

This problem critically depends on the strength and scalability of the image features, which used the characteristics of features vector. Also we examined different shape and color based features for the detection of shape.

A. PROPOSED ALGORITHM

Require: Test image from image database.

Ensure: Edges of input image (IM_{in})

Output: Result to draw edges with their corners and 3D map.

Step-1: An M x N color image to gray scale, Every pixel shows grayscale value $x \in [0,255]$.
If IM_{in} is colored then
GIM_{in}> Convert IM_{in} gray
else
$GIM_{in} > IM_{in}$
End if

Step-2: Apply some other pre-processing on image, It consist of Color conversion, Noise reduction and save image.

Step 3: In the Adaptive histogram H (IM_{in}), locate the maximum point h (a), a ∈ [0,255] and the minimum point zero h (b), b ∈ [0,255].
H (GIM_{in})> produce Histogram of image(GIM_{in}).

Step 4: Apply gradient direction and gradient magnitude with x and y direction.

Step 5: Apply edge and corner detection superimposed.

Step 6: Finally get the 3D map about edges and corners present in input image.

Step 7: Repeat step 1 to 6 for each query image.

B. PROPOSED MODEL

Our proposed system model is shown in Figure 2

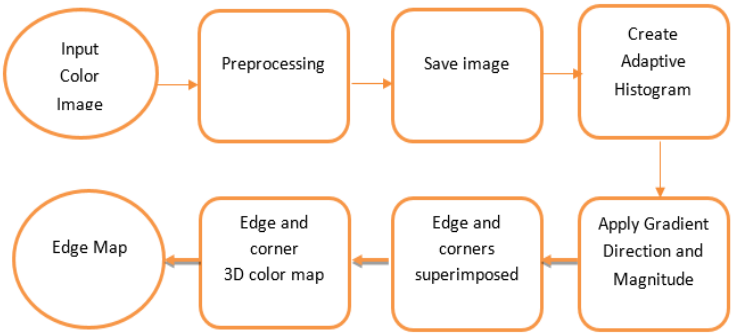


Fig. 2 Proposed work model

First select an image this will go through different process. Whose main aim is to obtain different shape and size? We have used static color images for detection of edges and corners. So these web images have requirement of some enhancement so we use preprocessing. It very well may be ordered into two classes: (1) Local and (2) Global difference improvement.

Adaptive Histogram Equalization (AHE)

It is unique in relation to conventional histogram equalization in it isn't global and it registers numerous histograms comparing to various segments of an image (Gupta et al, 2014). In this way, it is possible to improve the neighborhood differentiation of an image through AHE [7]. After the enhancement of an image reduce noise and apply color conversion on it.

Computing Gradient Magnitude from Directional Derivatives

So far we computed the gradients along horizontal and vertical directions as given by *fx*(*n*1, *n*2) and*fy*(*n*1, *n*2). These gradients are directional edge detector functions as they can be used to identify edges lying along horizontal and vertical directions respectively. But images, edges are not strictly aligned along horizontal or vertical directions [20]. In the proposed method we use the root mean squared value of the directional derivatives to formulate the non-directional edge detector function. The root mean squared value provides a good estimation of the edges which are not strictly aligned to horizontal or

vertical directions. The root mean squared value is computed from horizontal and vertical directional derivatives as shown in equation.

$$|\nabla f\ (n_1, n_2)| = \sqrt{(f_x\ (n_1, n_2))^2 + (f_y\ (n_1, n_2))^2}$$

Where $|\nabla f\ (n1, n2)|$ represents the gradient magnitude matrix which is non-directional. Genuine edge points can be extracted based on the gradient variations or local maxima in the gradient magnitude matrix $|\nabla f\ (n1, n2)|$. A point is identified as local maxima if its gradient value is greater than both its previous and next point either along the rows or the columns of the gradient matrix.

Edge and Corner Superimposed

Consequently, actualizing edge recognition algorithm on any image may fundamentally decrease the amount of information to be prepared and furthermore removes the unfortunate information. Many edge detection techniques come into existence. These detection techniques vary in the kinds of smoothing filters that are connected for ascertaining inclination evaluates in the X and Y-axis. Point and line detections are important in image segmentation. There are many edge detection techniques like Sobel, Prewitt, and Robert, canny edge detector and so on. Out of them canny edge detector operator used for identifying edges.

Canny edge detector was developed by *John F. Canny* in 1986. It is used as multi-arrange algorithm to identify an extensive variety of edges in images [16]. Watchful edge location discover edge by searching for nearby maxima of the gradient f(x, y). The nearby angle is given by Equation (4.6).

$$G = \sqrt{G_x{}^2 + G_y{}^2}$$
$$G = G_x + G_y$$
$$\theta = arctan\left(\frac{G_x}{G_y}\right)$$

Gradient along x direction and y direction is calculated by equations as [16]

$$G_x = f\ (x+1, y) - f\ (x, y)$$
$$G_y = f\ (x, y+1) - f\ (x, y)$$

Fig. 3 (a) Original images, (b) Gray image (c) After Edge Detection

In case of Canny's edge detection technique [9] hysteresis thresholding is applied. That is first upper and lower thresholds are determined, where upper threshold corresponds to the strong edges and lower threshold corresponds to the weak edge points. And then weak edge points are traced if they lie in the path of the strong edge points [10]. In the proposed method, to identify the strong edge points from the gradient magnitude matrix we use composite gradient variation amounts. One of the advantages of this method is without setting a very upper threshold we can determine the strong edge points and another advantage is faint spurious edge points along main stringer edge are reduced. To identify the weak edge points, we use dual maxima detection.

Corner detection

Harris Corner Algorithm: This is a mathematical operator which is used for corner detection and finds important feature and information of an image [9]. It is popular because scale, rotation, and illumination variation independent. Here we have some steps how it works.

1. Find the vertical gradient and horizontal gradient represent as follows:

$$M\ = (P\ R\ R\ Q\ ) = \begin{pmatrix} I_x^2 I_{xy} & I_{xy} I_y^2 \end{pmatrix}$$

2. Compute x and y derivatives of image:

$$I_x\ = G_\sigma^x\ *\ I, \qquad I_y\ = G_\sigma^y\ *\ I$$

3. Compute product of derivatives at every pixel:

$$I_x^2 = I_x * I_x,\ \ I_y^2 = I_y * I_y,\ \ \ I_{xy} = I_x * I_y$$

4. Apply Gaussian filter to the image:

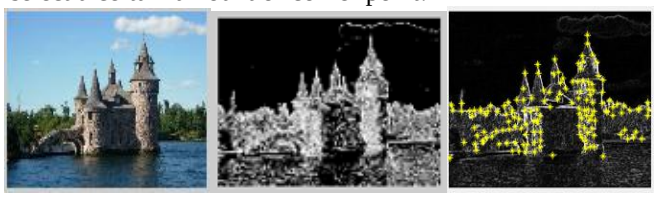
$$w_{\mu,v} = exp\ exp\left(\frac{-1}{2}(\mu^2 + v^2) / \delta^2\right)$$

Where, $w_{\mu,v}$ is a Gaussian Window

5. Calculate the r value of the pixel:

$$R_r = \left\{I_x^2 + I_y^2 - \left(I_x I_y\right)^2\right\} - k\left\{I_x^2 + I_y^2\right\}^2$$

6. Select the local extreme points.
7. Define the threshold and select a certain amount of corner point.



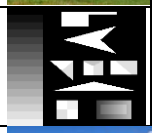
(a) (b) (c)

Fig.4 (a) Original images, (b) Edge and corner superimposed (c) Corner detection

IV. EXPERIMENTAL RESULT

Experimental results of the proposed method are presented and discussed in this section. All the images tested over proposed system and get corrected result for normal images. With this testing process we determine that the system accuracy is increased for the system. These images range numerous sources of inconstancy, including pose, illumination, smart cameras, and environment condition. Database includes different format as well as different resolution Table 5.1. Samples images.

TABLE I
SAMPLE DATABASE IMAGES

Sr. No	Image	Description
1		The image have a an object and background water and nature
2		In this image some animals are object and background is grass and trees
3		The image represent all type of geometrical figures
4		This scene have sea with sand and cloud

A. *User Interface with system*

Using MATLAB 2014a open command window >> start with run a main file is saved with the name "Gui", The first screen which appears after the command as shown in the Figure 5.2. Upload an image over the system by clicking on button "Select an image" image display from database in axis handler axis1 shown below in Figure. 5.2.

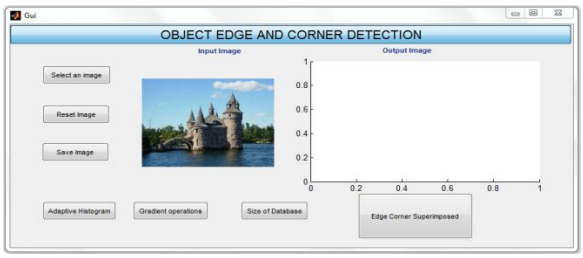


Fig.5 Screen showing after selected image

After selecting the test image we can apply different operation according to image requirement, after the processing image shown in axis handler axis2 in Figure 5.4. We apply AHE.

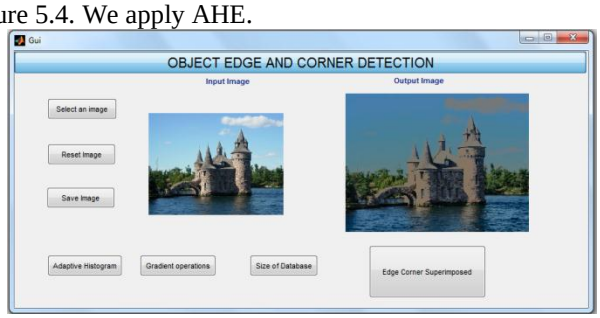


Fig. 6 Apply AHE on input image

By GUI we can reset or restore that particular image and we can apply another operation on same image this concept represent the reset by reset button**.** Save an image by using save button, after the image pre-processing the standard image save in database and we can apply operation on same image. After that apply Gradient operation on saved image using gradient operations button.

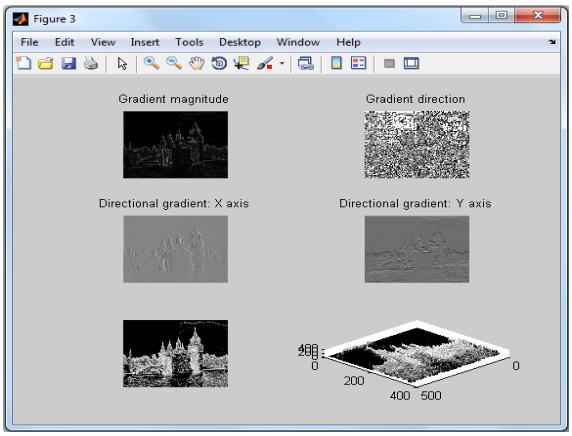


Fig. 7 After applying gradient operation

Edge and Corner Superimposed

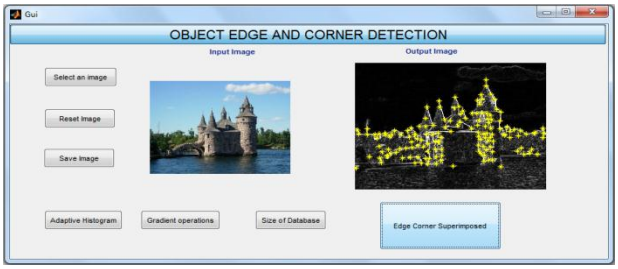


Fig. 8 Edge and corner superimposed

B. Experimental Results

In this section, we present the results of our evaluation, comparing our approach with several state of the art methods.

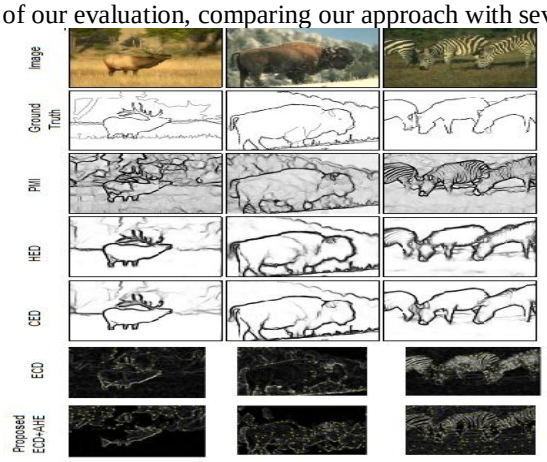


Fig. 9 Edge detection visualization results apply different methods

Starting row shows the original images and second row shows ground-truths edges. The next three rows include the raw edge maps of PMI, HED, and CED, respectively. Last two rows shows Edge and coroner detection at same time ECD and ECD+ AHE.

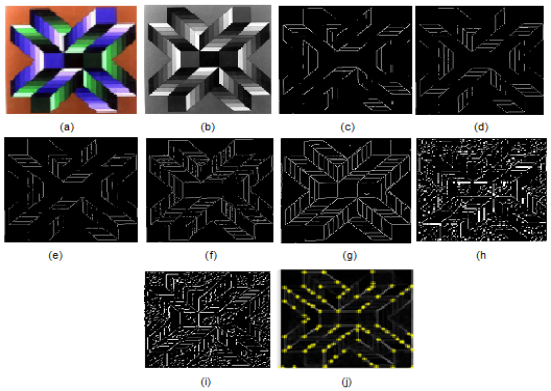
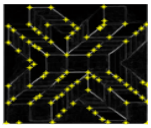
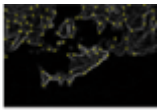
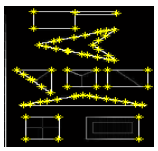


Fig. 10 (a) Original color Image (b) Gray Image (c) Robert's (d) Sobel's (e) Prewitt's(f) LoG (g)) Canny's (h) Marr-Hildreth's (i) Haralick (j) edge and corner detection with proposed method (ECD+AHE) [16]

C. Overall System Analysis

The overall system performance calculated based on true edge and corner detection.

TABLE II
ECD & ECD +AHE WITH COMPUTATION TIME

Query images	**Result**	**Time(Sec)**
Query 1 		4.290
Query 2 		1.108
Query 3 		1.373
Query 4 		1.841
Query 5 		2.668
Average computation time		**2.256**

In this work, we proposed a new edge detection system ECD+AHE have less computation time to give better result. Our results are précised in Table 5.3 Our enhancement module improves over the model CED, Our approach improves the ODS from 0.803 to 0.815, OIS .820 to .837 and AP .871 to .893 slightly higher than human performance. These results prove the effectiveness of ECD + AHE and get 87% accuracy.

TABLE III
ECD & ECD +AHE WITH COMPUTATION TIME COMPARISON TO THE STATE-OF-ARTS ON BSDS500 DATASET

Method	ODS	OIS	AP
Canny	.600	.640	.580
PMI	.741	.769	.799
HED	.788	.808	.840
CED	.803	.820	.871
ECD+AHE	.815	.837	.893

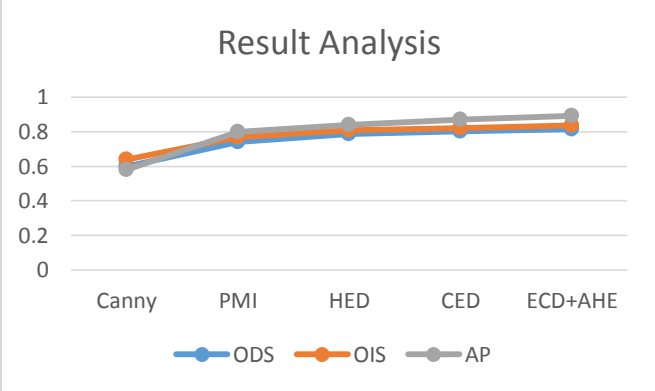


Fig. 11 Comparative analysis of performance

V. CONCLUSION AND FUTURE WORK

In this paper, we have find problems of the edge detection, corner detection field. We implemented the "Harris Corner Detection" algorithm on natural images and also modified algorithm by adding thinness property of corners detected by "smoothing", we have proposed an efficient method ECD+AHE for edge and corner detection at the same time and create a 3D edge map which is based on features of image. So there is lots of future scope in this existing area of corner detection. In future, there is a need to propose a method that can first smooth the colored image along with the boundaries and then identify the corners of each and every objects of that image. A new automatic threshold detection mechanism based on HD data can be used.

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