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A Java Applet Based Tool for Histogram Equalization and Edge Detection

Manas Yetirajam, Manas Ranjan Nayak

***Abstract*—Edge detection is a fundamentally important operation in image processing. It is the foundation of feature extraction and image information interpretation. It gives a description of the curvature of objects in an image. In this work, a tool has been developed for accurate edge detection. The tool has been developed in Java language which is applet based; it can run within a web browser or an applet viewer. To reduce the noise and produce sharp edges, series of preprocessing operations are performed initially on the image viz. blurring, grayscale conversion and histogram equalization. We basically focus on the canny edge detection technique.**

***Index Terms*—Blurring, Edge Detection, Grayscale, Histogram Equalization, Java Applet, Noise reduction, Sobel;**

I. INTRODUCTION

Edge Detection is a fundamental tool in the field of image analysis particularly in the domain of the feature detection and its interpretation. In fact, edge detection is very important in the field of Computer Vision, Image Processing viz. feature detection and feature extraction in which the image brightness changes sharply [1]. Objective of image processing is to identify points at which there is a sharp change in an image[2]. Changes can be due to discontinuity in depth, variations in color, variations in scene illumination or a sharp change in brightness[3]. Edges characterize object boundaries and are therefore useful for segmentation, registration, and identification of objects in an image[4]. The accuracy of the edges highly depends on the lighting conditions, presence of similar intensity objects, and presence of the noise.

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***Manas Yetirajam**, Dept. of Computer Science and Technology, National Institute of Science and Technology, Berhampur, India, Mob: +919439156325*

***Manas Ranjan Nayak**, Dept. of Computer Science and Technology, National Institute of Science and Technology, Berhampur, India, Mob: +919861773088*

The main challenge is to distinguish edges from other small features in the image such as textures and especially the noise, so that all edges are detected accurately, while the noise is suppressed. Accuracy of the edges i.e. sharpness falls drastically with the presence of the noise and high rate of color variations, which is common in any real world image.

Preprocessing of the image before detection of edges is very much essential in order to reduce noise and to neutralize the color variations[5][6]. In this work a series of preprocessing operations have been carried out blurring, grayscale conversion and histogram equalization to enhance the detected edges. Smoothing operation is used primarily to diminish the effect of spurious noise and to blur the false contours that may be present in a digital image. These unwanted effects may be due to detection and recording error or transmission channel noise or digitization error or some combination of these factors[7]. Grayscale conversion of digital image is a conversion of an image in which the value of each pixel is a single sample, that is, it carries only intensity information[3]. Images of this type are, also known as black and white images, are composed exclusively of shades of gray, varying from black at the weakest intensity to white at the strongest. After restricting the domain of color variation between black and white histogram equalization is performed which tries to flatten the histogram to create a better quality image. It treats an image as a probability distribution[2]. Histogram equalization may not always provide the desired effect because its aim is to evenly distribute the pixels[7]. After these preprocessing we are able to get sharp edges and the result obtained is free from noise to a great extent. Proposed work has been carried out in four phases to get an enhanced result.

The architecture of the developed tool is as following.

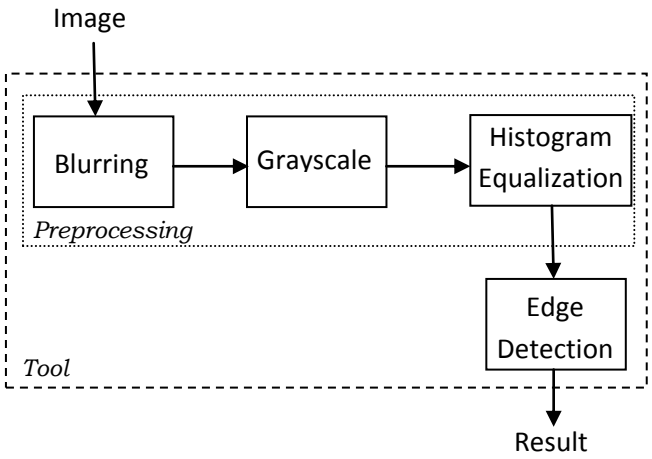

Fig1: Block diagram of architecture of the tool

II. METHODOLOGY

Proposed work has been broadly divided in two phases. Necessary procedure and algorithm involved with these phases are explained.

2.1 Preprocessing

Preprocessing has been carried out in three phases, which has been explained in the following.

2.1.1 Blurring

A low pass filter (*Gaussian blur*) has been used in this work for this purpose to reduce the high frequency noise component of the image. Gaussian filter has been used in many similar type of image processing work[5][6], because of its typical hat like structure of the filter.

$$A^* = \frac{1}{159}\begin{bmatrix} 2 & 4 & 5 & 4 & 2 \\ 4 & 9 & 12 & 9 & 4 \\ 5 & 12 & 15 & 12 & 5 \\ 4 & 9 & 12 & 9 & 5 \\ 2 & 4 & 5 & 4 & 2 \end{bmatrix} \text{ x } A$$

Where A: input image

A*: resultant image obtained by use of filter

Algorithm

- *Choose a appropriate kernel.*
- *Move the kernel over the image pixel values.*
- *Calculate average value during movement and place it in the respective center pixel value to increase its value.*

2.1.2 Histogram Equalization

After conversion of image to its grayscale equivalent histogram equalization is performed. Implemented algorithm has been described.

Algorithm

- *Form the cumulative histogram.*
- *Compute the frequency of each intensity level.*
- *Calculate the cumulative values using cumulative distributive function (cdf).*
- *Normalize (cdf) to [0,255].*
- *Compute the equalized value as h (v).*

$$h(v) = round\left(\frac{cdf(v) - cdfmin}{(M\ X\ N) - cdfmin} X(L-1)\right)$$

- *Map the original value to the result by a one-to-one correspondence.*

2.2 Edge Detection

Gradient based method has been used for the edge detection which is a search based method. We have used Sobel 3x3 kernel[3] which has been shown in the algorithm. This method detect edges by first computing a measure of edge strength(first-order derivative expression) such as the gradient magnitude, and then searching for local directional maxima of the gradient magnitude using a computed local orientation of the edges(gradient direction). Results of enhanced edge detection after operation of preprocessing are shown in section III.

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Algorithm

- *Compute a measure of edge strength (gradient magnitude).*

Sobel Operator

$$Lx = \frac{1}{4}\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} * L(x,y) \qquad Ly = \frac{1}{4}\begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix} * L(x,y)$$

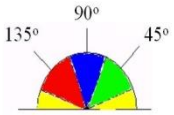
Where L(x,y) : array of pixel values

Gradient magnitude (gm) = $\sqrt{(Lx^2 + Ly^2)}$

Gradient Orientation/direction

$\Theta = \tan^{-1}(Ly,Lx)$

- *Round off the gradient direction (θ) to nearest 45°.*



- *Begin by using the upper threshold to find the start of an edge.*
- *Mark the edges whenever value lies between upper and lower threshold.*
- *Compare the edge strength of the current pixel with the edge strength of the pixel in the positive and negative gradient direction.*
- *If the edge strength of the current pixel is largest; preserve the value of the edge strength. If not, suppress the value.*
- *Stop marking edges when the edge strength falls below lower threshold.*

III. RESULTS AND DISCUSSION

The GUI(Graphical User Interface) for the developed tool is given in Fig 2.

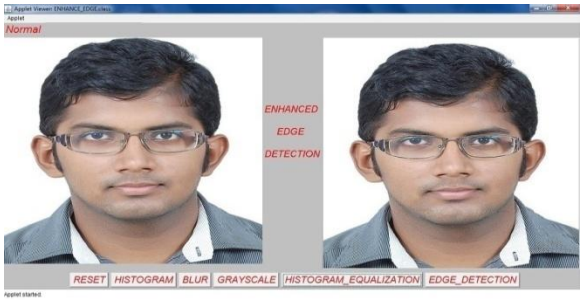


Fig 2: GUI of developed tool

Along with edge detection basic image processing operation can be performed by using the tool like to draw histogram and various preprocessing operations can also be carried out separately.

Histogram

Input image histogram can be viewed and analyzed.

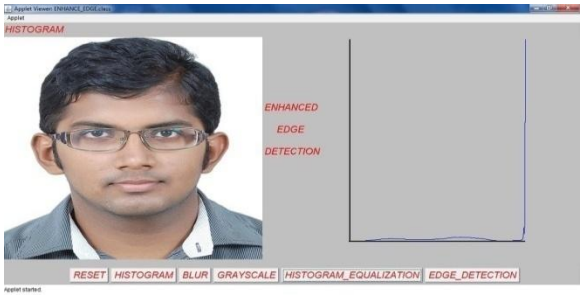


Fig 3: Histogram of an image

Blur

User can blur the image and reduce the effect of noise use the image for other purposes.

Fig 4 : Blur image

Grayscale

User can also use tool for grayscale conversion of the images

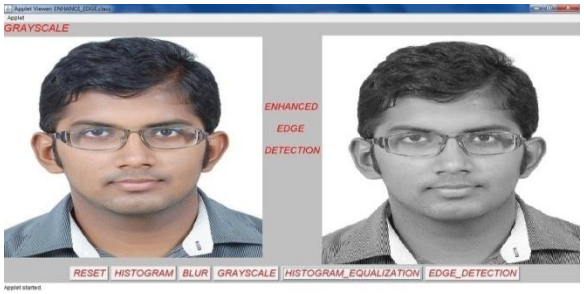


Fig 5: Grayscale equivalent of a color image

Histogram Equalization

Histogram equalization is performed on the grayscale image result of histogram equalization over test image is shown in following fig 6.

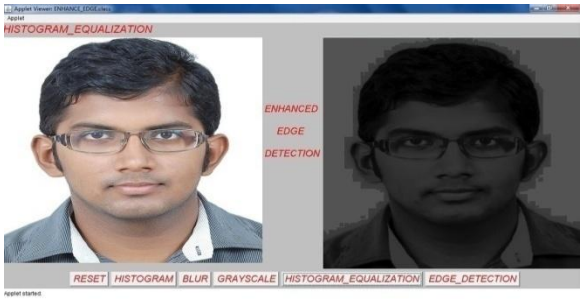
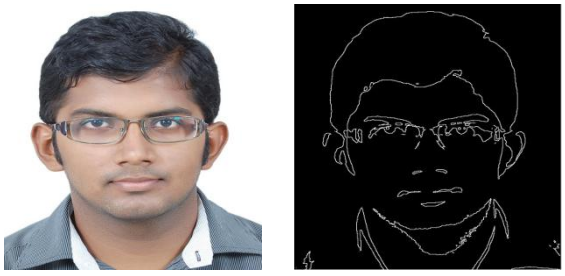


Fig 6: Histogram equalized image

Edge Detection

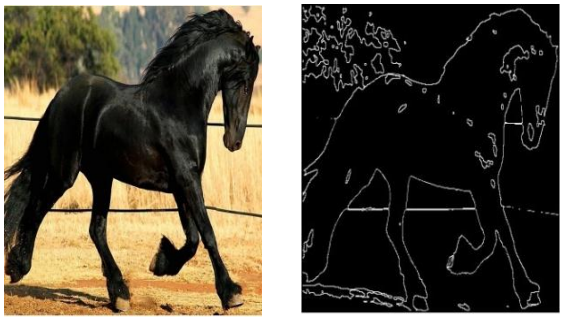
Proposed enhanced edge detection was tested on various images and the results are shown in fig 7



(a) (b)

(c) (d)

(e) (f)



(g) (h)

Fig 7: Enhanced edge detection of test images

Normal edge detection method are context dependent(objects in image) i.e from image to image sharpness and quality of edges changes drastically and thus the threshold used have to change with the image to get a desired result ,whereas proposed enhanced method works in all the contexts similarly. Providing good quality edges as result.

IV. CONCLUSION

This work proposed a java applet based tool which mainly focuses on the enhanced edge detection along with some basic image processing operations. Enhanced edge detection means context independent, sharp edges which are free from the noise. As tool is applet based it can be implemented within a web browser and can be made available online.

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Manas Yetirajam has completed his B.Tech, in the Dept. of Computer Science and Engineering at NIST, India. Soft computing, Pattern Recognition, and Image Processing is his key research interests. He have published three research papers.

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