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## PERFORMANCE ANALYSIS OF IMAGE ENHANCEMENT TECHNIQUES FOR OCR

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Received on: 25-02-2017

Accepted on: 28-03-2017

### Abstract

Digital image processing is a crucial expanse at current. Among numeral phases of it, Image enhancement plays a vital role and the chief aim of it is to process an image with the purpose to produce an appropriate effect than the original. Image lucidity has always influenced from neighboring such as capturing device, conditions, illumination, etc. Consequently, several image enhancement methods have been building up to recuperate image information. Image enhancement methods afford a various alternatives for image eminence perfection. The selection of these methods is subjective to numerous aspects like image input, display instrument, work to do and so forth. This work offers a general idea of image enhancement perception along with some frequently used algorithms those have been executed in MATLAB R2014a against four assessment parameters. Edge adaptive hybrid filter found superior.

**Keywords:** Contrast enhancement, Correlation coefficient, Histogram equalization, Image enhancement.

### Introduction

Image enhancement is essential to get better image information discernment for human beings else it is necessary to offer precise input for image processing methods. The foremost intent of image enhancement is to amend image traits and to formulate it further suitable for specified mission, spectator. As par necessity one or more image characteristics are processed and customized. Feature selection and the approach by which they will be altered are subjective to an assignment specified. Here viewer precise aspects like human visual organs and the viewer's knowledge will commence the subjectivity for the preference that which image enhancement techniques supposed to be used. Various methods exist to do image enhancement without blemish its substance. These methods can be divided into 2 categories; spatial domain methods that works straightforwardly on pixels itself and frequency domain methods which operate on image Fourier trans form. Regrettably, no universal speculation exists to ensure excellent image enhancement. Conversely, if image

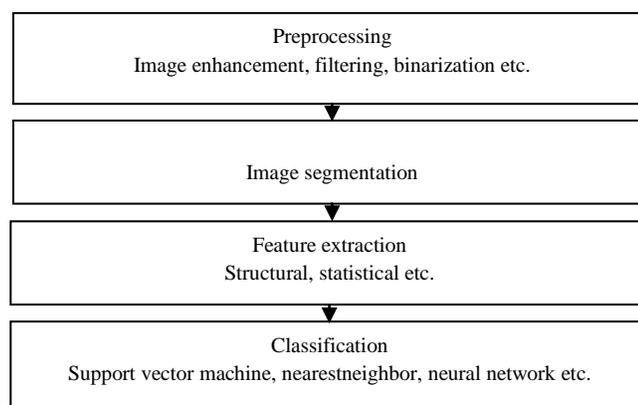
augmentation methods are used as a pre-processing apparatus, subsequently statistical parameters can resolve which methods are mainly suitable. Except geometrical transformations, several prelude gray levels adjustments might be signified, to consider flaws in the possessing system which can be done pixel by pixel, regulate with the image output with steady intensity [1].Frequently space-invariant gray level conversions are furthermore done for range compression, contrast stretching, etc. The significant distribution is the relative frequency of every gray value, the gray value histogram. The despoiled image eminence is able to result in a considerable number of specious minutiae being produced and authentic minutiae being disregarded. Accordingly, it is vital to make use of image enhancement methods earlier. The foremost intention of image development is to get better edge characteristics of an image, as these edges embrace the characteristic features information essential for minutiae extraction [6].Superlatively, in a well-defined image, the edges and valleys should rotate and row in a locally continuous direction. This promptness assists edge detection and accordingly tolerates minutiae to be correctly extracted from the thinned edges [4].Therefore, noise has to be diminished through image improvement methods to dig up the superior definition of the edges against valleys.

The rest part of the paper is organized as follows. Conversation about image enhancement stride is in section II; methods deemed are expressed in segment III. Section IV is about assessment parameters employed. In sector V trial fallouts are mentioned, and study efforts are recapitulated in segment VI.

## **Image Enhancement**

Image enhancement is one crucial component of the image processing sector, which allows upgrading the image class to construct the consequential image further valuable than the original. The sole impulse of image heightening is to emphasize the concealed details in an image with contrast amplification in a stumpy contrast image. Image renovation like image digitization might origin some type of deprivation at harvest, so demands requisite of some method to be employed to eradicate that deprivation [7].Image processing stages, including image enhancement are shown in Figure1. Medical image enhancement expertise has seized much deliberation as sophisticated medical instruments are being employed in medical applications. Issues such as pitiable contrast and higher altitude, noise in medical images must be highlighted. Image augmentation is one of the fundamental and mainly promising areas of digital image processing. Primarily, the vital initiative behind the enrichment methods is to illustrate details that are imperceptible to the addressees and it is chiefly done to renovate an image that was weakened during conversion. Intent of image enhancement relies on

the application milieu and the rules for image improvement are very weighty to be simply changed to convene objective measures. Image enhancement routines should be painless to comprehend and qualitative. Though, in any appliance method which is doing sound for one set of the images might not do as fine for else set[2].Image enrichment methods are of two kinds that are spatial domain and transform domain methods. In spatial domain methods [13] one could work straightly on image pixels. The pixel values are influenced to accomplish preferred enrichment. In frequency domain approaches, initially an image is reassigned into frequency domain, image Fourier transform is obtained first. Enhancement maneuvers are done on the image Fourier transform then inverse Fourier transform is performed to dig up the consequential image. While image augmentation, operations is performed to amend the image contrast, brightness, gray level distribution, etc. As a corollary the resultant image pixel intensities will be tailored according to the conversion function applied to the input image. The effects of translation are mapped into the gray level range as commerce is only with gray level images. For illustration for 8-bit image pixel value scale will be [0, 255]. Diverse fundamental and heuristic techniques [14] are employed to perk up images in some intelligence. Work elucidates few systems that have revealed to be handy both for machine recognition and the human onlooker. These techniques are application specific: a scheme that performs excellent in one scenario might be utterly scarce for else case. In study core image enhancement routines have been conversing. The paper will afford a general idea of causal perceptions, along with methods frequently called for image enrichment.



**Figure1. Image processing stages.**

### **Image Enhancement Methods**

The work spotlight spatial domain image enhancement schemes where the pixel value at coordinates (x, y) in the developed image is the result of applying some function on the pixels in the neighborhood of (x, y) in the input image. Neighborhoods could be in any form, although typically they are rectangular. Image development methods considered in work are as follows.

### 3.1 Image enhancement metric

Contrast, sharpness amends reveals intensity discrepancy between a pixel and it's nearer. Consequently, basic inspiration is to evaluate the absolute value of intensity disparity between a pixel and its nearer analogous to the allusion and improved images. IEM estimates the image sharpness, contrast by isolating an image into non- overlie obstruct. The middling value of the absolute discrepancy between the interior pixel and its 8 nearer for all local windows analogous to the input, improved image will confer sharpness, contrast revolutionize clue. 3\*3 window size is adequate as the metric exploit merely 8 neighbors [16].

### 3.2 Histogram equalization

Histogram equalizations a technique of contrast tuning using the image histogram where an attempt is to exploit the image contrast by performing a gray level renovate which seek to squash the ensuing histogram. Gray level alters are merely a scaled edition of the original image's swelling histogram. Gray level transforms T is specified by  $T[i] = (G-1) c(i)$ , where G is the count of gray levels and c(i) is original image's normalized cumulative histogram. To stipulate a non-flat, resulting histogram, do following ladder:

- a. Indicate the preferred histogram g(z).
- b. Find the transform that equalize the precise histogram,  $T_g, T_g^{-1}$ .
- c. Find the transform that would histogram equalize the original image,  $s=T[i]$ .
- d. Execute  $T_g^{-1}$  on the equalized image,  $z=T_g^{-1}[s]$ .

Technique performs well for images with foregrounds and backgrounds are dark or bright. Particularly, the technique can escort to superior views of bone formation in x-ray images, and to the superior aspect in snaps that are less or more rendered. Whenever the histogram equalization operation is acknowledged, the original histogram could be regained. Computation is not exhaustive; however, such procedure is indiscriminate and could increase the background noise contrast, while diminishing the exploitable signal. For scientific image spatial correlation is more significant than signal intensity.

### 3.3 Negative image enhancement

Image negative with gray levels in the assortment [0, L-1] is achieved by the negative transformation with the expression,

$$S = L - 1 - r \quad (1)$$

Where,  $S$  is pixel values in the output image,  $r$  is pixels values in the input image and  $L=2^k$ ,  $k$  is the number of bits in the image. For illustration, for 8-bit image the pixel value scale will be  $[0, 255]$ . Expression produces reverse of the gray level intensities of the image so producing an image negative. The yield of such function can be directly correlated into the gray scale look-up table containing values from 0 to  $L-1$ .

### **3.4 contrast stretching**

Contrast stretching or normalization is an easy image heightening way which efforts to perk up the image contrast by enlarging the intensity value scale. It extends to appropriate range, e.g. the full pixel value range that the image form permits. It varies from histogram equalization where it can only concern a linear scaling function to the values of image pixel. Specification of lower, upper pixel values, boundary over which an image can be stretched is necessary prior to stretching. Habitually these boundaries are the minimum, maximum pixel values that an image category tolerates, e.g. 0, 255 may be lower, upper bounds for 8-bit gray level images. An easy stretching type, then scans the image to get the lowest, highest pixel values currently present in the image and values below 0 are put to 0, above 255 are set to 255 correspondingly. It is usually exercised to look up the image contrast without warping comparative gray level values too radically.

Evaluate original image histogram with contrast-stretched edition, while production is a considerably in excess of the original, the improved image itself still materialize flat. Histogram equalization augments image contrast spectacularly, but capitulate an unnatural appearance, instead one could reach to superior consequences by image normalization over further narrowing gray level values range from the input image. E.g. keep the cutoff fraction factor at 0.03; attain the normalized image and its analogous histogram. Remember this maneuver has efficiently swelled out the data restrained in the input histogram peak by thrusting those intensity levels to the left of the peak down the histogram  $x$ -axis to 0. Lower, upper bounds for 8-bit image are 0, 255 similarly, hence basic normalization to the range 0 - 255 fabricate enormously no consequence. Conversely, one might boost an image by disregarding all pixel values exterior to 1%, 99% and only concerning normalization to those pixels in amid. The outliers are merely strained to either 0 or 255 relies on which region of the range they lounge on. Contrast stretching might be employed to transform an image from one form to another, for illustration from floatpoint pixel values to 8bit integer. Perceptibly few data may be vanished in the density course, but the comparative pixel intensities will be conserved.

### 3.5 adaptive weighted mean filter

Filtering is analog braicmaneuverw here pixel intensity is pooled with neighboring pixel intensities; the neighborhood is delineated by a box that has minimum 3 pixels in a region [8]. Mean filter conceivably effortless filter that sums the pixel intensities in the box followed by mean establishment. Neighboring pixels averaging will answer the blurred image because of the haphazard pixel nature of the neighboring spot. To circumvent this crisis, this work pioneer adaptive weighted amalgamation of pixel values  $I(i,j)$ ,  $I(i,j-1)$ ,  $I(i-1,j-1)$ ,  $I(i-1,j)$ ,  $I(i-1,j+1)$ ,  $I(i+1,j+1)$ ,  $I(i+1,j-1)$ ,  $I(i,j+1)$  and  $I(i,j-1)$  is employed to guesstimate the value for pixel  $I(i,j)$ .AWMF has been deemed as the 4 neighboring pixels of the current pixel those are mainly to be concerned with the invention of the back reflection value in pixel position  $(i, j)$ . Figure 2 represents a mask for this filter. An input image is approved through an edge detector and rehabilitated into a binary image. Whenever the pixel of interest  $I(i, j)$  is an edge subsequently pixel is omitted else adaptive weighted mean filter omitting the edge pixel is practical [9].

1	2	1
2	4	2
1	2	1

**Figure-2. Adaptive weighted mean filter mask.**

### 3.6 edge adaptive sigma filter

Sigma filter produces an average of pixels in a box of predestined size those do not digress, so much of the pixel that the box is middle of. To locate sigma filter threshold value, noise type distressing an image and its typical deviation should be known. To shun this calamity, study commence edge adaptive sigma filter to improve input image contrast. An input image is given to edge detector and renewed to binary. When the pixel of interest  $I(i, j)$  is an edge, high pass filter mask is employed to jagged edge or low pass mean filter neglecting the edge pixel is recommended [10][11].

### 3.7 Edge adaptive hybrid filter

With a rationale to advance the edges and fine details available in the specified image, this review paper intends a novel edge adaptive hybrid filter which is recipe of low pass, high pass filter. Here too an edge detector is exercised on input image and improved into black and white image. Whenever interest pixel  $I(i, j)$  is an edge, high pass filter mask is used to point an edge, else low pass mean filter is suggested [12][13].

## **Assessment Parameters**

With an aim to analyze the performance of above enlightened image improvement methods, assessment parameters believed are as follows.

### **4.1 Peak signal to noise ratio**

Peak measure PSNR is image pixel word length dependent which is computed as the ratio of peak signal power to average noise power. Since many signals have an incredibly spacious, dynamic series, PSNR is typically articulated in requisites of the logarithm. The PSNR is frequently employed as a quality assess of loss compression renovation. Original data are assumed as a signal, whereas noise is the blunder pioneer by compression. When evaluating compression it is considered as an approximation to human perception of restoration eminence, hence in a few scenarios, one restoration might emerge to be nearer to the original than else, yet it has a lower PSNR. The concern is desirable with the legality range of such metric; it is only convincingly legitimate when employed to evaluate the consequences from equivalent content [4] [5].

### **4.2 Mean absolute error**

Mean absolute error (MAE) or normalized error is a magnitude exercised to determine how near predictions or forecasts are to the eventual conclusions. It is an average of the absolute errors instead might comprise comparative frequencies as weight factors. It is a widespread forecast error measure in time series scrutiny, where the phrase "mean absolute deviation" is an occasion exploited in confusion with the further standard mean absolute deviation description.

### **4.3 Correlation coefficient**

The correlation is the quantify of the strength, path of a linear relationship between two variables. A correlation of 1 signifies a faultless one-to-one linear relationship while -1 specifies a negative relationship. Correlation coefficient square depicts how much of the discrepancy between two variables is illustrated by a linear fit.

### **4.4 Structural similarity index method**

The structural similarity index method (SSIM) is for resemblance appraising between images and it is a full reference metric for image quality determination relied on a preliminary un compressed or torture-free image. SSIM is intended with the intention to perk up on conventional schemes such as PSNR and mean, which have attested to be incoherent with human eye discernment [15]. These schemes guesstimate perceived errors while SSIM deems image squalor as an alleged revolution in structuring information. Structural information is the initiative that the pixels encompass burly

interdependencies principally when they are spatially near. These enslavements clutch imperative information concerning the object structure in the visual panorama.

## Result and Discussion

From this review paper, it is renowned that image processing system is superior whenever the performance of the image enhancement routine is high. For image augmentation, numerous methods are offered. Each one of them has their own compensation and shortcoming. Table 1 illustrates results scrutiny in a tabular form [3]. It is evidently seen that the EAHF image enrichment procedure offers the most excellent consequences when compared with remaining schemes.

**Table1. Performance Assessment of Enhancement Methods.**

Image Enhancement Methods	PSNR	MAE	CC	SSIM
EAHF	78.258	0.013	0.9931	0.999
EASF	38.9922	1.810	0.166	0.87787
AWMF	57.503	0.255	0.7087	0.99643
Contrast stretching	30.5928	20.41	0.9471	0.99832
Negative image enhancement	25.519	23.35	1	0.95245
Histogram equalization	24.3443	0	0.96855	0.99379
Image enhancement metric	21.96	18.73	0.92	0.84

## Conclusion

Image enhancement is a decisive stride in digital image processing. Copious enhancement procedures are obtainable; this work has premeditated some of them. Diverse methods are evaluated by considering factors PSNR, MAE, CC, and SSIM. For work images from access database are deemed and enhancement routines are executed in MATLAB R2014a. Study summarizes that exploit of the edge adaptive hybrid filter furnish superior outcomes against histogram processing, negative enhancement, contrast stretching, AWMF, EASF. For future vocation one could discover an innovative image enrichment method, amendment in presenting techniques with healthier truth or suitable amalgamation of image augmentation schemes.

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