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Evaluation Error Measurement Tools Based on Blurred Image

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Abstract

There are many paper used difference type of quality measurements without evaluate them to find the best one, in this paper create new comparative study between various type of error measurements tools. This comparison rely on characteristics of that error tools, where everyone have set of advantage and drawbacks, in addition where it can use exactly and what is the accuracy of result which can be provided. Overall this research focused on blurred images after manipulate it using more than one mean filters with set of image sample. So then mean reason for this research make best decision to select strong tools among different type of tools. Finally make over view to use the correct tool with specific purpose.

Keywords: Degraded colored image; Mean filters; Error measurement tools and Statistics analysis.

1. Introduction

The standard quality measure tools (RMSE, PSNR), which are usually used to compare between two images. The degraded and enhanced image in the other word blurred image and both of them give suitable results to detect error, but in different compression like in security projects the result need to be more accurate, so that is why check all types of tools became is necessary [1]. The difficulty lies in how to determine best tool in between set of tools, which all give convergent results, where tool measure the variance between two images based on specific function with varying numbers.

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There are many paper evaluate measurement tools using different type of statistical analysis, Ismail Avcıbas work on compression images to evaluate only two type of tools, which rely on plotting [3]. In addition, Kohonen maps, Jan Kotera and his colleagues proposed new bluer estimation, which compare it with MSE and PSNR based on graph depicting as a sold blue line to get accurate result from mentioned tools. Moreover F. Kerouh, A. Serir creates new metrics method for test blurred images, this is method evaluated depend on only values of standard deviation (SD) for original and blurred images and compare with results of new proposed method. When the value of SD became large that is mean the blurring was more in improved image than original [3]. The main different from previous works it is evaluate standard measurements tools based on different between standard deviation and mean, all operations of this paper can be summarize in the following block diagram.

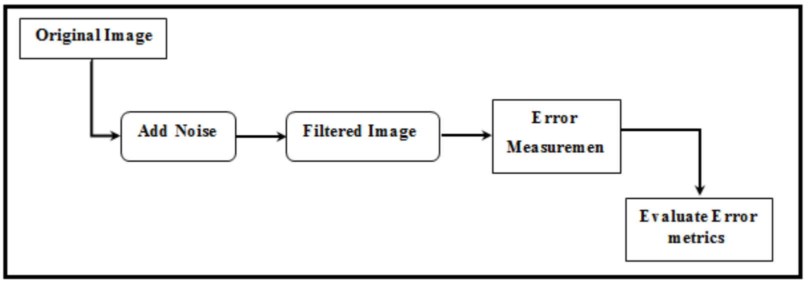


Figure 1: Evaluation block diagram

2. Degradation Image Using Salt and Pepper Noise

This paper used standard noises to get degraded image, because this research focus just on evaluation, salt and pepper noise represented on image as black and white dots. The probability p (with $0 \le p \le 1$) that a pixel is distorted, salt and pepper noise in an image can be given by put a fraction of p/2 randomly selected pixels to black, and another fraction of p/2 randomly selected pixels to white formula (1).

$$r(s) = \begin{cases} r_a & for\ s = a \\ r_b & for\ s = b \\ 0 & otherwise \end{cases} \quad \ldots\ldots (1)$$

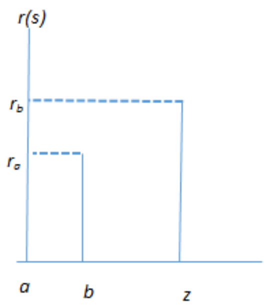


Figure 2: bipolar impulse noise model

The following figures show how add the salt and pepper noise to images.

Original Image	Noise Image
	
	
	

Figure 3: Effect Impulse Noise on original Image

3. Remove Noise from Degraded Image (Create Blurred Image)

Remove both pepper and salt noise usually is difficult, except using alpha trimmed mean filter can remove both of them. This filter can be apply if delete the r/2 minimum and the r/2 maximum intensity values, from a neighborhood g(s, t) of size m*n and let g(s, t) represent the remaining mn-d pixels, the average of the remaining pixels is called an alpha trimmed mean filter and is written by [2].

$$\hat{f}(x,y) = \frac{1}{mn-d} \sum_{(s,t)\in S_{x,y}} g_r(s,t) \quad \text{..... (2)}$$

Where this filter eliminate pixels at the start and end of order (d) which set in function, then calculate mean for remaining elements. The main reason behind use this filter for wiping off mentioned noises is that the filter combine between mean and median filters as show in figure(4).

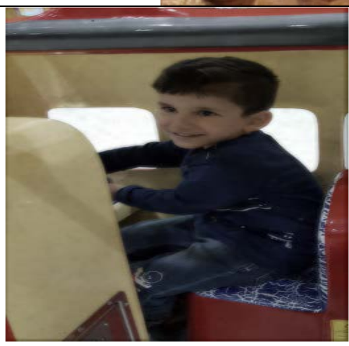
Noise Image	Filtered Image (Alpha-Trimmed Mean)
	
	
	

Figure 4: blurred image using Alpha Trimmed Mean Filter

Moreover contra-harmonic Mean Filter deal with salt or pepper noise, rely on order Q

$$\hat{f}(x,y) = \frac{\sum_{(s,t)\in S_{xy}} g(s,t)^{n+1}}{\sum_{(s,t)\in S_{xy}} g(s,t)^{n}} \quad \ldots\ldots. (3)$$

For negative values of n, it remove the salt noise, whereas positive values of n, it eliminates pepper noise. The n value depend on the size of mask. This paper focus on positive value. In addition and work on only monochrome image, eight bit per pixel and 24 bit per pixel images. Figure 5 show contra harmonic mean filter how to remove pepper noise and get blurred image.

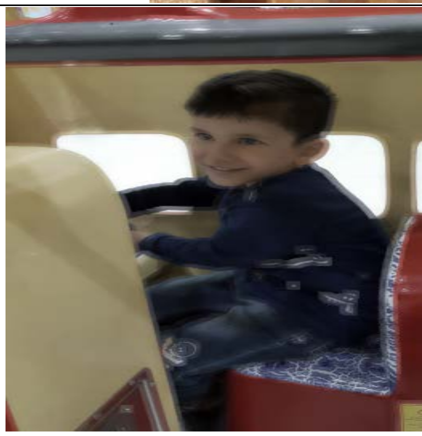
Noise Image	**Filtered Image (contra-harmonic Mean)**
	
	
	

Figure 5: Blurred Image using contra-harmonic mean filter

3. Results and Analysis

All standard error measurement, which was calculated to measure blurred degree or in another word how much the improved image deferent from the original, all of them give convergent results [5].

3.1 Mean Square Error

This measure find the mean of (I' – I), where I' blurred image and I original image [8], and this can represent as (4).

$$I' - I \qquad \mathrm{MSE} = \frac{1}{n}\sum_{i=1}^{n}(\hat{Y}_i - Y_i)^2 \qquad \ldots\ldots\ldots (4)$$

3.2 RMS (Root Mean Square Error)

When there is average value m error, which associated with original image value. Not that is also necessary to get a measure of the spread of the m values around that average that average, root mean square error do this, this measure rely on difference between predicated image value and original values then square results after that find the average, finally take the root.

$$RMSErrors = \sqrt{\frac{\sum_{i=1}^{n}(\hat{y}_i - }{n}\ (I' - I)^2} \qquad \ldots\ldots (5)$$

3.3 SNR (Signal to Noise Ratio)

SNR is a measure used to exhibit ratio of noise in blurred image and evaluate of the quality of image. The contrast of any area this means (signal) which must highlighting over noise of image, the human eyes can recognize object in image of 0.5 to 5 %. SNR can be calculated by formula (5).

$$\mathrm{SNR} = \frac{\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}\hat{f}(x,y)^2}{\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}[f(x,y) - \hat{f}(x,y)]^2} \qquad \ldots\ldots (6)$$

3.4 PSNR (Peak Signal to Noise Ratio)

PSNR it is represent percentage maximum value of signal to the distorting noise which effect on quality of image, this is measurement use to compare among squared error between the original and the blurred image , whenever PSNR is high means image have a good quality otherwise bad quality, (PSNR) can calculated by (6).

$$PSNR = 20\log_{10}\left(\frac{MAX_f}{\sqrt{MSE}}\right) \qquad \ldots. (6)$$

3.5 MAE (Mean Absolut Error)

This measurement acutely used to know how the value of improved image nearest to value of original image [6]. Therefore, the result of different between blurred image and right image used after take absolute of them to avoid negative value, which make the metrics more accurate [8], this measurement can calculated by (7).

$$\mathrm{MAE} = \frac{1}{n}\sum_{i=1}^{n}|y_i - \hat{y}_i| = \frac{1}{n}\sum_{i=1}^{n}|e_i|. \quad \ldots.(7)$$

3.6 SSIM (Structural Similarity Index)

SSIM used to measure degree of similarity between blurred images (improved Image) and original image. This metrics rely on brightness, contrast and structure. SSIM used standard deviation to check the contrast of image. Therefore, this three component grouped to measure the similarity between two mentioned images, this metrics formulated as in (8).

$$\mathrm{SSIM}(x, y) = [l(x, y)]^{\alpha}[c(x, y)]^{\beta}[s(x, y)]^{\gamma}$$

$$l(\mathbf{x},\mathbf{y}) = \frac{2\mu_x\mu_y + C_1}{\mu_x^2 + \mu_y^2 + C_1},$$

$$c(\mathbf{x},\mathbf{y}) = \frac{2\sigma_x\sigma_y + C_2}{\sigma_x^2 + \sigma_y^2 + C_2},$$

Table 1: show results of measure quality of set of blurred images

Image	PSNR	RMS	MSE	SNR	MAE	SSIM
J1_Alpha	32.13	8.83	32,689	1.0009	3,535	0.8127
J2_Alpha	34.7	7.82	21,019	0.9913	1,395	0.8331
M1Alpha	32.08	7.63	53,907	0.9983	3,459	0.8656
M2 Alpha	36.47	5.9	26,093	0.9434	593	0.8709
J1contra_Q2	34.57	8.04	8.0359	1.0118	2,134	0.7975
J2contra_Q2	40.93	6.69	6.6907	0.9776	504	0.8033
M1ContraQ2	36.65	5.29	5.2949	0.9954	1,151	0.8858
ContraM2	43.72	4.85	4.8515	0.8241	135	0.7852

Above table exhibit set of measurement tools for group of improved images, each one display special result to show error rate.

The Figure below show degrees of disparity between the measurement error Tools.

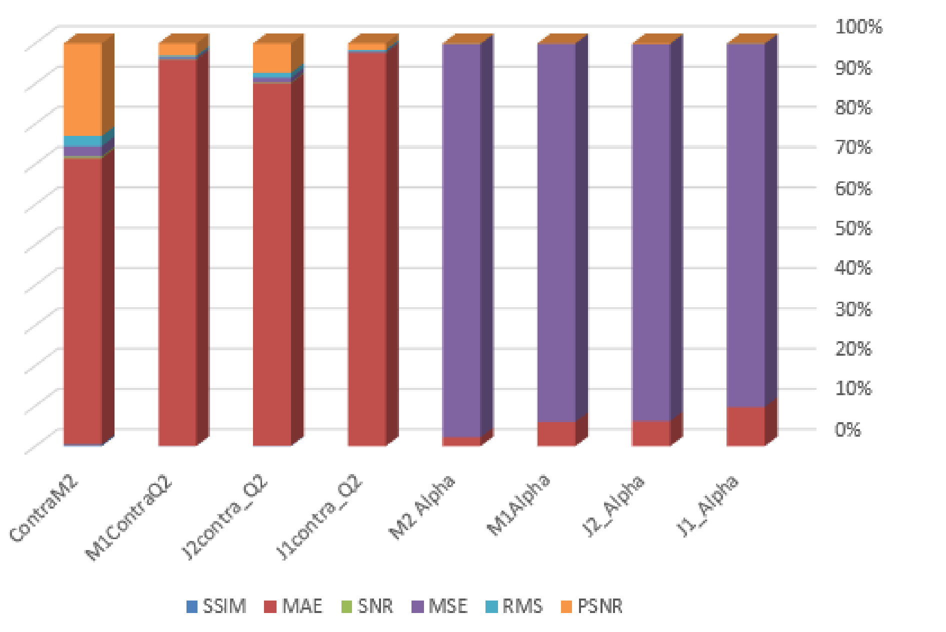


Figure 6: Results differentiated and converged error measurements

4. Error Measurements Tools Evaluation

In these section first things is calculate standard deviation (1) and mean (2) for histogram of original, and blurred images. When calculated mean for both of mentioned images, the results was same so the best idea to evaluate metrics tools is take the different between STD of blurred image and Mean [3,7].

$$s = \sqrt{\frac{\sum(x - x')^2}{n-1}} \quad \ldots (1)$$

$$X^{-} = \frac{\sum_{i=1}^{n} x}{n} \quad \ldots (2)$$

Whenever the value of standard deviation larger than mean then image have more blurred, therefore, value of some measurement error tool necessary to be large like (RMSE, MSE, MAE). For other metrics like (PSNR, SNR), the value hardly be relatively few and vice versa.

Moreover, the SSIM give the different result, where the value of SSIM near to one then image became clearer, in the other hand when the value close to zero so the blurring increased in improved image. Table (2) describe results of standard deviation and mean.

Table 2: results of standard deviation and mean for both of original and enhanced image

Improved Image	Standard Deviation	Standard Deviation of original Image	Mean
J1-alpha	388.8	447.3	547.9
J2 Alpha	388.8	398.8	437.7
M1Alpha	1714	5040	845.6
J1contra_Q2	388.8	447.3	547.9
J2contra_Q2	387.6	398.8	437.7
M1ContraQ2	3133	5040	845.6

From above table it is clear small difference between standard deviation and mean equal to 48 and 50, so the value of SSIM measurement in table (1) near to 1 when the image not blurred as compare with other metrics the results was disparity.

5. Conclusion

Finally get the different types of standard measurments tools , each one have specific characteristics with special evaluation for blurring image and show how much it degraded.

Standard deviation prove it is the perfect evaluation function to detect which tool is the best , in addtion this paper can't dispense from mean, which compared with SD. The standard deviation calculated from histogram of both of images original and blurred image.

This paper proved the SSIM is the accurate measurment tool that depend on different between standard deviation and mean.

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