Journal of Computer and Mathematical Sciences, *Vol.9(12),1931-1940 December 2018* *ISSN 0976-5727 (Print)*
(An International Research Journal), *www.compmath-journal.org* *ISSN 2319-8133 (Online)*

An Empirical Analysis of Filtering Techniques on Fingerprint Images

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(Received on: November 29, 2018)

ABSTRACT

Most recently popular biometric systems are based on recognition and classification of unique finger print patterns. Finger print images have several peaks and valleys on human fingertip. These peaks and valleys form ridge direction and ridge frequency. In open literature of finger print and researches done by novel researcher, it was studied that researches have been done considering ridge direction mostly. Complete image enhancement both features of fingerprint images are required to be addressed. In proposed work 23 samples of fingerprint images are used to find comparison, dataset image taken real time college students these datasets are considered as two types without Mehndi as original image and with mehandi as noise image. Proposed system Keeping the view in mind five filters, such as weiner, median, gradient, knv, and laplacian in the parameters MSE, PSNR, CORELATION and CPU time vales are compared and analyses. Results of this paper have been simulated on MATLAB 2013 version a. From the result This Paper proves that wiener filter is best filter for removing noise from the fingerprint images.

Keywords: Mean Square Error, Peak Signal to Noise Ratio, cpu time, laplacian, gradient, weiner, median, KNV neighbourhood.

1. INTRODUCTION

Image processing is a methodology which is capable of converting an image into discrete form and it performs certain operations on image, to achieve an enhanced image or to extract some vital information from it, identical to DSP. In Digital image processing allows one to enhance image features of interest while attenuating details irreverent to a given application, and then, extract useful information about the scene from the enhanced image[16]. The needs for credible appropriator certification methods have significantly enhanced in the ferment of overacted aftercare concerning safety, acute progress in mechanism, intelligence and maneuverability[12]. Fingerprint image basis authentications have provided great interest among all the people and community because people do not lose this physical characteristic in the way they forget or lose passwords or identity cards. Having such great advantage over other physical characteristics, fingerprint biometric is being spotlighted to be best authentication method and will remain best in future challenging days also as a means of authentication. Fingertip epidermis depicted on smooth surface form spiral curve like pattern denoted as fingerprint. This pattern has reversionary flaring derm known ridges and delves derm known valleys[8]. In defining other way, fingerprints are the traces of all friction ridges or some portion of dactyl (finger) on smooth surface[13].

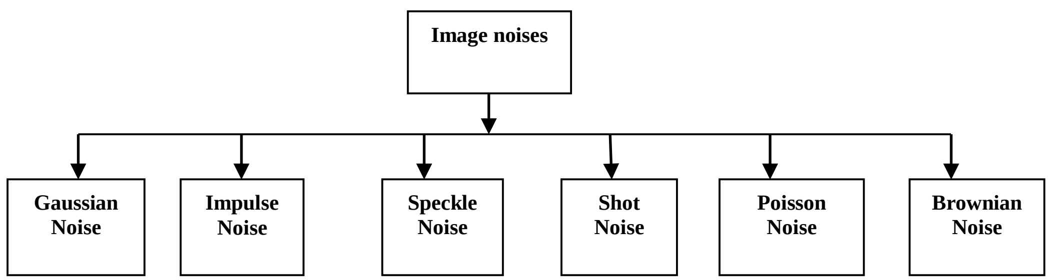

Figure 1 : Types of Noises

An abrades (friction) ridge skins are made by two layers-epicermis (outer layer) and dermis (innerlayer) and formed during fetal or embryonic development stage. Abrade ridge is formed by tiny ridge unit all with pore also their locations on ridge are randomly established[11].

Digital images are captured from different types of devices, and it creates different types of noises. The noise in an image can hardly affect the interpretation more difficult. The noise type is listed above[4] figure 1.The subsist of the paper is described as. The review in literature is done in Section II. The theoretical design and the phases of the scheme are described in Section III and the experimental results of the computerized system are documented in Section IV. Performance Evolution various parameter analysed in Section V, Finally, future work and conclusions are written Section VI.

2. LITERATURE REVIEW

In this section, attempts have been made for detailed literature reviews of impulse noise removal on the reported articles and a study of their performance through computer simulation. The various schemes for image denoising are broadly classified based on the characteristics of the filtering schemes[12]. These are (A) Filtering without detection, (B)

Detection followed by filtering, (C) filtering types and result and d) image dataset. Some of these filtering schemes are described as follows;

Abreu *et al*., (1996) designed A Minimum-Maximum Exclusive Mean (MMEM)[9] filter to remove impulse noise from highly corrupted images is proposed. This is a simple nonlinear, robust filter that centers around two windows of size 3×3 and 5×5. It checks for gray level in the 3×3 windows. This result fails, it goes to 5 ×5 window. If the average of all the pixels of that particular range is more than a certain value then that pixel is replaced with the average, otherwise it is left intact. This is one of the good schemes filters like SMF[5], rank-ordered mean (ROM)[1] because of its simplicity and easy implementation.

The Rank Order Absolute Difference (ROAD)[1] scheme presents efficient measures to determine the closeness of a test pixel to its surrounding pixels. This measured has been used to detect impulsive noise in an image. It quantifies how different in intensity the test pixels are from their neighbours. Fingerprints have been found among the ruins on clay seals attached to business documents in China as it is explained in its history[16].

Dinesh Kumar *et al*., (2013), As Gabor filter does keep frequency and orientation optional attribute, so filter is harmonized to render maximum repercussion (response) for ridges upon distinct inclination (orientation) and frequency in thumb mark and proficiently discard unwished clamor also intercede precise ridge and valley textures. Xue *et al*., (2009) Gabor filtration and its finger mark augmentation algorithm described below:[7,15]

1. First we divide thumb mark into non-overlap section of dimension 8×8.
2. Then we calculate ridge edging (direction)
3. Gaussian constant along horizontal axis and δy Gaussian constant along vertical axis, u0 considered as ridge frequency of segmented image, d(x,y) considered as distance through pixel (x,y) unto model centre. It also does keep similar direction along-with ridge direction of segmented finger mark[2].
4. Image after enhancement is calculated for all pixels in each segment of image

Histogram equalization, consider p denote the intensities of an image in range of (0, L-1) to be processed, defining p=0 black image and p=L-1 white image. Intensity mapping for above p definition can be of form [3,6] $s=T(p)$ $0 \leq p \leq L-1$ this equation yields intensified output with strata s for each pixel of acquired image penned with severity (intensity) p.

While reviewing literature no relevant research proposal found considering Fingerprint image based on Mahandi Noise estimation and its enhancement. It is worthful to mention that finger print mahandi noise (orientation) and ridge finding over singular pixel is easily done and filtration carried out in various filter domain. We could found out very certain research proposal with utilization of fingerprint noise removal in research field but no one mahandi noise.

3. COMPARITIVE STUDY

While doing the comparative study the images are input to the Registration phase (without mahandi fingerprint image) and trainee phase noised image (with mahandi fingerprint image) fed to the Noise Reduction phase (apply filter). The purpose of registration in this framework is to allow the use of multiple without mahandi fingerprint image modalities (co registration), and the use of information derived from the alignment of a template in a standard coordinate system (template registration). Therefore, the second input with mahandi fingerprint noise image of phase will be images in the different modalities that have been aligned with each other and have been additionally aligned with a template in a standard coordinate system. and find the following performance measures parameters. Figure 2 general block diagram for proposed system analysis

3.1 Performance Measures

One of the issues of denoising is the measure of the reconstruction error. The metrics used for performance comparison of different filters (both existing and proposed) are defined below. There are basically two classes through which we can measure the performance and quality of an image. These are objective quality and the subjective or qualitative or distortion measure. The metrics used for performance comparison among different filters are defined below:

a) Mean Square Error (MSE)

In statistics, the mean square error (MSE) of an estimator is one of many ways to quantify the amount by which an estimator differs from the true value of the quantity being estimated. Given an original image of size (m*n) pixels and as reconstructed image[10].

$$MSE = \frac{1}{M\times N}\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}(X_{i,j}- \hat{X}_{i,j})^2$$

Similarly, the mean absolute error (MAE) is defined as,

$$MAE = \frac{1}{M\times N}\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}\left|X_{ij} - \hat{X}_{ij}\right|$$

The goal of de-noising is to find an estimate image such that both MSE and MAE should be as minimum as possible.

b) Peak Signal to Noise Ratio (PSNR)

PSNR[1,2] analysis uses a standard mathematical model to measure an objective difference between two images. It estimates the quality of a noise fingerprint pictures with respect to an original fingerprint image. Reconstructed images with higher PSNR are judged as of better quality. PSNR is the ratio between the maximum possible power of a original fingerprint image signal and the power of noise Mahandi fingerprint image. PSNR is usually expressed in terms of the logarithmic decibel and defined as[17],

$$PSNR(dB) = 10\ log_{10}\left(\frac{255^2}{MSE}\right)$$

The original value of the pixel is included in the computation of the five filters. for certain types of random noise they provide excellent noise reduction capabilities, with considerably less blurring than linear smoothing filters of similar size.

4. RESULT AND DISCUSSION

The 8-bit images of dimensions Ml x M2 (256 x 256) pixels is used for simulations. In this work, real-data set is created with the help of volunteers (23) from an educational institution. It is an attempt to check the performance of the filters such as weiner, knv, laplacian, median and gradient in removing noise from raw image and comparatively the same on "Meganthi-applied" image. Fig. 2 and 3 visualizes the implementation of filter and its results.

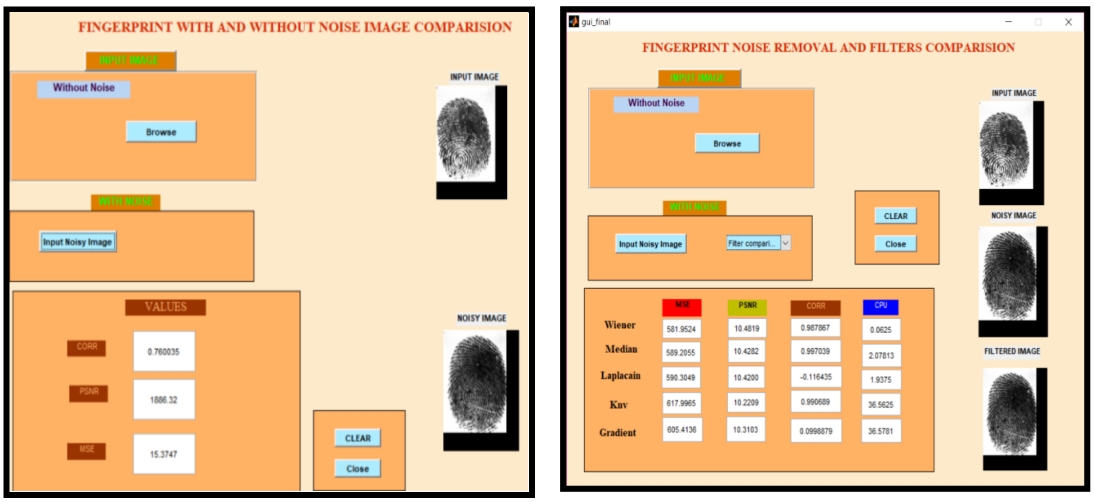

Figure 2: finger print samples a) without filter b) with filter

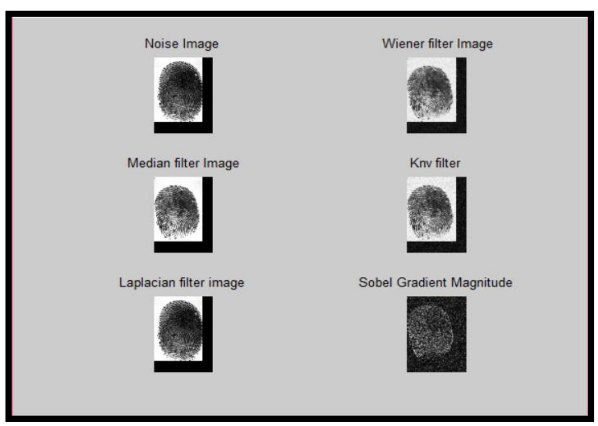

Figure 3 : Noise removed output of finger print with Mahanadi image

5. PERFORMANCE ANALYSIS

Performance of the filters are measured in terms off Mean Square Error (MSE) as tabulated in Table-1 and corresponding comparison graph represented in figure 4. The second measure is Peak Signal to Noise Ratio (PSNR) which is tabulated in table-2, corresponding comparison graph represented in figure 5. Co-relation Factors of images are also tabulated in table-3, corresponding comparison graph represented in figure 6 and finally the filtering time is tabulated in table-4 with corresponding diagram Figure 7.

Table 1: MSE values before and after filtering

IMAGE SAMPLES	BEFORE FILTERING MSE	AFTER FILTERING				
		WEINER	MEDIAN	GRADIENT	KNV	LAPLACIAN
Image 1	1388.366667	703.99264	739.49033	716.94690	692.98294	740.42990
Image 2	1886.318819	581.95241	589.20547	605.41363	617.99647	590.30490
Image 3	507.124583	838.58848	857.11599	820.30217	797.90773	858.22174
Image 4	749.573573	801.92982	823.57192	789.40429	764.11857	824.62132
Image 5	1354.124503	754.82923	804.69531	770.36261	734.82565	805.56390
Image 6	1028.680697	690.63609	728.15517	698.89079	668.57507	728.76084
Image 7	901.998168	747.24688	777.07964	747.85829	718.49063	778.01962
Image 8	597.495931	839.2815	849.00347	824.59006	809.41019	850.01735
Image 9	475.721368	888.0147	907.43826	865.35169	841.64865	908.45113
Image 10	901.176964	723.42023	740.10454	714.63953	695.85736	740.75929
Image 11	1671.630465	677.9987	730.26905	701.41564	665.7159	731.29559
Image 12	537.199387	831.89927	863.22363	820.11409	789.86099	864.11937
Image 14	1885.987665	605.60088	617.07858	588.07462	569.30742	618.113
Image 15	2211.248480	557.75969	607.70892	567.0268	523.32931	608.7679
Image 16	1337.979002	635.37798	694.6267	684.23003	665.34283	695.60245
Image 17	1270.072819	521.7641	560.30731	531.48041	495.97291	561.56491
Image 18	4168.768876	802.80215	836.21139	801.29862	770.98546	837.26929
Image 19	1248.633890	776.19993	816.80953	827.21991	843.33635	818.09296
Image 20	2845.987135	701.27565	739.95857	718.20318	691.30953	741.11224
Image 21	1448.327284	585.17143	630.50595	629.39109	624.05558	631.11721
Image 22	1686.257890	797.39029	836.60564	815.00516	791.55236	837.33463
Image 23	1370.883147	586.96835	616.08896	598.3657	576.60363	616.8086

Table 2 : PSNR values before and after filtering

IMAGE SAMPLES	BEFORE FILTERING PSNR	AFTER FILTERING				
		WEINER	MEDIAN	GRADIENT	KNV	LAPLACIAN
Image 1	16.705762	9.65513	9.4415	9.5759	9.7236	9.4359
Image 2	15.374653	10.4819	10.4282	10.3103	10.2209	10.4200
Image 3	21.079657	8.8953	8.8004	8.9911	9.1113	8.7948
Image 4	19.382661	9.0894	8.9737	9.1578	9.2992	8.9682
Image 5	16.814218	9.3523	9.0745	9.2638	9.4689	9.0698
Image 6	18.007998	9.7383	9.5086	9.6867	9.8793	9.5049
Image 7	18.578747	9.3962	9.2262	9.3926	9.5666	9.2209
Image 8	20.367454	8.891	8.8417	8.9684	9.0491	8.5005
Image 9	21.357277	8.6466	8.5526	8.7589	8.8795	8.5478
Image 10	18.582703	9.5369	9.4379	9.5899	9.7056	9.434
Image 11	15.899401	9.8185	9.496	9.6711	9.9015	9.4899
Image 12	20.829449	8.9301	8.7696	8.9921	9.1553	8.7651
Image 14	15.375415	10.309	10.2274	10.4365	10.5773	10.2201
Image 15	14.684428	10.6663	10.2939	10.5948	10.9431	10.2863
Image 16	16.866311	10.1005	9.7133	9.7788	9.9004	9.7072
Image 17	17.092517	10.9561	10.6466	10.876	11.1762	10.6368
Image 18	11.930725	9.0847	8.9076	9.0929	9.2603	8.9022
Image 19	17.166452	9.2311	9.0096	8.9546	8.8708	9.0028
Image 20	13.588474	9.6719	9.4387	9.5683	9.7341	9.432
Image 21	16.522136	10.458	10.1339	10.1416	10.1786	10.1297
Image 22	15.861564	9.1141	8.9056	9.0192	9.146	8.9018
Image 23	16.760799	10.4447	10.2344	10.3611	10.522	10.2293

Table 3: CO-RELATION values before and after filtering

IMAGE SAMPLES	BEFORE FILTERING CORELATION	AFTER FILTERING				
		WEINER	MEDIAN	GRADIENT	KNV	LAPLACIAN
Image 1	0.814388	0.694111	0.677378	0.293242	0.680534	0.680534
Image 2	0.760035	0.987867	0.997039	0.099888	0.990689	0.990689
Image 3	0.934754	0.771264	0.753596	0.278869	0.755488	0.755488
Image 4	0.906494	0.737205	0.719846	0.291464	0.721907	0.721907
Image 5	0.843509	0.782649	0.764026	0.258169	0.766651	0.766651
Image 6	0.878712	0.781482	0.762817	0.269273	0.765085	0.765085
Image 7	0.895078	0.738519	0.720048	0.297806	0.722645	0.722645
Image 8	0.926153	0.737135	0.718613	0.307133	0.721155	0.721155
Image 9	0.942455	0.762408	0.744114	0.293811	0.746843	0.746843
Image 10	0.888421	0.719096	0.701784	0.300764	0.704117	0.704117
Image 11	0.783298	0.752478	0.735322	0.244973	0.737223	0.737223
Image 12	0.938325	0.772051	0.753582	0.284053	0.756624	0.756624
Image 14	0.758978	0.760126	0.742208	0.294141	0.744771	0.744771
Image 15	0.715066	0.729667	0.712255	0.248024	0.712942	0.712942
Image 16	0.848202	0.734192	0.718012	0.232221	0.717895	0.717895
Image 17	0.847679	0.809067	0.790518	0.253206	0.793027	0.793027
Image 18	0.639801	0.714485	0.69761	0.280175	0.00449	0.00449
Image 19	0.858291	0.756352	0.739322	0.285029	0.741368	0.741368
Image 20	0.703138	0.746786	0.728975	0.288886	0.731295	0.731295
Image 21	0.829181	0.80304	0.784342	0.226828	0.786351	0.786351
Image 22	0.774796	0.779519	0.763684	0.213533	0.762632	0.762632
Image 23	0.840650	0.809009	0.79208	0.116562	0.791675	0.791675

Table 4 : Filtering Time

IMAGE SAMPLES	CPU TIME (millisec)				
	WEINER	MEDIAN	GRADIENT	KNV	LAPLACIAN
Image 1	0.140625	1.70313	35.8281	35.0781	1.51563
Image 2	0.078125	1.39063	36.5781	36.5625	1.51563
Image 3	0.109375	1.625	36.2344	36.0313	1.46875
Image 4	0.125	1.35938	35.8906	35.4531	1.39063
Image 5	0.140625	1.59375	36.6719	36.1719	1.46875
Image 6	0.15625	1.1875	34.9375	34.2656	1.375
Image 7	0.109375	1.76563	35.9219	35.2969	1.46875
Image 8	0.109375	1.57813	34.7969	35.0156	1.46875
Image 9	0.15625	1.73438	35.0156	39.7188	1.46875
Image 10	0.125	1.59375	36.5469	36.0469	1.48438
Image 11	0.15625	1.625	35.7031	35.5469	1.20313
Image 12	0.078125	1.67188	35.1563	35.2969	1.45313
Image 14	0.15625	1.625	36.6563	35.9844	1.46875
Image 15	0.046875	1.59375	39.6406	35.6094	1.5
Image 16	0.1875	1.60938	36.3594	35.7969	1.46875
Image 17	0.109375	1.59375	35.9688	35.4063	1.48438
Image 18	0.171875	1.65625	36.2344	35.3594	1.53125
Image 19	0.09375	1.65625	36.4688	35.7031	1.76563
Image 20	0.109375	1.60938	35.7188	35.4375	1.48438
Image 21	0.125	1.6875	36.3281	35.625	1.48438
Image 22	0.15625	1.60938	37.3438	34.5469	1.45313
Image 23	0.078125	1.53125	36	35.4219	1.46875

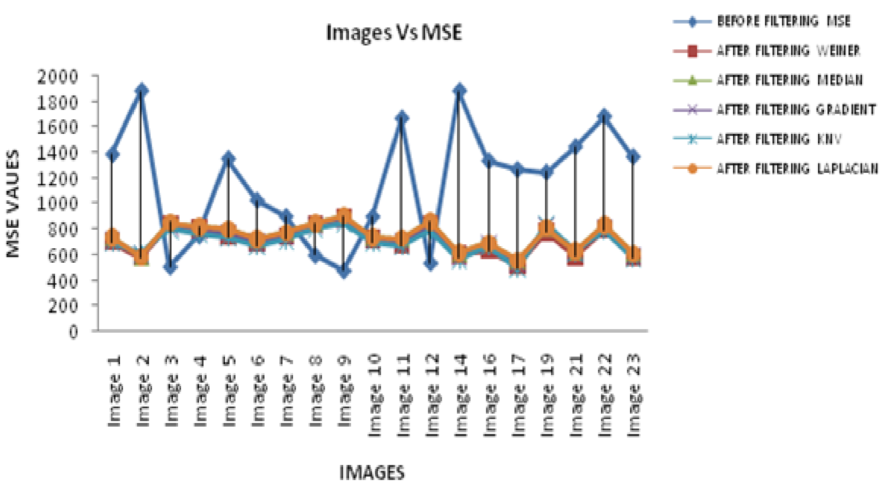

Figure 4: Comparison Graph image samples vs MSE values

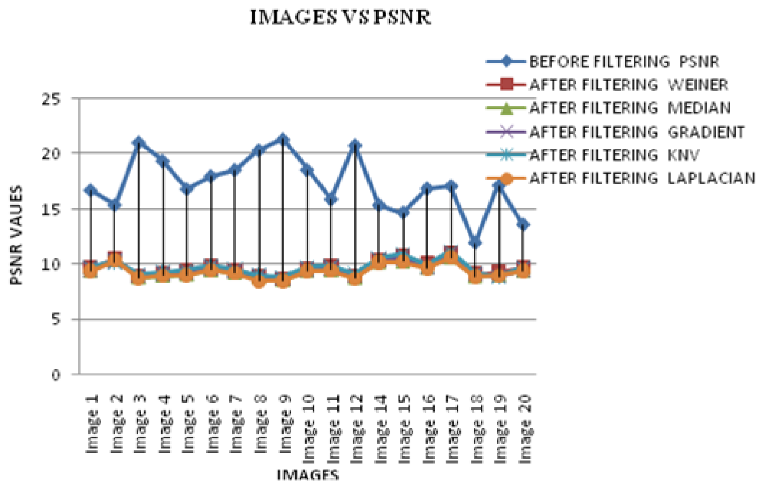

Figure 5 : Comparison Graph image for samples vs PSNR values

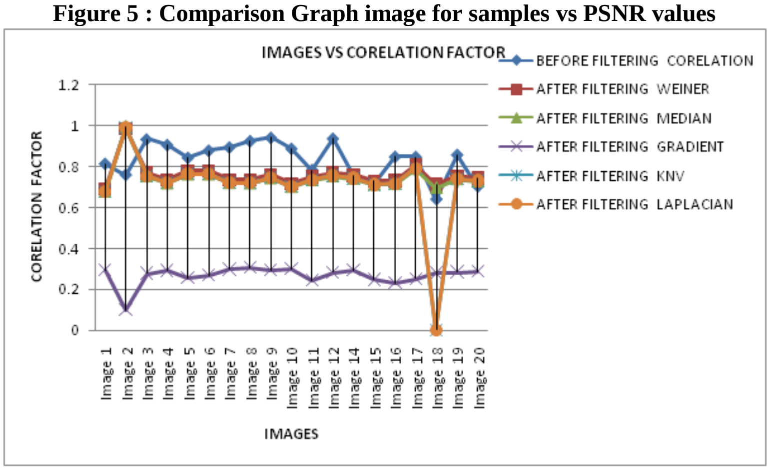

Figure 6: Comparison Graph for image samples vs corelation values

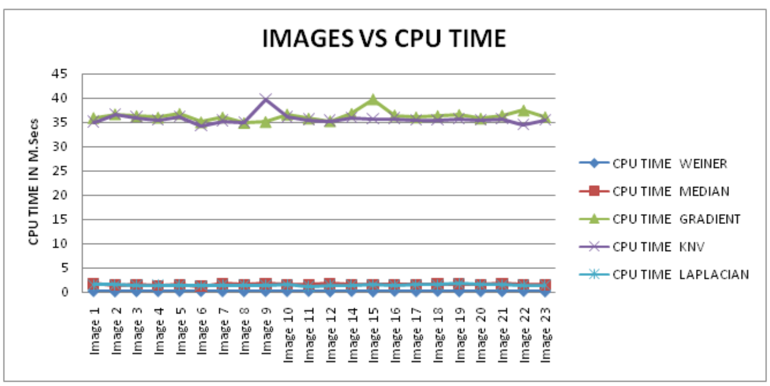

Figure 7 : Comparison Graph for image samples vs filtering time

6. CONCLUSION

In this research work, performance evolution of five filters namely Weiner, Median, **KNV**-neighborhood , Lapalcian, and Gradient is assessed. Based on the four quality measure PSNR, MSE, correlation factor, cpu time in milliseconds it is concluded that Wiener filter performs better than other filters considersed for the analysis.

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