High Density Noise Removal in Endangered Silent-Films Using Non-linear Filters: A Comparative Study

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(Received: 07-July-2015 – Accepted: 04- September-2015)

Abstract

The loss and distortion of the feature films at films silent-era constitutes an alarming in cultural recording for most nation's. So the first directive of congress library was to support archival research projects that would restore the American movies produced during the 19th and 20th centuries. Noise removal is an important task in video restoration where the "original" video is discernible. Therefore this work contemplates to introduce an overview of some algorithms that can be used to restore the corrupted video that presented in AVI container format. These algorithms are untrimmed decision based median filter (UDBMF), decision based median filter (DBMF), weighted median filter (WMF), and standard median filter (SMF). A comparable analysis among all filters was done at different levels of noise based on some calculated parameters as mean square error (MSE), mean absolute error (MAE), image enhancement factor (IEF), peak signal to noise ratio (PSNR), and correlation ratio (CORR). Simulation results indicate that DBMF and UDBMF have superior performance compared to other nonlinear filters for noise level up to ninety percent. Also the necessary details in video were preserved.

1. Introduction

An image is an array or a matrix of square pixels (picture elements) arranged in columns and rows. Image may be captured in optical devices such as telescopes, lenses, mirrors, cameras, microscopes, etc., and natural objects and phenomena, such as the human eye or the water surfaces. The word image is also used in the broader sense of any two-dimensional figure. In wider sense; images can also be rendering manually, such as by painting, drawing, carving, rendered automatically by computer graphics technology, printing, or developed by a combination of methods [1].

Digital images and digital video are, respectively, pictures and movies that have been converted into a computer- readable format. Usually, image means a still picture that does not change with time, whereas a video evolves with time and generally contains moving and/or changing objects. Digital images or video are usually obtained by converting continuous signals into digital format. Likewise, digital visual signals are viewed by using diverse display media, included digital printers, computer monitors, and digital projection devices [2].

Video frames are often corrupted by impulse noise. In general, the impulse noise in video frames is present due to bit errors in transmission or introduced during the signal acquisition stage. Based on the noise values, the impulse noise is classified into two types; salt and pepper noise (fixed valued noise) and random valued noise. Salt and Pepper noise can corrupt the frame where the corrupted pixel takes either maximum or minimum gray level. Random valued impulse noise, in which noise is dispersed uniformly. It may take any value in the dynamic range of [0,255]. In this paper a deal with the removal of salt and pepper noise from corrupted video images [3].

Linear filters were the primary tools that used with signal and image denoising but it tend to blur edges, do not remove impulsive noise effectively, and do not perform well in the presence of signal dependent noise [4]. To overcome these shortcomings, nonlinear filters have replaced linear filters in many image processing applications since they can operate effectively in various noisy conditions and potentially preserve the structural information of the image, so various types of nonlinear filters are used [5].

To satisfy the objective of this work the paper has been structured as follows; section II describes restoration process, section III contains sources of noise in video images and its types. Section IV discusses the means of image de-noising, while filtering techniques are given in section V. Section VI briefly illustrates the suggested methodology. Simulation and the discussions of results are presented in section VII. Conclusions are drawn in section VIII. Section IX gives a scope of the future work. Finally, the references that used for completion of this work were incorporated.

2. RESTORATION PROCESS

Image Restoration is an attempt to reconstruct or recover a video frame that has been degraded by using a priori knowledge of the degraded phenomenon. Thus, restoration techniques are oriented toward modeling the degradation and applying the inverse process in order to restore the original image [6]. The idea of image restoration is to balance for or unwrap a defect which corrupts an image. Degradation comes in many forms such as motion blur, noise, and camera misfocus. In cases where the image is corrupted by noise, the best hope is to compensate for the degradation it caused [7].

The objective of image restoration procedures is to suppress degradation of the image with the help of the knowledge about its nature. The image degradation could be attributed to the defects present in the optical lenses, relative motion between the object and the camera, wrong focus, turbulence in the atmosphere, scanning quality etc. The goal of image restoration is to reconstruct the original image from its degraded form. The image restoration techniques can be broadly classified into two groups as: (1) deterministic and (2) stochastic. Deterministic method suits in restoring images with a little noise and a known degradation function. The original image can be obtained by applying a transformation inverse to the degradation of the degraded image. Stochastic technique tries to find the best restoration according to a particular stochastic criterion [8].

The possible approach for noise removal is using filters such as low-pass filters or median filters. More sophisticated methods assume a model of how the local image structures look like, a model which distinguishes them from the noise; that's by first analyzing the image data in terms of the local image structures, such as lines or edges, and then controlling the filtering based on local information from the analysis step [6].

Restoring an original image, when given the degraded image, with or without knowledge of the degradation function degree and type of noise present is an ill posed problem [9].Fig.1. Shows block diagram for the degradation/ restoration process. The objective of restoration is to find the estimated F(x,y) that closely approximates the original input image f(x,y) [10].

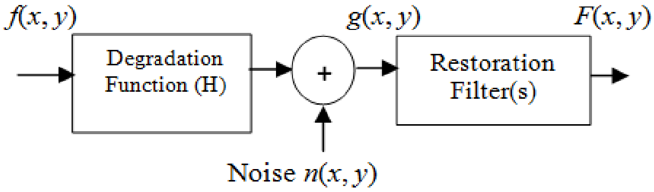


Fig.1. Model of the image degradation/restoration process

Where, f(x,y) is a given input image, H is a degradation function, n(x,y) is the additive noise, g(x,y) is the degraded image, and F(x,y) is the restored image.

3. SOURCES of NOISE in IMAGES and ITS TYPES

Noise is a disturbance that affects a signal; it may distort the information carried by the signal. Presence of noise is manifested by undesirable information, which is not at all related to the image under study, but in turn disturbs the information present in the image. The noise is translated into values, which are getting added or subtracted to the values on the levels of image pixels. Image noise can be originated due to camera quality, acquisition condition, illumination level, calibration. Image noise can also be occurred due to the electronic noise in the sensors in the digital cameras, and it can be a function of the scene environment [11].

Image noise can be classified as Impulse noise (Salt-and-pepper noise), Amplifier noise (Gaussian noise), Shot noise, Quantization noise (uniform noise), Film grain, non-isotropic noise, Multiplicative noise (Speckle noise) and Periodic noise [12].

A. **Various Sources Of Noise**

In signal processing or computing it can be considered data without meaning; that is, data not being used to transmit a signal, but is simply produced as an unwanted by-product of other activities. In Information

Theory, however, noise is still considered to be information. In a broader sense, film grain or even advertisements in web pages can be considered as noise [4].

Reference [12] introduces noise in the image at the time of image acquisition or transmission. Different factors may be responsible for introducing noise in the image. The number of pixels corrupted in the image will define the quantification of the noise. The principal sources of noise in the digital image are:

- The imaging sensor may be affected by environmental conditions during image acquisition.
- Insufficient light levels and sensor temperature may introduce noise in the image.
- Interference in the transmission channel may also corrupt the image.
- If dust particles are present on the scanner screen, they can also introduce noise in the image.

B. Types Of Noises

Noise is to be any degradation in the image signal caused by external disturbance [13]. If an image is being sent electronically from one place to another via satellite or wireless transmission or through networked cables, the expecting errors may be occurred in the image signal. These errors will appear on the image output in different ways depending on the type of disturbance in the signal [14]. The type of noise and errors in the image can be expected as:

1. ***Amplifier Noise* (*Gaussian noise*):** The standard model of amplifier noise is additive, Gaussian, dependent at each pixel and dependent of the signal intensity, caused primarily by Johnson–Nyquist noise (thermal noise), including that which comes from the reset noise of capacitors ("kTC noise"). It is an idealized form of white noise, which is caused by random fluctuations in the signal [14]. Amplifier noise is a major part of the noise of an image sensor, that is, of the constant noise level in dark areas of the image. In Gaussian noise, each pixel in the image will be changed from its original value by a (usually) small amount. A histogram, the amount of distortion of a pixel value against

the frequency with which it occurs, shows a normal distribution of noise. While other distributions are possible, the Gaussian (normal) distribution is usually a good model, due to the central limit theorem that says that the sum of different noises tends to approach a Gaussian distribution [15].

2. ***Impulse Noise*:** Impulse noise is a short duration noise that affects the contents of digital images. Impulse noise is normally produced due to electromagnetic interference, errors and scratches on recording disks, malfunctioning of pixel elements in the camera sensors, faulty memory location and erroneous synchronization in digital recording and communication equipment [16]. Impulse noise distorts image pixels where replacing the original value either by fixed value or random value. Two types of impulse noise are fixed value impulse noise and random-valued impulse noise. Fixed value impulse noise e.g. Salt and pepper noise in which the gray value takes a value of either 255 or 0, Random-valued impulse noise, in which noise is dispersed uniformly. It may take any value in the dynamic range of [0,255]. It is therefore apparent that the original pixel and the random-valued impulse noise have the same range of values. Random valued impulse noise is difficult to remove [17].

   In salt and pepper noise model, there are only two possible values ‘a’ and ‘b’ .The probability of getting each of them is less than 0.1 (else, the noise would greatly dominate the image). For 8 bit/pixel image, the intensity value for pepper noise typically found nearer to 0 and for salt noise it is near to 255. Salt and pepper noise is a generalized form of noise typically seen in images [2]. In image criteria the noise itself represents as randomly occurring white and black pixels. An effective noise reduction algorithm for this type of noise involves the usage of a median filter, morphological filter [18].

3. ***Multiplicative Noise* (*Speckle noise*):** This kind of noise is also called as the speckled noise. This noise gives a ‘magnified’ view of the original image. For *example*, when this noise is applied to high pixel intensities or bright area in an image, a higher random variation will be observed. On the other hand, when this noise is applied to a darker region in the image, the random variation observed is not that much as compared to that observed in the brighter areas. Thus, this type of noise is signal dependent and distorts the image in a big way [11].

Speckle noise is a granular noise. This noise generally degrades Synthetic Aperture Radar (SAR) images to large extent. This noise is generally caused due to random ups and downs in the signal coming back from an object that is smaller than a single image-processing element. It is also caused by consistent processing of backscattered signals from number of distributed targets. This noise also increases the mean gray level of affecting image. This noise creates a lot of difficulty in interpreting the image [19].

4. ***Poisson Noise*** **(*Shot Noise*):** The dominant noise in the lighter parts of an image from an image sensor is typically that caused by statistical quantum fluctuations, that is, variation in the number of photons sensed at a given exposure level; this *noise* is known as photon shot noise. Shot noise has a root mean- square value proportional to the square root of the image intensity, and the noises at different pixels are independent of one another. Shot noise follows a Poisson distribution, which is usually not very different from Gaussian. In addition to photon shot noise, there can be *additional* shot noise from the dark leakage current in the image sensor; so this noise is known as "dark shot noise" or "dark-current shot noise"[15].
5. ***Quantization Noise*** **(*Uniform Noise*):** The Uniform noise caused by quantizing the pixels of image to a number of distinct levels is known as Quantization noise. It has approximately uniform distribution. In this type of noise, the levels of *the* gray values of the noise are uniformly distributed over a specified range. It can be used to create any type of noise distribution. This type of noise is mostly used to evaluate the performance of image restoration algorithms. This noise provides the most neutral or unbiased noise [20].
6. ***Film Grain*:** The grain of photographic film is a signal-dependent noise, related to shot noise. That is, if film grains are uniformly distributed (equal number per area), and if each grain has an equal and independent probability of developing to a dark silver grain after absorbing photons, then the number of such dark grains in an area will be random with a binomial distribution. In areas where the probability is low, this distribution will be close to the classic Poisson distribution of shot noise; nevertheless a simple Gaussian distribution is often used as an accurate model [15].

7. ***Non-Isotropic Noise*: Some noise sources show up with a significant orientation in images. For example, image sensors are sometimes subjected to row noise or column noise. In film, scratches are an example of non-isotropic noise. While cannot completely do away with image noise, it can certainly reduce some of it. Corrective filters are yet other devices that help in reducing image noise. [15].
8. ***Periodic Noise*:** If the image signal is subjected to a periodic rather than a random *disturbance*, an image corrupted by periodic noise is obtained. The effect is of bars over the image [15].

4. IMAGE DE-NOISING

Image denoising is considered as an important step and is generally done prior to processing of an image. It shows the process of recovering a good estimate of the original image from a corrupted image without modifying the useful structure in the image such as edges, discontinuities and fine details [21].

Many algorithms have been implemented for denoising and each algorithm has its advantages and limitations. Having a good knowledge about the noise present in the image will be crucial in selecting a suitable denoising algorithm. The significance of the image denoising could be a weighty task for medical imaging, satellite image processing, and space exploring etc. A wide variety of noise types are present and good number of denoise filters have been developed to reduce noise from degraded images to enhance image quality by preserving edges. [8]. It has many applications in other domains like object recognition, digital entertainment, and remote sensing imaging etc. As the number of image sensors per unit area increases, camera devices capture the noise with the image more often [22].

In early times, as the signals handled, the analog, filters were used. Gradually digital filters were took place because of their flexibility, low cost, programmability, reliability, etc. The design-of digital filters involves three basic steps: (1) the specification of the desired properties of the system, (2) the approximation of these specifications using a causal discrete time system, and (3) the realization of the system using finite precision arithmetic [23].

FILTERING TECHNIQUES

Filtering in an image processing is a basis function that is used to achieve many tasks such as noise reduction, interpolation, and re-sampling. Filtering image data is a standard process used in almost all image processing systems. The choice of filter is determined by the nature of the task performed by filter and behavior and type of the data. Filters are used to remove noise from digital image while keeping the details of image preserved is a necessary part of image processing [24].

A traditional way to remove noise from image data is by using spatial filters. Spatial filters are a low pass filter. It can be further classified into nonlinear and linear filters. Linear filters, which consist of convolving the image with a constant matrix to obtain a linear combination of neighborhood values. They have been widely used for noise elimination in the presence of additive noise [25], Linear filters are used for generic tasks such as image/video contrast improvement, denoising, and sharpening, as well as for more object or feature specific tasks such as target matching and feature enhancement but it destroy lines and other fine image details [2]. Non-linear filters are used to remove the noise without any effort to explicitly identify it. These filters often remove noise to a reasonable extent but at the cost of blurring images and consequently makes the edges in image invisible [8].

A. Method Used

Some important turns seen the literature with the common frameworks used by these filters. The modifications of the basic frameworks with combination of one or two are used in different methods [5].

The standard median filter (SMF) is a simple nonlinear smoother that can suppress noise while retaining sharp sustained changes (edges) in signal values. The output of SM filter at a point is the median value of the input data inside the window centered at the point [5].But the main drawback of this filter is that it is effective only for low noise densities. At high noise densities, SMF often exhibit blurring for large window size and insufficient noise suppression for small window size [3].When the noise level is over 50%, the edge details of the original frame will not be preserved by SMF. However, most of the median filters operate uniformly and modifies both noise and noise-free pixels, and causes information loss. Ideally, the filtering should be applied only to corrupted pixels not to uncorrupted ones [26].

One of the branches of median filter is weighted median filter (WMF). It was first introduced by Justusson in 1981, and further elaborated by Brownrigg. The operations involved in WMF are similar to those of SMF, except that WMF has weight associated with each of its filter element. These weights correspond to the number of sample duplications for the calculation of median value. However, the successfulness of weighted median filter in preserving image details is highly dependent on the weighting Coefficients and the nature of the input image itself. Unfortunately, in practical situations, it is difficult to find the suitable weighting coefficients for this filter, and this filter requires high computational time when the weights are large [5].

In decision based median filter (DBMF), the noisy and noise-free pixels in the image are detected by checking the pixel values against the maximum and minimum values which are in the dynamic range (0, 255) .If the pixel being currently processed has a value within the minimum and maximum values in the currently processed window, then it is a noise-free pixel and no modification is made to that pixel. If the value doesn't within the range, then it is a noisy pixel and will be replaced by either the median pixel value or by the mean of the neighboring processed pixels (if the median itself is noisy) which ensure a smooth transition among the pixels [27].

In untrimmed decision based median filter (UDBMF), the selected 3 x 3 window elements are arranged in either increased or decreased order .This filter is called trimmed median filter because the pixel values 0’s and 255’s are removed from the selected window, then the median value of the remaining pixels is taken in consideration. This median value is used to replace the noisy pixel. The processing pixel is checked whether it is noisy or noise free. That is, if the processing pixel lies between maximum and minimum gray level values then it is noise free pixel, it is left unchanged. If the processing pixel takes the maximum or minimum gray level then it is noisy pixel which is processed by UDBMF [28, 29].

B. Performance Measures

To assess the performance of the proposed filters for removal of impulse noise and to evaluate their comparative performance, different standard calculated parameters have been used [11, 20, 25–30]. These are defined as follows:

1) *Mean Squared Error (MSE):* It is computed pixel-by- pixel by adding up the squared difference between the uncorrupted (original) image $s(i, j)$ and the restored image $r(i, j)$ and dividing by the total pixel count. It is defined as:

$$MSE = \frac{1}{m \times n} \sum_{i=1}^{m} \sum_{j=1}^{n} \left(s(i,j) - r(i,j) \right)^2 \tag{1}$$

Where, $m \times n$ is image size; the minimum value of *MSE* reflects the better visual.

2) *Peak Signal to Noise Ratio (PSNR):* is the ratio between the maximum pixel value of an image and the mean square error. It is measured in decibel (dB) and for gray scale image it is defined as:

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

The higher the value of the *PSNR* in the restored image, the better is its quality.

3) *Image Enhancement Factor (IEF):* is a measure of Image quality, and is defined as**:**

$$IEF = \frac{\sum_i \sum_j \left[\psi(i,j) - s(i,j) \right]^2}{\sum_i \sum_j \left[r(i,j) - s(i,j) \right]^2} \tag{3}$$

Where $\psi(i, j)$ is the pixel value of the corrupted image, $r(i, j)$ and $s(i, j)$ are the pixel values of the restored and the original images respectively. The higher the value of *IEF* reflects the better visual, and restoration performance.

4) *Mean Absolute Error (MAE):* is a quantity used to measure how close the restored image are to the original, and it is defined as:

$$MAE = \frac{1}{m \times n} \sum_{i=1}^{m} \sum_{j=1}^{n} \left| r(i,j) - s(i,j) \right| \tag{4}$$

Where, r (i, j) and s (i, j) are the pixel values of the restored and the original images respectively at the location (i, j).The minimum value of MAE reflects the better visual.

5) *Correlation ratio* (*CORR*)*:* measures the degree to which two images vary together or oppositely and taking values from 0.0 to 1 .0 and it is defined as:

$$CORR = \frac{\sum_i (x_i - x_m)(y_i - y_m)}{\sqrt{\sum_i (x_i - x_m)^2 (y_i - y_m)^2}} \quad (5)$$

Where x_i is the intensity of the i^{th} pixel in the original image, y_i is the intensity of the i^{th} pixel in the restored image, x_m is the mean intensity of the original image, and y_m is the mean intensity of the restored image. The value of *CORR*, which gets close to 1.0 reflects the better visual impression.

5. PROPOSED METHODOLOGY

A. *Implementation for Video restoration Sequence:*

The video sequence is first converted into frames and frames into images; impulsive noise (salt and pepper) was added at different levels of noise densities ranging from 5% up to 90% of salt and pepper to images. Specific filters were applied to the noisy images. After the filtering process was done the frames are converted back as a restored movie. Fig.2 shows the process flow.

1) *Video to Frames:* The video sequence (silent film) is converted into AVI format, and then frames are extracted from the Video.
2) *Frames to Images:* Frames are then converted into JPEG images for further processing.
3) *Noise Addition:* Add salt and pepper noise to images to become noisy images and then pass it through the Filtering process to remove the Impulse noise presented.
4) *Filtering:* The impulse noise from the noisy images is removed using the filters which are used.

5) *Frames to video:* After removal of impulse noise from all noisy images, the frames are converted back into video as a restored data at 15 f/s rate.

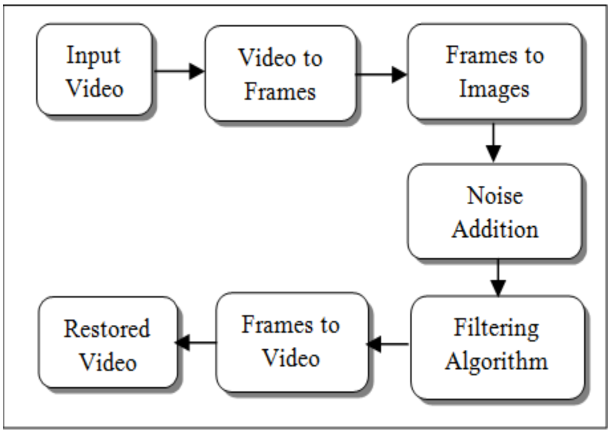


Fig.2. Block Diagram for restore processing of video Sequence.

B. The proposed algorithm

The proposed algorithm can be described in the following: read input video, then convert it to frames then, to images, an impulse noise were added with different levels of noise densities beginning with 5% up to 90% of salt and pepper. After having noisy image; different nonlinear filters were applied as SMF, WMF, DBMF and UDBMF, then a quantitative and qualitative parameters as MSE, MAE, IEF, PSNR, and CORR are calculated for each filter for comparison. Finally convert back the frames to video format in order to satisfy the discernible concept as a visual impression. Fig.3 illustrates the flow chart of the computerized program that used to satisfy the proposed restoration algorithm.

6. SIMULATION RESULTS & DISCUSSIONS

To validate the suggested methodology, a silent film in AVI format is used in the simulation at different levels of noise densities. The proposed algorithm has been implemented using five programs that designed under

MATLAB 7.10.0.499 (R2010a); as a language of technical computing. The performance of the proposed algorithm is evaluated with comparable study for various standard filters as: SMF, WMF**,** DBMF, and UDBMF. Figures (4-9) give the used noisy frames and the restored frames. The comparison was done in terms of MSE (1), PSNR (2), IEF (3), MAE (4), and CORR (5); where the results are illustrated in Fig.10.

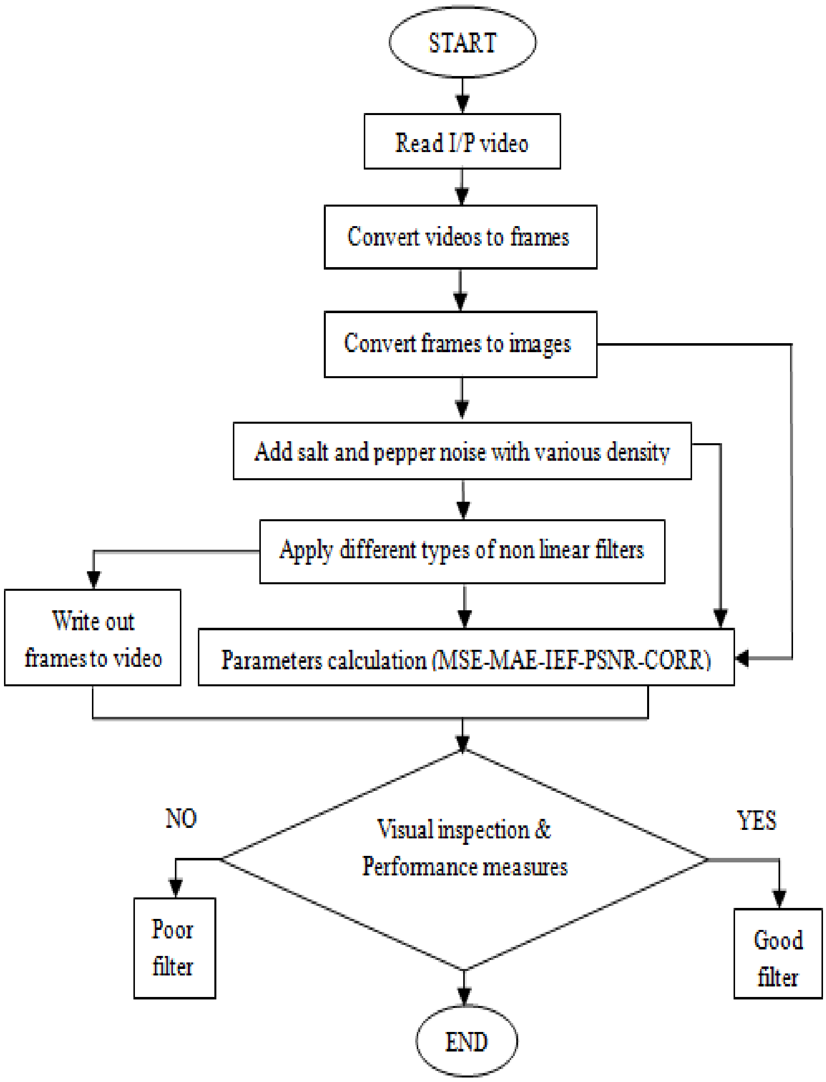


Fig.3. Flowchart of the proposed algorithm

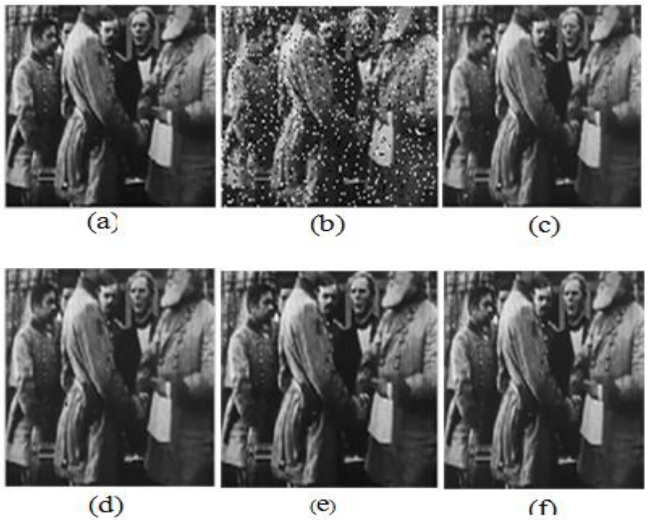


Fig.4. Results for 10% noise corrupted a selected first frame from silent film sequence. (a) Original frame, (b) Noisy frame, (c) WMF outputs, (d) SMF outputs, (e) DBMF outputs, and (f) shows the outputs of UDBMF.

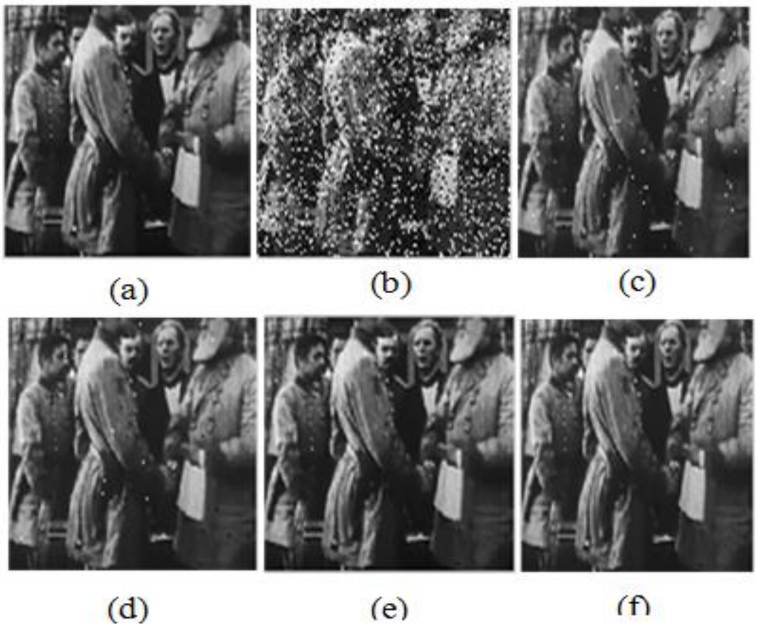


Fig.5. Results for 20% noise corrupted a selected first frame from silent film sequence. (a) Original frame, (b) Noisy frame, ((c) WMF outputs, (d) SMF outputs, (e) DBMF outputs, and (f) Shows the outputs of UDBMF.

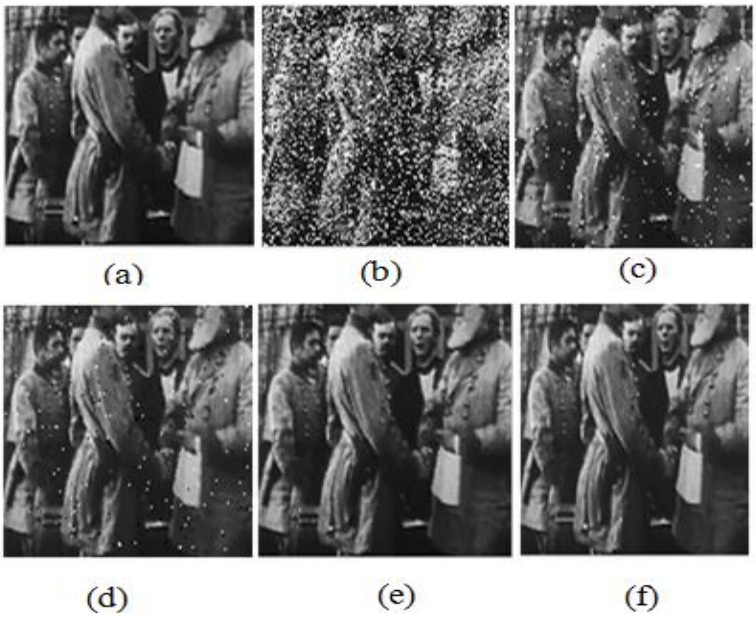


Fig.6. Results for 30% noise corrupted a selected first frame from silent film sequence. (a) Original frame, (b) Noisy frame, (c) WMF outputs, (d) SMF outputs, (e) DBMF outputs, and (f) Shows the outputs of UDBMF.

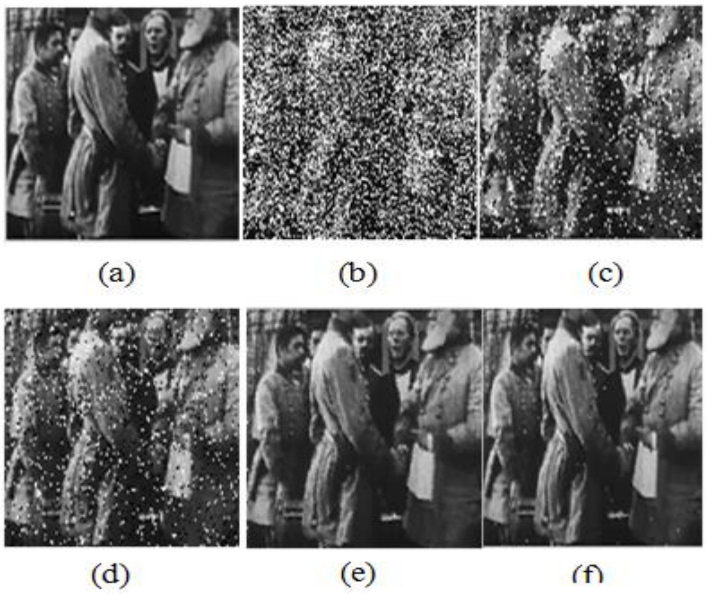


Fig.7. Results for 50% noise corrupted a selected first frame from silent film sequence. (a) Original frame, (b) Noisy frame, (c) WMF outputs, (d) SMF outputs, (e) DBMF outputs, and (f) shows the outputs of UDBMF.

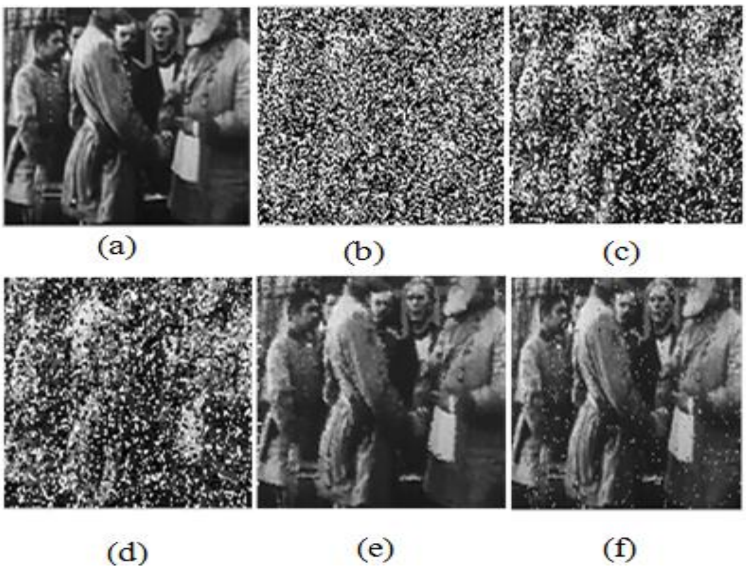


Fig.8. Results for 70% noise corrupted a selected first frame from silent film sequence. (a) Original frame, (b) Noisy frame, (c) WMF outputs, (d) SMF outputs, (e) DBMF outputs, and (f) Shows the outputs of UDBMF.

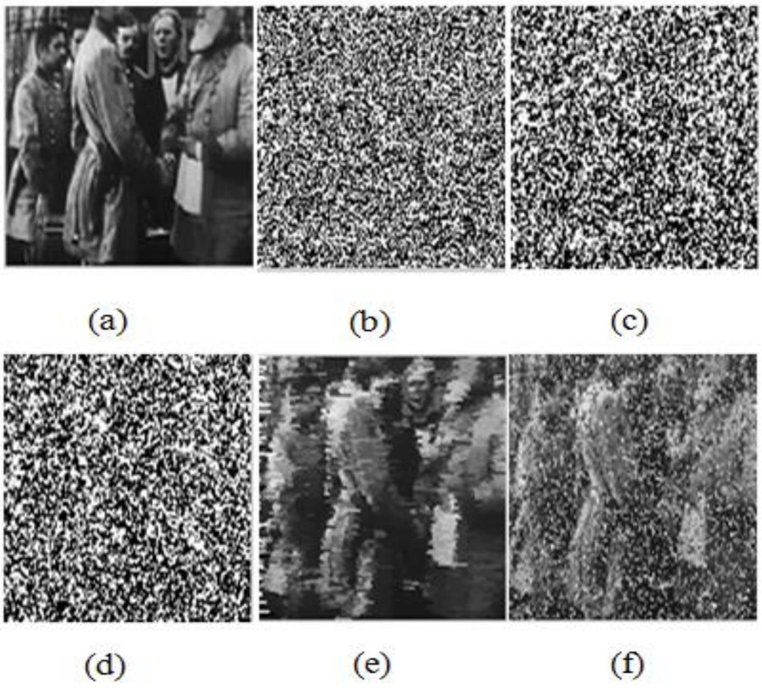
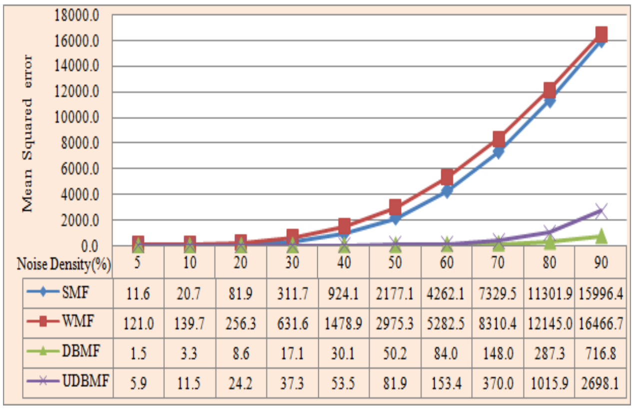
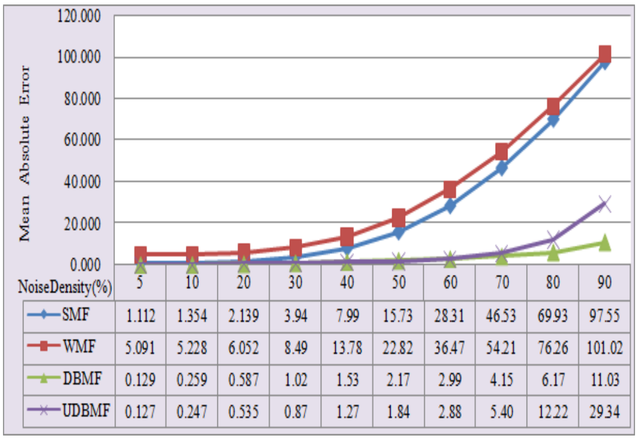


Fig.9. Results for 90% noise corrupted a selected first frame from silent film sequence. (a) Original frame, (b) Noisy frame, (c) WMF outputs, (d) SMF outputs, (e) DBMF outputs, and (f) Shows the outputs of UDBMF.



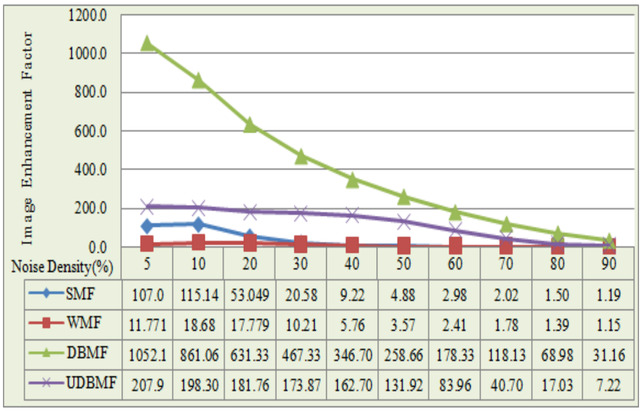
Noise Density(%)	5	10	20	30	40	50	60	70	80	90
SMF	11.6	20.7	81.9	311.7	924.1	2177.1	4262.1	7329.5	11301.9	15996.4
WMF	121.0	139.7	256.3	631.6	1478.9	2975.3	5282.5	8310.4	12145.0	16466.7
DBMF	1.5	3.3	8.6	17.1	30.1	50.2	84.0	148.0	287.3	716.8
UDBMF	5.9	11.5	24.2	37.3	53.5	81.9	153.4	370.0	1015.9	2698.1

(a) MSE



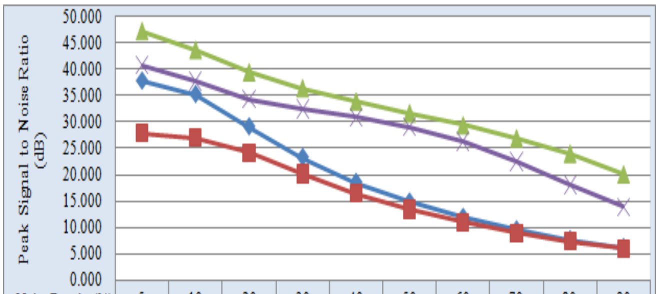
NoiseDensity(%)	5	10	20	30	40	50	60	70	80	90
SMF	1.112	1.354	2.139	3.94	7.99	15.73	28.31	46.53	69.93	97.55
WMF	5.091	5.228	6.052	8.49	13.78	22.82	36.47	54.21	76.26	101.02
DBMF	0.129	0.259	0.587	1.02	1.53	2.17	2.99	4.15	6.17	11.03
UDBMF	0.127	0.247	0.535	0.87	1.27	1.84	2.88	5.40	12.22	29.34

(b) MAE



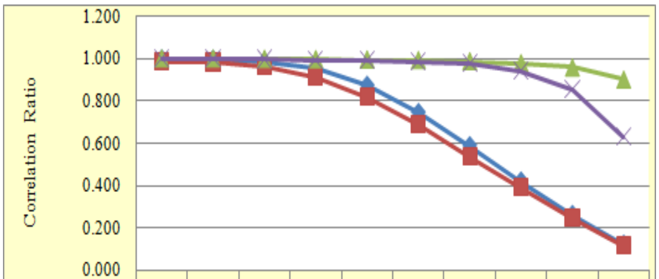
Noise Density(%)	5	10	20	30	40	50	60	70	80	90
SMF	107.0	115.14	53.049	20.58	9.22	4.88	2.98	2.02	1.50	1.19
WMF	11.771	18.68	17.779	10.21	5.76	3.57	2.41	1.78	1.39	1.15
DBMF	1052.1	861.06	631.33	467.33	346.70	258.66	178.33	118.13	68.98	31.16
UDBMF	207.9	198.30	181.76	173.87	162.70	131.92	83.96	40.70	17.03	7.22

(c) IEF



Noise Density(%)	5	10	20	30	40	50	60	70	80	90
SMF	37.695	35.15	29.014	23.21	18.48	14.77	11.84	9.49	7.61	6.10
WMF	27.838	27.07	24.175	20.15	16.44	13.40	10.91	8.94	7.29	5.97
DBMF	47.117	43.56	39.301	36.28	33.78	31.56	29.25	26.80	23.89	19.94
UDBMF	40.721	37.67	34.324	32.43	30.91	29.05	26.31	22.50	18.13	13.90

(d) PSNR



Noise Density(%)	5	10	20	30	40	50	60	70	80	90
SMF	0.998	0.997	0.987	0.953	0.874	0.745	0.588	0.421	0.262	0.121
WMF	0.982	0.979	0.962	0.911	0.816	0.686	0.536	0.387	0.243	0.115
DBMF	1.000	1.000	0.999	0.997	0.996	0.993	0.987	0.978	0.958	0.900
UDBMF	0.999	0.998	0.996	0.994	0.992	0.987	0.977	0.945	0.853	0.630

(e) Correlation ratio for old video sequence at different noise densities.

Fig.10. Comparison graphs and results

From Fig.10, it can be seen that (SMF, and WMF) filters didn't give better results when they are compared with (DBMF-UDBMF) filters at different noise densities from (5% to 90%).The results of DBMF and UDBMF give lower (MSE, MAE), and higher (PSNR, IEF, CORR). It can be indicated that the performance of the DBM filter is superior to the other filters for MSE, PSNR, IEF, CORR from (5% to 90%), and MAE from (70% to 90%). The UDBM filter is superior to the other filters at MAE values (5% to 60%).

7. CONCLUSION

In this work, filters have been used as a tool for removing low and high density salt and pepper noise with edge preservation in silent film. As a visual sense: For low noise density up to 30%, all filters give well visual impression in removing the salt and pepper noise. For noise densities above 40%, bad impressions are given by some existing filters such as SMF and WMF; while other filters as DBMF and UDBMF are able to suppress high density of impulse noise but they produce streaking effect for noise densities above 70%.

Related to comparable calculated parameters; DBMF and UDBMF give higher values for PSNR, IEF, and CORR. The lower values for MSE and MAE were satisfied when using DBMF and UDBMF. Both visual and quantitative results are demonstrated that the DBM, UDBM filters are effective for salt and pepper noise removal from gray video frames at high noise densities.

8. FUTURE SCOPE

Hybrid filtering approach as restoration techniques can be considered and applied in further transformed domain to incorporate with the proposed algorithm to improve the comparative study.

The comparative study can be further extended by including more noise types and more parameters like entropy and structure Similarity Index to validate the filtering performance.

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إزالة الضوضاءِ ذات الكثافةِ العاليةِ فى الأفلامِ الصامتةِ المعرَّضة للخطر باستخدام المرشّحات اللاخطّية

إن فقد وتشويه الأفلام الطويلةِ فى عصر الأفلامِ الصامتِ تشكل قلقاً بالغاً فى توثيق وحفظ السجل الثقافى لكثير من الأمم. لذلك كان التوجه الأول لمكتبةِ الكونجرس أنْ يَدْعمَ مشاريعَ بحوث أرشيفية تستُعيدُ الأفلامَ الأمريكية التى أُنتِجتْ أثناء القرون التاسعة عشرةِ والعشرون. تعتبر إزالة الضوضاءِ من الإجراءات الهامة عند استعادةِ الفديو التالف بحيث يمكن استرداد الفديو الأصلي.

يهدف هذا العمل لتَقديم نظرة عامّة لبَعْض الخوارزمياتِ التى يمكن أن تستخدم لإستعادة الفيديو التالف. هذه الخوارزمياتِ هى المُرشِح المتوسط غيرَ المضعف والمُرشِح المستند على المتوسط والمُرشِح المتوسط ذو الوزن ٍ والمُرشِح المتوسطِ العادى.

تم عمل مقارنة بين آداء كُلّ المرشحات عند مستويات مختلفةِ من الضوضاءِ استناداً على بعض البارامتراتَ المحسوبة مثل: خطأ المربّع المتوسط ٍ الخطأ

المُطلق المتوسط، معامل تحسين الصورةِ، أكبر نسبة بين الإشارة إلى الشوشرة ونسبة الإرتباط .

تُشيرُ نتائجُ المحاكاةِ إلى أن مرشِح المتوسط غيرَ المضعف والمرشِح المستند على المتوسط يعطيا آداءً متفوّقاً مقارنةً بالمرشحاتِ اللاخطّيةِ الأخرى عند مستويات للضوضاءِ فى حدود تسعون بالمائة. كما أمكن الإحتفاظ بالتفاصيل الضرورية فى الفيلم.