

VIDEO PRE-PROCESSING OF IMAGE INFORMATION FOR VEHICLE IDENTIFICATION

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Abstract:

This paper presents a video-based vehicle identification system which consists of preprocessing, segmentation, object extraction, object tracking and vehicle classification. The linear and non-linear filtering techniques are adopted here to filtering the video sequences for noise removal. Image filtering algorithms are applied on videos to remove the different types of noise that are either present in the video during capturing or injected in to the video during transmission. In this work the different filtering algorithms are adopted and the performances of the filters are compared using Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE).

Keywords: vehicle Identification, video processing, Linear Filters, Non Linear Filters, Performance Metrics.

1. Introduction

Preprocessing consists of those operations that prepare data for subsequent analysis that attempts to correct or compensate for systematic errors. The digital imageries are subjected to several corrections such as geometric, radiometric and atmospheric, though all these corrections might not be necessarily are applied in all cases. These errors are systematic and can be removed before they reach the user. The investigator should decide which pre-processing techniques are relevant on the basis of the nature of the information to be extracted from remotely sensed data. Clearly, a poor contrast is expected between targets and surrounding, as the temperature differences are very low. Thereby after image acquisition, some pre-processing is required to enhance specific image features. Image enhancement is performed to improve the raw image by suppressing noise and to emphasis structures [3][4]. This will make segmentation easier.

As an image enhancement technique often drastically alters the original numeric data, it is normally used only for visual (manual) interpretation and not for further numeric analysis. Common enhancements include

- Image reduction,
- Image rectification,
- Image magnification,
- Transect extraction,
- Contrast adjustments,
- Band rationing,
- Spatial filtering,
- Fourier transformations,
- Principal component analysis and
- Texture transformation.

Generally image collected by image sensors are contaminated by noise. There are many different cases of distortions. One of the most prevalent cases is distortion due to additive Gaussian noise which can be caused by

poor image acquisition or by transferring the image in noisy communication channels. Gaussian noise removal can effectively do by linear methods. Other types of noises include impulse and speckle noises. Thus, denoising is often necessary and the first step to be taken before the image is analyzed. Transmission technology is prone to a degree of error, and noise is added to each image. In the same way, in the acoustic equipments used for image acquisition some noise is present internally or during transmission the noise can be added to an image. To reduce the noise significant work has been done in both hardware and software for improving the signal-to-noise ratio in acoustic images.

1.1. Significance of pre-processing

The pre-processing is required for any kind of data to refine for further processing due to poor captured quality. The following reasons justify why the pre-processing is necessary.

- i. Image degradation is due to specific transmission properties of light like absorption and scattering.
- ii. Specificity of environment like light changing, Weather condition, and hue is more or less predominant when vehicles move.
- iii. Specificity of video captures like unknown rigid scene and unknown color or low light sensitivity.

Therefore an attempt has been made to identify the suitable filter for pre processing the video sequences frames. This work is organized as follows. Section.2 describes the filtering techniques that are widely available for video pre processing [2], Section.3 represents the experiments and results. Finally Section 4 gives the conclusion. The quantitative results of comparison are also tabulated by calculating the PSNR and MSE of the output vehicle video frame. It also provides a future scope.

2. Filtering Techniques

Filters decrease the noise by diminishing statistical deviations. It helps to reduce image noise. When an image is captured or acquired it is affected by some noise. So when image is processed, filtering techniques are applied. The main objective of filter is to reduce noise in image and to enhance the input image. It is a necessary step to improve image quality before further analysis and processing, e.g. image segmentation and restoration, can be achieved. The purpose of filtering is to reduce noise level while preserving principal signal features, such as edge contours and line details [1][6]. There are two different type of filtering techniques in basic, they are,

- i. Linear Filters
- ii. Non Linear Filters

2.1. Linear Filter

Low pass filtering involves the elimination of the high frequency components in the image. Linear filtering can improve images in many ways: sharpening the edges of objects, reducing random noise, correcting for unequal illumination, and not convolution to correct for blur and motion, etc. These procedures are carried out by convolving the original image with an appropriate filter kernel, producing the filtered image. A serious problem with image convolution is the enormous number of calculations that need to be performed, often resulting in unacceptably long execution times. Low pass filter lack the capabilities for performing image analysis.

2.2. Non Linear Filter

The non-linear filters applied in images are required to preserve edges and details, and remove Gaussian and impulsive noise.

In this paper, a study is made on the various denoising algorithms and the algorithms are implemented in Matlab 7.9.0. Each method is compared and classified in terms of the metrics like Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE). In order to quantify the performance of the various denoising algorithms, high quality images are taken and some known noise is added to them. Then the modified image is given as input to the denoising algorithm, which produces an image close to the original high quality image. The performance of each algorithm is compared by computing PSNR and MSE ratios.

Figure 1 shows the different classification of filters namely linear and non-linear type of filters used for vehicle video processing.

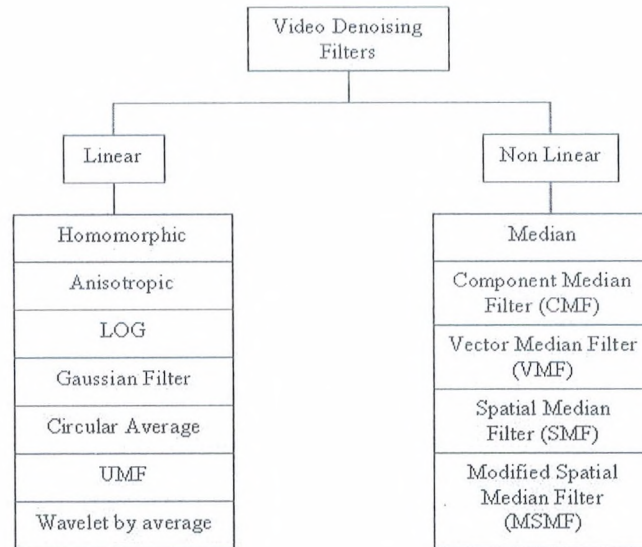


Figure 1: Filter classification

Noise removal or noise reduction can be done on video or image using any one of these techniques. Each technique has its own advantages and disadvantages.

3. Results and Discussion

The performance of the seven filters of linear type and five filters of non linear type for vehicle video sequences are evaluated using two metrics namely PSNR and MSE. The video sequence taken for study is given in Annexure-I as frames. The PSNR value must be high and MSE value should be low for good image. During the reconstruction of a frame, each frame is assumed to have the dimension of 256. The video frames in this contain a wide variety of subject matters and textures. The quality of a video frame is examined by objective evaluation as well as subjective evaluation. For subjective evaluation, the video frames have to be observed by a human expert. The human visual system (HVS) is so complicated that it is not yet modeled properly. Therefore, in addition to objective evaluation, the video frame must be observed by a human expert to judge its quality. The following metrics are used for evaluation. They are,

The metric MSE is defined in Eq. (1):

$$MSE = \frac{1}{mn} \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} \|I(i, j) - K(i, j)\|^2 \quad \text{----- (1)}$$

For two $m \times n$ monochrome images I and K, one of the images is considered a noisy approximation of the other. Other metrics like RMSE, MAE and PSNR are defined using MSE.

The metric Peak Signal to Noise Ratio (PSNR) is defined in Eq. 2:

$$\begin{aligned}
 PSNR &= 10 \cdot \log_{10} \left(\frac{MAX_I^2}{MSE} \right) \\
 &= 20 \cdot \log_{10} \left(\frac{MAX_I}{\sqrt{MSE}} \right)
 \end{aligned}
 \quad \text{----- (2)}$$

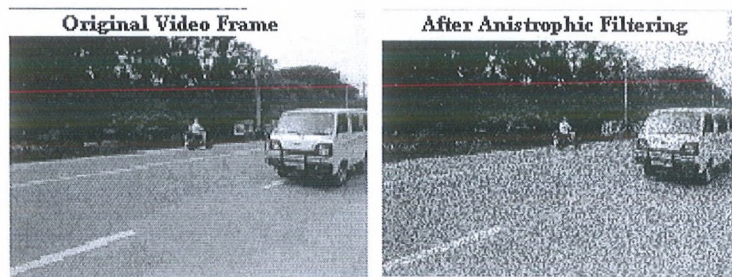
The PSNR is defined in logarithmic scale, in dB. It is the ratio of peak signal power to noise power. Since the MSE represents the noise power and the peak signal power, it is unity in case of normalized image signal.

Here, MAX_i is the maximum possible pixel value of the image. When the pixels are represented using 8 bits per sample, this is 255. More generally, when samples are represented using linear Pulsed Coupled Modulation (PCM) with B bits per sample, the typical values for the PSNR in lossy image and video compression are between 30 and 50 dB. The higher the value, the better the images are. Acceptable values for wireless transmission quality loss are considered to be about 20 dB to 25 dB. PSNR and MSE value is calculated between the original image and the filtered images. The values are used to evaluate and to find out the best suited filter which gives the better performance for vehicle video sequence. Here, wide variety of filtering algorithms have been implemented to detect and remove noise, leaving as much of possible of the pure signal. As the vehicle video frames exhibit more noise than visible and light ones spatial filters is robustly used. On the experimental results the Gaussian filter is very effective against the Impulse noise. Thus there is always a need for robust noise eliminating algorithm that has the capability to analyze the pattern of distribution of the pixels to separate pixels of the vehicle from background pixels. Here the linear and non linear noise removal methods are evaluated with performance metrics like MSE and PSNR. Figure 2 shows the subjective analysis of linear filtering techniques of frame 2 of the vehicle video sequence.



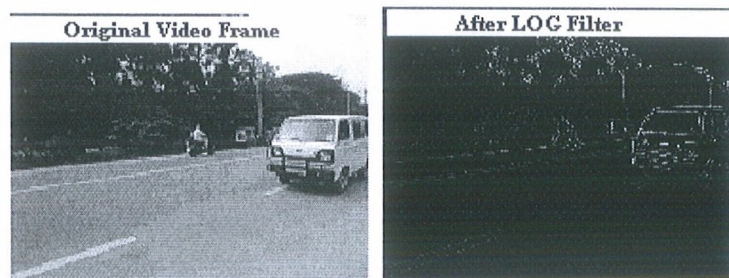
(a) Original Video Frame

(b) After Homomorphic Filtering



(a) Original Video Frame

(b) After Anisotropic Filtering



(a) Original Video Frame

(b) After Laplacian of Gaussian Filtering

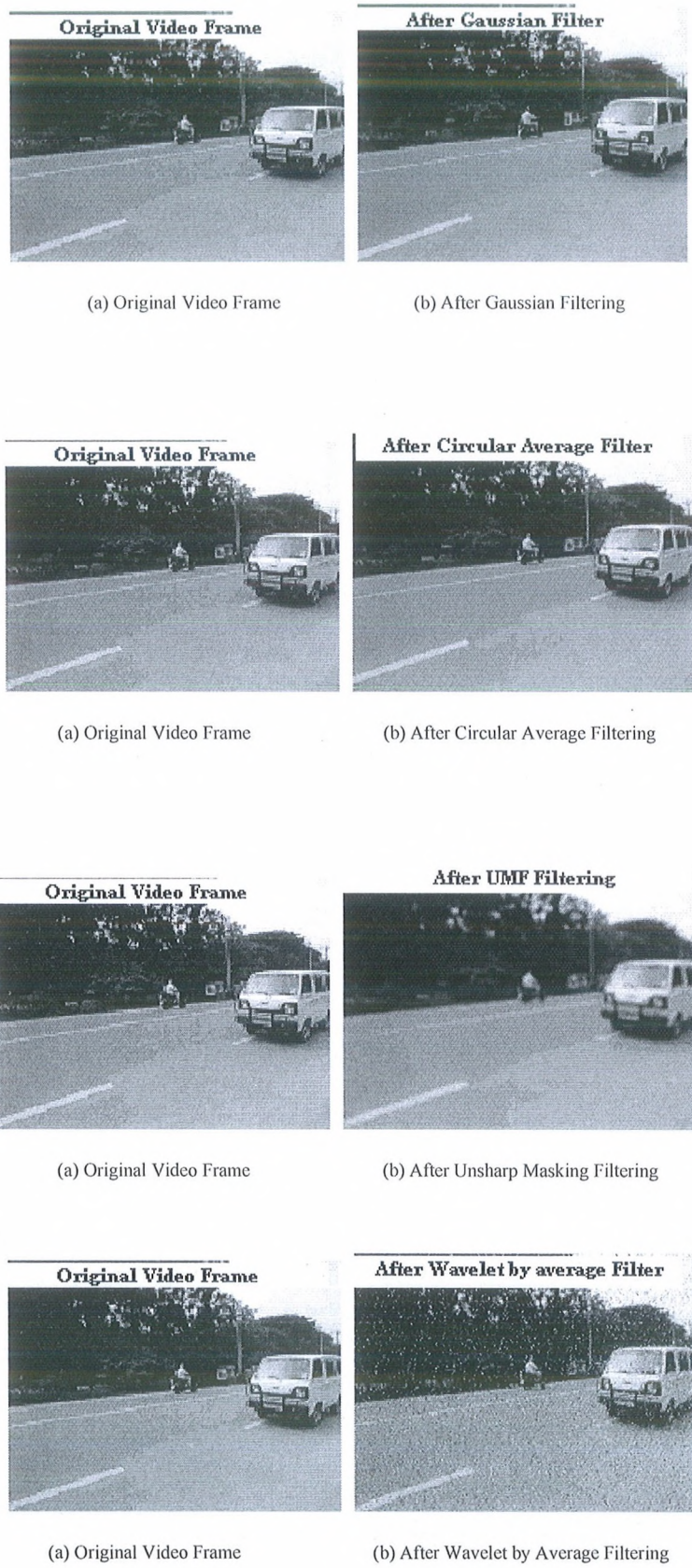


Figure 2: Subjective analysis of linear filtering techniques of frame 2 of the vehicle video sequence

The objective analysis of linear filtering techniques of frame 2 of the vehicle video sequence is shown in figure 3 by means of PSNR. Figure 4 shows the comparison of various linear filtering techniques.

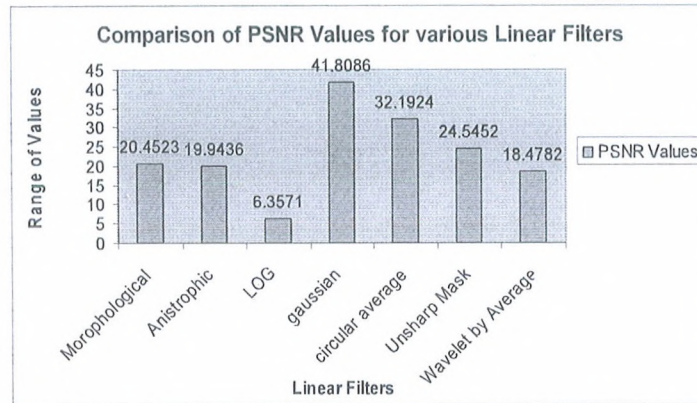


Figure 3: Comparison of PSNR values for various linear filtering techniques

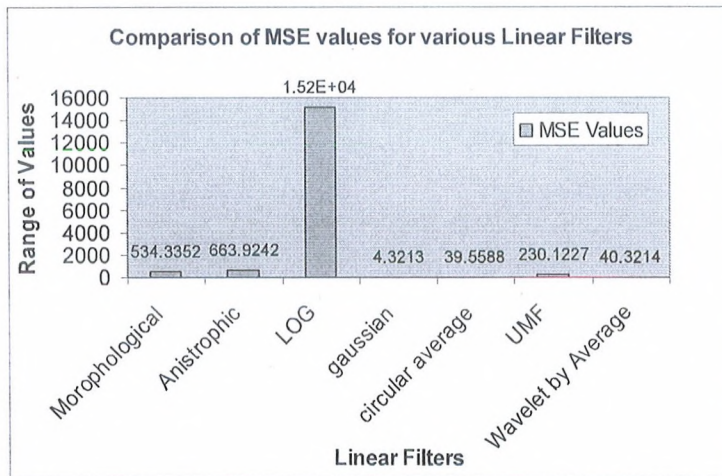
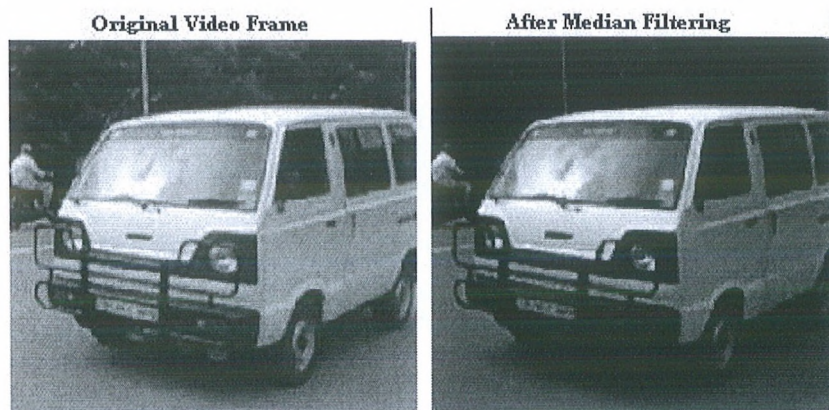
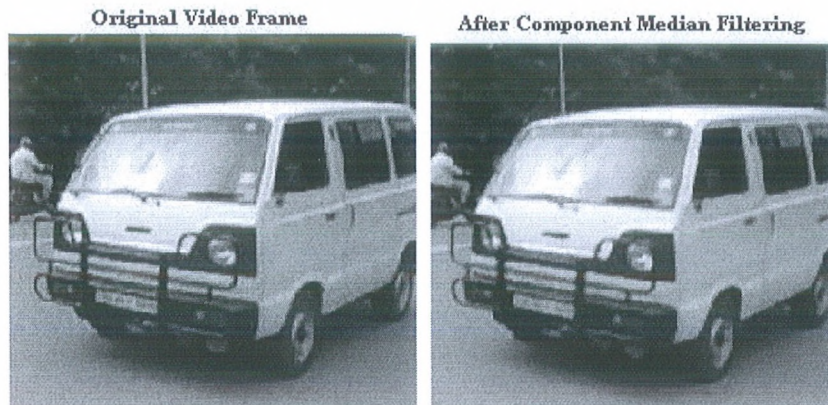


Figure 4: Comparison of MSE values for various linear filtering techniques

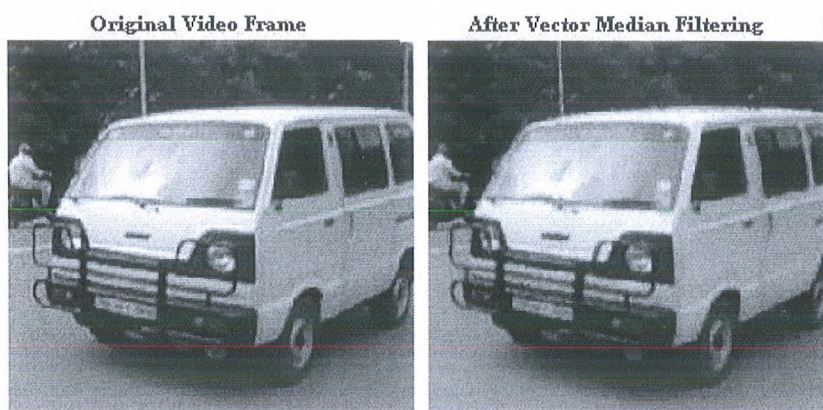
From the above analysis it is clear that the Gaussian filter performs well in vehicle video preprocessing. The non linear filtering techniques are discussed below. Figure 5 shows the subjective analysis of the non linear filtering techniques.



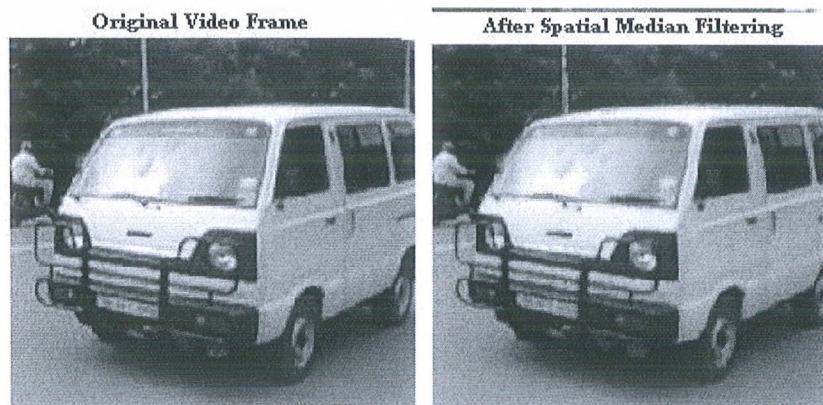
(a) Original Video Frame (b) After Median Filtering



(a) Original Video Frame (b) After Component Median Filtering



(a) Original Video Frame (b) After Vector Median Filtering



(a) Original Video Frame (b) After Spatial Median Filtering

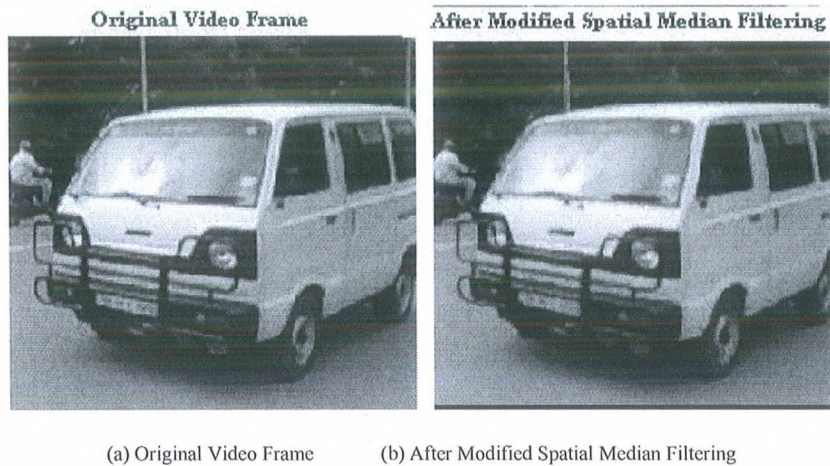


Figure 5: subjective analysis of non linear filtering techniques of frame 2 of the vehicle video sequence.

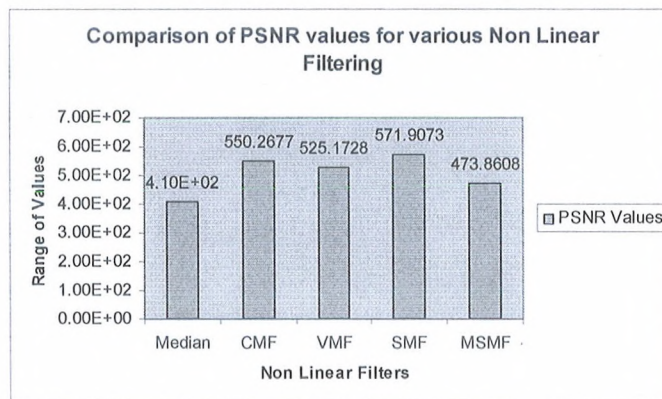


Figure 6: Comparison of PSNR values for various non linear filtering techniques

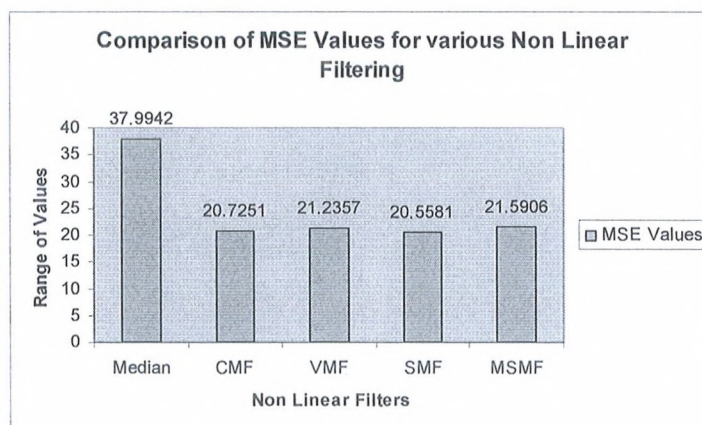


Figure 7: Comparison of MSE values for various non linear filtering techniques

Figure 5 shows the subjective analysis of the non linear filtering techniques. From the figure 6 and 7 shows objective analysis of non linear filtering techniques it is clear that the Spatial Median filter performs well in vehicle video preprocessing.

4. Conclusion

The vehicle video sequence frames basically suffer from transmission properties, the transmission of limited range of light, disturbance of lightening, low contrast and blurring of frame, color diminished during capturing and etc. Nowadays pre-processing is only done for correcting the non-uniform lights or color and intensity adjustment. There is also a requirement for additional knowledge about the environment during pre-processing. The filters discussed in this paper are linear and non linear filtering techniques. Among these two filters, the performances of the filters are compared and analyzed by the PSNR and MSE for vehicle video sequence frames. The resulting filters which improve the image quality, suppress the noise, preserves the edges in a frame, enhance and smoothen the frame. The performance of filtering are calculated by the mean square error value which must be low for an image and peak signal to noise ratio which must be high in an image. The results are compared and concluded that Gaussian Filer in linear filtering and Spatial Median filtering in non linear filtering is best for this vehicle video sequences.

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Annexure I

The video sequences frames are taken into study are shown below.



frame 2



frame 8



frame 15



frame 22



frame 27



frame 31



frame 40