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A HYBRID FILTER DESIGNED FOR NOISE REMOVAL IN VIDEO APPLICATIONS

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ABSTRACT

This paper presents a three dimensional hybrid filter to remove random valued impulse noise from colour video sequences. The switching median technique is utilized to protect noise free isolated pixels from filtering so as to avoid blurring of frames. The restoration of noisy pixels is done by brightness information obtained from median filtering and chromaticity information is obtained from vector directional filtering. This hybrid filter is applied in three dimensional sliding window where spatial as well as temporal information about neighbourhood is available for restoration of frame under consideration. Only noise free pixels of three dimensional sliding window are used for restoration of frame under consideration Simulation results show that the proposed three dimensional hybrid filter yields superior performance in comparison to other filtering methods.

Keywords: Color video filtering, Impulse detector, Random valued impulse noise, Median filtering, Vector directional filtering.

I. INTRODUCTION

Impulse noise is often introduced into frames of videos during acquisition and transmission. Based on noise Values, it can be classified as easier to remove salt and pepper noise and more difficult random valued impulse noise. We focus on removing the latter. Several filtering methods have been proposed for the removal of impulse noise from color images using different approaches. Most of these techniques use vector processing approach as it is widely accepted that it is more appropriate than component-wise filtering approach, which can generate color artifacts in filtered images. The vector median filter (VMF), vector directional filter (VDF), and the distance directional filter are most commonly used vector filters for noise removal from color images. The main drawback of applying component wise filtering is that inherent correlation among different channels may be lost, resulting into color artifacts.

Often, the filtering operation is preceded by an impulse detection stage separately, which ensures that only the noisy pixels are filtered. This prevents blurring which is caused by filtering of noise-free pixels. Filtering of only noisy pixels results into better preservation of detail features. Most of the impulse detection methods available in literature require a threshold value to make a decision whether the pixel under consideration is noise free isolated pixel or an impulse. The decision of filtering is based on neighboring pixels further, to overcome the problem of color artifacts in component-wise filtering scheme, color of filtered pixel may be restored separately using some suitable color correction method.

II. PROBLEM STATEMENT

For color correction a VMF is followed by VDF to obtain the angle information in for restoration of corrupt pixel the scheme uses a vector approach for both detection as well as for filtering. However, in it has been shown that component-wise filtering approach provides a better estimate for magnitude of filtered vector and prevents blurring caused by changes in noise free components. In the proposed work the impulse detection is done using switching median technique and we generalize the filtering scheme proposed in [9] resulting in a three dimensional hybrid filter which can be used for impulse noise removal from color videos. Generalization of some basic filters to three dimensions is given in but our generalized hybrid filter.

III. LITERATURE SURVEY

A digital video is a moving picture, or movie. Digital video processing is the study of algorithms for processing moving videos that are represented in digital format. Here, we distinguish digital video from digital still videos, which are videos that do not change with time basically, digital photographs. Digital videos are multidimensional signals, meaning that they are functions of more than a single variable. Indeed, digital video is ordinarily a function of three dimensions – two in space and one in time, as depicted in Fig.1. Because of this, digital video processing is data intensive: significant bandwidth, computational, and storage resources are required to handle video streams in digital format.

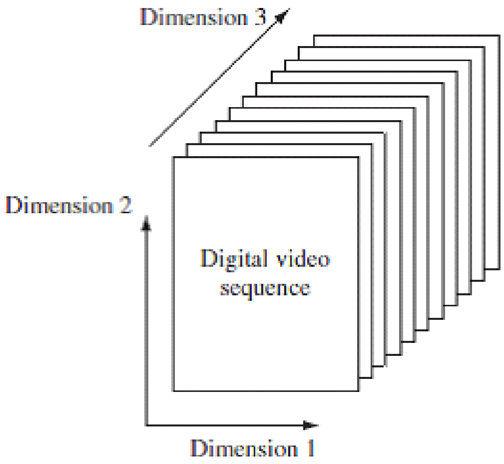

Fig. 1 Digital Video Sequence

Digital processing of video requires that the video stream be in a digital format, meaning that it must be sampled and quantized. There are several methods which have been used for video de noising. In this paper, we have used hybrid color image filtering method for restoration of color video sequence.

IV. FILTER IMPLEMENTATION

Duality between the time domain and the frequency domain makes it possible to perform any operation in either domain. Usually one domain or the other is more convenient for a particular operation, but you can always accomplish a given operation in either domain. To implement general IIR filtering in the frequency domain, multiply the discrete Fourier transform (DFT) of the input sequence with the quotient of the DFT of the filter:

n = length(x); (1)

y = ifft (fft(x).*fft (b,n)./fft(a,n)); (2)

This computes results that are identical to filter, but with different startup transients (edge effects). For long sequences, this computation is very inefficient because of the large zero-padded FFT operations on the filter coefficients, and because the FFT algorithm becomes less efficient as the number of points n increases.

For FIR filters, however, it is possible to break longer sequences into shorter, computationally efficient FFT lengths. The function

y = fftfilt(b,x) (3)

fvtool(b,a) (4)

Freqz can also accept a vector of arbitrary frequency points for use in the frequency response calculation. For example,

w = linspace (0, pi); (5)

h = freqz (b,a,w); (6)

Calculates the complex frequency response at the frequency points in w for the filter defined by vectors b and a. The frequency points can range from 0 to 2Π. To specify a frequency vector that ranges from zero to your sampling frequency, include both the frequency vector and the sampling frequency value in the parameter list.

V. MATLAB SIMULATION RESULTS

To access the performance of the proposed method, we compare it with several methods, video vector median filter (VVMF), generalized vector directional filter (GVDF), video generalized directional distance filter (VGDDF), video median filter (video-MF), video switching vector median filter (VSVMF), generalized switching vector directional filter (GSVDF), video switching median filter (VSMF). The video sequence used in simulation is Salesman ‘in which size of each frame is 176144. The first 16 frames were extracted for filtering, each corrupted by uncorrelated random valued impulse noise of 20% noise density. The hybrid filter is applied from frame no. 2 to frame no.15. The criteria used to compare the performance of various filters are peak signal to noise ratio (PSNR), mean absolute error (MAE) and normalized color difference (NCD). The average value of mean square error (MSE), average MAE and average NCD over this length of 14 filtered frames of video sequence is computed. Peak signal to noise ratio is computed from average MSE. For a single frame these parameters are defined as:

$$PSNR = 10\log_{10}\left(\frac{255^2}{\left(\frac{1}{3MN}\right)\sum_{i=1}^{M}\sum_{j=1}^{N}\left\|z_{i,j}-o_{i,j}\right\|_2^2}\right) \quad (7)$$

$$MAE=\sum_{i=1}^{M}\sum_{j=1}^{N}\left|z_{i,j,}-o_{i,j}\right| \quad (8)$$

Out Put Values for Calculations

Peak signal to noise ratio (PSNR)=52.9052

Mean absolute error (MAE) =1.2942e+007

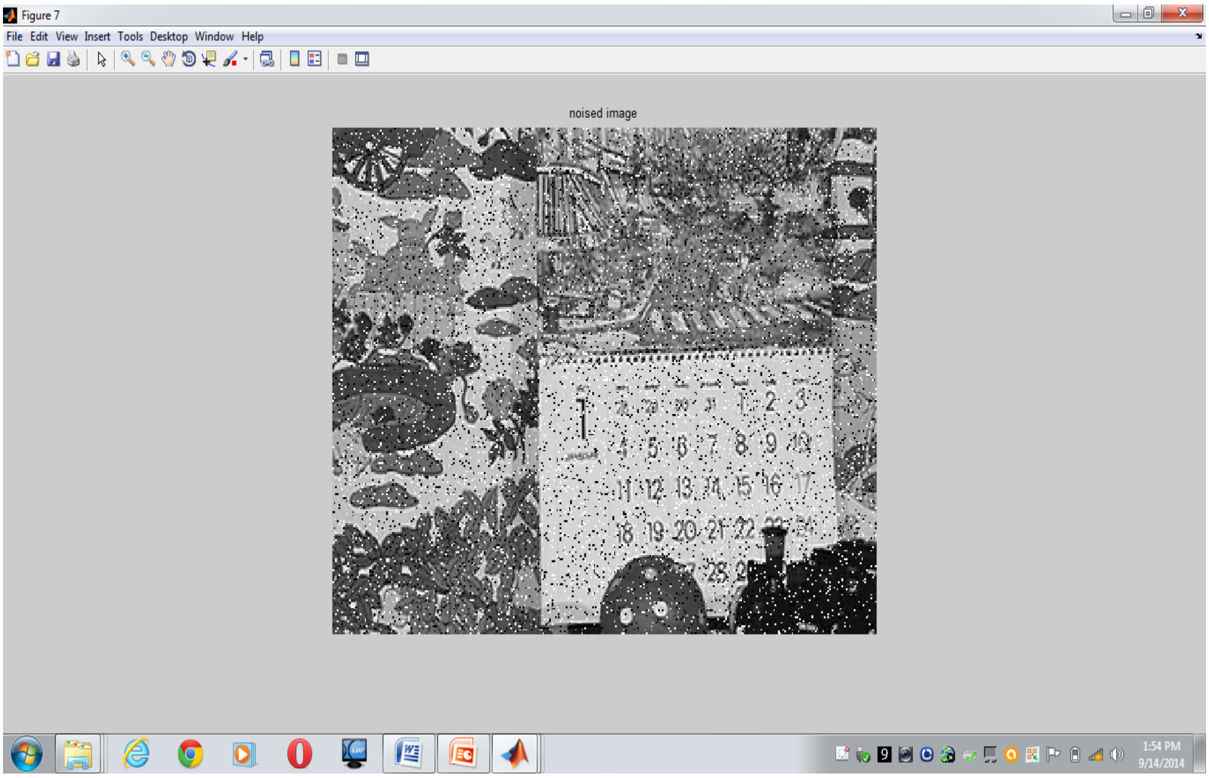

Fig.2 Noise Image

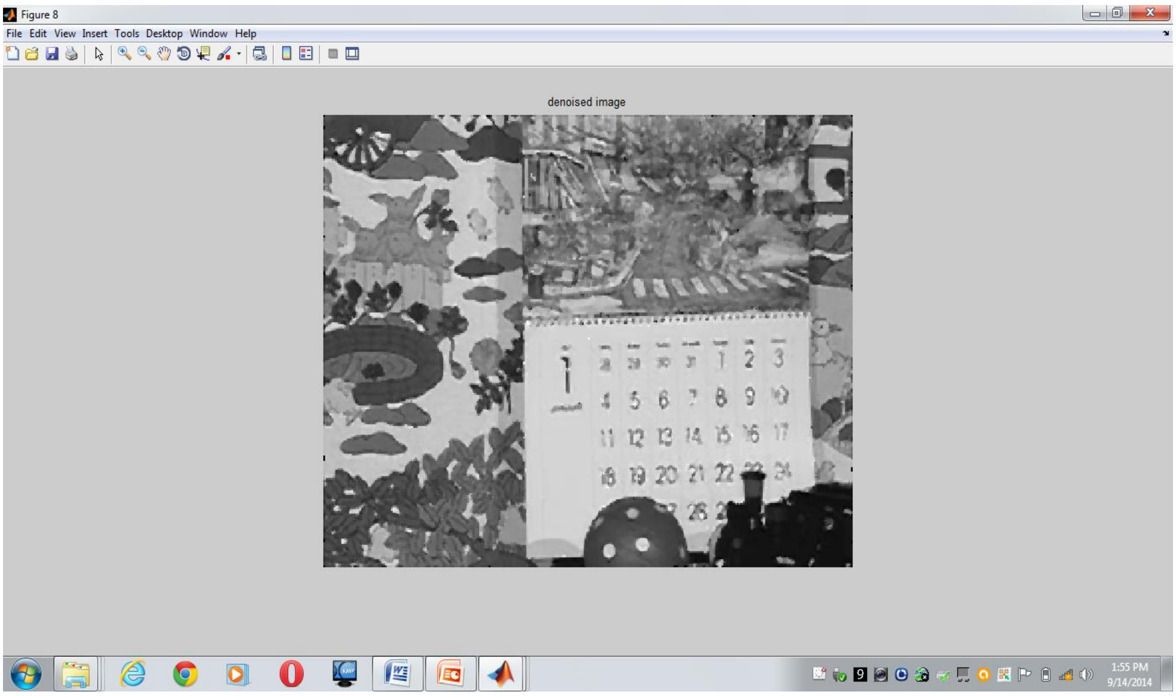

Fig.3 Denoised Image

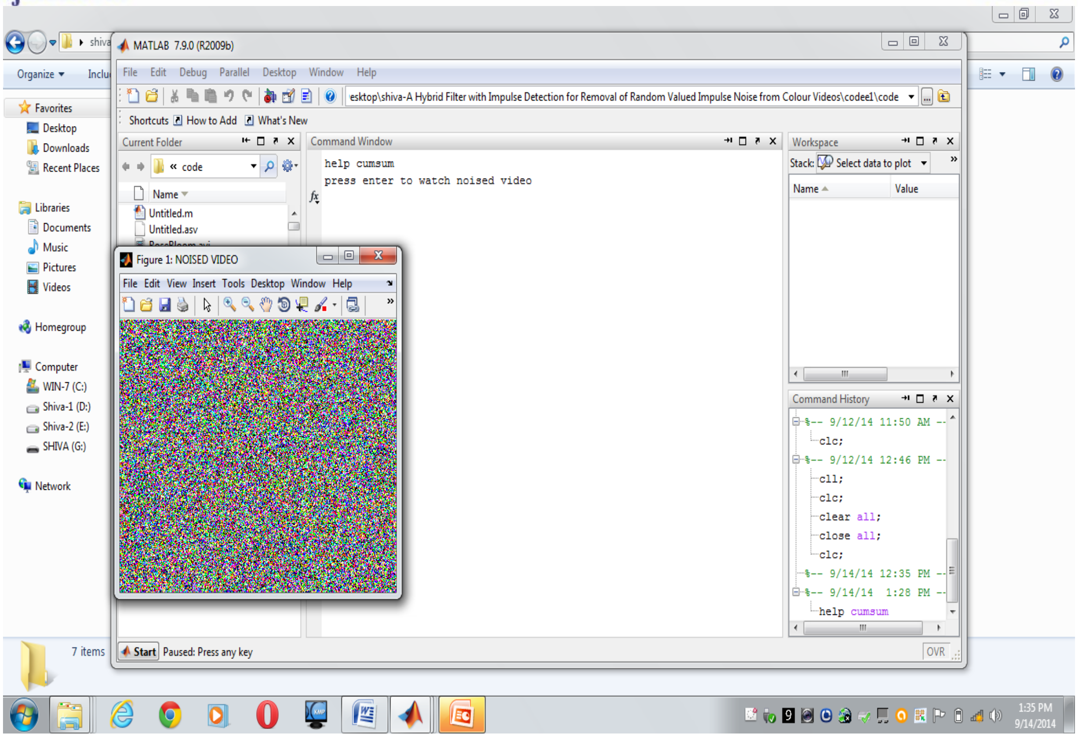

Fig.4 Noise Video

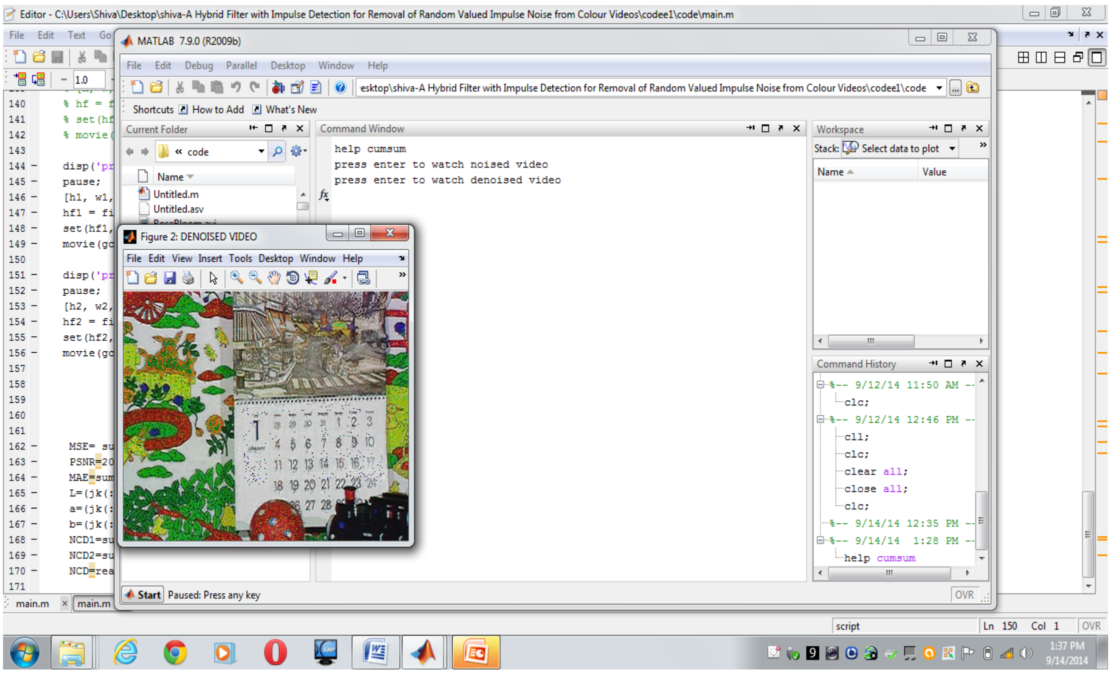

Fig.5 Denoised Video

Where $Z_{i,j}$ and $O_{i,j}$ are the pixel values of pixel at location (i,j), in the filtered and original frame of test video sequence. The frame size is *MN* and maximum intensity level in each colour channel is 255. ||.|| denotes the Euclidean distance between pixels and |.| denotes city block distance between pixels.

$$NCD = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}\left([L_r^*(i,j) - L_o^*(i,j)]^2 + [a_r^*(i,j) - a_o^*(i,j)]^2 + [b_r^*(i,j) - b_o^*(i,j)]^2\right)^{\frac{1}{2}}}{\sum_{i=1}^{M}\sum_{j=1}^{N}\left([L_o^*(i,j)]^2 + [a_o^*(i,j)]^2 + [b_o^*(i,j)]^2\right)^{\left(\frac{1}{2}\right)}}$$

Out Put Value for Calculation: Normalized color difference (NCD) =0.9964

VI. CONCLUSION

This paper has proposed the generalization of hybrid color image filtering method for restoration of color video sequences. The filter uses the component-wise filtering to preserve the brightness information which may result in color artifacts that are removed by using color information provided by VDF. The use of impulse detector improves the results as it avoids blurring of frames as well as it limits the use of noisy pixels in filtering which may affect the results to a great extent. The hybrid filter presented here is different from that presented for color images as it also utilizes the temporal information about the current frame which is unavailable in case of 2D color image. This spatio-temporal hybrid filtering results in better subjective quality of video in terms of PSNR, MAE and NCD.

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