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A New Approach for video denoising and enhancement using optical flow Estimation

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Abstract - *Day to day applications make use of image or video denoising technique. For example, object detection, medical imaging, traffic management, remote sensing imaging, digital entertainment and many more. Image processing investigated the field of video processing. After early 90s, various techniques were placed to maximize denoising in the video with retaining the legacy of video signal. The suggested approach uses motion compensation using optical flow. In addition to this, Principal component analysis (PCA) gives fine details of video. But PCA has a limitation of not eliminating out noise to desired level. To overcome mentioned limitation, implemented method tries to replace PCA with wavelet transformation. Wavelet transform gives an extra advantage of multi-resolution and sparsity. Wavelet transformation gives better results in terms of RMSE and PSNR as compare to that of PCA.*

Key Words: Video denoising, Patch processing, Optical flow estimation, non-local means, motion compensation

1. INTRODUCTION

Denoising is any signal processing method, which reconstructs the signal from a noisy image/video. Its aim is to preserve the useful information by removing unnecessary noise. Video denoising is actually process of removing noise from the original video signal, where noise reduction in an image can be performed through the frame individually and between the frames. Different denoising methods make different presumptions, depending upon the picture and the kind of picture. Noise may be analog and digital. Analog noise includes film artifacts, VHS artifacts, and Radio channel artifacts. Digital type includes blocking, block slices and ringing. In paper discussed, the creator considered first edge as foundation edge and contrasting this casing and the present edge to get the distinction. It takes an advantage of motion estimation in Real time video streaming using continuously moving frame background. Here the initial step for is taken as moving object identification and additionally objects tracking. This method utilizes division of moving articles from stationary foundation objects. This is focused on higher level processing and decreases calculation time. Shadow object segmentation is troublesome and noteworthy because of light changes. Video denoising method mainly depends up on a single noise for example, Gaussian or background noise. Different statistical distributions are being found with major contributing sources of noise, for example, dark current noise and quantization noise. The most widely recognized way for dealing with taking care of impediments in the optical stream literature is to define them as regions where forward and backwards motion estimates are inconsistent. Most methodologies return estimation of motion in occluded regions, where they cannot be invalidated. In an occluded region one can't decide a movement field that maps one picture onto another, because the scene is not visible. Some methodologies, while additionally misusing motion symmetry, discount occlusions by weighting the data fidelity with a monotonically decreasing function. The resulting problem is non-convex, and in this manner the proposed rotating minimization procedures can be prone to local minima. A substitute approach is to define joint movement estimation and occlusion detection in a discrete setting, where it is NPhard. Many approximate and near point solutions using combinatorial optimization technique require fine quantization and thus suffer through a wide number of labeling which results in loose approximation bounds. Another class of techniques uses the motion estimation residual for classifying a location as occluded or visible either with a direct threshold on the residual or with a more elaborate probabilistic model.

1.1 Objective

1. Improved surface and detail reproduction.
2. The primary protest is to decreasing noise amplitude.

2. LITERATURE SURVEY

In literature survey, various techniques used for video denoising related to patch based or optical flow or motion estimation are discussed with their advantages and disadvantages.

Jeong-Jik Seo, Jisoo Son, Hyung-Il Kim, Wesley De Neve1, and Yong Man Ro, presented a paper on, 'Efficient and Effective Human Action Recognition in Video through Motion Boundary Description with a Compact Set of Trajectories'. The method proposed effective and efficient human action recognition, with decreased redundant trajectories, using trajectory rejection. The only disadvantage of this method is computational complexity [1].

Borislav Anti´c, Timo Milbich and Bj¨orn Ommer, presented a paper on, 'Less is more: Video Trimming for Action Recognition'. Method suggests a subsequent classifier which can be utilized for classification and detection of video which corresponds to some action. A sequential algorithm is used which can decrease the number of interfering action subsequences. This method jointly trains the subsequences and label classifier. A Hollywood dataset is used so that temporal localization can be observed with improved performance [2].

Nazim Ashraf and Hassan Foroosh, presented a paper on, 'Human action recognition in video data using invariant characteristic vectors'. The concept of characteristic invariant vector is introduced. If motion of sets of points differs up to a similarity transformation, then elements of characteristic invariant vector differ up to some scale independent of directions and cameras. That's why characteristic vector can be used for reorganization of set of points. Obtaining Homograph, which is consistent with the epi-polar geometry, is discussed [3].

'Space-time adaptation for patch-based image sequence restoration', by J. Boulanger, C. Kervrann, and P. Bouthemy has proposed spatiotemporal method for restoration of image sequence, particularly for a patch based image. An adaptive statistical estimation framework based on local analysis of bias-variance trade-off. For each pixel, the space-time neighborhood is adapted to improve the performance of proposed patch-based estimation. The proposed method does not require motion detection/estimation. Experiments performed proved that this method can drastically improve quality of the image sequences which are highly corrupted [4].

'Patch Matching for Image Denoising Using Neighborhood-based Collaborative Filtering', by Shibin Parameswaran, Enming Luo and Truong Q. Nguyen, has explained the new patch matching using NN-CF that means nearest neighbor-based collaborative filtering. Approach constitutes recommendation of patches similar. With the use of item-oriented and user-oriented combinations of NN-CF, variations of CF-based patch matching criterion are extracted. For observation of best matches found from this method, new patch matching technique is applied to patch-based image denoising and evaluates effect on the denoising performance. The methods are tested on different datasets with different background and for various levels of noise. The proposed method actually improves robustness for patch matching and also provides new formulation to combine external and internal denoising [5].

'Patch-based Video Processing: a Variational Bayesian Approach', by Xin Li and Yunfei Zhengwe present patch-based Bayesian framework for video processing and observes its potential in in-painting and de-interlacing. Suggested method is based upon embed motion related information into relationship among video patches and develops a non-local sparsity-based prior for video sequences. Initially Nearest Neighbor search that is block-matching is extended into k-Nearest-Neighbor search that is patch-clustering. How to exploit sparsity constraint using sorting, packing similar patches is then demonstrated. Using Bayesian framework, unobservable data and patch-clustering result are both treated as latent variables. Weighted averaging of fusing diverse inference results from overlapped patches is derived. Experimental results showed the effectiveness of patch-based video models [6].

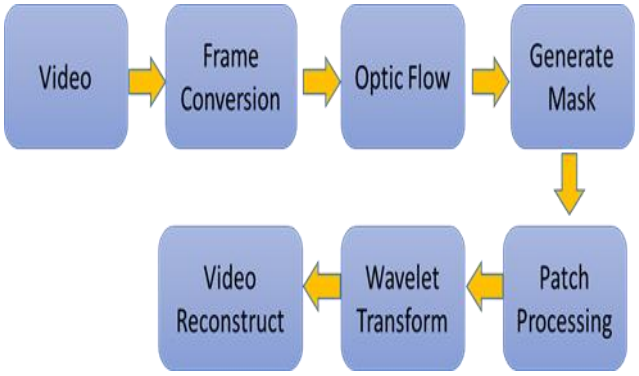
'Occlusion detection and motion estimation with convex optimization', by A. Ayvaci, M. Raptis, and S. Soatto, has thrown a light on Occlusion detection. Assuming static illumination and Lambertian reflection, the occlusion can be considered as convex minimization problem. Thus the proposed algorithm considers any number of independently moving objects and any number of layers of occlusion. Only disadvantage of this approach is of natural scenes can be complex [7].

3. PROPOSED METHODOLOGY

The proposed paper that is 'Patch-Based Video Denoising with Optical Flow Estimation' suggests video denoising using combination of motion estimation and optical flow estimation. The last but not the least step uses Principal component analysis technique in order to remove the noise and reconstruct the video. Principal component analysis (PCA) is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. PCA is mostly used as a tool in exploratory data analysis and for making predictive models. The paper uses the PCA approach for denoising. PCA allows reduced complexity in grouping of images. PCA contributes for noise reduction as the maximum variation basis is selected and thus small variations in back-ground are ignored automatically. Along with that PCA has some disadvantages. The results of PCA depend on the scaling of the variables. The applicability of PCA is limited by certain assumptions made in its derivation. And there are some more advantages of Wavelet transformation method over PCA, due to which we can get improved results. The simplest invariance cannot be captured by PCA unless and until the data explicitly provides the information.

On the other hand, wavelet transform based approach takes less response time which is more beneficial for online verification with more accuracy and experimental showed that it denoise the video to more extent than that of PCA. Wavelet transform is well localized in frequency and time and domains. Irregularities of profile such as scratches or cracks of surfaces can be easily detected by wavelet

transform. Wavelet transform is a convenient tool for denoising the measuring signal. Block diagram for proposed implementation that is Exchanging the PCA with Wavelet transform is depicted in the figure below.



Block Diagram: Proposed Approach

Detailed Algorithm for denoising frame is -

Algorithm:

Step 1 -Input video sequence

Step 2 - Extraction of frame

Step 3 - Creation of aligned sequence and detection of occluded pixels

Step 4 - Background Subtraction

Step 5 -Optical flow from I_k to I_j

Step 6 - Build mask using definition

Step 7 - Denoise the frame k

Step 8 - Extended patch at x

Step 9 - Set of differences between sets of patches

Step 10 - Extended patch at y

Step 11 - Compute difference between sets of patches

Step 12 - Sort differences in increasing order

Step 13 - Set of patches used for denoising

Step 14 - Set of denoised patches

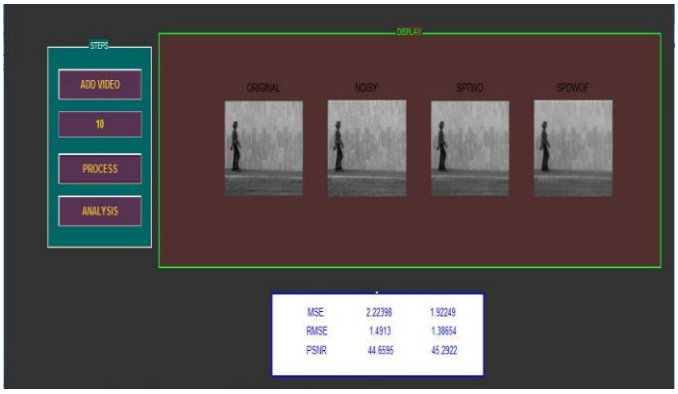
Step 15 - Output denoised sequence

4. RESULT ANALYSIS

Tried to apply the proposed algorithm to various video with changing value of sigma, that is noise value. As per the observation, the Root mean square value (RMSE) of wavelet transform is less than that for PCA, also we can observe increased value of PSNR. Means the video is denoised to more extent by wavelet transformation.

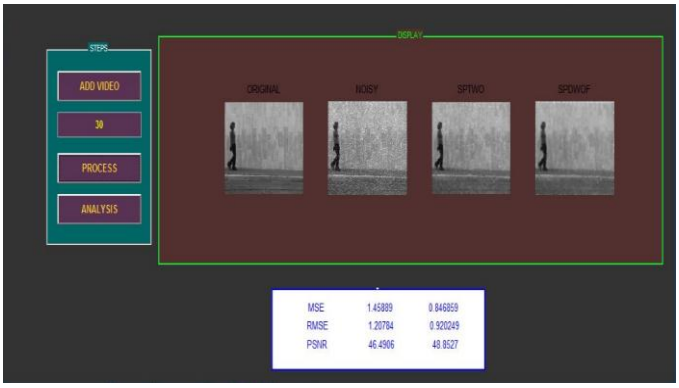
Also tried for different values of sigma, as per the observation, if we concentrate at same instant if time for video, RMSE is getting increased for increase in sigma.

Sigma-10



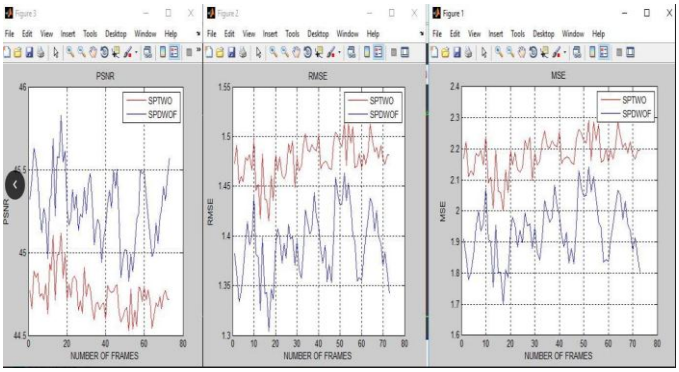
Sigma-20

Sigma-30

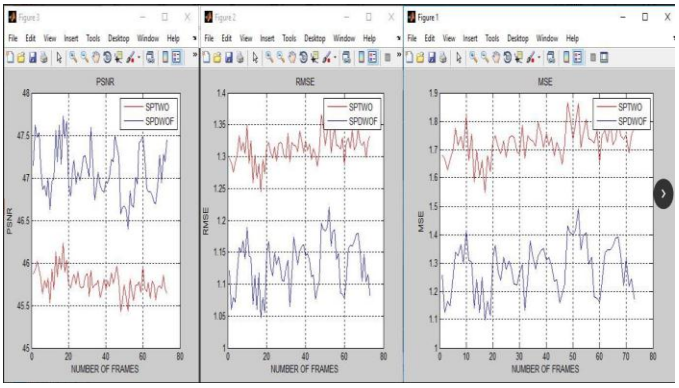


We can observe the RMSE, PSR and MSE values for existing method(SPTWO) and proposed method(SPDWOF) for different values of sigma as shown in above figures, The graphical representation for the existing and proposed approach for RMSE, PSNR, MSE are graphically shown in below diagrams -

Sigma-10



Sigma-20



5. CONCLUSION

As per the experimental results showed, on changing the PCA method by Wavelet transform, we are getting less RMSE value. Thus we can say that wavelet transform denoise the video to more extent than that of wavelet transform. Also the results are computed for different sigma, number of frames. On increasing the sigma value, we get increased value of RMSE at same point of time for a video. On increasing the number of frames the PSNR, RMSE and MSE values are showing the values as show in result analysis.

6. REFERENCES

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