CS754 - ROBUST VIDEO DENOISING

A PREPRINT

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ABSTRACT

Most existing video denoising algorithms assumes a single noise model but which is often violated in practice. We are presenting a patch based video denoising algorithm based on grouping similar patches in spatial and temporal domain. We will formulate this as low-rank matrix completion matrix. Our implementation based on the paper [1] will be effective for removing mixed noise in video sequences.

Keywords Video Denoising · Adaptive Median Filter · TSCS · TSS · Block Matching · Block Motion Vectors

1 Introduction

In general, video data tend to be more noisy than single image due to high speed capturing rate of video camera. Video denoising aims at efficiently removing noise from all frames of a video by utilizing information in both spatial and temporal domains. Standing out from most of the denoising techniques, our implementation will be able to perform well for video frames with mixed noise (viz. Gaussian Noise, Quantization Noise, Photon Shot noise, Inpulsive noise, . . .).

2 Implementation

We maintain a matrix Omega to store the locations of corrupted pixels which we find at each level of our algorithm. Initially Omega is all ones as no pixel is detected to be corrupt. Firstly, four different types of noises are added to the loaded video. Then we apply a median filter and update the Omega for each pixel updated. Then we run patch matching algorithm between frames to get a mapping of similar blocks from frame i to frame j. Finally, Matrix completion algorithm is run and video is reconstructed patch-wise.

3 Algorithms

For median filtering we used a Adaptive Median Filter (2).
Block Matching was accomplished using Three-Step-Cross Search Algorithm (4).
For Low-Rank Matrix Completion we used the algorithm stated in section 3.2 (1). An iterative procedure using projection and shrinkage operators to compute minima.

4 Challenges

1. Overflow Errors: There is a lot of typecasting involved which were difficult to avoid because MATLAB didn't show any warning and uses uint8 by deafult for most of the variable.
2. Median Filter was making the image too smooth so it is only partially applied.
3. Channel Separation: The RGB channels of the image are all independently denoised (so failure to use their correlation), as the paper didn't mention any method for handling channels.

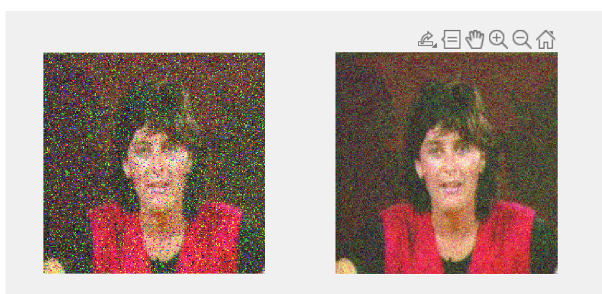
4. Ambiguity: Many of the explanations in the paper were very vague. Like calculating threshold, forming Omega, and recommended stride.

5 Future Work

1. Our TSCS algorithm is better the algorithm mentioned in the paper, but we are calling this function for more number of time which is redundant, so the reconstruction can be made faster with much improved implementation

2. The TSCS algorithm performs better for square image sequence, but most of the videos have an aspect ratio of $4:3$. We will try to modify TSCS to get better results for videos with $4:3, 16:9, \ldots$ aspect ratio.

6 Results



7 Conclusion

1. It takes a minute to reconstruct 30 frames with image of resolution 240×240, which is fast. For images with more resolution the running time will increase but will improve the reconstruction
2. In the first image, all the details are somewhat preserved. Like the shadow spots in the top aren't removed. The light and dark regions in the background are well separated. The second image is formed using 4*4 patches.
3. Third image is formed only using median filter.
4. In the Fourth image, the mic and the creases are present. Even the texture of background is preserved. The Fifth image is formed using 4*4 patches.
5. The images are a bit blocky and blurry. This might have improved if we had used SVT, overlapping patches, and larger patch matrix.

References

[1] Hui Ji, Chaoqiang Liu, Zuowei Shen and Yuhong Xu. *Robust video denoising using Low rank matrix completion.*

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[3] Bede Liu, André Zaccarin *New fast algorithms for the Estimation of Block motion vectors*

[4] Rahul Bhandari, Ashutosh Vyas *New Technique of Three Step Search Algorithm used for Motion Estimation in Video Compression*