International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)
Volume 3, Issue 4, April 2014

An Optimization Based Edge-Aware Video Processing Using Temporal Filtering and Mixed-Domain Concept

Lidiya Augustine, Nagalakshmi Venugopal

***Abstract*— The existing state-of-the-art edge-aware processing techniques may not be capable to completely preserve its edges while manipulating images. High dimensional filters, most remarkably the local laplacian filters are significant tools for numerous computer graphics and vision tasks. These filters are useful for edge aware processing of images and videos. In recent days, a number of techniques for accelerating edge aware manipulation have been developed by exploiting the separability of these Gaussian filters. In this paper we present a new method for edge-aware video processing, which reduces all the un-necessary artifacts in the image edges. This technique also helps to prevent blurring or distortion of its edges during manipulation. It is based on a key observation that temporally adjacent video frames share, identical visual and semantic contents. Using this prior information, temporal filtering of video frames results in splitting of video volumes to small segments suitable for processing. To correctly classify the motion of each scene point an optical vector flow representation is used. Global optimization is used to join the results of local filters at each step. Different resolution images are constructed using Gaussian pyramid concept. Hence applying mixed domain idea makes the result more accurate. This method solves compound edge aware manipulation tasks of videos.**

***Index Terms*— temporal filtering, temporal consistency, optical flow vector, LLF filters.**

I. INTRODUCTION

Edge preserving image manipulation method has recently emerged as a precious tool for a range of applications in computer graphics and in digital image processing. In many of these applications it is a principal to have direct control over the spatial scale of the particulars captured by the detail layer. Conventionally, working on images at several scales is done using multi-scale de-compositions, such as Gaussian and Laplacian pyramids. Filtering is possibly the most elementary action of digital image processing and computer vision. In “filtering”, the significance of the filtered image at a given position is a function of the values of the input images in a small region of the same location [13].

The technique underlying LLF filtering is to do in the range of an image what usual filters do in its field. Two pixels can be next to one another that are taking up nearby spatial locality, or can be comparable to one another, that is, encompass nearby values, maybe in perceptually imperative manner.

We propose a new approach for performing high class edge-aware processing of images and videos in actual time. This technique allows processing of video frames without destroying its fine scale information called edges. This is achieved by passing videos through an additional separable box filter called local laplacian filter. Observing that video is fragmented to small sized segments, based on the temporal consistency approach. Temporally dependable video frames share same visual and semantic contents among the frames. We are using an optical vector flow representation to correctly classify the movement of each scene point over the motion path. Commonly edges are definite by high dimensional local contrast, so adding up visually dissimilar edges to regions of high contrast further increases the visual individuality of these locations. Hence edges are called high frequency components in the images.

Non-linear filters are appropriate for edge-aware image processing rather than linear filter banks. Even though non-linear filters are more difficult to propose, it can preserve edges more sharply than linear filter banks and it is very efficient at removing impulsive noise. Whereas linear filters have a tendency to blur edges and other details of the image and its performance is very poor with Gaussian noise. Among the variety of optimization methods, multi-scale approach is more suitable for producing improved results; this can be achieved by comparing the results in each level with the previous one. Here, a more recent technique called mixed-domain concept is used (it uses both the real space and DCT space) [1].

This method includes the process of identifying video segments from a continuous stream of videos. Traditional video filtering approaches were aimed at accepting or rejecting video information by manipulating the video in spatial or frequency domain [2]. These techniques make use of, the mathematical models related to signal processing for filtering (say low-pass or high-pass) by computing pixel values. However this method to filtering is more "semantic" in nature, where filtering of video frames depends on the visual content present in them. This technique divides video frames based on the temporal consistency among video frames; where temporally nearby video frames share same visual and semantic contents. The problem of video filtering can be modeled in a way which is complementary to video retrieval. Here, the main focus is to enhance the throughput of the system and making this method applicable to multiple examples. This method efficiently utilizes the sequence

Manuscript received Apr, 2014.

Ms. Lidiya Augustine, Department of Computer Science and Engineering, Dr. N.G.P. Institute of Technology, Coimbatore
***Mrs. Nagalakshmi Venugopal**, Department of Computer Science and Engineering, Dr. N.G.P. Institute of Technology, Coimbatore*

information of the video streams, rather than treating it as a set of frames.

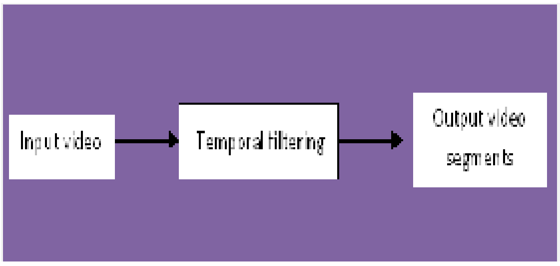

Fig.1 Overview of the Video Filtering

The idea of the video filtering is well related to image and video retrieval. We can implement this method on CPU and GPU.

II. LITERATURE REVIEW

In computer graphics and Digital image processing a lot of image manipulation techniques have been proposed over the years. But the key area which has received much attention than any other techniques in image processing is edge-aware image and video manipulation.

Y. Li, et.al [3] proposed Scribble boost method, for adding classification to, Edge aware image interpolation of local image and video adjustments. This work uses matting techniques that are primarily designed for the challenge of cutting an object from one image and parsing it into another. This technique significantly improves the performance of edge-aware interpolation by adding a boosting based classification step that helps to discriminate the appearance of scribbled pixels.

Manuel Lang, et.al [4] gives an efficient and simple way for introducing temporal consistency to a great class of optimization driven image based computer graphics problem. This method approximates costly global regularization by using a fast iterative joint filtering operation. Hence it reduces memory requirements and running time. This method enables us to process whole shots at once, taking benefit of supporting information that exists across far away. It is straightforward and efficient approach for approximating global smoothness over video sequences using temporal edge filtering. The main advantage is that this method is robust and achieves steady results over a range of datasets using a fixed set of parameters per application. But it has not been fully optimized for speed.

Pravin Bhat, et.al [5] introduces an optimization framework for analyzing gradient domain solutions for image and video processing. This technique propose a new metric for measuring local gradient-saliency that helps to identify salient gradients that give rise to long, coherent edges, even when individual gradients are faded. Here the main focus is on a particular form of spatial domain filtering called gradient-domain filtering. It computes pixel differences in addition to pixel values of an image. Gradient shop uses motion-compensated temporal constraints to root the temporal characteristics of the input video (e.g. illumination changes, temporal coherence).

Eduardo S. L. Gastal, et.al [6] presents a new method for performing high quality edge preserving filtering of images and videos in real time. It is based on a data dependent transform from the 5D image manifold to 2D real space that keeps geodesic distance. However, like several other high-speed filtering techniques, the domain transform is not rotationally invariant (i.e. filtering the rotated image and rotating the filtered image gives different results).

Fattal's [7] paper, is based on WLS (weighted least square) approach, which provides more careful edge-aware image decomposition. Typically the weights are made small at sharp edges, to preserve them. In WLS technique, it first manipulates the smooth component of the input image, by means of optimizing quadratic energy based on squared gradients where individual pixels have spatially varying weights. This technique provides an outstanding foundation for multi-scale tone manipulation of HDR and LDR images, image abstraction, detail and tone manipulation. Limitation of this paper is that it involves solution of large linear sparse systems. Later on Fattal, et. al [8] proposed a new approach to edge-aware image manipulation, which focus on generating edge avoiding wavelets, for producing more accurate results. These wavelets act as the foundation for representing images in various levels of resolution. This method is mainly used for image compression where images are first changed to waves or signals of varying frequency and duration. Here the generating wavelets depend on the edge content of the image. (i.e. it doesn't contain pixels from both sides of the image edges). Determining wavelets are difficult in this method. Sometimes the quality of the output image may become poor because of the approximation used during parameter computations.

In optimization based image processing Regularization and relaxation in both narrow and broad senses are used in diverse fields and problems in image processing, and now they are being combined with the general purpose optimization algorithms. We can use optimization with a choice of objective functions. The total variation optimization [9] method is largely used for removing the noise content in the images. The use of many constraints in this method will yield more details of the solution in our de-noising method. L0 Gradient optimization method [10], presents a sparse gradient counting scheme in an optimization framework. The most important contribution of this paper is a new strategy to confine the discrete number of intensity variations with neighboring pixels, which relates directly to the mathematical L0 standard for information sparsity detection. These two methods uses iterative algorithms hence they are normally slow and may be lacking in mathematical guarantees of convergence and constancy.

In recent times multi-scale optimization method is proposed. Unlike the other optimization methods, it permits a fast accurate frequency domain solution to the resulting optimization problem. Here at each level we optimize the quadratic energy function over sub windows to combine the outputs of a set of local edge-aware filter banks [1]. Hence it reduces halos successfully. It is rapid and can be readily accelerated it on the GPU too. This method involves operation of very few pixels rather than large complex solvers for linear systems.

In sparse optimization technique [11], it searches for a simple, straight forward solution for an optimization problem rather than a more complex precise solution. This technique can be used for image de-noising operation also.

III. EXISTING SYSTEM

In mixed-domain edge-aware image processing approach [1], it uses global optimization technique instead of conventional optimization methods. Here it makes use of Gaussian pyramid concept. This technique processes Gaussian pyramid from coarse to fine, and at each step it applies non-linear filter banks to the neighborhood of each pixel in the image. Here outputs are combined using explicit mixed-domain concept. This technique is very easy to implement and it produces more accurate results than any other previous methods. The main contributions of this method are it gives a novel approach for producing new rotationally invariant results, during edge-aware image manipulation. It uses optimization based formulation for edge-aware processing and avoids all the undesirable artifacts in the images such as halos, aliasing, and gradient reversal etc. It produces a direct mixed domain solution to the resulting optimization problem, which is precise, competent and easy to implement. This method is best suitable for processing rectangular images. It also points out that currently this method can sustain only two-scale manipulation of images (detail versus overall appearance) as we have to process the Gaussian pyramid as a whole to reduce artifact such as halos. Also parameter selection needs more careful attention. Another limitation is that, the optimization technique used here is not generalized so that we can't apply this method to additional spatially varying filters for more applications such as de-blurring and up-sampling of the images. This method can only be applicable to images not for videos also. Our proposed system handles edge-aware video manipulation well.

IV. PROPOSED SYSTEM

Our approach is inspired by the Xian-Ying Li, et. al [1] paper on mixed-domain edge-aware image manipulation. Here it extends this approach to video by using the same mixed domain concept. This helps to achieve highly accurate results. Before applying optimization, video frames are passed through a separate box filter for temporal filtering of video frames. This filtering method is based on temporal consistency [4] among contiguous video frames. This means temporally dependable video frames share the same visual and semantic content. Temporal filtering can be done by passing video frames in temporal T dimension and grouping them as short video segments based on consistency among the frames. A vector representation is used for identifying the motion of each scene point. Hence local filtering can be easy. Here temporal consistency has been known as a significant open problem. With the previous methods for temporal filtering of video frames, each output frame is still computed in the vicinity, and greedy decisions may lead to temporal inconsistencies. In addition choice of window size is an important, parameter balancing computational necessities with temporal smoothness. Our method avoids this trade-off as we are able to process the entire video shots. LLF filter banks are used here for achieving high accuracy. The global optimization troubles on video volumes can be directly solved by using pre-computed optical flow to model frame-to-frame interaction. These approaches can create very high quality outputs.

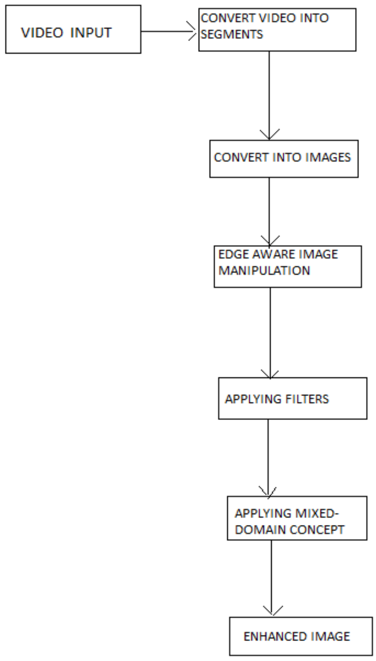

Fig. 1. Block Diagram

This method used the same Gaussian pyramid concept which is applied for image manipulation. It can generate different resolution images and processing is from coarse to fine images. The result is computed from top to bottom (from fine to coarse level of pyramid). At each step the results are compared with the previous level's output. It is important to note that the top level output has the desired properties for the overall appearance, but it may lack some details. We are using an optimization frame work for producing highly accurate results. This optimization frame work is applied to mixed-domain consisting of both the real space and DCT transform space. Hence it reduces error rate during computation. This method is useful for producing rotationally invariant results.

V. APPLICATIONS

Applications of this technique come under compression of HDR images, where images having biggest ratio between the darkest and the brightest part of the image. Another important application is Haze removal [12], used for improving the clarity of the outdoor images, which posses high moisture content. In image processing noise content of the image can be reduced by image smoothing process. Image abstraction can be used for retrieving particular features of the images such as its edges. It can be used for reducing the aliasing effect in images also. Other applications include color contrast enhancement, detail enhancement etc. Some of them are shown in Fig.2 and Fig.3 [1].

ISSN: 2278 – 1323

Fig. 2. Image Abstraction (a) Input Image (b) Abstraction Result

Fig. 3. Haze removal (a) Input Image (b) Haze free results

VI. SUMMARY AND FUTURE WORK

In summary, this paper has presented a novel approach to edge-aware video manipulation by means of Gaussian pyramid concept. It uses LLF for temporal filtering of video frames. Hence it preserves edges well. Use of mixed-domain concept helps to provide more accurate results than traditional edge-aware processing method. This technique provides simple and efficient approach for edge-aware video manipulation. It is possible to implement this technique, both in CPU and GPU. It give good results for difficult image based computer graphics problems in videos by just using temporal filtering and global optimization instead of total minimization. Our approach has not been fully optimized for rate, and additional performance gain could be achieved by exploiting the GPU parallelism. Further problem of interest, is to simplify our optimization approach to other spatially varying local filters.

ACKNOWLEDGMENT

We would like to thank the anonymous reviewers for their insightful comments. Some of the source images here come from other researchers and we thank them for making their data available.

REFERENCES

[1] Xian-Ying Li, Yan Gu, Shi-Min Hu "Mixed-Domain Edge-Aware Image Manipulation". IEEE Trans. on Image Processing, Vol.22, NO.5, MAY 2013.

[2] Mihir Jain, Sreekanth Vempati, "Example Based Video Filters" ACM Trans. On image and video retrieval. July 2009.

[3] Y. Li, E. Adelson, "Scribble Boost: Adding Classification to Edge-Aware Interpolation of Local Image and Video Adjustments" Euro graphics Symposium on Rendering, vol.27, No.4, 2008.

[4] Manuel Lang, Oliver Wang. "Practical Temporal Consistency for Image-Based Graphics Applications", ACM. Trans. Graph., Vol.32, No.4, JULY 2013.

[5] Pravin Bhat, C. Lawrence Zitnick, "Gradient Shop: A Gradient-Domain Optimization Framework for Image and Video Filtering",

[6] E.S.L. Gastal and M. M. Oliveira,"Domain Transform for edge aware image and video processing". ACM Trans.Graph., vol.30, no.4, pp.69:1-69:11, 2011.

[7] Z.Farbman, R.Fattal, D. Lischinski and R.Szeliski,"Edge preserving decompositions for multi-scale tone and detail manipulation", ACMTrans.Graph, vol.27, no.3, pp.67:1-67:10, 2008.

[8] R.Fattal,"Edge avoiding wavelets and their application".ACM Trans.Graph. vol.28, no.3, pp.22:1-22:10, 2009.

[9] L.I. Rudin, S. Osher, and E. Fatemi, "Nonlinear total variation based noise removal algorithms", Phys.D, Nonlinear Phenomena,vol.60,nos.1-4,pp.259-268,1992.

[10] L. Xu, C. Lu, Y. Xu, and J. Jia, "Image smoothing via L0 gradient minimization" ACM Trans.Graph.,vol.30,no.6,pp.174:1-174:12,2011.

[11] S.J. Wright," Sparse optimization methods", In proc. Conf. Adv. methods perspect Non-linear Optimization control, 2010, pp.1-60.

[12] K. He, J. Sun, and X, Tang,"Single image haze removal using dark channel prior" in Proc. IEEE Comput. Vis. Pattern Recognition, Jun.2009, pp. 1956-1963.

[13] E. S. L. Gastal and J. Kautz,"Domain transform for edge-aware image and video processing" ACM Trans.Graphics, vol.30,no.4,pp.68:1-68:12,2011.