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Video Distortion Alleviation Using Region Based DT-CWT Fusion

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ABSTRACT- A variety of image restoration methods have been proposed that estimate an improved image by processing a sequence of images. Restoring a scene distorted by atmospheric turbulence is a challenging problem in video surveillance. Image registration enables the geometric alignment of two images and is widely used in various applications in the fields of remote sensing, medical imaging and computer vision. In this paper, we propose a novel method for mitigating the effects of atmospheric distortion on observed images. Region of interest (ROI) for each frame is taken, in order to extract accurate detail about objects behind the distorting layer. A simple and efficient frame selection method is proposed to select informative ROIs, only from good quality frames. Each ROI should be register in order to reduce the distortion. The space varying problem can be solved by image fusion using complex wavelet transform. Finally contrast enhancement is applied.

KEYWORDS – Dual tree complex wavelet transform (DTCWT), Image Registration, Image Fusion.

I. INTRODUCTION

Atmospheric turbulence is a naturally occurring phenomenon that can severely degrade the quality of long range surveillance video footage. Various types of atmospheric distortion can influence the visual quality of video signals during acquisition. Based on temperature variations to reduce the contrast and atmospheric turbulence, due to distortions include fog or haze. When the temperature difference between the ground and the air increases then the thickness of each layer decreases, In strong turbulence, not only scintillation, which produces small-scale intensity fluctuations in the scene [1] and blurring effects are present in the video imagery, but also a shearing effect occurs and is perceived as different parts of objects moving in different directions [2].

To interpret information behind the distorted layer, turbulence effects in the acquired imagery make it extremely difficult. Using various methods, there has been significant research activity attempting to faithfully reconstruct this useful information. In practice, the perfect solution is however impossible, since the problem is ill-posed, despite being simply expressed with a matrix–vector multiplication as in (1).

$$Iobv = D\ Iidl + \varepsilon. \qquad (1)$$

Here Iobv and Iidl are vectors containing the observed and ideal images, respectively. Matrix D represents geometric distortion and blur, while ε represents noise. Various approaches have attempted to solve this problem by modeling it as a point spread function (PSF). Where D is considered as a convolution matrix, and then applying deconvolution with an iterative process to estimate Iidl. For the atmospheric distortion case, the PSF is generally unknown, so blind deconvolution is employed [3],[4]. However, the results still exhibit artifacts since the PSF is usually assumed to be space-invariant.

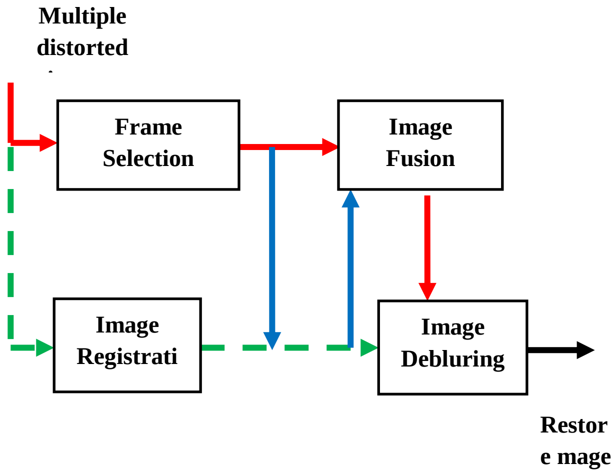

Fig. 1 Block diagram of image restoration for atmospheric

Current multi-frame methods that address this problem are illustrated in Fig. 1, where most approaches employ all functions or a subset of them. The restoration process can be described by two main routes through the diagram. The first (green dashed line) employs an image registration technique with deformation estimation [5], [6]. This process attempts to align objects temporally and also to solve for shake of the camera and temporal variations due to atmospheric refraction. The image fusion block may optionally be employed (blue line) in order to combine several aligned images. Then, a deblurring process is applied to the combined image (this in itself is challenging since the blur is space-varying). The other route (red solid line) employs image selection and fusion, often referred to as "lucky region" techniques [7].

Effective mitigation of atmospheric turbulence is a challenging problem. Model-based solutions are impractical and blind de-convolution methods suffer from spatial and temporal variation due to PSF. For large distortion and are also time-consuming, conventional registration methods are ineffective. Finally conventional fusion methods require a large number of frames in order to select lucky regions. In this paper we introduce a new approach that overcomes these problems. Image registration and Image fusion is performed by the Dual Tree Complex Wavelet Transform (DT-CWT) domain since this provides near shift-invariance and good directional selectivity [9].

II. PROPOSED METHOD

We propose a new fusion method for reducing the effects of atmospheric turbulence as depicted in Fig. 2. Before taking the image fusion we are taking ROI from the frames and alignment them. Then frame selection is done by the sharpness, intensity similarity and ROI size. Non-rigid Image registration is applied. We then employ a region-based scheme to perform fusion at the feature level. This has advantages over pixel-based processing since more intelligent semantic fusion rules can be considered based on actual features in the image, rather than on single or arbitrary groups of pixels. The fusion is performed in the Dual Tree Complex Wavelet Transform (DT-CWT) which employs two different real discrete wavelet transforms (DWT) to provide the real and imaginary parts of the CWT. Two fully decimated trees are produced, one for the odd samples and one for the even samples generated at the first level. This increases directional selectivity over the DWT and is able to distinguish between positive and negative orientations giving six distinct sub-bands at each level, corresponding to ± 15°, ± 45°, ± 75°. Additionally, the phase of a DT-CWT coefficient is robust to noise and temporal intensity variations thereby providing an efficient tool for removing distorting ripples. Finally, the DT-CWT is near-shift invariant an important property for this application. After fusion, the effect of haze is reduced using locally-adaptive histogram equalization. Finally contrast limited adaptive histogram equalization is applied.

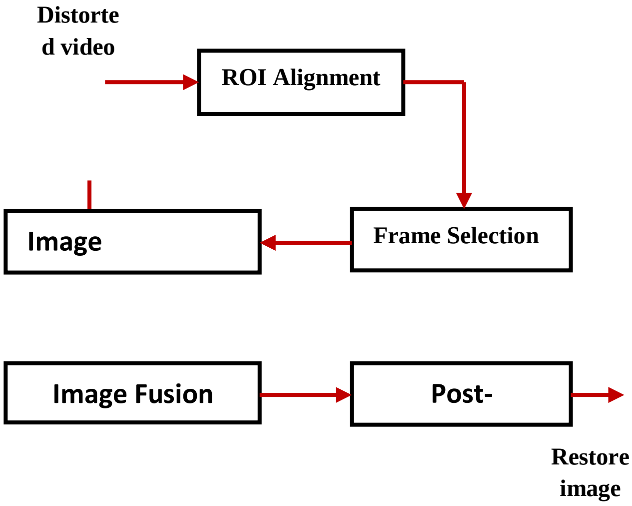

Fig. 2 Block diagram of the proposed Method

A. *ROI Alignment*

When using high magnification lenses, Capturing video in the presence of atmospheric turbulence, may cause the ROI in each frame to become misaligned. The ROI (or ROIs) is manually marked in the first frame. In order to find an otsu threshold, the histogram generated from the selected ROI and the surrounding area. Otsu threshold [14] is used to convert the image to a binary map. An erosion process is then applied. The areas connected to the edge of the sub-image are removed and the step is performed iteratively until the area near the ROI is isolated. The same number of iterations is employed in other frames with the same Otsu threshold. If there is more than one isolated area, the area closest in size and location to the ROI in the first frame is used. Finally, the centre of the mask in each frame is utilized to shift the ROI and align it across the set of frames. Note that the frames with incorrectly detected ROIs will be removed in the frame selection process.

B. *Frame Selection*

All frames in the sequence are not used to restore the image since the low quality frames would possibly degrade the fused result. A subset of images is carefully selected using three factors: sharpness, intensity similarity and detected ROI size.

1) Sharpness: G_n is one of the most important image quality factors and it can determine the amount of detail an image can convey. Here, the sharpness parameter G_n is computed from the summation of the high pass coefficient magnitudes.
2) Intensity Similarity: S_n is employed to remove outliers. The most frames in the sequence contain fairly similar areas under assumption. Frames with significantly different content to others are likely to be greatly distorted. For

calculating the mean square error (MSE), take the average frame of the whole sequence as a reference for frame n. Then inverse MSE represents the similarity of each frame. It should be noted that this approach is not robust to illumination changes.

3) Detected ROI Size: A_n is the total number of pixels contained in the ROI. ROIs are used because it contains more useful information. The cost function C_n for frame n is computed using

$$C_n = \frac{\omega_G \quad G_n}{\lambda_G + \quad |G_n|} + \frac{\omega_S \quad S_n}{\lambda_S + \quad |S_n|} + \frac{\omega_A \quad A_n}{\lambda_A + \quad |A_n|} \qquad (2)$$

where ω_k and λ_k are the weight and slope control of the factor k ∈ {G, S, A}, respectively. The λ_k is set to equal the mean of factor k so that at the mean value, its cost value is 0.5. The cost C_n is ranked from high to low. The Otsu method can then be applied to find how many frames should be included in the selected set.

C. Image Registration

Image registration is the process of overlaying two or more images of the same scene taken at different times, from different viewpoints, and/or by different sensors. It geometrically aligns two images the reference and sensed images. The present differences between images are introduced due to different imaging conditions.

In this paper, Registration of non-rigid bodies using DT-CWT, as proposed in [15], is employed. This algorithm is based on phase-based multidimensional volume registration, which is robust to noise and temporal intensity variations. Motion estimation is performed iteratively, firstly by using coarser level complex coefficients to determine large motion components and then by employing finer level coefficients to refine the motion field. Image registration has applications in remote sensing (cartography updating), and computer vision. In Medical images and It is also used in astrophotography to align images taken of space. Image registration is essential part of panoramic image creation

D. Image Fusion

Image fusion is a process by which two or more images are combined into a single image retaining the important features from each of the original images. Due to its shift invariance, orientation selectivity and multi-scale properties, the DT-CWT is widely used in image fusion where useful information from a number of source images are selected and combined into a new image [16]–[18]. A number of region-based fusion schemes have been proposed. These initially transform pre-registered images using an MR transform.

Regions representing image features are then extracted from the transform coefficients. A grey-level clustering using a generalized pyramid linking method is used for segmentation. The regions are then fused based on a simple region property such as average activity. These methods do not take full advantage of the wealth of information that can be calculated for each region. The image fusion rule is applied and a measure of the average energy of the wavelet coefficients in a region is generally a good measure of the importance of a regions. In a simple activity measure taking the absolute value of the wavelet coefficient is used.

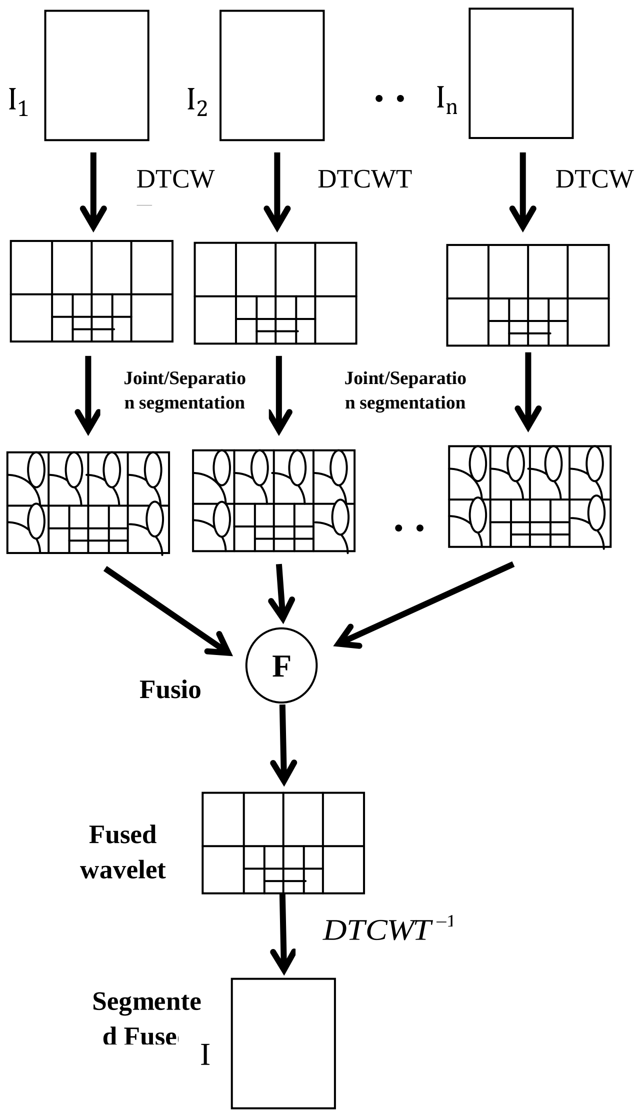

Fig. 3 The Region-based Image Fusion using DTCWT

The region-based fusion scheme, initially proposed, is shown in Fig. 3. The numbers of frame are first applying the DTCWT and then apply the joint/separate segmentation using watershed segmentation. After than fusion rule and inverse DTCWT is applied. Finally fused single frame is obtained.

E. Post Processing

The principal objective of image enhancement is to process a given image so that the result is more suitable than the original image for a specific application. It accentuates or sharpens image features such as edges, boundaries, or contrast to make a graphic display more helpful for display and analysis. The enhancement doesn't increase the inherent information content of the data, but it increases the dynamic range of the chosen features so that they can be detected easily

Contrast Enhancement: In many cases, atmospherically degraded images also suffer from poor contrast due to severe haze or fog. In such cases, pre- or post-processing is needed to improve image quality. Numerous techniques have been proposed for haze reduction using single images [22], [23]. Here we employ a simple and fast method using contrast limited adaptive histogram equalization (CLAHE) [24]. The method enhances intensity locally, so it is suitable for applications which consider the ROI and its information content. Advantages of CLAHE are given below.

- CLAHE was developed to prevent the over amplification of noise that adaptive histogram equalization can give rise.
- CLAHE, though able to increase contrast more than other techniques.
- It introduces large changes in the pixel gray levels.

CLAHE may lead to introduction of the processing artifacts and affect of decision making process.

III. RESULT

From the distorted video, we are trying to retrieve the fames and applying image registration, image fusion using DTCWT and finally image enhancement, in-order to get the undistorted frame.

From the Distortion video, we are retrieving the frames.

Fig. 4 Frame is retrieve from the video.

After retrieving frames, apply region of interest to each frame in-order to extract the features.

Fig. 5 ROI Frame

After retrieving the ROI from each frame, apply image registration using of non-rigid bodies using the phase-shift properties of the DT-CWT.

Fig. 6 Image Registration

IV. CONCLUSION AND FUTURE WORK

This paper has introduced a new method for mitigating atmospheric distortion in long-range surveillance imaging. Significant improvements in image quality are achieved using region-based fusion in the DT-CWT domain. The cost functions for frame selection to pre-process the distorted sequence. The process is completed with local contrast enhancement to reduce haze interference. From the distorted video we get the quality of the single frame for the ROI image.

In this paper, we have given a distorted video as a input and take one frame as a output. In future, distorted video is given as a input and take a multi frame as a output and make the frame into video. We can use the full frame for processing the output. While processing the input image, first apply a frame selection using sharpness of the image, intensity of the image and size of the image and calculate the cost function with the help of this parameter. We can do fusion for two images, one as a reference image and another as the input image and we can fuse these two images to get the multi-frame as the output. Finally apply contrast enhancement inorder to improve the quality of the image.

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