ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 5, Issue 3, March 2016

ROI Based DT-CWT Fusion for Distorted Video

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Abstract— **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.**

Index Terms—**Dual Tree Complex Wavelet Transform (DT-CWT), Image Fusion, Region of Interest(ROI)**

I. Introduction

Image fusion is the technique of merging several images from multi-modal sources with respective complementary information to form a new image, which carries all the common as well as complementary features of individual images. 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 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. Instances a system using image fusion at all levels of processing. This general structure could be used as a basis for any image processing system.

A. Single Sensor Image Fusion System

The basic single sensor image fusion scheme has been presented. The sensor shown could be visible-band sensors or some matching band sensors. This sensor captures the real world as a sequence of images. The sequence of images are then fused together to generate anew image with optimum information content. For example in illumination variant and noisy environment, a human operator may not be able to detect objects of his interest which can be highlighted in the resultant fused image.

The fundamental single sensor picture combination plan has been introduced. The sensor indicated could be unmistakable band sensors or some coordinating band sensors. This sensor catches this present reality as an arrangement of pictures The
computerized camera is suitable for sunlight scenes; the infrared camera is proper in inadequately lit up situations.

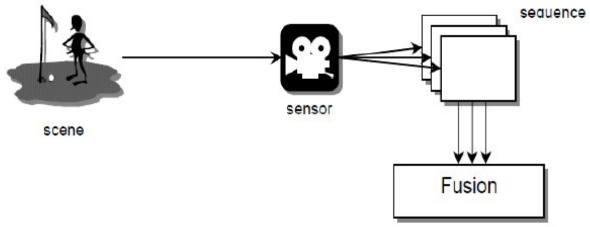

Fig 1: Single sensor Image Fusion System

B. Multi-Sensor Image Fusion System

A multi-sensor image fusion scheme overcomes the limitations of a single sensor image fusion by merging the images from several sensors to form a composite image. Figure 1.4illustrates a multi-sensor image fusion system. Here, an infrared camera is accompanying the digital camera and their individual images are merged to obtain a fused image. This approach overcomes the issues referred to before. The digital camera is suitable for daylight scenes; the infrared camera is appropriate in poorly illuminated environments.

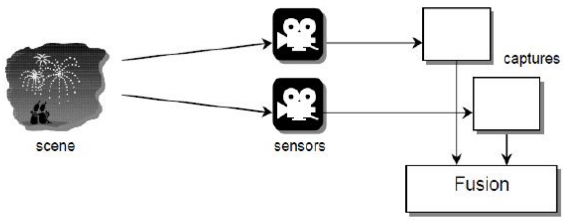

Fig 2: Multi sensor Image Fusion System

II. Literature Survey

Using various methods, there has been significant research activity attempting to faithfully reconstruct this useful information. In practice, the perfect solution is however impossible. 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 selectivity.

A. Blind Deconvolution

Blind deconvolution is a deconvolution technique that permits recovery of the target scene from a single or set of "blurred" images in the presence of a poorly determined or unknown point spread function (PSF). Regular linear and non-linear deconvolution techniques utilize a known PSF. For blind deconvolution, the PSF is estimated from the image or image set, allowing the deconvolution to be performed. Researchers have been studying blind deconvolution methods for several decades, and have approached the problem from different directions.

Blind deconvolution can be performed iteratively, whereby each iteration improves the estimation of the PSF and the scene, or non-iteratively, where one application of the algorithm, based on exterior information, extracts the PSF. Iterative methods include maximum a posteriori estimation and expectation-maximization algorithms. A good estimate of the PSF is helpful for quicker convergence but not necessary.

B. Model Based Processing

Model-based image processing is a collection of techniques that have emerged over the past few decades that provide a systematic framework for the solution of inverse problems that arise in imaging applications. A physical system of some type provides measurements, Y , that depend on an unknown signal or image, X. The objective is then to determine the unknown signal or image, X, from these measurements. Since X is not directly observed, this problem of determining X from Y is known as an inverse problem because it requires that the physical process that generated the measurements be inverted or reversed to create X from Y.

III. PROPOSED METHOD

We propose another combination technique for diminishing the impacts of atmospheric turbulence as delineated .Some time recently taking the picture combination we are taking ROI from the edges and arrangement them. At that point outline determination is finished by the sharpness, force similitude and ROI size. Non rigid Picture enrollment is connected. We then utilize a locale based plan to perform combination at the component level. This has focal points over pixel-based preparing since more insightful semantic combination guidelines can be considered in view of genuine components in the picture, rather than on single or self-assertive gatherings of pixels. The combination is performed in the Dual Tree Complex Wavelet Transform (DT-CWT) which utilizes two diverse genuine discrete wavelet changes (DWT) to give the genuine and nonexistent parts of the CWT. Two completely devastated trees are created, one for the odd specimens and one for the indeed, even specimens created at the principal level. This expansions
directional selectivity over the DWT and can recognize positive and negative introductions giving six particular sub-groups at every level, comparing to ± 15°, ± 45°, ± 75°. Also, the period of a DTCWT coefficient is strong to commotion and worldly force varieties in this way giving an effective instrument to uprooting contorting swells. At long last, the DT-CWT is near shift invariant a critical property for this application. After combination, the impact of fog is decreased utilizing locally adaptive histogram equalization Finally contrast limited adaptive histogram equalization is applied.

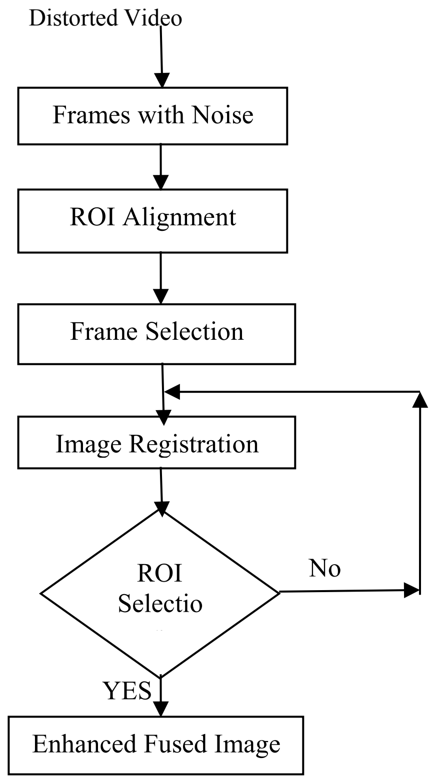

Fig 3: Block Diagram of Proposed Method

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 (orROIs) 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 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: Gn 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 Gn is computed from the summation of the high pass coefficient magnitudes.

2) Intensity Similarity: Sn 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: An is the total number of pixels contained in the ROI. ROIs are used because it contains more useful information. The cost function Cn for frame n is computed using

$$C_n = \frac{w_G G_n}{\lambda_G + |G_n|} + \frac{w_S S_n}{\lambda_S + |S_n|} + \frac{w_A A_n}{\lambda_A + |A_n|}$$

Where *wk* and *λk* are the weight and slope control of the factors Respectively. The sigmoid function is used here to prevent one factor dominating the others, e.g. a blocking artifact may cause significantly high values of sharpness, yet this frame should probably not be included in the selected dataset. The *λk* is set to equal the mean of factor *k* so that at the mean value, its cost value is 0.5. The cost *Cn* 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 DTCWT, 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 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.

$$P(r_n^{\theta}) = \frac{1}{|r_n^{\theta}|} \sum_{\forall l,(x,y)\in r_n^{\theta}} \left| d_n^{\theta,l}(x,y) \right|.$$

The air-turbulence scenario differs from other image-fusion problems as the segmentation boundaries which separate inhomogeneous regions vary significantly from frame to frame (due to turbulence distortion). To provide the sharpest and most temporally consistent boundaries for each region, we use the maximum of DT-CWT coefficient magnitudes over all frames instead of selecting only one region based on *P(r θn)*. To each boundary map *Bθ,l* (constructed from the multistate watershed segmentation approach for each sub band *θ* at level *l*), the dilation operation with a size of 1 pixel is applied. A 2D averaging filter is then applied to *Bθ,l* to prevent discontinuity after combining neighboring areas. The DT-CWT coefficients, *dθ,l* , of the fused image can be written as

$$d^{\theta,l} = (1 - B^{\theta,l}) \sum_{R} \phi(d_1^{\theta,l}, d_2^{\theta,l}, \ldots, d_N^{\theta,l}) + B^{\theta,l} \max(d_1^{\theta,l}, d_2^{\theta,l}, \ldots, d_N^{\theta,l}).$$

The most essential dispute concerning image fusion is to decide how to merge the sensor images. In recent years, a number of image fusion methods have been projected. One of the primitive fusion schemes is pixel-by-pixel gray level average of the source images.

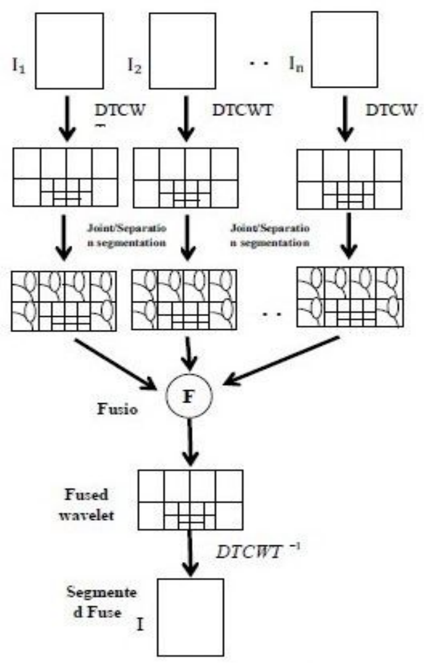

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Fig 4:Region based image Fusion using DT-CWT

This simplistic method often has severe side effects such as dropping the contrast. Some more refined approaches began to develop with the launching of pyramid transform in mid-80s. Improved results were obtained with image fusion, performed in the transform domain. The pyramid transform solves this purpose in the transformed domain. The basic idea is to perform a multi resolution decomposition on each source image, then integrate all these decompositions to develop a composite depiction

E. Enhancement Techniques

The principle 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. Here we employ a simple and fast method using contrast limited adaptive histogram equalization (CLAHE) . The method enhances intensity locally, so it is suitable for applications which consider the ROI and its information content

Quality Assessment: Image quality assessment is used to measure perceived image degradation, typically compared to an ideal or perfect image. This is important when assessing the performance of individual systems or for comparing different solutions. Image quality metrics can be classified according to the availability of a reference (distortion-free) image, with which the distorted image is to be compared. Most existing approaches are classed as full-reference (FR), meaning that a complete reference image is available. Example FR methods include Peak Signal to Noise Ratio (PSNR), Multistage Structural Similarity (MSSSIM) Visual Signal to Noise Ratio (VSNR) and Perception-based Image Model (PIM) .

These metrics are employed for evaluating the performance of the proposed method when a reference is not available, as is often the case for heat haze reduction, quality assessment becomes challenging, and is referred to as no-reference (NR) or blind quality assessment. This is described in the following section.

IV RESULTS

From Distorted video we are getting frames with noise, ROI alignment has been done to the frames later frames are selected. After retrieving the ROI from each frame, apply image registration using of non-rigid bodies using the phase shift properties of the DT-CWT.

The following are some of the pictures like ROI,Target image ,frame retrieved from a video, Fused image that are extracted from the project.This type of methods are mainly used to find a registration number plate of vehicle, to identify the persons in robbery case etc.

Fig 5: Frame Retrived from video

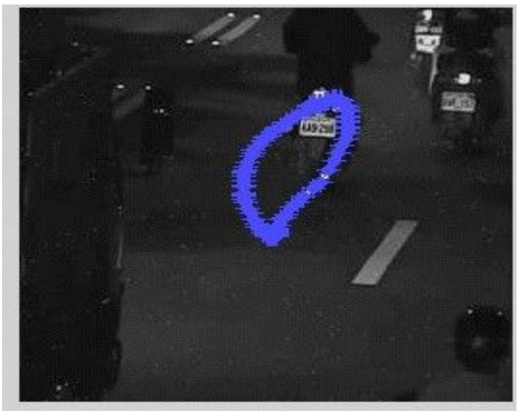

Fig 6: Region of Interest

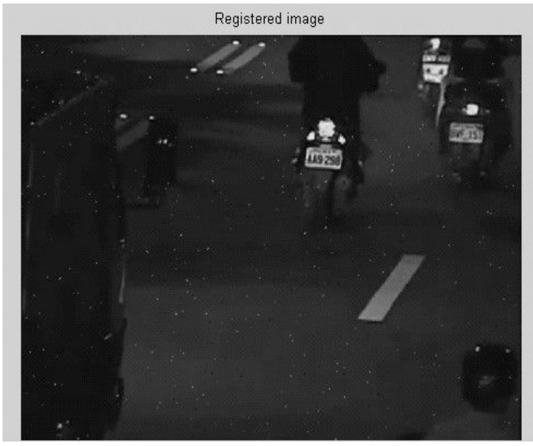

Fig 7: Registered image

V. CONCLUSION & 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 preprocess 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 in order to improve the quality of the image.

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