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A Survey on Color Image Fusion for Multi sensor Night Vision Image

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***Abstract* — Image fusion involves merging of two or more images in such a way that, to get the most desirable characteristics of each image. Here the Visible image is fused with InfraRed(IR) image, so that the desired result will be a single highly informative image providing full information. The color fusion methods incorporated with color transfer technology have achieved greater success in multi-band night vision fusion. The aim of color transfer technology is to give the multiband fused image as natural day-time color appearance and the hot targets are popped out with intense colors while the background details present with natural color appearance. The multi-band fused image technology has been widely used in surveillance, intelligence gathering, and security. This paper presents the survey on different methods for color transfer technology to give the multiband fused image as natural day-time color appearance.**

***Keywords* - Image Fusion, Histogram Equalization, Color contrast enhancement, color transfer technology.**

I. INTRODUCTION

The IR image records the thermal radiations emitted by objects in a scene and can be utilized to discover targets as it has better hot contrast and can present camouflaged targets. The visible image has much more high-frequency information of the background, which is essential to accurate target localization and situation awareness. The IR image contains the information that is not available in the visible image. The IR reflectance of objects will be different from the visible light. Fusion of IR and visible images with different contents could be utilized to enhance image quality. The image fusion method goal is for enhance the interesting objects visible in thermal images against the visible image surroundings. The results can contain the IR band data highlighted with unnatural colors for good perception [1].

The next goal in multiband fused image is to create the colored night vision image. These false colored night images are more pleasing to look than the plain IR images, but this color mapping technique produce the results that resembles slightly the natural coloring in the daylight [2]. The color level which human can distinguish is about hundreds times more than the gray level and many experiments show that the color fusion may improve the feature contrast of the image, which allows for better scene segmentation and object detection [4,5]. Here to enhance the false color image we use the color transfer technology is to give the multiband fused image as natural day-time color appearance and the hot targets pops out with intense colors while the background details present with natural color appearance. So color fusion is becoming more and more important research field and a number of color fusion methods have been proposed. This multiband fusion method for combining infrared image with visible image concentrates heavily on the surveillance and remote sensing applications. The fusion goal in surveillance is to enhance the interesting objects visible in thermal images against the visible image surroundings. In remote sensing applications multiband image data is fused to increase the spatial resolution and to improve information representation [3].

II.LITERATURE SURVEY

A. A Local-Coloring Method For Night-Vision Colorization Utilizing Image Analysis And Fusion[6]

Yufeng Zheng , Edward A. Essock proposed a new ‘local-coloring’ method. The source image (False-Color Image) is rendered segment-by-segment by its color properties. A set of preliminary ‘clusters’ are formed by analyzing the histograms of the three components of the diffused image in the lab space. Those clusters are then merged to produce the final ‘segments’. Then nonlinear diffusion filtering process is applied to the segmented false-colored image to reduce the number of colors. The association between the source region segments and the target color schemes is carried out automatically by utilizing the nearest-neighbor paradigm. Then the statistic-matching procedure is combined with the histogram-matching procedure in order to assure that the source

image is more closely resembled to the target image with respect to the chromaticity.

Here instead of a single color image, the average mean, standard deviation and histogram of the large sample of natural scene images are used as the target color properties for each color scheme. The target color schemes are grouped by their contents and colors such as plants, mountain, roads, sky, water, buildings, people, etc. The advantage of 'Local Coloring Method' is, the resultant output image is more natural and realistic coloration produced by the previous 'global-coloring' method [6]. Drawback is its time-consuming procedure such as nonlinear diffusion, color space transform, histogram analysis, segment recognition.

B. Fast Natural Color Mapping For Night-Time Imagery[7]

Maarten A. Hogervorst, Alexander Toet presented a simple lookup-table based on the algorithm for applying the natural daytime colors to multi-band night time images with bands largely outside the visual part of the spectrum. In this method certain statistical properties of a reference daytime image are transferred to the multi-band night time image. First, second or third bands of a multi-band night time image are mapped onto the RGB channels of a False-Color image. Then false-color RGB night vision image is then transformed into a perceptually de-correlated color space. In this color space the first order statistics of a natural color image (the target scene) are transferred to the multi-band night vision image (the source scene).The inverse transformation back to RGB space yields a night-time image with a daytime color appearance. The advantage of fast natural color mapping method is, it can contain more than three bands. Drawback is, process in all three channels of the color space and low contrast between the target and the background.

C. One Color Contrast Enhanced Infrared And Visible Image Fusion Method [8]

Songfeng Yin, Liangcai Cao presented a color transfer step, here all three channels of the color space are processed with the same linear mapping without color enhancement, resulting in low color contrast between the target and the background. The diagram for one color contrast enhanced method is shown in Fig 1.

This paper deals with the new method. This involves by taking the ratio of local to global divergence of the IR image to improve the color contrast. Here infrared and visible images are fused by the linear fusion Method. It then transfers the color from the reference images using YUV color space.

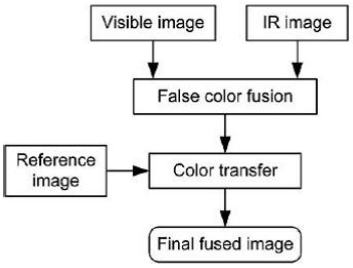

Fig 1 Schematic Diagram of One Color Contrast Enhanced Image Fusion

As a result, the proposed method pops out both hot and cold targets in color, and hot targets will appear intense red, and cold targets will appear cyan. The advantage of One Color Contrast Enhanced Image Fusion method is, the improvement in target detection, and hot targets will appear intense red and cold targets will appear cyan. Drawback is, the image looks unnatural.

D. Color Fusion Based on EM Algorithm for IR and Visible Image[9]

Gang Liu, Guohong Huang proposed a new multi-scale scheme for color image fusion using EM algorithm and color transfer algorithm for IR and visible image. The diagram for Color Fusion Based on EM Algorithm method is shown in Fig 2.

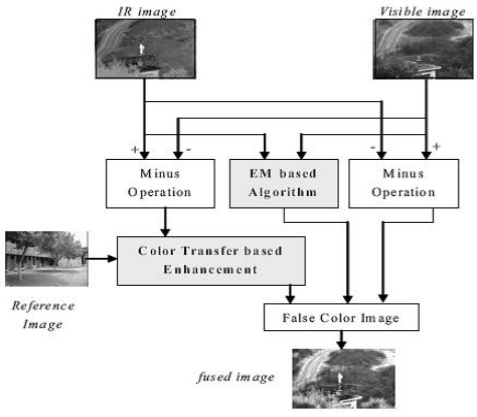

Fig 2 Color Fusion Based on EM Algorithm method

The high frequency band of the visible and IR images and low-frequency band of the visible and IR images are separately fused using minus operation. Then fused lowest frequency band and the fused high frequency band are obtained. Final fused image can be achieved by performing non-subsampled conto-urlet domain by using EM algorithm. Then color transfer is implemented using YUV color space to make the final fused image. The advantage of Color

Fusion Based on EM Algorithm is, it gives very abundant detail information and the color metric representation is better than the other method. Drawback is, low color contrast problem between hot target and cold target.

E. *An Adaptive Color Fusion Method For Night-Vision Images With NSC.[10]*

Weihua He, Yongcai Guo, Chao Gao focuses on blurry visual effects and low luminance contrast between target and background problem. To solve the aforementioned problems, they proposed an adaptive color fusion method for night vision. The diagram of adaptive color fusion method is shown in Fig 3.

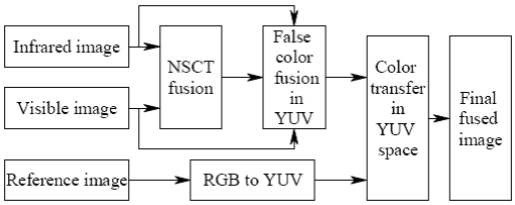

Fig 3 Adaptive Color Fusion Method

Firstly both the Infrared and Visible source images are analyzed in the NSCT domain, so as to produce an intermediate fused grayscale image. Then the fused grayscale image and the source images are simultaneously mapped into the YUV color space to form a pseudo-color image. Finally, the color transfer technique is employed, to give a natural color appearance to pseudo-color image. The advantage in adaptive color fusion method is, it can give abundant details of the background and also improve the target delectability.

F. *Fast Color Contrast Enhancement Method For Color Night Vision [11]*

Xiaoyan Qian, Yujin Wang, Bangfeng Wang focuses on the low color contrast problem of linear fusion algorithms with color transfer method. The diagram of Fast Color Contrast Enhancement Method is shown in Fig 4

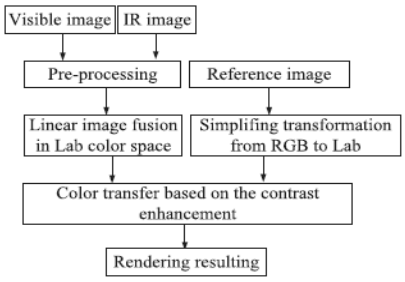

Fig 4 Fast Color Contrast Enhancement Method

Firstly, the contrast of Infrared And Visible images is enhanced using Local Histogram Equalization. Then the two enhanced images are fused into the three components of a Lab image in a simple linear fusion strategy. To obtain false color images possessing a natural day-time color appearance, this paper present a method which transfers color from the reference to the fused images in a simplified Lab space. To enhance the contrast between the target and the background, they introduced a transferring equation in to 'b' channel. Finally the hot targets are popped out with intense colors while the background details present the natural color appearance based on three different data sets. The advantages of Fast Color Contrast Enhancement method is, better performance in Target detection than the former methods, owing to the target recognition area, detection rate, color distance and running time enhance the color contrast between the target and the background.

G. *Efficient Color Transfer Method based on Color map clustering for Night Vision Applications[12]*

Ishit Makwana, Tanish Zaveri and Vivek Gupta proposed a new novel and efficient framework to colorize the Night Vision imagery is to utilize the colormap clustering and cluster recognition based on color similarity. In proposed method the false color fusion is performed in RGB color space, to achieve better separation in color based clustering. Then performance decorrelation stretch for color enhancement image and linear contrast stretch for intensity enhancement image. The diagram for Efficient Color Transfer Algorithm is shown in Fig 5.

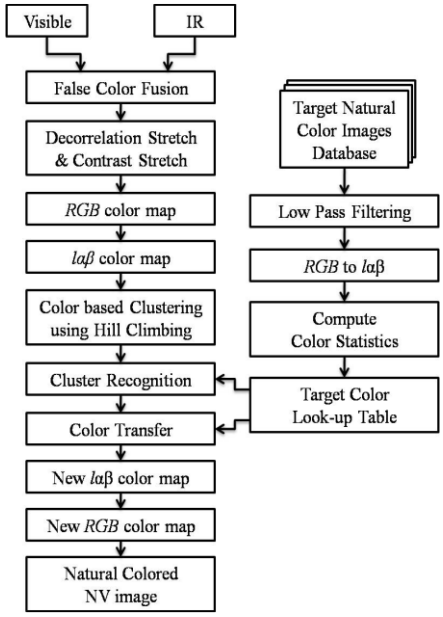

Fig 5 Efficient Color Transfer Algorithm

The enhanced false color fused image is converted to an indexed image where each pixel contains a single index which refers to a RGB value in a color lookup table or colormap. The RGB colormap is then transformed into lαβ color space to generate the lαβ colormap of the same size. Color based clustering is performed on the lαβ colormap using the Hill Climbing algorithm.

The target color look-up table is created as follows, Each image from the natural color target image database is smoothed by low pass filter and transformed into lαβ color space and first order statistics, mean μ and standard deviation σ, are computed for each band. A nearest neighbor criteria is used for automatic association of a cluster of colormap with a unique natural color image in the target color look-up table. The diagram for image fusion algorithm is show in Figure 6

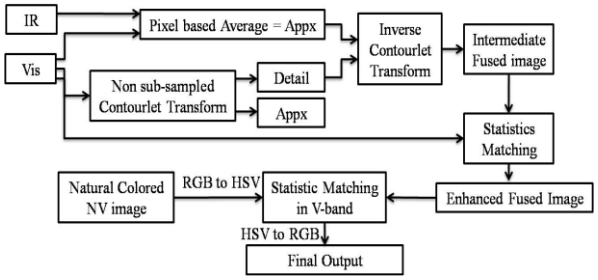

Fig 6 Block diagram of the Image Fusion Algorithm

Thus the purpose of cluster recognition is to decide which natural color image of a particular cluster should be rendered. The complete lαβ colormap is transformed to RGB color space to produce the new RGB colormap, which is then applied to the indexed false color image to generate the natural colored night vision image. The advantage of Efficient Color Transfer Method is, the image has more natural and realistic appearance but it is a time consuming procedure.

III. ANALYSIS ON MULTI-BAND FUSED IMAGE METHOD

A survey has been done on different multi-band fused image based on its image fusion method and color transfer method. This analysis helped to get the detailed information on various procedures, algorithms, Color Space Transform, Histogram Analysis and accuracy of Segment Recognition. In Table 1, gives the comparison on multi-band fused image method.

Local-Coloring method: The Local-Coloring method is based on Image Segmentation, Recognition And Local Color Transfer methods to enhance the color mapping effect. However, these methods are even more expensive than global method since they are time-consuming procedures such as Nonlinear Diffusion, Local Recognition, Local Comparisons and Image Segmentation.

Fast Natural Color Mapping Method: The Fast Natural Color Mapping method consistently renders Multi-Band Night Vision Imagery in natural colors. This method was implemented using standard color lookup table techniques to optimize the match between the false color fused image and the reference image. Once the lookup-table has been derived the color mapping can be deployed to different multi-band image sequences with similar scenes.

One Color Contrast Enhanced Method: The One Color Contrast Enhanced Image Fusion method introduces a ratio of local to global divergence of the IR image into the color transfer equations. As a result, both hot and cold targets are popped out, where hot targets appear intense red and cold targets appear cyan.

EM Algorithm: In EM algorithm the low frequency band image and high frequency band image is fused by Non-Subsampled Contourlet domain. Then color transfer is implemented using YUV color space to make the final fused image. It gives very abundant detail information and the color metric representation.

Adaptive Color Fusion Method: In adaptive color fusion method both the Infrared and visible source images are fused using NSCT domain, so as to produce an intermediate fused grayscale image. Then it is mapped into the YUV color space to form a pseudo-color image. Finally, the Color Transfer technique is employed, to give the pseudo -color image with natural color appearance.

Fast Color Contrast Enhancement method: In Fast color contrast enhancement method visible and IR images are preprocessed using Local Histogram Equalization. Consequently, the two enhanced images are fused into the three components of a Lab image by means of a simple linear fusion strategy. Then the color transfer technology in simplified Lab color space is followed. But it is different from the global statistic method, by means of transferring equation in the 'b' channel is amended by a stretch factor. It will change according to the distance between the current luminance value and the mean luminance value.

Efficient Color Transfer Method: In Efficient Color Transfer Method a new novel and efficient framework to colorize the night vision imagery utilizing the colormap clustering and cluster recognition based on color similarity is proposed.

Table 1: Comparison Table on Multi-Band Image Fused Method

Methods	Color Transformation	Background Natural color Appearance	Target Detection
Local-Coloring Method [6]	Lαβ Color Space	Medium	Poor
Fast Natural Color Mapping Method [7]	Color Look-Up Table	Medium	Poor
One Color Contrast Enhanced Method[8]	YUV Color Space	Poor	High
Color Fusion Based On EM Algorithm Method [9]	YUV Color Space	Medium	Medium
Adaptive Color Fusion Method [10]	YUV Color Space	Poor	Poor
Fast Color Contrast Enhancement Method [11]	Lab Color Space	High	Medium
Efficient Color Transfer Method [12]	Lαβ Color Space	Medium	Poor

Here the false color fusion is performed in RGB color.space, to achieve better separation in color based clustering. Then it performs decorrelation stretch for color enhancement and linear contrast stretch for intensity enhancement

IV.CONCLUSION

In this paper, a different color transfer technologies to give the multiband fused image as natural day-time color appearance and to pop out the hot targets with intense colors while the background details present the natural color appearance are discussed. The survey presents different methods with its own strengths and weaknesses. The idea behind this survey paper is not to compare different fusion methodologies or performance comparison using different quality metrics, but rather to get deeper knowledge in improving the performance of image enhancement methods using image fusion.

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