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Fusion for Video Enhancement using Fuzzy-C means Clustering Algorithm

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ABSTRACT

Video fusion is used for imparting all relevant and complementary details from multiple sources of image into a single composite image. The proposed method uses a class of image fusion techniques to automatically combine images of a scene captured under different illumination. Fuzzy-C means clustering is an unsupervised and robust clustering algorithm, which allows one input vector into two or more cluster regions. Proposed fusion method is based on segmented regions of source images obtained by a fuzzy-C means clustering algorithm and is the robust clustering method. Principal components are evaluated for the clustered regions of source video and average of all principal components is evaluated to get fused result as a linear combination of input video. This algorithm is applied to get fusion result with maximum average quality index.

Keywords : Enhancement, Fusion, Fuzzy-C Means Clustering Algorithm And Color Transfer

I. INTRODUCTION

Enhancement of night vision into day vision using fusion and color transfer methods is proposed. The algorithm extracts day reference video and enhances to night-time background image. The alpha rooting method is efficient to enhance dark pixels but difficult to extract parameters hence feature work is simplifying the parameter computation using the measure of enhancement. The input video is enhanced using alpha rooting and applies fuzzy C means clustering algorithm for fusion and finally applies color transfer methods to the frame fusion video. The result demonstrates that the proposed algorithm is robust method. Objective measures can be applied to evaluate the performance of proposed method.

The term fusion in general means an approach to extract information acquired in several domains. Video Fusion is the process of combining relevant information from two or more videos into a single video. The resulting video will be more informative than any of the input video. The goal of video fusion is to integrate complementary multi-sensor, multi-temporal and/or multi-view information into one new video containing information, the quality of which cannot be achieved otherwise. One way is to perform multi-sensor fusion of visual and infrared (IR) videos. In night-time environment, only limited visual information can be captured by CCD cameras under poor lightning conditions, thus making it difficult to do surveillance only by visual sensor. Meanwhile IR camera, that is IR sensor, captures thermal image of object. Thermal image of pedestrian in night-time environment can be seen clearly in infrared video sequence used for this work. Infrared video provides rich information for higher temperature objects, but poor information for lower temperature objects. Visual video, on the other hand, provides the visual context to the objects. Thus, the fusion of the two videos will provide good perceptibility to human vision under poor lightning condition. This will help detect the moving objects during night-time.

The fusion of low-light visible and thermal infrared imagery in real time has put us on the threshold of a new era in night vision. Laboratory breadboards, integrated field cameras, and prototype digital goggles that fuse the spectral content of reflected VNIR and emitted LWIR, are being developed world-wide. This complementary information will provide the user with enhanced situational awareness, but just how effectively remains to be demonstrated, assessed and quantified where possible. The fusion of noise-limited low-light imagery with thermal LWIR imagery, it enhances image quality by two means. One is the enhanced contrast and resultant target pop-out inherent in color fusion under any illumination conditions. The other is perceptual filling-in of brightness and color within the form generated by the object's boundary and feature contours, and not by the spatiotemporal noise. The flow chart of general fusion technique is shown in figure 1.

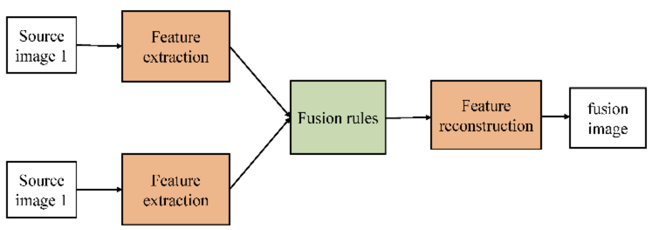

Figure 1: Flow chart of general fusion technique

II. RELATED WORK

In applications of digital cameras, when a lens focuses on a subject at a certain distance, all subjects at that distance are sharply focused. Subjects not at the same distance are out of focus and theoretically are not sharp. It is often not possible to get an image that contains all relevant objects in focus. One way to overcome this problem is image fusion, in which one can acquire a series of pictures with different focus settings and fuse them to produce an image with extended depth of field. During the fusion process, all the important visual information found in the input images must be transferred into the fused image without introduction of artifacts. In addition, the fusion algorithm should be reliable and robust to imperfections such as noise. Image fusion is a branch of data fusion where data appear in the form of arrays of numbers representing brightness, color, temperature, distance, and other scene properties. Such data can be two-dimensional (still images), three-dimensional (volumetric images or video sequences in the form of spatio-temporal volumes), or of higher dimensions. In recent years, multivariate imaging techniques have become an important source of information to aid diagnosis in many medical fields. Early work in image fusion can be traced back to the mid-eighties. Burt [1] was one of the first to report the use of Laplacian pyramid techniques in binocular image fusion and later Burt and Adelson [2] later introduced a new approach to image fusion based on hierarchical image decomposition at about the same time Adelson disclosed the use of a Laplacian technique in construction of an image with an extended depth of field from a set of images taken with a fixed camera but with different focal lengths. Later Toet [3] used different pyramid schemes in image fusion which were mainly applied to fuse visible and IR images for surveillance purposes. Some other early image fusion work are due to Lillquist [4] disclosing an apparatus for composite visible/thermal infrared imaging, Ajjimarang [5] see suggesting the use of neural networks in fusion of visible and infrared images, Nandhakumar and Aggarwal [6] providing an integrated analysis of thermal and visual images for scene interpretation, and Rogers et al. [7] describing fusion of LADAR and passive infrared images for target segmentation. Use of the discrete wavelet transform (DWT) in image fusion was almost simultaneously proposed by Li and Chipman et al. [8] at about the same time Koren et al. [9] described a steerable dyadic wavelet transform for image fusion and around the same time Waxman and colleagues developed a computational image fusion methodology based on biological models of color vision and used opponent processing to fuse visible and infrared images. The need to combine visual and range data in robot navigation and to merge images captured at different locations and modalities for target localization and tracking in defence applications prompted further research in image fusion. Many other fusion techniques have been developed during the last decade. Today, image fusion algorithms are used as effective tools in medical, remote sensing, industrial, surveillance, and defence applications that require the use of multiple images of a scene.

III. METHODOLOGY

Fuzzy C-Means clustering based principal component averaging fusion has been proposed for fusion of images. Source images are segmented into K number of clusters by FCM clustering algorithm and the segmented regions are sorted to have relevant regions for fusion. Principal components are evaluated for each pair of relevant clusters of source images. This algorithm aims at fusion of image details from same modality by segmenting source images into number of clusters using a robust Fuzzy C-Means clustering (FCM) algorithm. FCM algorithm provides fuzzy membership values for each data point for the belongingness to various clusters. The main aim of FCM clustering is to reduce intra-cluster variance, thus leads to fusion of similar regions of source images. For better fusion results, number of clusters is decided based on average quality index (AQI) between fused image and source images. Performance of proposed fusion algorithm is analyzed by AQI, mean structural similarity index (MSSIM) and average mutual information (AMI). Comparative analysis is carried out with PCA fusion, multiresolution algorithms such as discrete wavelet fusion (DWT), dual tree complex wavelet transform (DTCWT) and stationary wavelet fusion (SWT).

IV. RESULTS

The proposed method uses a class of image fusion techniques to automatically combine images of a scene captured under different illumination. Beyond providing digital tools for artists for creating surrealist images and videos, the methods can also be used for practical applications. For example, the non-realistic appearance can be used to enhance the context of night time traffic videos so that they are easier to understand. The context is automatically captured from a fixed camera and inserted from a day-time image (of the same scene). Our approach is based on a gradient domain technique that preserves important local perceptual cues while avoiding traditional problems such as aliasing, ghosting and haloing. There are several results in generating surrealistic videos and in increasing the information density of low quality night-time videos.

Night-time images such as the one shown in figure 2 are difficult to understand because they lack background context due to poor illumination. As a real-life example, when you look at an image or video seen from a traffic camera posted on the web or shown on TV, it is very difficult to understand from which part of the town this image is taken, how many lanes the highway has or what buildings are nearby. What can be seen is pair of headlights moving on the screen. How to improve this image? The solution is based on a very simple observation. Exploit the fact that, the traffic camera can observe the scene all day long and create a high-quality background. Then, we can simply enhance the context of the low-quality image or video by fusing the appropriate pixels as shown in the following figure.

Figure 2 : Enhanced traffic image. first image is night traffic image and the second is the result of proposed method.

Providing context to captured events and actions can also enhance low quality videos, such as the ones obtained from security and traffic surveillance cameras. The context, as in the previous subsection, comes from a single higher-quality day image. Videos, however, present several additional challenges: (a) inter-frame coherence must also be maintained i.e. the weights in successive images should change smoothly and (b) a pixel from a low-quality image may be important even if the local variance is small (e.g., the area between the headlights and the taillights of a moving car).

The solution is based on the simple observation that in a sequence of video frames, moving objects span approximately the same pixels from head to tail. For example, the front of a moving car covers all the pixels that will be covered by rest of the car in subsequent frames. Using temporal hysteresis, although the body of a car may not show enough intra-frame or inter-frame variance, we maintain the importance weight high in the interval between the head and the tail. Finally, consider a video fusion where, the pair being fused have a different temporal rate of sampling. In the accompanying video, a sunrise sequence is fused with a sunset sequence creating an illusion of a bi-solar illumination. However, the shadows at sunset move much quicker than the rate at which the sun appears to be rising.

V. CONCLUSION

The proposed algorithm avoids most of the visual artifacts as ghosting, aliasing and haloing. However, it may cause observable color shifts in the resulting images, especially when the segmented foreground occupies a substantially large portion in the result. This phenomenon unfortunately has been a common problem and can be observed in most previous works. There are two major reasons that cause the color shifting. First, a valid vector field is not guaranteed to be maintained when modifying it with non-linear operators. The resulting image computed by proposed method is only an approximation of the desirable one. Secondly, in some cases, it is difficult to maintain the perception of high contrast in a single image because the day and night time images are captured at significantly different exposure times. A minor but important issue is capturing of the high-quality background. Although using medians of several images, in some cases some object may remain in the frame for a long time.

Further work is needed to bridge the gap and generate fused image metrics that are predictive of human performance in different task domains. This requires using analytical operators to approximate non-linear mask and blending function. This remains an active area of research and hope to use better reconstruction algorithms in the future. Separating intrinsic and color images, then applying proposed algorithm on intrinsic images and fusing them back with the color images could be another possible solution.

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