International Journal of Enhanced Research in Management & Computer Applications, ISSN: 2319-7471
Vol. 3 Issue 7, July-2014, pp: (1-7), Impact Factor: 1.147, Available online at: www.erpublications.com

The Shortcomings of Various Visual Sensor Fusion Techniques - A Review

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Abstract: This paper has presents a study on the several digital image fusion methods. The most important function of visual sensor image fusion is found to be in multi-focus cameras to merge information from numerous digital images of the identical sight in order to bring only more informative fused digital image. The DCT based algorithms of visual sensor fusion are supplementary appropriate and time-saving in real-time organization. In this study an well-organized technique for fusion of multi-focus imagery based on variance calculated in DCT domain is presented. The overall objective is to find the gaps in existing literature and signifying a suitable method to decrease the gaps of existing techniques.

Index Terms: Image Fusion, Visula Sensors, DCT, Alternating Current.

I. INTRODUCTION

Digital image processing is the function of computational algorithms to do image processing on digital picture. As a subcategory or application of digital signal processing, digital image processing has many benefits over analog image processing. It permits a very much wider variety of procedures to be useful to the input records and can avoid difficulties such as the build-up of noise and motion distortion during processing. Since image are well-defined over two dimensions digital image processing may be modeled in the form of multidimensional system.

II. VISUAL SENSOR NETWORK

A visual sensor network is a network of spatially extend smart camera devices able of processing and merging pictures of a act from a range of viewpoints into some form extra valuable than the individual picture. A visual sensor network may be a type of wireless sensor network, and much of the principle and use of the last applies to the former. The network generally contains of the cameras themselves, which have certain local image processing, message and storage skills, and possibly one or more central computers, where image data from a number of cameras is further processed and fused (this processing may, however, simply take place in a scattered fashion across the cameras and their local controllers). Visual sensor networks also provide some complex services to the consumer so that the big amount of records can be distilled into information of interest using specific requests.

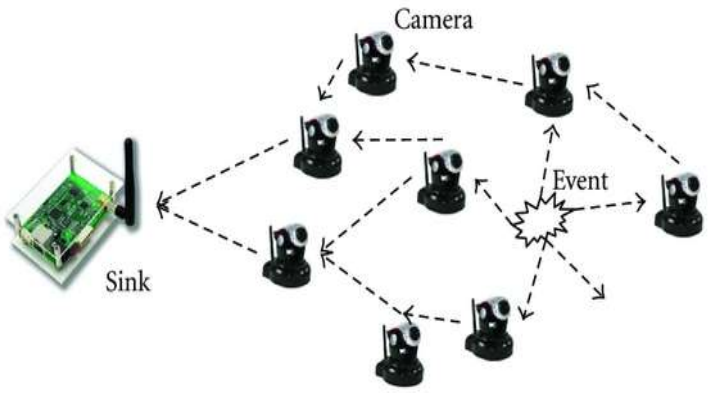

Figure 1.1 Visual sensor networks

The key difference between visual sensor networks and other types of sensor networks is the nature and volume of information the separable sensors acquire: unlike most sensors, cameras are indicator in their field of image, and they capture a huge amount of visual material which may be partially processed independently of records from other cameras in the network. Alternatively, one may say that while most sensors measure some value such as temperature or pressure, image sensors measure forms. In light of this, communication in visual sensor networks varies significantly from traditional sensor networks.

A. VISUAL SENSOR FUSION

Visual sensor fusion is the merging of sensory image records or records derived from sensory records from disparate sources such that the resultant information is in some sense well than would be possible when these sources were used independently. The term enhanced in this case can mean more truthful, more complete, or more reliable, or refer to the result of an developing vision, such as stereoscopic image (calculation of deepness information by merging two-dimensional image from two cameras at slightly different views). The data sources for a combination process are not particular to originate from same sensors. One can distinguish direct merging, indirect fusion and fusion of the outputs of the former two. Direct mixture is the mixture of sensor records from a set of mixed or same sensors, soft sensors, and history values of sensor records, while indirect mixture uses information sources like a priori knowledge about the environment and human input. Sensor combination is also known as (multi-sensor) Data mixture and is a subset of information mixture.

B. IMAGE FUSION

Image fusion is an important subject in image processing. Image fusion is a process of combining the related information from a set of pictures into a single image where the resultant merged picture will be more useful and complete than any of the input pictures. picture fusion means the combining of two into a single picture that has the highest information content without producing details that are non existent in a given picture. With rapid development in technology, it is now possible to get information from multi-source pictures to produce a high quality combined image with spatial and spectral information. The result of image fusion is a new image that retains the most desirable information and characteristics of input image. a number of situations in image processing require high spatial and high spectral resolve in a particular image. Most of the obtainable equipment is not capable of provided that such records convincingly. In remote sensing and in astronomy, multi sensor merging is used to achieve high spatial and spectral resolution by merging visions from two sensors one of which has high spatial resolution and the other one high spectral resolution. The main use of image fusion is merging the grey level high resolution panchromatic image and the colored low resolution multispectral image**.** The image fusion techniques allow the mixture of different information sources. The fused image can have complementary spatial and spectral resolution features.

When using the vision merging technique, some general requirements must be considered

- The fusion procedure should not discard any information contained in the source pictures.
- The fusion procedure should not introduce any artifacts or inconsistencies that can distract or mislead a human observer or any subsequent image processing steps.
- The fusion procedure must be consistent, strong and have, as much as possible, the capability to tolerate imperfections such as noise or miss registrations

Vision focus is a property closely related to image quality. In some imagery it is not possible to acquire a clear focus in all regions simultaneously, so an substitute is to use image fusion to merge pictures with different focus into one with all the best-focused regions. In some situations it is not likely to achieve totally focused imagery in just one single camera shot, since some regions become visible to be blurred due to variation in the deepness of the vision and of the camera lenses focus. This means that if the camera is focused at one exact object, another region of the scene can be out of focus. An attractive explanation is to capture more imagery of the desired scene in the same position, but with focus centered in dissimilar elements of the view. Then, using the vision fusion concept, all source imagery are joint, creating a single image that contains all the best focused regions. A characteristic directly related to vision quality is focus. Sharp pictures provide enhanced information than shadowy images. However, in some situations it is not possible to get totally focused pictures in just one single camera shot, since some regions show to be unclear due to variations in the deepness of the vision and of the camera lenses focus. This means that if the camera is focused at one specific point, another region of the scene can be out of focus. It has application in many fields such as photography, microscopy, astronomy, medical imaging, remote sensing, machine vision, biometrics and surveillance. The main aim of vision fusion is to fuse two (or more) different images to

make a new one that is more suitable to the difficulty analyzed, either by combination individual features present in each image or improving the overall picture quality.

Figure 1.4(a): Input image focused on the foreground (clock region)

Figure 1.4(b): Input image focused on the background (books region)

Figure 1.4(c): Fused image

C. MULTI FOCUS IMAGE FUSION

Multi focus Image fusion is process of merging information of two or more images of a vision and as a result has "all in focus" picture. When one view contains things in different distance, the camera can be focused on each object one after the other, creating set of images. When an image of a 3-D view is captured, only view parts at the focus plane appear sharp. view parts in frontage of or behind the focus plane appear unclear. In order to make an image where all view parts appear sharp, it is necessary to capture imagery of the scene at different focus levels and combine the imagery. Then, using image fusion technique, an picture with better focus across all area can be generated. There are many multi focus picture fusion methods, today. One of them is experimental Mode Decomposition based multi focus image fusion.

Figure 1.5: Example of two defocused images

D. REMOTE SENSING

Remote sensing is the gaining of data about an objective or phenomenon without making physical contact with the thing. Aircraft and satellites are the common platforms for remote sensing of the earth and its normal resources. There are two key types of remote sensing: passive remote sensing and active remote sensing. Passive sensors discover natural radiation that is emitted or reflected by the object or neighboring areas. An active sensor emits energy in order to search objects and areas whereupon a sensor then detects and measures the rays that is reflected or backscattered from the object.

E. DISCRETE COSINE TRANSFORM

The digital imagery are displaying on a screen instantly after they are captured. There are two characterize type for digital picture that is spatial domain or frequency domain. Spatial domain imagery can be realize through our human eyes, but frequency domain use to analysis of spatial domain. Discrete cosine transform are important to several purpose in science. Discrete cosine transforms is more time saving and easier to apply. Discrete cosine transform is an important transformation used in digital image processing. Discrete cosine transform based image fusion are more appropriate and time saving in real time system using discrete cosine transform based standard of unmoving picture or video. The discrete cosine transform algorithm is work on frequency domain. It divides the image into fixed size of blocks in order to decide which source image should be chosen to constitute the final resulting image. Discrete cosine transform then performed on each block. Discrete cosine transform based fusion is one of the best applications of the discrete cosine transform based algorithms. Discrete cosine transform are main to application in engineering, science and image compress. For simplicity, discrete cosine transform can exchange the spatial domain image to frequency domain image. Discrete cosine transform are important to application in engineering, science and vision compress. The Discrete Cosine Transform attempts to decorrelate the image data. After decorrelation each transform coefficient can be encoded independently without losing compression efficiency.

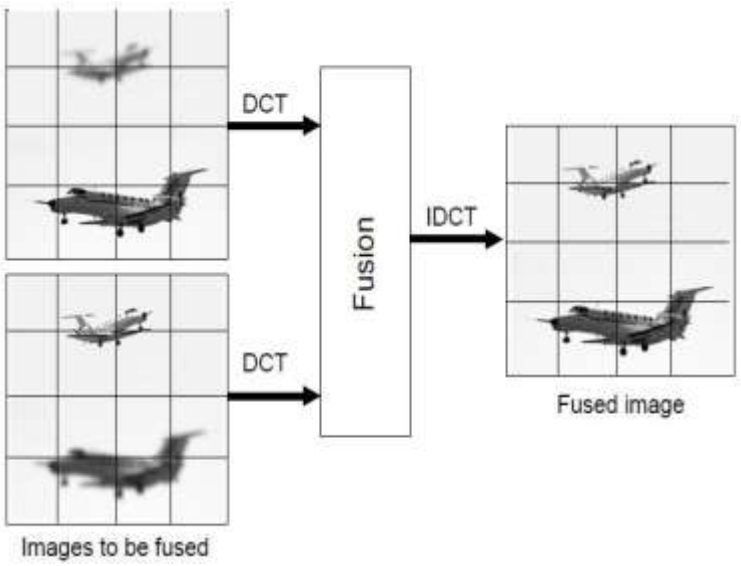

Figure 1.6: Framework of DCT based image fusion algorithm

DCT coefficients are computed for each block and mixture rules are apply to get fused DCT coefficients. IDCT is then apply on the fused coefficients to produce the fused picture/block. The procedure is repetitive for each block. DCTs are important to numerous applications in science and engineering, from lossy comp-ression of audio (e.g. MP3) and imagery (e.g. JPEG) (where small high-frequency components can be discarded), to spectral methods for the numerical solution of fractional differential equations.

III. RELATED WORK

Haghighat et al. (2010) [1] has studied that the objective of image fusion is to merge information from many imagery of the same vision in order to deliver only the useful information. The discrete cosine transform based methods of vision fusion are more suitable and time-saving in real-time systems using discrete cosine transform based values of unmoving image or video. Haghighat et al. has proposed an efficient approach for fusion of multi-focus images based on variance calculated in discrete cosine transform domain. Lui et al. (2010) [2] has discussed that image fusion is a very main step for image mosaic. Fusion algorithms affect the visual effect and quality of the mosaic imagery directly. An adaptive weighted coefficients algorithm for image fusion has been proposed. Adaptive weighted coefficients algorithm can adjust weighted coefficients adaptively along with changes of the variety and shape of the overlapping regions. Cao et al. (2010) [3] has proposed that multi focus vision fusion deals with a stack of imagery that were acquired with a different focus point to obtain an image with all the objects in the view full focused.

Multi focus noisy vision fusion algorithm using the contour let transform has been proposed. Utilizing the captured directional information by the contour let transform, the directional windows are used to determine the fusion weight. Pei et al. (2010) "[4] has discussed that improved discrete wavelet based vision fusion algorithm, after studying the principles and characteristics of the discrete wavelet framework. These algorithms can efficiently mixture the useful information of the each source image retrieved from the multi sensor. It can combination the two or more images into one image which is more correct and reliable. Tao et al. (2011) [5] has proposed medical image fusion has very important value of application for medical image analysis and diagnosis. The traditional way of wavelet fusion is improved and a new algorithm of medical image fusion is presented. When choosing high frequency coefficients, the regional edge intensities of each sub-vision are calculated to realize adaptive fusion. The low frequency coefficient choosing is based on edges of images, so that the fused image can preserve all useful information and appears clearly. Patil et al. (2011) [6] has proposed vision fusion algorithm using hierarchical PCA. image fusion is a process of combining two or more imagery (which are registered) of the same view to get the more informative image. Hierarchical multiscale and multiresolution vision processing techniques, pyramid decomposition are the basis for the majority of vision fusion algorithms.

Principal component analysis (PCA) is a well-known scheme for feature extraction and dimension reduction and is used for image fusion. We propose image fusion algorithm by combining pyramid and PCA techniques and carryout the value analysis of proposed fusion algorithm without reference image. There is an increasing require for the quality analysis of the fusion algorithms as fusion algorithms are data set dependent. Haozheng et al. (2011) [7] image fusion is one of the important embranchments of data fusion. Its use is to mixture multi-vision information in one vision to one picture which is more suitable to human image and computer vision or more adapt to further vision processing, such as target identification. Discussion was carried on the image fusion method based on wavelet transformation. Firstly, the article gives the basic concept of multi-focus image fusion. The theory of wavelet analyses and its fast arithmetic is given, hereon gives the image fusion process based on singe wavelet. Getting on with the single wavelet, it presents some improved wavelet as multi-wavelet, multi-band multi-wavelet, including their theories and their sums of decomposition and reconstruction. At the same time, it applies the multi-band multi wavelet in the vision fusion with the wavelet fusion thought.

Mohamed et al.(2011) [8] image fusion is a method which combines the data from two or more source images from the same view to generate one single image containing more precise details of the vision than any of the source images. Among many image fusion methods like averaging, principle component analysis and various types of Pyramid Transforms, Discrete cosine transform, Discrete Wavelet Transform special frequency and ANN and they are the most common approaches. In this paper multi-focus image is used as a case study. This paper addresses these issues in vision fusion. Lavanya et al. (2011) [9] has shown that the multisensor vision fusion is the process of combining related information from high spatial resolution vision and high spectral resolution image. This paper proposes a new image fusion method based on wavelet combined IHS and PCA transformations for remotely sensed lunar image data in order to extract features correctly. Different combination techniques have been used in the past individually for spatial and spectral quality vision enhancement. Albuquerque et al. (2012) [10] has discussed that image focus is a property closely related to vision quality. In some images it is not possible to obtain a clear focus in a all regions simultaneously, so an alternative is to

use image fusion to merge images with different focus into one with all the best focused regions. There are two image fusion algorithms in the frequency domain that are based on focus- DCT and spatial frequency. The algorithms separate the image into fixed size of blocks to decide which picture should be selected to constitute the final result. Parmar et al. (2012) [11] has analyzed that medical image fusion has been used to derive useful information from multimodality medical image data. The idea is to develop the image content by fusing imagery like computer tomography and magnetic resonance imaging images; magnetic resonance imaging provides better information on soft tissue whereas computed tomography provides better information about denser tissue. Fusing these two types of imagery creates a fused picture which is more useful than any of the input signals provided by a single modality. image fusion has become a common process used within medical diagnostics and treatment.

Fast Discrete Curve let Transform using Wrapper algorithm based image combination technique, has been implemented, analyzed and compared with Wavelet based mixture Technique. Fusion of imagery in use at different resolutions, intensity and by different techniques helps physicians to extract the features that may not be normally visible in a single picture by different modalities. Desale et al. (2013) [12] image Fusion is a process of combining the related information from a set of imagery, into a single image, where in the resultant fused image will be more informative and complete than any of the input images. This paper discusses the Formulation, Process Flow Diagrams and algorithms of PCA (principal Component Analysis), DCT (Discrete Cosine Transform) and DWT (Discrete Wavelet Transform) based vision fusion techniques. The results are also presented in table & picture format for comparative analysis of above techniques. The PCA & DCT are conventional fusion techniques with many drawbacks, whereas DWT based techniques are more favorable as they provide superior results for image fusion. In this paper, two algorithms based on DWT are proposed, these are, pixel averaging & maximum pixel replacement approach. Asnath et al. (2014) has focused on This paper presents a simple and efficient multi-focus image fusion system explicitly designed for wireless visual sensor systems equipped with resource unnatural, battery powered vision sensors employed in surveillance, hazardous environment like battlefields etc. Here the mixture of multi-focus imagery is based on higher valued Alternating Current (AC) coefficients calculated in Discrete Cosine Transform (DCT) domain.

IV. GAPS IN LITERATURE

By conducting the review it has been found that the most of the existing literature has neglected at least one of the following.

1. As most of the existing methods are based upon therefore it may results in some color artefacts which may reduce the performance of the transform based image fusion methods.
2. It is also initiate that the problem of the uneven illuminate has also been neglected in the most of existing work on combination.

V. CONCLUISON AND FUTURE WORK

The main objective of image fusion is to merging information from multiple images of the same vision in order to deliver only the useful information. The DCT based methods of image fusion are more suitable and time-saving in real-time systems using DCT based standards of still images. In this dissertation an efficient approach for fusion of multi-focus images based on variance calculated in DCT domain is presented. But review has shown that still much improvement is required in combination techniques. In near future his study will propose a new technique which will integrate the higher valued Alternating Current (AC) coefficients calculated in DCT domain based fusion with color normalization with adaptive histogram equalization to reduce the color artifacts which will be introduced due to the transform domain process i.e. DCT. The combination process may degrades the sharpness of the edges in the digital imagery so to overcome this problem edge preserving smoothing will be integrated with proposed algorithm to improvement the results further.

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