A NOVEL COMPARATIVE STUDY OF MULTIMODAL MEDICAL IMAGE SENSOR FUSION FRAMEWORK OF DCT & DWT DOMAINS

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ABSTRACT:

The energy compaction and multi-resolution properties of wavelets have made the image fusion successful in combining important features such as edges and textures from source images without introducing any artifacts for context enhancement and situational awareness. The wavelet transform is visualized as a convolution of wavelet filter coefficients with the image under consideration and is computationally intensive. The advent of lifting-based wavelets has reduced the computations but at the cost of visual quality and performance of the fused image. To retain the visual quality and performance of the fused image with reduced computations, a discrete wavelet (DWT) based image fusion followed by morphological filter using top hat transform is proposed. . The performance of Enhanced DCT is compared with DWT image give remarkable differences. In choosing the low-frequency coefficients, the concept of local area variance was chosen to measuring criteria. In choosing the high frequency coefficients, the window property and local characteristics of pixels were analyzed. Simulation results show the proposed approach outperform the traditional discrete wavelet transform-based and the Contourlet-based image fusion methods.

1.0 INTRODUCTION:

The developments in the field of sensing technologies multisensor systems have become a reality in a various fields such as remote sensing, medical imaging, machine vision and the military applications for which they were developed. The result of the use of these techniques is a increase of the amount of data available. Image fusion provides an effective way of reducing the increasing volume of information while at the same time extracting all the useful information from the source images. Multi-sensor data often presents complementary information, so image fusion provides an effective method to enable comparison and analysis of data. The aim of image fusion, apart from reducing the amount of data, is to create new images that are more suitable for the purposes of human/machine perception, and for further image processing tasks such as segmentation, object detection or target recognition in applications such as remote sensing and
medical imaging. For example, visible-band and infrared images may be fused to aid pilots landing aircraft in poor visibility. Multi-sensor images often have different geometric representations, which have to be transformed to a common representation for fusion. This representation should retain the best resolution of sensor. A prerequisite for successful in image fusion is the alignment of multi-sensor images.
However, image fusion does not necessarily provide multisensory sources, there are interesting applications for both single-sensor and multi-sensor image fusion.

SINGLE SENSOR IMAGE FUSION SYSTEM

A single sensor image fusion system is shown in Figure 1.The sensor shown could be a visible-band sensor such as a digital camera. This sensor captures the real world as a sequence of images. The sequence is then fused in one single image and used either by a human operator or by a system to do some task. For example in object detection, a human operator searches the scene to detect objects such intruders in a security areaMaintaining the Integrity of the Specifications.

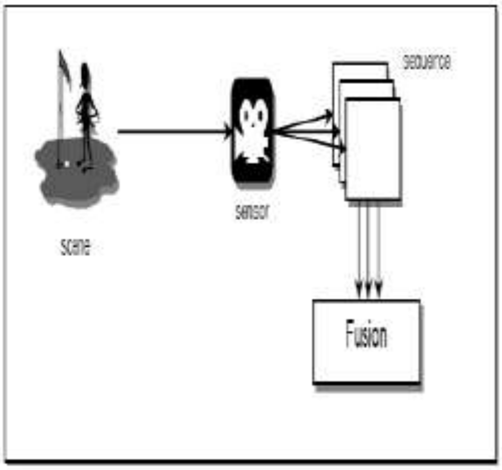


Figure 1: Single Sensor Image Fusion System

This kind of systems has some limitations due to the capability of the imaging sensor that is being used. The conditions under which the system can operate, the dynamic range, resolution, etc. are all limited by the capability of the sensor. For example, a visible-band sensor such as the digital camera is appropriate for a brightly environment such as daylight scenes but is not suitable for poorly situations found during night, or under conditions such as in fog or rain.

Cryptography VS Steganography

Cryptography is the science of encrypting data in such a way that nobody can understand the encrypted message, whereas in steganography the existence of data is conceived means its presence cannot be noticed. The information to be hidden is embedded into the cover object which can be text, image, audio or video so that the appearance of cover object doesn't vary even after the information is hidden. To add more security the data to be hidden is encrypted with a key before embedding. To extract the hidden information one should have the key. A STEGO object is one, which looks exactly same as cover object with hidden information.

Information to be hidden + cover object = STEGO Object

2.0 LITERATURE SURVEY

Literature survey is the most important step in software development process. Before developing the tool it is necessary to determine the time factor, economy and company strength. Once these things are satisfied, then next step is to determine which operating system and language can be used for developing the tool. Once the programmers start building the tool the programmers need lot of external support. This support can be obtained from senior programmers, from book or from websites. Before building the system the above considerations are taken into account for developing the proposed system.

A literature review is a body of text that aims to review the critical points of current knowledge including substantive findings as well as theoretical and methodological contributions to a particular topic. Literature reviews are secondary sources, and as such, do not report any new or original experimental work. Also, a literature review can be interpreted as a review of an abstract accomplishment.

Most often associated with academic-oriented literature, such as a thesis, a literature review usually precedes a research proposal and results section. Its main goal is to situate the current study within the body of literature and to provide context for the particular reader.

Multiresolution DCT decomposition for multifocus image fusion

Image fusion is gaining momentum in the research community with the aim of combining all the important information from multiple images such that the fused image contains more accurate and comprehensive information than that contained in the individual images. In this paper, it is proposed to fuse multifocus images in the multiresolution DCT domain instead of the wavelet domain to reduce the computational complexity. The performance of the fused image in the proposed domain is compared with that of the wavelet domain with four recently-proposed fusion rules. The proposed method is applied on several pairs of multifocus images and the performance compared visually and quantitatively with that of wavelets. It is found that the performance of the proposed method is superior/similar to that of wavelets in terms of visual quality and quantitative parameters with extra benefits of computational efficiency and simplicity of implementation.

Multimodal image fusion in Visual Sensor Networks:

In this paper, we present a novel method for adaptive fusion of multimodal surveillance images, based on Non-Subsampled Contourlet Transform (NSCT), which has an improved performance over Visual Sensor Networks (VSN). In sensor networks, energy consumption and bandwidth are the main factors that determine the lifetime of the sensors. In order to reduce the energy and bandwidth used in transmission, the proposed method uses Compressive sensing (CS) which can compress the input data in the sampling process efficiently. Since CS is more efficient for sparse signals, in this work, each sensor image is first decomposed into sparse and dense components. We have introduced Contourlet Transform for this decomposition because of its ability to capture and represent smooth boundaries of objects in images, so that the reconstructed images have a better quality. The reconstructed input images are fused using an adaptive algorithm based on NSCT in a centralized server. The improvement in the quality of the fused image is achieved by the use of an image fusion metric and a search algorithm to assign optimum weights to the various regions in the segmented source images. Experimental results show, no significant change in the quality of the fused images with and without compression. The results show that the proposed method achieves better visual quality and objective metrics than the state-of-art methods

3.0 PROPOSED METHOD

In wireless visual sensor networks, multiple sensors are applied to obtain images of the same scene, and a centralized fusion centre combines source images from multiple sensors into a single image, which is more suitable for human visual and machine perception So far, a lot of researches have concentrated on image fusion performed in the spatial domain . Methods based on multi-scale transform such as discrete wavelet transform (DWT), shift invariant discrete wavelet transform (SIDWT) , and non-subsampled contourlet transform (NSCT) are popular. However, most of the image fusion approaches based on multi-scale transform are complex and time-consuming, which limits their applications for wireless visual sensor networks equipped with constrained resources. In WVSN, images are compressed before transmission to the other nodes. When the source images are saved or transmitted in DCT based standards, the methods applied in DCT domain will reduce computation complexity considerably [6]. Recently, several image fusion techniques in DCT domain have been proposed. Tang et al. [7] proposed two methods in DCT domain, namely.

FUSION:-

Standard Image Fusion Methods

Image fusion methods can be broadly classified into two groups - spatial domain fusion and transform domain fusion.

The fusion methods such as averaging, Brovey method, principal component analysis (PCA) and IHS based methods fall under spatial domain approaches. Another important spatial domain fusion method is the high pass filtering based technique. Here the high frequency details are injected into upsampled version of MS images. The disadvantage of spatial domain approaches is that they produce spatial distortion in the fused image. Spectral distortion becomes a negative factor while we go for further processing, such as classification problem. Spatial distortion can be very well handled by frequency domain approaches on image fusion. The multiresolution analysis has become a very useful tool for analysing remote sensing images. The discrete wavelet transform has become a very useful tool for fusion. Some other fusion methods are also there, such as Laplacian pyramid based, curvelet transform based etc. These methods show a better performance in spatial and spectral quality of the fused image compared to other spatial methods of fusion.

The images used in image fusion should already be registered. Misregistration is a major source of error in image fusion. Some well-known image fusion methods are:

- High pass filtering technique
- IHS transform based image fusion
- PCA based image fusion
- Wavelet transform image fusion
- Pair-wise spatial frequency matching

Remote Sensing Image Fusion

Image fusion in remote sensing has several application domains. An important domain is the multi-resolution image fusion (commonly referred to pan-sharpening). In satellite imagery we can have two types of images

- **Panchromatic images** - An image collected in the broad visual wavelength range but rendered in black and white.
- **Multispectral images** - Images optically acquired in more than one spectral or wavelength interval. Each individual image is usually of the same physical area and scale but of a different spectral band.

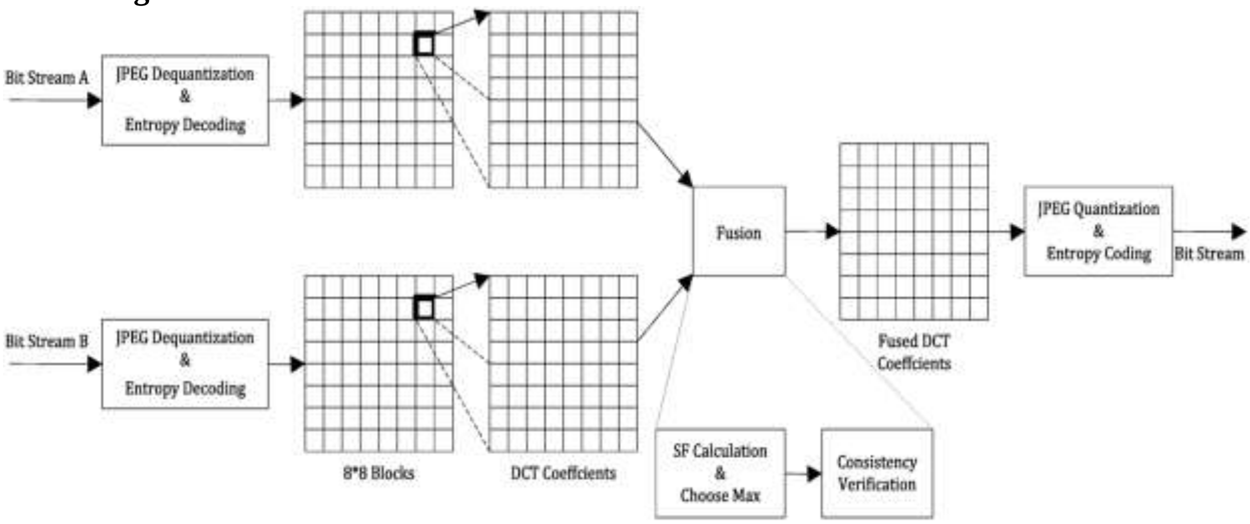
The SPOT PAN satellite provides high resolution (10m pixel) panchromatic data. While the LANDSAT TM satellite provides low resolution (30m pixel) multispectral images. Image fusion attempts to merge these images and produce a single high resolution multispectral image.

The standard merging methods of image fusion are based on Red-Green-Blue (RGB) to Intensity-Hue-Saturation (IHS) transformation. The usual steps involved in satellite image fusion are as follows:

1. Resize the low resolution multispectral images to the same size as the panchromatic image.
2. Transform the R, G and B bands of the multispectral image into IHS components.
3. Modify the panchromatic image with respect to the multispectral image. This is usually performed by histogram matching of the panchromatic image with Intensity component of the multispectral images as reference.

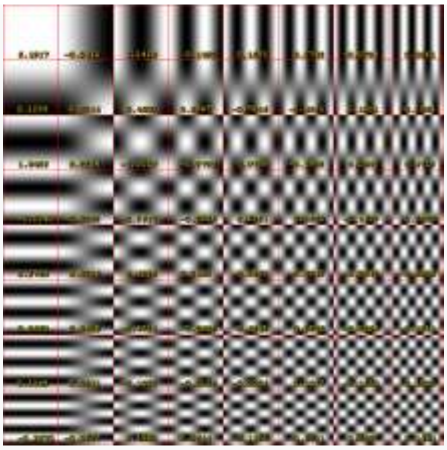
Replace the intensity component by the panchromatic image and perform inverse transformation to obtain a high resolution multispectral image.

Block Diagram:-



DCT of the image.

$$\begin{bmatrix} 6.1917 & -0.3411 & 1.2418 & 0.1492 & 0.1583 & 0.2742 & -0.0724 & 0.0561 \\ 0.2205 & 0.0214 & 0.4503 & 0.3947 & -0.7846 & -0.4391 & 0.1001 & -0.2554 \\ 1.0423 & 0.2214 & -1.0017 & -0.2720 & 0.0789 & -0.1952 & 0.2801 & 0.4713 \\ -0.2340 & -0.0392 & -0.2617 & -0.2866 & 0.6351 & 0.3501 & -0.1433 & 0.3550 \\ 0.2750 & 0.0226 & 0.1229 & 0.2183 & -0.2583 & -0.0742 & -0.2042 & -0.5906 \\ 0.0653 & 0.0428 & -0.4721 & -0.2905 & 0.4745 & 0.2875 & -0.0284 & -0.1311 \\ 0.3169 & 0.0541 & -0.1033 & -0.0225 & -0.0056 & 0.1017 & -0.1650 & -0.1500 \\ -0.2970 & -0.0627 & 0.1960 & 0.0644 & -0.1136 & -0.1031 & 0.1887 & 0.1444 \end{bmatrix}$$



Basis functions of the discrete cosine transformation with corresponding coefficients (specific for

4.0 SOFTWARE DESCRIPTION

MATLAB

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:

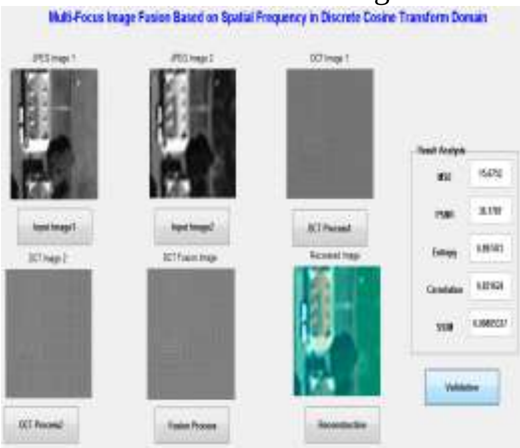
- Math and computation
- Algorithm development
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including graphical user interface building

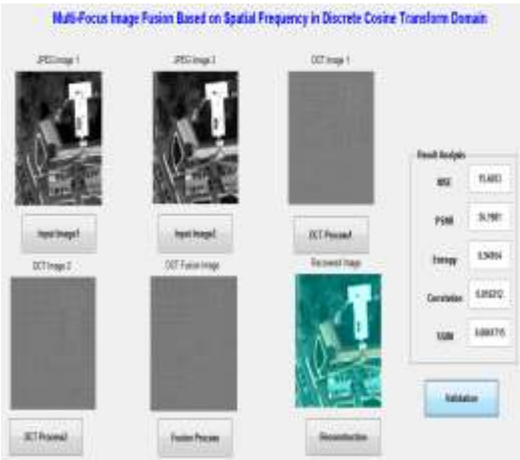
MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar noninteractive language such as C or FORTRAN.

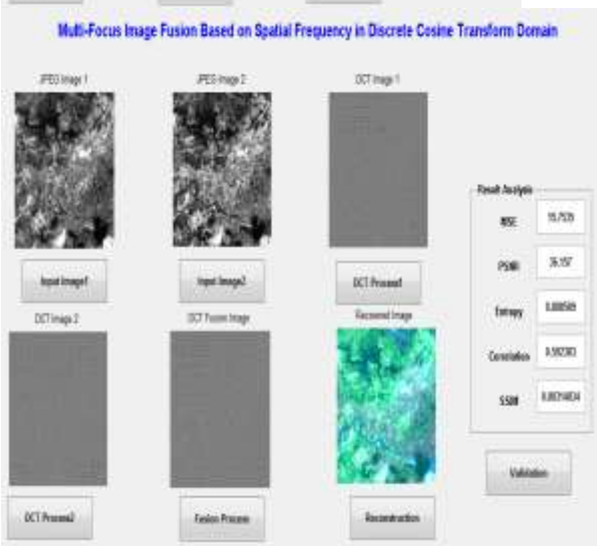
5.0 EXPERIMENTAL ANALYSIS

The simulations of the fusion methods have been conducted with an Intel i5 4570 processor with 4 GB RAM. For the wavelet based methods, the DWT with DBSS (2, 2) and the SIDWT for Haar basis with three levels of decomposition are applied. For the NSCT, we use 2, 4, 8 directions in the scales from coarser to finer. For the proposed method, we obtain the results with the threshold of 2. All the images in the simulations are converted to JPEG files. In this section, we compare the performance of our technique with the existing image fusion methods in the DCT domain, like The multi-scale based fusion such as DWT , SIDWT , and NSCT are treated as state-of-the-art approaches. In the first experiment, the performance of the proposed fusion method is demonstrated by fusing 30 pairs of blurred images which are generated by filtering the standard grayscale images shown in Fig. 2 with averaging filter of different radiuses (5, 7, and 9 pixels). In each of these pairs, complementary regions of the source images are blurred. The standard grayscale images are taken as ground truth images.

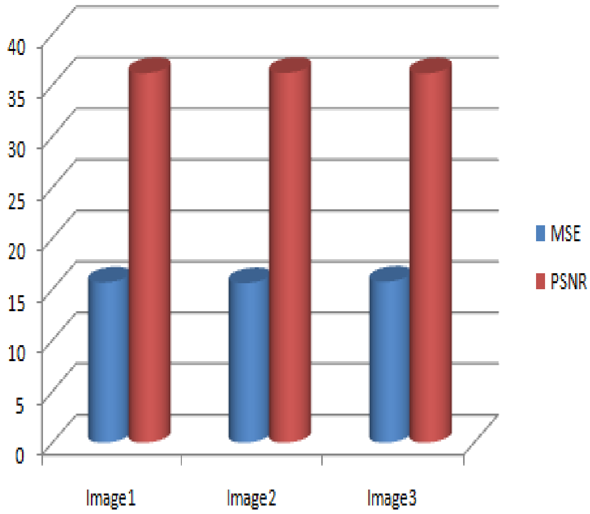
The root mean square error (RMSE) and structural similarity measure (SSIM) [16] are used for objective evaluation in the first experiment. RMSE is the cumulative squared error between the fused and the referenced image. SSIM is used to evaluate salient information that has been transferred into the fused image

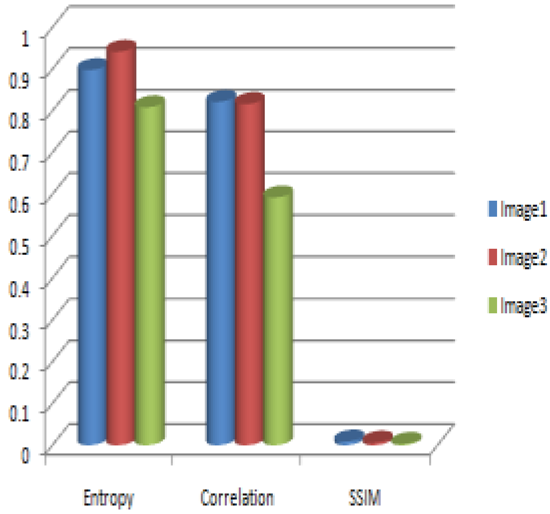


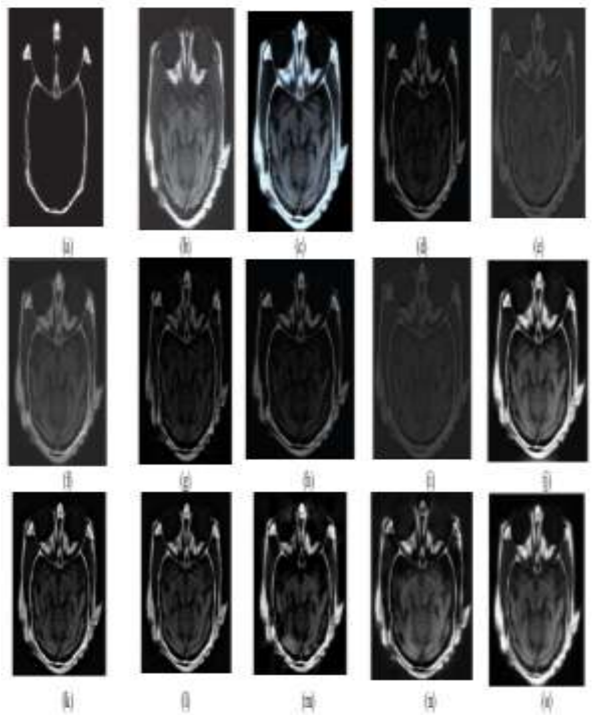


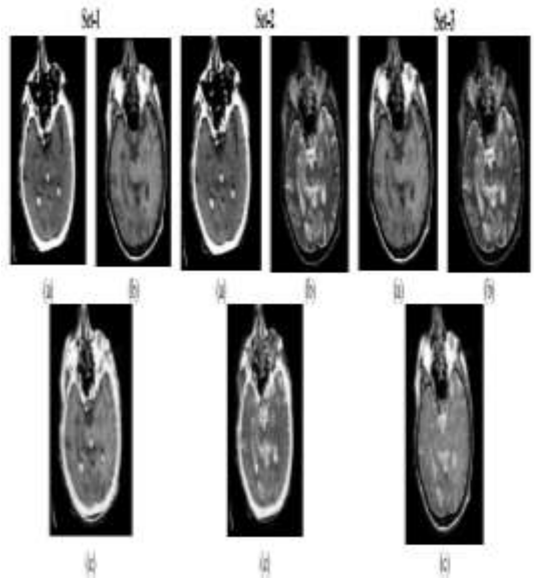


Parameters	MSE	PSNR	Entropy	Correlation	SSIM
Image1	15.6752	36.1787	0.8975	0.8216	0.0089
Image2	15.6053	36.1981	0.9416	0.8162	0.0062
Image3	15.7535	36.157	0.8085	0.5924	0.0031









6.0 CONCLUSIONS

In this letter, a new approach based on spatial frequency for fusion of multi-focus images has been proposed in the DCT domain instead of the spatial domain. We evaluate the performance of the proposed method with various evaluation metrics and it is found that the performance of fusion in the DCT domain is superior to that of conventional approaches based on DCT and the state-of-the-art methods including DWT, SIDWT, and NSCT, in terms of visual quality and quantitative parameters. Moreover, the proposed method is simple to implement and computationally efficient when the source images are coded in JPEG format, especially in wireless visual sensor networks.

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