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# A COMPARATIVELY ANALYSIS OF VARIOUS HYBRID IMAGE FUSION TECHNIQUES

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## ABSTRACT
This paper presents a low complex, highly energy efficient sensor image fusion scheme explicitly designed for wireless visual sensor systems equipped with resource constrained, battery powered image sensors and employed in surveillance, hazardous environment like battlefields *etc*. Here an energy efficient simple method for fusion of multi focus images based on higher valued AC coefficients calculated in discrete Wavelet transform domain is presented. The proposed method overcomes the computation and energy limitation of low power devices and is investigated in terms of image quality and computation energy. Simulations are performed using processor of Mica 2 mote, to measure the resultant energy savings and the simulation results demonstrate that the proposed algorithm is extremely fast and consumes only around 1% of energy consumed by conventional discrete cosine transform based fusion schemes. Also the simplicity of our proposed method makes it more appropriate for real-time applications.

**KEYWORDS**: sensor image fusion, discrete wavelet transform (DWT), energy consumption, computation complexity, fusion metrics.

## I. INTRODUCTION
Image fusion is the technique of merging several images from multi-modal sources with respective complementary information to form a new image and image properties enhancement, which carries all the common as well as complementary features of individual images. With the recent rapid developments in the domain of imaging technologies, multisensory systems have become a reality in wide fields such as remote sensing, medical imaging, machine vision, embedded system, DSP and the military applications. Image fusion provides an effective way of reducing this increasing volume of information by extracting all the useful information from the source images and other noisy image. It provides an effective method to enable comparison and analysis of Multi-sensor data having complementary information about the concerned region and detection. The output are new images that are more suitable for the purposes of human/machine perception, and for further image-processing tasks such as segmentation, Classification object detection or target recognition in applications such as remote sensing and medical imaging with feature extracting.

Images from multiple sensors usually have different geometric representations, which have to be transformed to a common representation for fusion. This representation should retain the best resolution of either sensor. The alignment of multi-sensor images is also one of the most important preprocessing steps in image fusion. Multi-sensor registration is also affected by the differences in the sensor images. However, image fusion does not necessarily imply multi-sensor sources. There can be single-sensor or multi-sensor image fusion, which has been vividly described in this report.

Analogous to other forms of information fusion, image object fusion is usually performed at one of the three different processing levels: **Pixel, feature and decision**. Pixel level image fusion, also known as signal-level image fusion, represents fusion at the lowest level, mid level where a number of raw input image signals are combined to produce a single fused image signal and higher efficient image. Feature level is a middle level of fusion which extract important features from an image like shape, length, edges, segments and direction with

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color properties of image. Finally, the highest level, decision or symbol level image fusion represents fusion of probabilistic decision information obtained by local decision makers operating on the results of feature level processing on image data produced from individual sensors and camera feature of image.

## II. GOAL OF PROJECT DESIGN

The motivation for image fusion research is mainly due to the contemporary developments in the fields of multi-spectral, high resolution, robust and cost effective image sensor design technology with De noising of two different image. Since last few decades, with the introduction of these multi-sensory imaging techniques, image fusion has been an emerging field of research in remote sensing, medical imaging, night vision, military and civilian avionics, autonomous vehicle navigation, recognition technique, feature extraction, remote sensing, concealed weapons detection, various security and surveillance systems applications. There has been a lot of improvement in dedicated real time imaging systems with the high spatial, spectral resolution as well as faster digital image processing technology system. The solution for information overloading can be met by a corresponding increase in the number of processing units, using faster Digital Signal Processing (DSP) and larger memory storage devices like as RAM and ROM. This solution however, can be quite expensive and easily design. Pixel-level image fusion algorithms represent an good solution to this problem of operator related information overload and better PSNR improvement. Pixel Level fusion effectively reduces the amount of data that needs to be processed without any significant loss of useful information and also combine image from multi-spectral sensors and other noise image generating source.

## III. TYPES OF SENSORE BASED IMAGE FUSION SYSTEM

**Single Sensor Image Fusion System:**
The basic single sensor image fusion scheme has been representation in Figure 1.2. The sensor shown different band could be visible-band sensors or some matching band sensors. This sensor captures the real world as a sequence of different images.

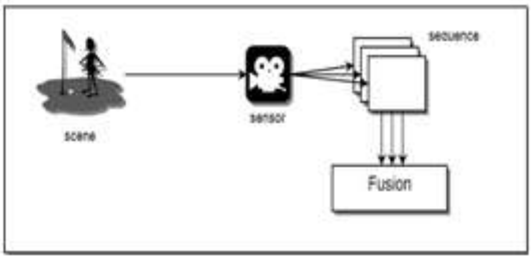


***Fig. 1.2 Single  Sensor Image Fusion System with its Architecture***

**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 combination of image. Figure 1.3 shows a multi-sensor image fusion system with its Algorithmic block. Here, an infrared camera is accompanying the digital camera and their individual images are merged to obtain a fused image input image. This approach removes the issues referred to before. The digital camera is suitable for daylight scenes; the infrared camera is appropriate in poorly illuminated environmental conditions.

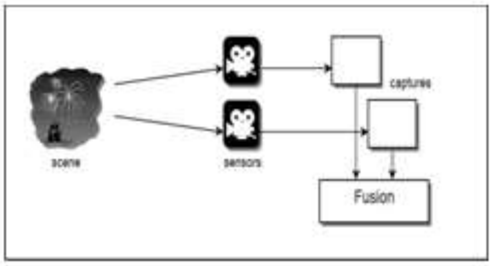


***Fig.1.3 Multisensory block representation of Image Fusion System***

## IV. ISSUES OF OLD ARTICLE IN IMAGE FUSION

*Patil, U et al. (2011) [9]* has focused on image fusion algorithm using hierarchical PCA. Authors described that the Image fusion is a process of combining two or more images (which are registered) of the same scene to get the more informative image. Hierarchical multiscale and multiresolution image processing techniques, pyramid decomposition are the basis for the majority of image 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 quality analysis of proposed fusion algorithm without reference image.

Katartzis and Petrou describe the main principles of SR reconstruction and provide an overview of the most representative methodologies in the domain. The general strategy that characterizes super-resolution comprises three major processing steps which are low resolution image acquisition, image registration/motion compensation, and high resolution image reconstruction. Katartzis and Petrou presented a promising new approach based on Normalized Convolution and a robust Bayesian estimation, and perform quantitative and qualitative comparisons using real video sequences.

Mitianoudis and Stathaki demonstrate the efficiency of a transform constructed using Independent Component Analysis (ICA) and Topographic Independent Component Analysis based for image fusion in this study [10]. The bases are trained offline using images of similar context to the observed scene. The images are fused in the transform domain using novel pixel-based or region-based rules. An unsupervised adaption ICA-based fusion scheme is also introduced. The proposed schemes feature improved performance when compared to approaches based on the wavelet transform and a slightly increased computational complexity. The authors introduced the use of ICA and topographical ICA based for image fusion applications. These bases seem to construct very efficient tools, which can complement common techniques used in image fusion, such as the Dual-Tree Wavelet Transform. Their proposed method can outperform the wavelet approaches. The Topographical ICA based method offers a more accurate directional selectivity, thus capturing the salient features of the image more accurately.

*Li and Yang* first describe the principle of region-based image fusion in the spatial domain [11]. Then two region-based fusion methods are introduced. They proposed a spatial domain region-based fusion method using fixed-size blocks. Experimental results from the proposed methods are encouraging. More specifically, in spite of the crudeness of the segmentation methods used, the results obtained from the proposed fusion processes, which consider specific feature information regarding the source images, are excellent in terms of visual perception. The presented algorithm, spatial domain region-based fusion method using fixed-size blocks, is computationally simple and can be applied in real time. It is also valuable in practical applications. Although the results obtained from a number of experiments are promising, there are more parameters to be considered as compared to an MR-based type of method, such as the wavelet method. Adaptive methods for choosing those parameters should be researched further. In addition, further investigations are necessary for selecting more effective clarity measures

*Desale, R.P et al. (2013) [2*] discusses the Formulation, Process Flow Diagrams and algorithms of PCA (principal Component Analysis), DCT (Discrete Cosine Transform) and DWT based image 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 provides better results for image fusion. In this paper, two algorithms based on DWT are proposed, these are, pixel averaging & maximum pixel replacement approach.

## V. HYBRID IMAGE FUSION TECHNIQUES

Traditional image fusion method lacks the ability to get high-quality image when to combine two different images. So, there is a bad need to use hybrid fusion techniques to achieve this objective target archive. The basic idea of the hybrid techniques is to combine spatial domain with transform domain fusion techniques to improve the performance and increase fused image quality with reduction of image noise component .Another possibility is applying two stage transformations techniques on input images before fusion process. These transformations provide better characterization of input images, better handling of curved shapes, and higher quality for fused details. The overall advantages of the hybrid techniques are improving the visual quality and image entropy increase of the images, and decreasing image artifacts and noise. Flowchart depicting a hybrid image fusion technique of PCA with DWT is shown below for given content:-

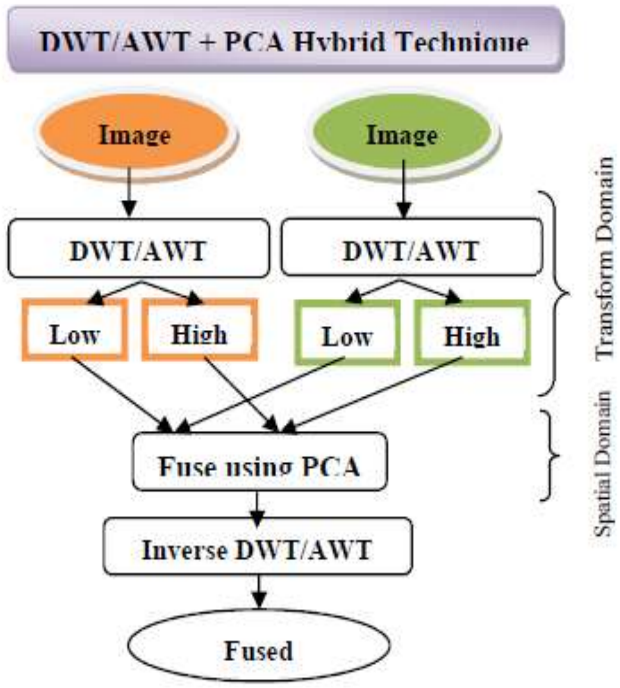


***Fig5.1 Figure showing (DWT+AWT) based hybrid image fusion algorithm (DWT + PCA).***

## VI. IMAGE FUSION APPLICATIONS

Image Fusion has become a commonly used technology to increase the visual interpretation of the images in various applications like enhanced vision system, Object recognition, Feature extraction, medical diagnosis, robotics, military and surveillance to name a few. It has been widely used in many fields such as object identification, classification and change detection and Extraction.

**Object identification:** In order to maximize the amount of information extracted from satellite image data useful products can be found in fused images and data content of image behalf.

**Classification**: Classification is one of the key tasks of Basic rules based remote sensing applications. The classification accuracy of remote sensing images is improved when multiple source image data are introduced to the processing and classification.

**Change detection**: Change detection is the process of identifying differences in the state of an object by observing it at different times with same time duration. It is an important process in monitoring and managing natural resources and urban development because it provides mathematical quantitative analysis of the better distribution of the population of interest. Image fusion for change detection takes advantage of the different configurations of the platforms carrying the sensors and image fusion.

## VII. PREVIOUS RESULT AND COMPARIOSION

The hybrid image fusion methodology based on directional DCT and PCA along with the 2D used to enhance the output, has been performed using various multi-sensor images from standard image database. The robustness of the proposed fusion technique is verified successfully with some multi-sensor images and multi focus image datasets shown below:

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***Table (1) Comparison between Base paper and Proposed algorithm result.***

| Fused image AA 512× 512 Parameters | DWT+PCA | AWT+PCA | AWT+DTCWT |
|---|---|---|---|
| MSE of fused image | 0.03326 | 0.03687 | 0.03745 |
| PSNR of fused template | 62.73 | 58.79 | 57.08 |
| Entropy | 7.5944 | 7.5435 | 6.8150 |
| Standard deviation | 0.2834 | 0.3212 | 0.4389 |

## VIII. CONCLUSION

In this thesis work, we presented a hybrid image fusion algorithm based on Discrete Wavwlet Transform (DWT) and Principal Component Analysis (PCA) followed by a 2D filter for enhancement purposes and evaluated the obtained results. The source images were divided in non-overlapping blocks then fusion is applied to the corresponding blocks of the two source images which were to be fused. It is conducted in a 2-stage process, where, firstly, modes 0-8 are applied on the source images and coefficients from the source images for each mode are used in the fusion process. Repeated the same for other modes, then, three different fusion rules are applied for fusion process. Between the images. In the second stage, eight fused images obtained (one from each mode) after applying the fusion rules are fused into a single image using PCA. Then this fused output image is passed through the 2-D filter appended at the end of the algorithm to get an enhanced output. This final filtered outcome is the required output which is compared with the other fusion techniques to get the results..

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