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Implementation of Image Fusion Algorithm Using Laplace Transform

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Abstract:

In recent years many algorithms to combine two or more images in a single image to detect some sort of features. The methodology used for this technology is known as image fusion. The successful fusion of images acquired from different modalities or instruments is of great importance in many applications, such as medical imaging, microscopic imaging, remote sensing, computer vision and robotics. In this paper we propose a new efficient algorithm for image fusion for combining two images acquired from the different sensors .Here we decompose two images using laplacian pyramid and fusing is done in each level of decomposition. Finally we reconstruct the fused images in to one. Experimental results demonstrate the proposed fusion algorithm can obtain the quality output image, both in visual effect and objective evaluation criteria. Three performance metrics, namely, Root Mean Square Error (RMSE), Peak Signal to Noise Ratio (PSNR) and speed of fusing images, were used during experimentation. All the experiments showed that the proposed hybrid model is an improved version to fuse images when compared with wavelet-based algorithms.

I. INTRODUCTION:

With the recent rapid developments in the field of sensing technologies, single-sensor and multi-sensor systems have become a reality in a growing number of fields such as remote sensing, medical imaging, machine vision and military applications.The result of the use of these techniques is a great increase in the amount of data, both images and videos, available. As the volume of data grows, the need to combine data gathered from different sources to extract the most useful information also increases. The technique which performs this is generally referred to as data fusion. Image fusion, an interdisciplinary of data fusion, where the data type to combine, is restricted to image format. Image fusion is a process of combining the relevant information from a set of images, into a single image, wherein the resultant fused image will be more informative and complete than any of the input images. 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.Multi-sensor images often have different geometricrepresentations, 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.

II. REVIEW OF LITERATURE:

The concept of data fusion goes back to the 1950's and 1960's, with the search for practical methods of merging images from various sensors to provide a composite image which could be used to better identify natural and manmade objects. terms such as merging, combination, synergy, integration, and several others that express more or less the same concept have since appeared in the literature. The idea of combining multiple image modalities to provide a single, enhanced picture offering added value to the observer or processor is well established, but the technology to realize it is somewhat less mature. In the past few years computing power has advanced sufficiently to finally enable affordable, real-time image fusion systems to become a reality and the field has started to move out of the research laboratories and into real products.

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Although algorithmic techniques for fusing images are now well known and understood, challenges remain with regard to exploiting different sensor modalities, robustness to environmental and operational conditions and proving performance benefit, to name but a few. This chapter provides a broad review of the field of image fusion, from initial research published to the latest technology being developed and systems being deployed.

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.

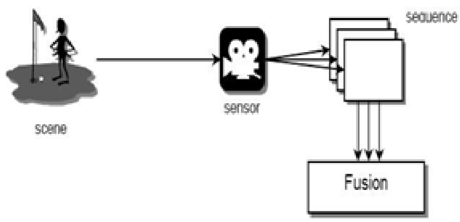


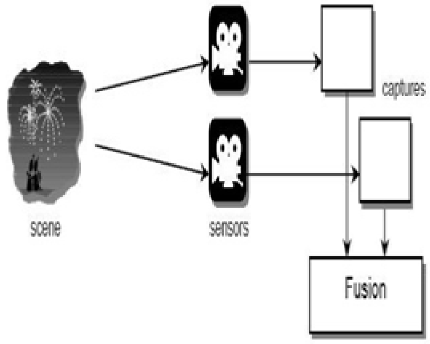
Figure 1: Single Sensor Image Fusion System

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.

Multi- sensor Image Fusion System :

A multi-sensor image fusion system overcomes the limitations of a single sensor fusion system by combining the images from these sensors to form a composite image. Figure 2 shows an illustration of a multi-sensor image fusion system. In this case, an infrared camera is being used the digital camera and their individual images are fused to obtain a fusedimage.

This approach overcomes the problems referred to single sensor image fusion system, while the digital camera is appropriate for daylight scenes; the infrared camera is suitable in poorly illuminated ones.



Multi -Sensor Image Fusion System

A. Benefits of multi-sensor image fusion

1. Extended range of operation – multiple sensors that operate under different operating conditions can be deployed to extend the effective range of operation.

2. Extended spatial and temporal coverage – joint information from sensors that differ in spatial resolution can increase the spatial coverage.

3. Reduced uncertainty – joint information from multiple sensors can reduce the uncertainty associated with the sensing or decision process.

4. Increased reliability – the fusion of multiple measurements can reduce noise and therefore improve the reliability of the measured quantity.

5. Robust system performance – redundancy in multiple measurements can help in systems robustness. In case one or more sensors fail or the performance of a particular sensor deteriorates, the system can depend on the other sensors .

6. Compact representation of information – fusion leads to compact representations. For example, in remote sensing, instead of storing imagery from several spectral bands, it is comparatively more efficient to store the fused information.

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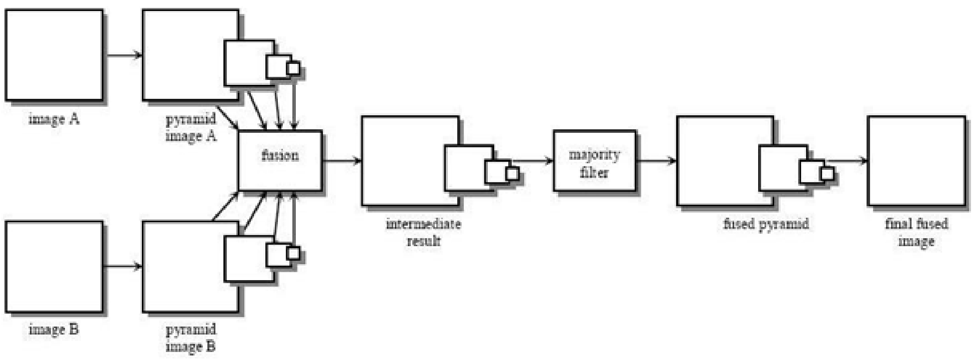
Fusion Techniques:

The important issue for image fusion is to determine how to combine the sensor images. In recent years, several image fusion techniques have been proposed [1].The important fusion schemes perform the fusion right on the source images. One of the simplest of these image fusion methods just takes the pixel-by-pixel gray level average of the source images. This simplistic approach has disadvantage such as reducing the contrast. With the introduction of pyramid transform, it was found that better results were obtained if the fusion was performed in the transform domain. The pyramid transform appears to be very useful for this purpose. The basic idea is to perform a multi resolution decomposition on each source image, then integrate all these decompositions to form a composite representation, and finally reconstruct the fused image by performing an inverse multi-resolution transform. Several types of pyramid decomposition or multi-scale transform are used or developed for image fusion such as Laplacian Pyramid, with the development of wavelet theory, the multi-scale wavelet decomposition has begun to take the place of pyramid decomposition for image fusion. The wavelet transform can be considered to be one special type of pyramid decompositions. It retains most of the advantages for image fusion.

LaplacianPyramid :

Image pyramids have been described for a multi-resolution image analysis as a model for the binocular fusion for human vision. An image pyramid can be described as collection of low or band pass copies of an original image in which both the band limit and sample density are reduced in regular steps [2]. The Laplacian Pyramid implements a “pattern selective” approach to image fusion, so that the composite image is constructed not a pixel at a time. The basic idea is to perform a pyramid decomposition on each source image, then integrate all these decompositions to form a composite representation, and finally reconstruct the fused image by performing an inverse pyramid transform.



Schematic diagram of the Laplacian Pyramid fusion method:

Laplacian Pyramid used several modes of combination, such as selection or averaging [3]. In the first one, the combination processes selects the component pattern from the source and copy it to the composite pyramid, while discarding the less pattern. In the second one, the process averages the sources patterns. This averaging reduces noise and provides stability where sou

Implementation :

The function GUImainwas implemented in MATLAB to perform the Laplacian fusion. This function uses a recursively algorithm to achieve three main tasks. rce images contain the same pattern information.

First, it constructs the Laplacian pyramid of the source images. Second, it does the fusion at each level of the decomposition. And finally, it reconstructs the fused image from the fused pyramid. Finally inter face the matlab function with matlab GUI (Graphical user interface) for better output vision inMATLAB. The implementation of proposed algorithm in MATLAB as follows. Figure 4 shows that flow chart of proposed algorithm.

Step 1: Load images in to MATLAB
Step 2: Find size of two images and compare if size is not equal than stop the operation.
Step 3: Decompose both images in to tree multi resolution representation by laplacian pyramid.
Step 4: compare magnitude intensity of both images and select best intensity for final result in each level.

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Step 5: Reconstruct fused image by fused pyramid.
Step 6: show results in MATLAB GUI.

Results :

In this session we show that how proposed algorithm is better than conventional wavelet transform and we show the results of gray to color image and color to color image fusion using proposed algorithm.

Image 1	Imag1 2	Result
		
		

Image 1	Image 2	Result
		
PSNR 31.169	PSNR 29.0684	Proposed
PSNR 26.530	PSNR Inf	wavelets

Conclusion :

From this paper, image fusion algorithm has been implemented. The results were implemented using MATLAB. There is also different image fusion techniques were carried out of which Laplacian Pyramid method gives better results.

For this purpose some psycho visual tests were carried out, where a group of individuals express their subjective preferences between couples of images obtained with different fusion methods.

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