An Innovative Algorithm for Faster Determination of Information in Image Using Image Fusion

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Abstract— *In computer vision, Multi sensor Image fusion is the process of combining relevant information from two or more images into a single image. The resulting image will be more informative than any of the input images. In remote sensing applications, the increasing availability of space borne sensors gives a motivation for different image fusion algorithms. Several situations in image processing require high spatial and high spectral resolution in a single image. Most of the available equipment is not capable of providing such data convincingly. Image fusion techniques allow the integration of different information sources. The fused image can have complementary spatial and spectral resolution characteristics. However, the standard image fusion techniques can distort the spectral information of the multispectral data while merging. In satellite imaging, two types of images are available. The panchromatic image acquired by satellites is transmitted with the maximum resolution available and the multispectral data are transmitted with coarser resolution. This will usually be two or four times lower. At the receiver station, the panchromatic image is merged with the multispectral data to convey more information.*

Keywords— Image Fusion, Image Processing, DWT

I. Introduction

Image fusion is the technique of merging several images from multi-modal sources with respective complementary information to form a new image, 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 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. Image fusion provides an effective method to enable comparison and analysis of Multi-sensor data having complementary information about the concerned region. Image fusion creates 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.

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 fusion is usually performed at one of the three different processing levels: signal, feature and decision. Signal level image fusion, also known as pixel-level image fusion, represents fusion at the lowest level, where a number of raw input image signals are combined to produce a single fused image signal. Object level image fusion, also called feature level image fusion, fuses feature and object labels and property descriptor information that have already been extracted from individual input images. 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.

Figure 1.1 instances a system using image fusion at all three levels of processing. This general structure could be used as a basis for any image processing system, for example an automatic target detection/recognition system using two imaging sensors such as visible and infrared cameras. The main objective is to detect and correctly classify objects in a presented scene. The two sensors (1 and 2) survey the scene and register their observations in the form of image signals. Two images are then fused at pixel-level to produce a third fused image and are also passed independently to local feature extraction processes. The fused image can be directly displayed for a human operator to aid better scene understanding or used in a further local feature extractor. Feature extractors act as simple automatic target detection systems, including processing elements such as segmentation, region characterization, morphological processing and even neural networks to locate regions of interest in the scene. The product of this process is a list of vectors describing the main characteristics of identified regions of interest. Feature level fusion is then implemented on the feature sets produced from the individual sensor outputs and the fused image. This process increases the robustness of the feature extraction process and forms a more accurate feature set by reducing the amount of redundant information and combining the complimentary information available in different individual feature sets. Feature level fusion may also produce an increase in the dimensionality of the feature property vectors.

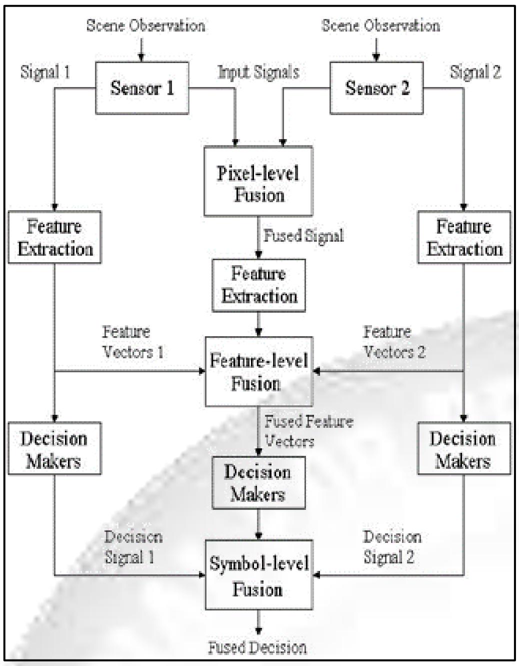

Fig. 1.1: An information fusion system at all three processing

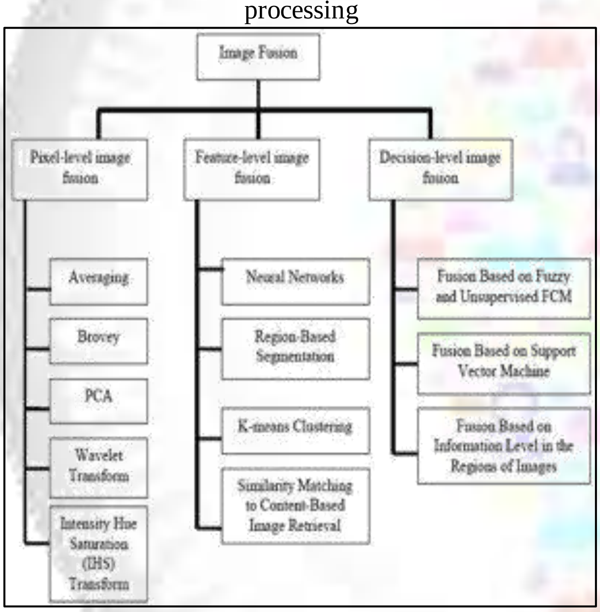

Fig. 1.2: Level classification of the various popular image fusion methods based on the computation source.

II. PROBLEM IDENTIFICATION

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. 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, remote sensing, concealed weapons detection, various security and surveillance systems applications.

A. *Limitation of Exisiting work*

There has been a lot of improvement in dedicated real time imaging systems with the high spatial, spectral resolution as well as faster sensor technology. 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 devices. This solution however, can be quite expensive. Pixel-level image fusion algorithms represent an efficient solution to this problem of operator related information overload. Pixel Level fusion effectively reduces the amount of data that needs to be processed without any significant loss of useful information and also integrates information from multi-spectral sensors. Explicit inspiration for the research work has come from the necessity to develop some competent image fusion techniques along with the enhancement of existing fusion technologies. Furthermore, a Non-Destructive Testing (NDT) has been a popular analysis technique used in industrial product evaluation and for troubleshooting in research work without causing damage which can also save both money and time. There has always been the requirement of some novel edge detection techniques based on NDT for detection of faults in industrial products suppressing the diversity and complexity of measuring environment. Using the wavelet based Multi resolution analysis techniques and some efficient edge detection technique, it is possible to accomplish distortion less fusion which results in a reduced loss of input information. The proposed novel fusion methods in this research work also exhibit improvement with respect to objective as well as subjective evaluation point of view as compared to some of the existing image fusion techniques.

The objectives of the thesis are as follows.

1) Development of a novel crack detection technique using discrete wavelet transform based image fusion suppressing the diversity and complexity of imaging environment.
2) Development of an effective edge detection technique for multi-focus images using Dual-Tree Complex Wavelet Transform (DT-CWT) based image fusion technique.
3) Development and implementation of an improved image fusion technique based on Bilateral Sharpness Criterion in DT-CWT Domain

III. METHODOLOGY

Analysis of image contents has been a substantial target for computer vision as well as image processing researchers since last few decades. An image carries variety of information regarding contour, colour, as well as orientation. The first step for contour extraction begins with the detection of edges. This realism exposes the real significance of edge detection techniques in image processing field. Edge detection has a wide range of applications in image compression, enhancement of images, watermarking, morphological operations, and restoration process and so on. The most important advantage of edge detection is that it reduces the bulky data in an image, upholding the structural attributes for further processing. The introduction of multi-sensory image fusion techniques have pointed towards a new dimension of research work in edge detection process. This chapter of the research work illustrates the development and implementation of some novel edge detection techniques using image fusion algorithms.

A. Crack Detection Using Image Fusion

Since last few decades, Non Destructive Technique (NDT) has been concerning field of research for quality evaluation of civil structures, aerospace engineering and industrial products. In civil structures, the typical foundation crack will run vertically or at an angle. Although human operator based crack detection methods have successfully illustrated that by manually tracking the start and end of a crack, one can use pixel-based algorithms to define the crack characteristics. Many literatures concerning tracking of defects in civil structures are unable to identify the crack edges accurately due to poor contrast, uneven illumination and noisy environment. Complications due to the inherent noise in the scanning process, irregularly shaped cracks, as well as wide range of background patterns are also challenges for error free detection in camouflaged environment. Therefore a new crack detection technique is required which is based on Non Destructive Evaluation (NDE) along with some efficient edge detection algorithms and an efficient image fusion technique to combat contrast, noise sensitivity and uneven illumination. Since more than 25 years, so many systems have been developed which basically deals with detection of linear features on optic imaging. Basically it has been tried to combine a local criterion using evaluating radiometry and a global criterion using wide scale knowledge for edges to be detected. In many cases local criterion are insufficient in detecting very fine crack edges. Some classical gradient-magnitude (GM) methods are usually dependent on edge strength; hence, weaker edges due to texture may not be detected. An alternative method for detecting edges regardless of their magnitude is being proposed . It is based on the computation of the cosine of the projection angles between neighbourhoods and predefined edge filters. So it is otherwise known as an angle-based (AN) method. But this technique is very sensitive to noise and uneven illumination. Local thresholding of image gradients are also sensitive to uneven illumination since they inhibit low luminance regions. The improved method based on phase congruency described the frequency domain image representation. Since an edge exists near points of maximum phase congruency, such methods are invariant towards uneven illumination and low contrast. Due to the use of the log polar Gabor filter, they produce poorer edge localization in those false edges and are detected in the vicinity of sharp transitions. A contrast invariant edge detection method based on the Helmholtz principle describes edges as geometric structures with large deviations from randomness; but, sensitive to the window size and edge localization. The other filter projected by Marr and Hildreth suffers from the problems affined to zero-crossing approach. This approach is basically undeviating in edge localization, provided these are properly separated when the SNR in the image is high. Again the localization of the real edge dislodges for a bounded width staircase steps. The secondary issue is related to the identification of false edges. Laplacian of Gaussian filter also can’t deal with the missing edges. However, merging Laplacian of Gaussian filtering and zero crossing approach is a unmanageable job. Because, an edge does not cope with a zero crossing for very confined number of steps. A robust edge detection algorithm produces superior result than the methods discussed above. This method basically emphasizes on optimizing two of Canny’s criteria- accurate edge detection and localization, without explicitly including the third criterion i.e. minimal response.

B. Crack detection technique

We have a model for an efficient and reliable crack detection, which combines the best features of canny edge detection algorithm and Hyperbolic Tangent filtering technique using an efficient Max-Mean image fusion rule. Here the detection architecture consists of the some major steps as follows:

1) Acquisition of concerned wall image.
2) Crack detection using two efficient algorithms.
3) Wavelet decomposition and Fusion.

The algorithm is shown in Fig.4.1.2

C. Concerned Wall Image

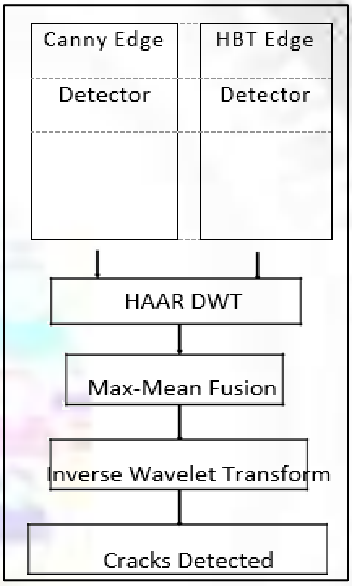

Fig. 4: Proposed crack detection algorithm

IV. RESULT & DISCUSSION

The image fusion technique is used here to find out the minerals in the located satellite image

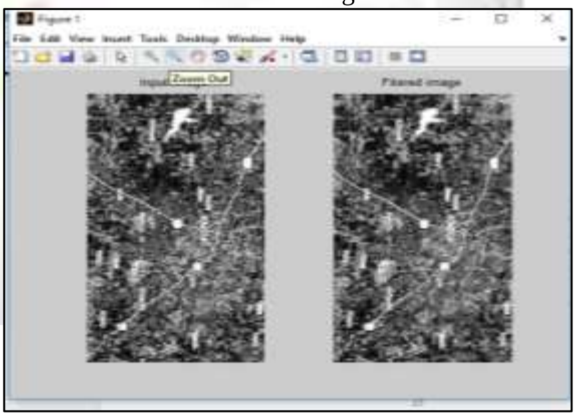

Fig. 5.1: Input images

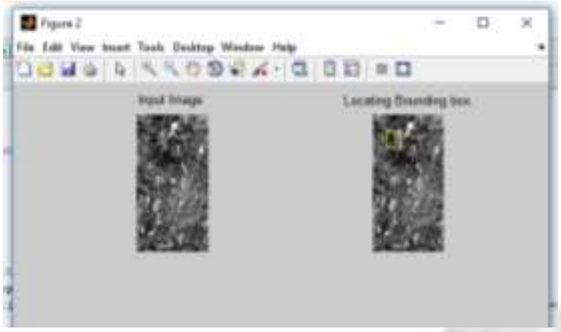

Fig. 5.2: First stage simulation

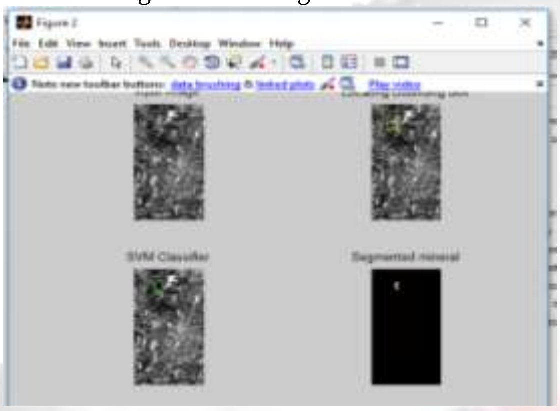

Fig. 5.3: final simulated image

The image fusion technique is used here to find out the minerals in the located satellite image

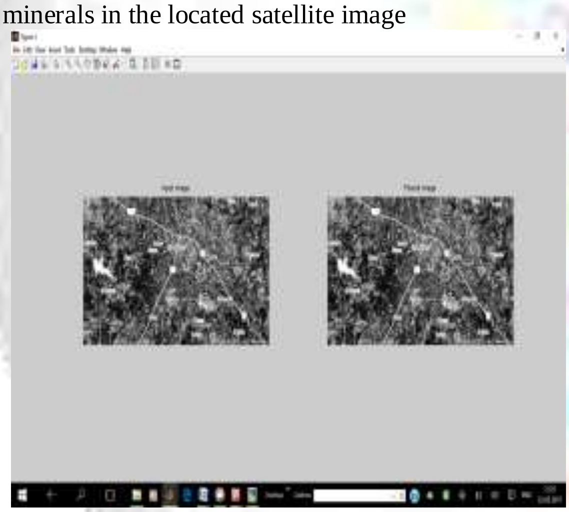

Fig. 5.4: First stage simulation

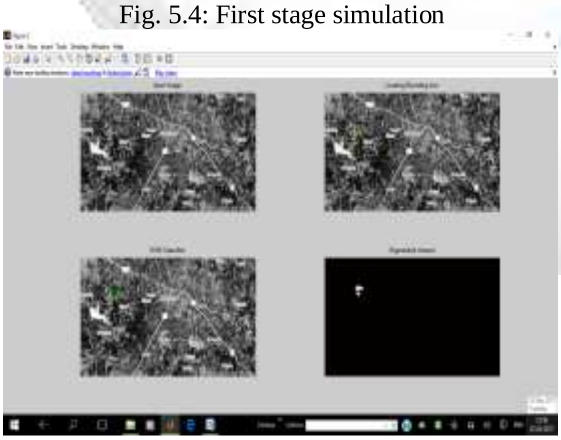

Fig. 5.4: Final stage simulation

V. CONCLUSION & FUTURE SCOPE

In this research work, attention was drawn towards the current trend of the use of multi resolution image fusion techniques, especially approaches based on discrete wavelet transforms and Dual Tree Complex Wavelet Transforms. The work started with the review of several image fusion algorithms and their implementation. The significance of image fusion in edge detection has been illustrated with some proposed techniques in chapter-3. A novel crack detection technique has been proposed here, which is based on two efficient crack detection algorithms along with an efficient image fusion by means of Haar discrete wavelet transform. The Normalized Absolute Error also gets reduced. Finally, the smoothness parameter should be taken relatively high value to decrease the slope of the filter function reducing the oscillations of the filter response function in the time domain.

Edge detection in multi-focus images has been one of the challenging tasks due to severe blurring effects. The proposed fusion technique compensates all the shortcomings of Discrete Wavelet Transform by the implementation of Q-shift DT-CWT. It also removes the ringing artefacts introduced in the fused image by assigning suitable weighting schemes to high pass wavelet coefficients and low pass coefficients independently.

VI. FUTURE SCOPE

Image Registration has significant contribution towards the enhancement of image fusion quality. Image Registration has not been incorporated in this research work. By the Implementation of suitable image registration techniques, the competitiveness of the proposed image fusion methods can be properly justified with some more set of sample test/perfect images.

The number of decomposition levels in the Multi resolution analysis has a great impact on image fusion performance. However, using more decomposition levels do not necessarily implies better results. Therefore methods for selection of optimized number of decomposition levels can be explored.A learning algorithm like neural networks and more specifically Support Vector Machine could be devised for assigning weightage to the image quality metrics so as to assess them. A more extensive number of image sets could be considered initiating a learning process using SVM, based on which the metrics could be provided with weighted ranks.The final aspect in future development and improvement is how to estimate and evaluate the quality of afused image. As we have discussed in the previous chapter, depending on the applications, some fusion system might not have a perfect ground truth reference image for objective evaluation. Therefore, access methods without reference image are important for our concern in multi-camera imaging system.

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