Review of Feature Selection and Optimization of Image Fusion Using Wavelet Transform and Heuristic Function

Pooja Malviya¹ Prof.Amit Saxena²

Department of Computer Science & Engineering¹,²
Truba Institute of Engg & Information Technology, Bhopal, India

Abstract

Feature selection and optimizations of selected feature is very important process for quality improvement of image fusion technique. Image fusion technique compromised various methods of wavelet transform function and heuristic function for quality improvement. Wavelet well knowns method for data processing in image fusion. The process of wavelet data in fusion technique needs some optimization process. The optimization process gives optimal feature for fusion process.

In this paper discuss various method of image fusion technique based on wavelet transform function and heuristic function. Heuristic is artificial searching technique used for optimal feature selection such as genetic algorithm, ant colony optimization and particle of swarm optimization. Here we also discuss some standard method result for image fusion. Our empirical result shows the continuous improvement is required for image fusion process.

Keywords: - image fusion, wavelet transforms, heuristic function

I. INTRODUCTION

The continuous development of multi-media knowledge, user have more and more ways to obtain images, and the image fusion types are also gradually more well-to-do, such as the Image fusion of same category of image. Traditional data fusion can be divided into three levels, which are pixel-level fusion, feature-level fusion and decision-level fusion. The different fusion levels use different fusion algorithms and have different applications, usually, all research the lower-level fusion [1,5]. Classical fusion algorithms include computing the average pixel-pixel gray level value of the source images. Feature-level fusion is intermediate level, it is to carry out feature extraction for the original information of the various images, and then comprehensively analyze and process the feature information. In general, the extracted feature information should be a sufficient statistic of the pixel information, and then multi-image data will be classified, collected and integrated according to the feature information. If the data the multimedia obtained is image data, then the feature is abstractly extracted from the image pixel information, and the typical feature information has cable type, edge, texture, spectrum, similar brightness area, similar depth of field areas, etc.

In this paper discusses various method of image fusion which are pixel gray level value of the source images. The process of wavelet data in fusion technique needs some optimization process. The optimization process gives optimal feature for fusion process.

In this section discuss related work to image fusion. In section II we describe related work of image fusion. In section III image fusion methods. In section IV discuss some experimental result of image fusion and finally conclude in section V.

II. RELATED WORK

In this section describe some related work to image fusion based on feature selection method using wavelet transform function and heuristic function. The feature selection method for image fusion is intermediate steps along with fused process.

[1] Authors used the high frequency coefficients of transform function; the regional edge intensities of each sub-image are calculated to realize automated fusion. The low occurrence value choosing is based on boundary of images, so that the fused image can protect all useful information and appear visibly. The edge and contour of the image target region is important, in the image, different edge represent boundaries of different component of image. The proposed fusion algorithm of multi-modality image based on DWT. This method prevent the average in fused proceeding, extract abundant information, important features and boundary information from source images.
Algorithms were proposed to compress the image. The result will be based on data assimilation and genetic algorithm for image fusion. This matrix is divided into four parts: approximation coefficient occupying the top left quarter of the matrix, diagonal coefficients occupying the bottom right quarter, and the diagonal coefficients occupying the top right quarter of the matrix. After DWT is introduced, several codec algorithms were proposed to compress the transform coefficients as much as possible. Among them, Embedded Zerotree Wavelet (EZW), Set Partitioning In Hierarchical Trees (SPIHT) and Embedded Bock Coding with Optimized Truncation (EBCOT) are the most famous ones. The embedded zero tree wavelet algorithm (EZW) is a simple, yet remarkably effective image fusion algorithm, having the property that the bits in the bit stream are generated in top-right quarter of the matrix and the diagonal coefficients occupying the bottom-right quarter of the matrix. After DWT was introduced, several codec algorithms were proposed to compress the image.

[2] Authors describe noised image fusion using Dual-tree Complex Wavelet Transform (DT-CWT). Complex wavelet transform is complex valued extension of the standard wavelet. The real 2-D dual-tree DWT of an image is implemented using two critically-sampled separable 2-D DWTs in parallel. Then for each pair of sub-bands we take the sum and difference. The complex 2-D DT-DWT also gives rise to wavelets in six distinct directions. The complex 2-D dual-tree is implemented as four critically-sampled separable 2-D DWTs operating in parallel as structure needs four trees for analysis and for synthesis.

[3] Authors used rule based technique for image fusion using Pixel level rules may reduce the contrast in some images and does not always succeed in effectively removing ringing and noise in source images. The inadequacies of these types of fusion rules point to the importance of developing a Hybrid algorithm to improve the visual quality by combining the advantages of four pixel based methods. The proposed Hybrid Image Fusion method is based on Pixel level image Fusion methods. These methods are basically based on various standards Pixel level fusion rules. Combination of various fusion rules is done to get better quality final fused image. Here the image fusion techniques used are based on wavelet transformation. First level and second level decomposition of original image is based on Discrete Wavelet Transformation

[4] Authors used data assimilation conception in meteorological image fusion. It means that observation data and numerical simulation data are integrated to obtain more nature point analysis results. The framework of fusion based on data assimilation and genetic algorithm for multispectral and panchromatic image was present. In the framework, Weights of indices of the various attributes were determined according to their important degree in the following processing. Data assimilation can combine the advantage of model operator and observe operator. Method can integrate the advantages of DWT and HIS, construct object function according to successive application to satisfy the aim of adaptively adjustment of fusion parameters.

[5] Authors used image fusion technique for image retrieval method based on multi-feature similarity score fusion using genetic algorithm. Single feature describes image content only from one point of view, which has a certain one-sided. Fusing multi-feature similarity score is expected to improve the system's retrieval performance. For the purpose of assigning the fusion weights of multi-feature similarity scores reasonably, the genetic algorithm is applied. They are image retrieval based on color feature, texture feature and fusion of color-texture feature similarity score with equal weights.

III WAVELET TRANSFORMS FUNCTION

Wavelet transform (WT) represents an image as a sum of wavelet functions (wavelets) with different locations and scales. Any decomposition of an image into wavelets involves a pair of waveforms: one to represent the high frequencies corresponding to the detailed parts of an image (wavelet function \( \psi \)) and one for the low frequencies or smooth parts of an image (scaling function \( \phi \)). The Discrete wavelet transform (DWT) has gained wide popularity due to its excellent decorrelation property, many modern image and video fusion systems embody the DWT as the transform stage. It is widely recognized that the 9/7 filters are among the best filters for DWT-based image fusion. In fact, the JPEG2000 image coding standard employs the 9/7 filters as the default wavelet filters for fusion and 5/3 filters for lossless fusion. The performance of a hardware implementation of the 9/7 filter bank (FB) depends on the accuracy with which filter coefficients are represented. Lossless image fusion techniques find applications in fields such as medical imaging, preservation of artwork, remote sensing etc. Day-by-day Discrete Wavelet Transform (DWT) is becoming more and more popular for digital image fusion. Biorthogonal (5, 3) and (9, 7) filters have been chosen to be the standard filters used in the JPEG2000 codec standard. Discrete wavelet transform as reported by Zervas et al., there are three basic architectures for the two-dimensional DWT: level-by-level, line-based, and block-based architectures. In implementing the 2-D DWT, a recursive algorithm based on the line based architectures is used. The image to be transformed is stored in a 2-D array. Once all the elements in a row are obtained, the convolution is performed in that particular row. The process of row-wise convolution will divide the given image into two parts with the number of rows in each part equal to half that of the image. This matrix is again subjected to a recursive line-based convolution, but this time column-wise. The result will DWT coefficients corresponding to the image, with the approximation coefficient occupying the top-left quarter of the matrix, horizontal coefficients occupying the bottom-left quarter of the matrix, vertical coefficients occupying the top-right quarter of the matrix and the diagonal coefficients occupying the bottom-right quarter of the matrix.
transform coefficients as much as possible. Among them, Embedded Zero tree Wavelet (EZW), Set Partitioning In Hierarchical Trees (SPIHT) and Embedded Bock Coding with Optimized Truncation (EBCOT) are the most famous ones. The embedded zerotree wavelet algorithm (EZW) is a simple, yet remarkably effective image fusion algorithm, having the property that the bits in the bit stream are generated in order of importance, yielding a fully embedded code. A discrete wavelet transform or hierarchical sub band decomposition. 2) Prediction of the absence of significant information across scales by exploiting the self – similarity inherent in images. 3) Entropy-coded successive-approximation quantization, and 4) Universal lossless data fusion which is achieved. In the optimization technique of fusion, there is limited number of studies employing heuristics in quantization or thresholding of the coefficients. Moore introduced an approach based on genetic algorithm (GA) that evolves coefficients instead of wavelet transform \[18]\]. An inverse wavelet transform is calculated by the coefficients produced by GA and then the compressed signals are generated. Mean square error (MSE) values of the compressed signals and the original signals in the set are used by GA to update the coefficients. Chen et al. used Particle Swarm Optimization (PSO) algorithm to find a global threshold and a step size to reach a target bit rate \[19]\. Kaur et al. jointly optimizes the best-basis selection, coefficient thresholding and quantizes selection within the minimum description length (MDL) framework to develop a wavelet packet image coder \[8\]. Ye et al. proposed a method based on PSO algorithm to enhance the quality of the compressed images \[20\]. Artificial Bee Colony (ABC) \[5\] algorithm is an optimization algorithm which simulates the foraging behaviour of honey bees. The algorithm is a promising tool for optimizing various unconstrained and constrained optimization problems \[21\], \[22\]. In this paper, ABC algorithm is used to solve the fusion problem which can be considered as multi-objective since there is a trade-off between high fusion rate and high quality.

IV EXPERIMENTAL RESULT ANALYSIS

In this section some of experimental results of our work on wavelet based Image Fusion are discussed. Input image database is taken in different environment through a digital camera; the multi focused environment is generated using different light effects. In the proposed hybrid method, first wavelet decomposition of the input source images is performed up to level second level using discrete wavelet transform.

Evaluation criteria for image fusion

Objective image quality measures play an important role in various image processing applications. There are different types of object quality or distortion assessment approaches. The fused images are evaluated, taking the following parameters into consideration.

Root Mean Square error (RMSE)

The root mean square error (RMSE) between each unsharpened MS band and corresponding sharpened band can also be computed as a measure of spectral fidelity. It measures the amount of change per pixel due to the processing.

The RMSE between a reference image R and the fused image F is given by

\[
E_1 = \sqrt{\frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} (R(i,j) - F(i,j))^2}
\]

There are different approaches to construct reference image using input images. In our experiments, we used the following procedure to compute RMSE. First, RMSE value $E_1$ is computed between source image A and fused image F.

\[
E_1 = \sqrt{\frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} (I1(i,j) - F(i,j))^2}
\]

Similarly $E_2$ is computed as RMSE between source image B and fused image F.

\[
E_2 = \sqrt{\frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} (I2(i,j) - F(i,j))^2}
\]

Then the overall RMSE value is obtained by taking the average of $E_1$ and $E_2$.

\[
RMSE = \frac{(E1+E2)}{2}
\]

Smaller RMSE value indicates good fusion quality. Peak Signal to Noise Ratio PSNR can be calculated by using the formula

\[
PSNR = 20 \log_{10} \left[ \frac{L^2}{MSE} \right]
\]

Where MSE is the mean square error and L is the number of gray levels in the image.

Image Quality Index IQI measures the similarity between two images (I1 & I2) and its value ranges from -1 to 1. IQI is equal to 1 if both images are identical. IQI measure is given by

\[
IQI = \frac{m_{ab}}{m_a m_b} \frac{2xy}{x^2 + y^2} \frac{2m_a m_b}{m_a^2 + m_b^2}
\]

Where x and y denote the mean values of images I1 and I2 and , , and denotes the variance of I1 , I2 and covariance of I1 and I2.
Mutual Information

Mutual Information (MI) measures the degree of dependence of two images. Its value is zero when I1 and I2 are independent of each other. MI between two source images I1 and I2 and fused image F is given by

$$MI = \sum_{(f,a)} P_{FA}(f,a) \log_2 \frac{P_{FA}(f,a)}{P(f)P_A(a)} + \sum_{(f,b)} P_{FB}(f,b) \log_2 \frac{P_{FB}(f,b)}{P(f)P_B(b)}$$

and PA(a), PB(b) and PF(f) are histograms of images A, B and F, PFA(f,a) and PFB(f,b) are the joint histograms of F and A, and F and B respectively. Higher MI value indicates good fusion results.

<table>
<thead>
<tr>
<th>METHOD</th>
<th>IQI</th>
<th>MI</th>
<th>RMSE</th>
<th>PSNR</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCT</td>
<td>0.9851</td>
<td>1.1293</td>
<td>12.3288</td>
<td>26.3124</td>
</tr>
<tr>
<td>WT</td>
<td>0.9468</td>
<td>1.0042</td>
<td>20.6849</td>
<td>21.8177</td>
</tr>
</tbody>
</table>

Table 1 shows that comparative result analyses of transform function with optimization technique.

**V CONCLUSION AND FUTURE WORK**

They are various method of fusing images. We have compared the regular image fusion techniques with the Genetic Algorithm based techniques. It can be seen from the above table and the image results that the GA based techniques are having much better results when compared with the conventional techniques. Two Genetic Algorithm based image fusion algorithms are introduced and their objective and subjective comparison with other classical techniques is carried out. It is concluded from experimental results that GA based image fusion schemes perform better than existing schemes.

**REFERENCES:**


[9] Special Issue on Recent Advances in System Applications and Methods of Data Management 2010 ACADEMY PUBLISHER.

[10] Dr. V. T. Ingle, Prof. C. N. Deshmukh, Mrs. Anjali Joshi, Mr. Deepak Shete” MEDICAL IMAGE REGISTRATION USING GENETIC ALGORITHM” 978-0-7695-3884-6/09 2009 IEEE.