Effigy Melding and its Applications

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Abstract— **Effigy melding 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. The image fusion is use to integrate complementary information from multisensor data such that the new images are more suitable for the purpose of human visual perception and computer-processing tasks such as segmentation, feature extraction, and object recognition. 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. The image fusion techniques allow the integration of different information sources. The fused image can have complementary spatial and spectral resolution characteristic**s.

Image fusion techniques can improve the quality and increase the application of these data. However, the standard image fusion techniques can distort the spectral information of the multispectral data while merging.
Image fusion method can be broadly classified into two groups:
1.Spatial domain fusion method
2.Transform domain fusion

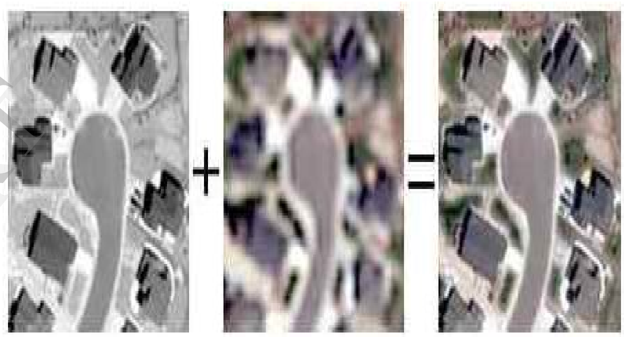
Keywords—IHS, PCA, Brovey, pyramid, Wavelet

I. INTRODUCTION

EFFIGY MELDING refers to the acquisition, processing and synergistic combination of information provided by various EFFIGYs or by the same EFFIGY from many measuring contexts. With the development of multiple types of biosensors, chemical sensors, and remote sensors on satellites, more and more data have become available for scientific researches. As the volume of data grows, so does the need to combine data gathered from different sources to extract the most useful information. EFFIGY MELDING has gained considerable attention in recent years, where it can provide remarkable outputs for many EFFIGY applications (i.e., detection of hidden objects).

EFFIGY MELDING is basically a process of combining EFFIGYs of different wavelengths simultaneously viewing of the same scene, to form a composite EFFIGY. The composite EFFIGY is formed to improve EFFIGY content and to make it easier for the user to detect, recognize, and identify targets and increase his situational awareness. The mainly area in EFFIGY MELDING is developing MELDING algorithms that improves the information content of the composite EFFIGYry, and for making the system robust to the variations in the scene.

The goal of EFFIGY MELDING is obtain information of greater quality which may consist of a more accurate description of the scene than any of the individual source EFFIGYs. Simple EFFIGY MELDING shown in figure.



EFFIGY from first sensor + EFFIGY from second sensor = Melded EFFIGY

Fig.1.1 Effigy Melding

II. MELDING DECOMPOSITION APPROACHES

The notion of multiresolution analysis was initiated by Burt and Adelson who introduced a multiresolution EFFIGY representation, called Gauss-Laplacian pyramid. Their underlying idea is to decompose an EFFIGY into a set of band-pass filtered component EFFIGYs, each of which represents a different band of spatial frequency. This idea was further elaborated by other researchers such as Mallat and Meyer, to establish a multiresolution analysis for continuous functions in connection with wavelet transformation. There are two approaches of MELDING decompositions namely: Wavelet Approach and Pyramid Approach.[1]

A. Wavelet Approach

The wavelet transform is a signal analysis tool that provides a multi-resolution decomposition of an EFFIGY and results in a non-redundant EFFIGY representation. This basis is called wavelets.

Wavelet transform can be applied to EFFIGY decomposition and reconstruction .Wavelet transform allows the EFFIGY decomposition in different kinds of coefficients preserving the EFFIGY information. The coefficients coming from different EFFIGYs can be appropriately integrated to get new coefficients, so that the information in the original EFFIGYs is collected appropriately. Therefore, wavelet transform is suitable for performing data MELDING tasks.

B. Pyramid Approach

The data structure used to represent EFFIGY information can be critical to the successful completion of an EFFIGY processing task. One structure that has attracted considerable attention is the EFFIGY pyramid. This consists of a set of low pass or band pass copies of an EFFIGY, each representing pattern information of a different scale. Typically, in an EFFIGY pyramid every level is a factor two smaller as its predecessor, and the higher levels will concentrate on the lower spatial frequencies. Most of the work revolves around a representation known as a "pyramid," which is versatile, convenient, and efficient to use. We have applied Convolution is the basic operation of most EFFIGY analysis systems, and convolution with large weighting functions is anotoriously expensive computation. In a multiresolution system one wishes to perform convolutions with kernels of many sizes, ranging from very small to very large. and the computational problems appear forbidding. Therefore one of the main problems in working with multiresolution representations is to develop fast and efficient techniques. Members of the Advanced EFFIGY Processing Research Group have been actively involved in the development of multiresolution techniques for some time. Most of the work revolves pyramid-based methods to some fundamental problems in EFFIGY analysis, data compression, and EFFIGY manipulation.

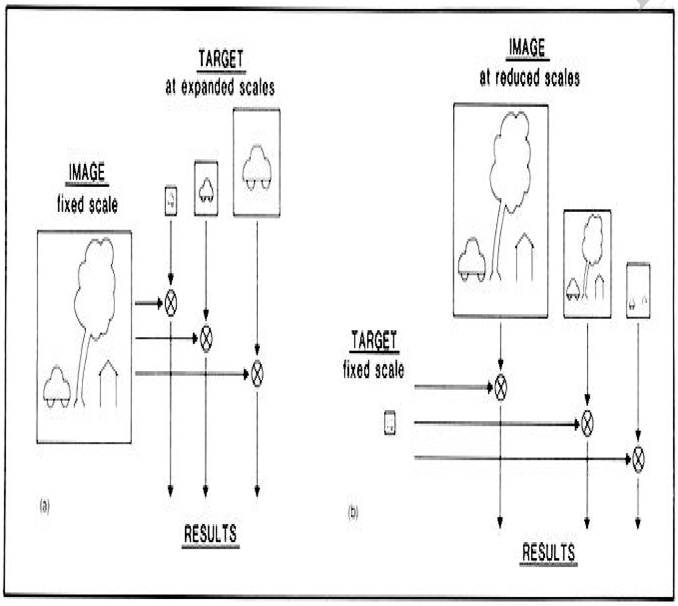


Fig 2.1.Pyramid Approach

a. The Gaussian pyramid:

It consists of a sequence of copies of an original EFFIGY in which both sample density and resolution are decreased in regular steps. An example is shown in Figure. These reduced resolution levels of the pyramid are themselves obtained through a highly efficient iterative algorithm. The bottom, or zero level of the pyramid, $G0$, is equal to the original EFFIGY. This is low pass- filtered and subsampled by a factor of two to obtain the next pyramid level, $G1$. $G1$ is then filtered in the same way and subsampled to obtain $G2$. Further repetitions of the filter/subsample steps generate the remaining pyramid levels. Because of this resemblance to the Gaussian density function we refer to the pyramid of low pass EFFIGYs as the "Gaussian pyramid." Gaussian pyramid could have been obtained directly by convolving a Gaussianlike equivalent weighting function with the original EFFIGY, each value of this bandpass pyramid could be obtained by convolving a difference of two Gaussians with the original EFFIGY.

Fig 2.2.The Gaussian pyramid

b. Laplacian pyramid

before that level is subtracted from the next-lower level. Interpolation can be achieved by reversing the REDUCE process. An important property of the Laplacian pyramid is that it is a complete EFFIGY representation: the steps used to construct Band pass, rather than low pass, EFFIGYs are required for many purposes. These may be obtained by subtracting each Gaussian (low pass) pyramid level from the next lower level in the pyramid. Because these levels differ in their sample density it is necessary to interpolate new sample values between those in a given level the pyramid may be reversed to recover the original EFFIGY exactly. A Laplacian pyramid representation was constructed for this EFFIGY, then the values were quantized to reduce the effective data rate to just one bit per pixel, then to one-half bit per pixel. EFFIGYs reconstructed from the quantized data.

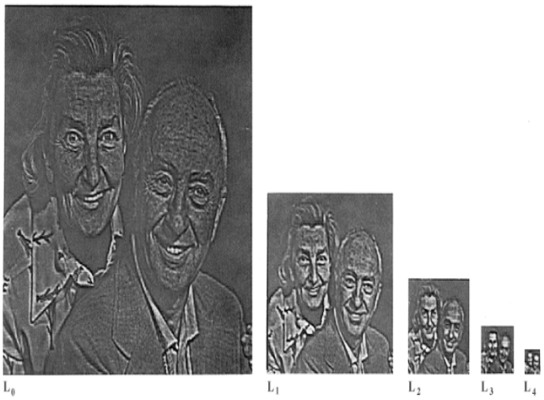


Fig 2.3.Laplacian pyramid

C. Low Pass Pyramid:

In this the EFFIGY is passed through low pass filter. Pyramid methods may be applied to analysis in several ways.All levels of the pyramid combined contain just one third more nodes than there are pixels in the original EFFIGY. Thus the cost of searching for a pattern at many scales is just one third more than that of searching the original EFFIGY alone. The complexity of the patterns that may be found in this way is limited by the fact that not all EFFIGY scales are represented in the pyramid. As defined here, pyramid levels differ in scale by powers of two, or by octave steps in the frequency domain. Power-of-two steps are adequate when the patterns to be located are simple, but complex patterns require a closer match between the scale of the pattern as defined in the target array, and the scale of the pattern as it appears in the EFFIGY. Variants on the pyramid can easily be defined with squareroot-of-two and smaller steps. However, these not on]y have more levels, but many more samples, and the computational cost of EFFIGY processing based on such pyramids is correspondingly increased. a nonlinear intensity transformation is performed on each sample value.

Fig 2.4 . Low Pass Pyramid

D. PYRAMID DATA COMPRESSION

The pyramid representation also permits data compression. Although it has one third more sample elements than the original EFFIGY, the values of these samples tend to be near zero, and therefore can be represented with a small number of bits. Further data compression can be obtained through quantization: the number of distinct values taken by samples is reduced by binning the existing values. This results in some degradation when the EFFIGY is reconstructed, but if the quantization bins are carefully chosen; the degradation will not be detectable by human observers and will not affect the performance of analysis algorithms.

FIG.2.5 PYRAMID DATA COMPRESSION

III. EFFIGY MELDING TECHNIQUES

The process of EFFIGY MELDING the good information from each of the given EFFIGYs is fused together to form a resultant EFFIGY whose quality is superior to any of the input EFFIGYs.

A. Spatial domain MELDING method

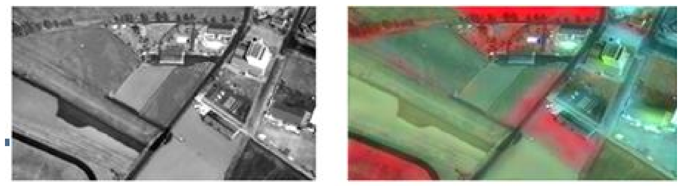


Fig.3.1 Filtered Image and Melded Image

IV. TRANSFORM DOMAIN MELDING TECHNIQUE:

Spatial distortion can be very well handled by frequency domain approaches on EFFIGY MELDING. The multi resolution analysis has become a very useful tool for analyzing remote sensing EFFIGYs. The discrete wavelet transform has become a very useful tool for MELDING. Some other MELDING 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

EFFIGY compared to other spatial methods of MELDING. Wavelets decomposes the EFFIGY into low-high, high-low, high-high spatial frequency bands at different scales and the low –low band at the coarsest scale contains average EFFIGY information[4].

IV METHODS OF EFFIGY MELDING

A. Intensity-hue-saturation (IHS) transform based MELDING:

Intensity-hue-saturation (IHS) transform based MELDING: The detail study indicates that color distortion problem arises from the change of saturation during MELDING process. To understand the color distortion during the EFFIGY MELDING process it is necessary to understand two essential conversions which are RGB-IHS conversion and vice versa. The use of IHS technique in EFFIGY MELDING is based on one principle: the replacement of one of the three components (I, H or S) of one data set with another EFFIGY. Most commonly the intensity channel is substituted .The IHS colour transformation effectively separates spatial (I) and spectral (H, S) information from a standard RGB EFFIGY. It relates to the human colour perception parameters. The mathematical context is expressed by following equation:

$$\begin{bmatrix} I \\ v1 \\ v2 \end{bmatrix} = \begin{bmatrix} 1/3 & 1/3 & 1/3 \\ -\sqrt{2}/6 & -\sqrt{2}/6 & 2\sqrt{2}/6 \\ 1/\sqrt{2} & -1/\sqrt{2} & 0 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

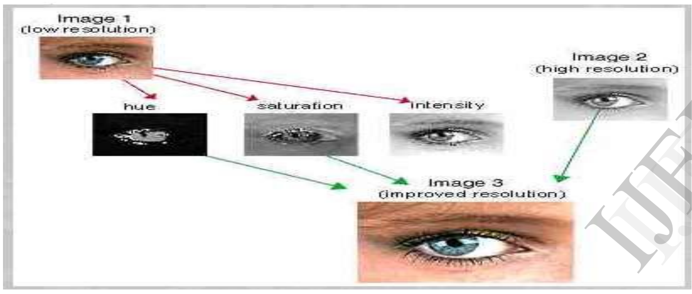


Fig 4.1. Intensity-hue-saturation (IHS)

Step 1:"IHS transformation"

RGB EFFIGY -> HSI

Step 2: Hue, Saturation, Intensity

Step 3: The intensity channel is replaced by the high res (PAN) channel and the transformation is reversed: HIS -> RGB

B. Principal component analysis (PCA) based MELDING:

PCA is a mathematical tool which transforms a number of correlated variables into a number of uncorrelated variables. The PCA is used extensively in EFFIGY compression and EFFIGY classification. The PCA involves a mathematical procedure that transforms a number of correlated variables into a number of uncorrelated variables called principal components. It computes a compact and optimal description of the data set. The first principal component accounts for as much of the variance in the data as possible and each succeeding component accounts for as much of the remaining variance as possible. First principal component is taken to be along the direction with the maximum variance. The second principal component is constrained to lie in the subspace perpendicular of the first. Within this Subspace, this component points the direction of maximum variance. The third principal component is taken in the maximum variance direction in the subspace perpendicular to the first two and so on. The PCA is also called as Karhunen-Loève transform or the Hotelling transform.

C. Brovey Transformation:

The Brovey Transformation is the simple EFFIGY MELDING method that preserves the relative spectral contribution of each pixel but replace its overall brightness with high resolution parachromatic EFFIGY. Different arithmetic combinations have been developed for EFFIGY MELDING. The basic procedure of the Brovey Transform first multiplies each MS band by the high-resolution Pan band, and then divides each product by the sum of the MS bands:

newR = Pan*R / (R+G+B)

newG = Pan*G / (R+G+B)

newB = Pan*B / (R+G+B)

Changes are automatically detected in buildings, building structures, roofs, roof color, industrial structures, smaller vehicles, and vegetation. Brovey transformation MELDING method was used.

D. Wavelet Transform MELDING Method:

A mathematical tool developed originally in the field of signal processing can be applied to fuse EFFIGY data following the concept of the multiresolution analysis (MRA).

Wavelet transform is based on a Multi-Resolution Analysis (MRA), because it is well suited to manage the different EFFIGY resolutions. The wavelet transform creates a summation of elementary functions (=wavelets) from arbitrary functions of finite energy. The weights assigned to the wavelets are the wavelet coefficients which play an important role in the determination of structure characteristics at a certain scale in a certain location. Wavelets are finite duration oscillatory functions with zero average value.

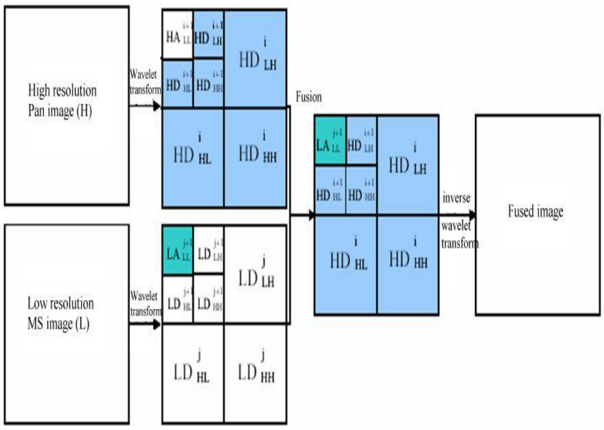


Fig.4.2 Wavelet based EFFIGY MELDING

E. High Pass Filter Method:

High Pass Filter (HPF) method can extract high frequency components, i.e. spatial detail, from the panchromatic EFFIGY by using spatial High Pass Filter, then the spatial detail is injected into the low-resolution multi-spectral EFFIGY, so as to produce a fused EFFIGY with sharp high frequency characteristics. The HPFA technique has been optimized using a wide variety of test EFFIGYs. The HP filter and the injection parameters were initially determined by visually assessing and comparing the MELDING results.

F. Averaging Method

A simple approach for MELDING, based on the assumption of additive Gaussian noise, consists of synthesizing the fused EFFIGY by averaging corresponding pixels of the sensor EFFIGYs. Averaging should work well when the EFFIGYs to be fused are from the same type of sensor and contain additive noise only. If the variance of noise in sensor EFFIGYs is equal then averaging them reduces the variance of noise in the fused EFFIGY according to the error propagation law.

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