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INTERNATIONAL CONFERENCE of SCIENTIFIC PAPER
AFASES 2013
Brasov, 23-25 May 2013

IMAGE FUSION BASED ON WAVELET TRANSFORM

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Abstract: *Image fusion is based on a series of methods in order to integrate images from more of one sensor in to one image, more suitable for human eye or computer sequential processing. This article presents few theoretical methods for image fusion. The results of experimental image fusion, using algorithms developed by the research team revealed advantages like increase of spectral domain, and difficulties regarding image fusion process.*

Keywords: *image, fusion, transform, wavelet, Haar.*

1. INTRODUCTION

In nature, the concept of multisensor data fusion is hardly new. Humans and animals have evolved the capability to use multiple senses to improve their ability to survive. For example, it may not be possible to assess the quality of an edible substance based solely on the sense of vision or touch, but evaluation of edibility may be achieved using a combination of sight, touch, smell, and taste. Thus multisensor data fusion is naturally performed by animals and humans to achieve more accurate assessment of the surrounding environment and identification of threats, thereby improving their chances of survival.[1]

2. DEFINITION OF FUSION

With the development of multiple types of biosensors, chemical sensors, and remote sensors on board 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 useful information. Since early 1990's, "Data fusion" has been adopt and widely used. The definition of data fusion/image fusion varies:

- Data fusion is a process dealing with data and information from multiple sources to achieve refined/improved information for decision making (Hall 1992) [1];
- Image fusion is the combination of two or more different images to form a new image by using a certain algorithm (Genderen and Pohl 1994) [3];
- Image fusion is the process of combining information from two or more images of a scene into a single composite image that is more informative and is more suitable for visual perception or computer processing. (Guest editorial of Information Fusion, 2007) [4].
- Image fusion is a process of combining images, obtained by sensors of different wavelengths simultaneously viewing of the same scene, to form a composite image. The composite image is formed to improve image content and to make it easier for the user to detect, recognize, and identify targets and increase his situational awareness. 2010.[5]

Simultaneous with de recent developments in multisensor systems area used in different

domains like medicine (diagnostics), security, defense, the quantity of data available increased significant. Image fusion is an alternative for decreasing date information volume and extraction of most usefully information for source images.

Data generated from many sensors represent complementary information about surveyed region. Fusion give an efficient method to reduce the volume of data by creating compatible images with perception capability of human operator by completing image processing tasks like: image segmentation, object detection or target recognition.

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 either sensor. A prerequisite for successful in image fusion is the alignment of multi-sensor images.

Image fusion does not necessarily imply multi-sensor sources; fusion images can be obtained using one sensor, and can be used in application like intrusion detection. [10]

3. IMAGE FUSION PROCESS ARCHITECTURE

Data fusion technology for multisensor systems is rapidly evolving. There are a lot of research into the development of new algorithms and improvement the old ones for understanding how their will be use in methods of fusion for various applications. [1]

The most mature image fusion process is the processing of Level 1 (JDL model) using data from multi-sensor systems for detection and identification of various properties of different objects or entities. [1]

A special problem in the processing of Level 1 is the development of robust systems in terms of identification of the targets on the basis of the characteristics or attributes determined. Currently, object recognition is dominated by methods based on shapes that are used in relationship with a database of known objects.

Processing level 2 or 3 (JDL model) currently are not fully mature, the systems are being implemented in the state of prototype or experimental model stage. The main challenges in this area are represented by a set of rules or methods that provide support to the process of assessing the situation and threats. [1]

4. FUSION PROCESSES BASED ON WAVELET TRANSFORM

Discrete wavelet transform decompose the image into a set of coefficients which records image information and then can be combined in order to obtain fusion images. The key method for using the wavelet transform image fusion is the combining of coefficients to obtain high quality image. The simplest method is the use of fusion in the reconstruction process of the average image fusion coefficients fused images. [8]

According to [9], the fusion aim to obtain a high spatial resolution and also high quality spectral information of from two types of images provided by the sensors or to obtain high spatial resolution with a single spectral band.

The first discrete wavelet transform was invented by Alfred Haar for the case of an input represented by a string of 2^n numbers. Haar transform groups input values recorded using forward differences and sums. This process is repeated recursively grouping amounts to give the following scale. Finally, are determined 2^n-1 differences and a final sum.

Another intensively used transform is the Daubechies wavelet which is based on a recurrence relation that generates progressive functions, fine copy of mother wavelet, each resolution is two times lower than the previous one.

Other forms of discrete wavelet transform include Dual-Tree Complex Wavelet Transform, Newlan transform, wavelet transform complex etc

For Haar wavelet transform decomposition process can be represented using a decomposition tree (Figure 1).

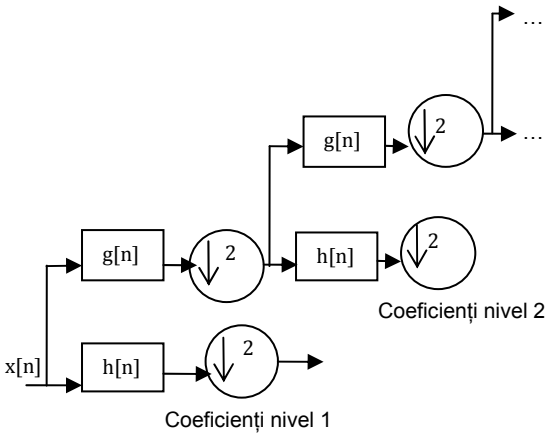

Figure1 Level 2 decomposition process

From the point of view of image processing algorithm, experimental results were obtained using it theory of Haar wavelet transform. Following the scheme presented in Figure 2, it can be separated into five sections: image data acquisition, image transformation, wavelet transform coefficients fusion, image inverse transformation and image display.

Analysis of the experimental results allowed drawing a series of conclusions regarding the ways of achieving fusion with emphasis on methods of combining decomposition and transform coefficients, with implications for the geometric approximation image and resolution and in the future research directions that involve the development of additional algorithms designed to improve the detection and identification of targets.

Geometric harmonization process is very important in order to obtain quality image fusion. It grows in complexity with fusion images structure differences and with objects representation. Reducing the complexity of the approximation can be made from the level sensors and related optical systems.

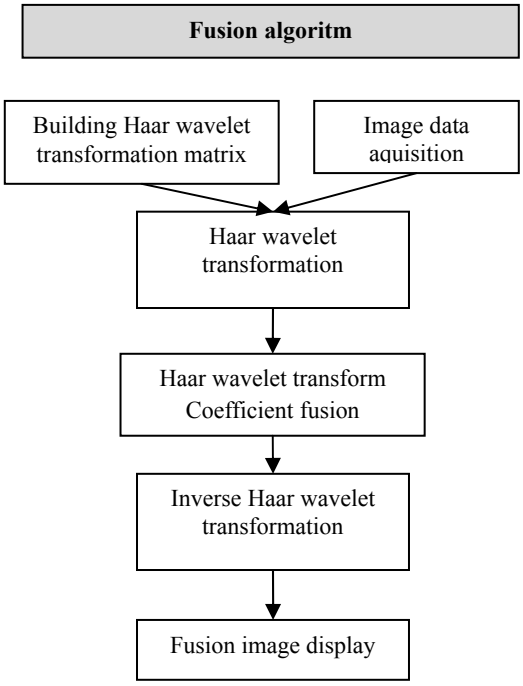

Figure 2 Image fusion algorithm

For high quality image fusion and to avoid errors in assessing the relative position between the constituent objects of the scene, it is necessary, before the fusion, the two images to be related from the point of view of the geometrical parameters. For considering geometric similarity are taken mainly three criteria: size, orthoscopy (likeness) and images alignment.

4. CONCLUSIONS

For observation and surveillance systems, image fusion quality requirements are not very high, detection and recognition of targets can be achieved also in case of imperfect representation overlapping of objects in different spectral ranges. For other applications such as medical diagnosis, aiming and tracking systems, mapping systems, is required a judicious harmonization of

geometric shapes to allow detection, recognition and identification with high accuracy. [10]

Experimental results analysis generated conclusions about method of fusion, focusing on methods of decompositions and combining for transform coefficients, with implications in image geometric preprocessing and resolution changes, and also about future research directions which involve development of supplementary algorithms for improving detection and identification.

In order to obtain high quality fusion images, is very important to preprocess geometrically the images for fusion. Preprocessing became more complex with the differences between structure and representation of the same object. Reduction of preprocessing can be made from the level of sensors and deserving optical systems. [10]

Using Haar wavelet transform has allowed, through an easy to use method, the study of fusion process in laboratory condition using unspecialized video/photo systems. The result were very important in the process of construction of an experimental and theoretical expertise from the point of view of signal processing, fusion algorithms construction and optical designing.

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