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Quality assessment parameters for iterative image fusion using Fuzzy and Neuro Fuzzy Logic and applications

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Abstract

Image fusion is a process to reduce ambiguity and diffusion while retrieving the valuable information from the original images. Image fusion is demanded for different contexts like remote sensing, medical imaging, machine vision and biometrics. In this paper, an iterative image fusion using fuzzy and neuro fuzzy logic approaches are used to fuse images taken from different sensors to enhance the perception. The proposed work also explores comparison among fuzzy based image fusion, iterative fuzzy fusion, neuro fuzzy logic based image fusion and iterative image fusion using neuro fuzzy logic techniques through quality assessment metrics for image fusion like image quality index, mutual information measure, fusion factor, fusion symmetry, fusion index, root mean square error, peak signal to noise ratio and spatial frequency. Experimental outcomes attained from proposed method prove that the use of the iterative fuzzy and iterative neuro fuzzy fusion can efficiently retain the illusory information while increasing the spatial information of the remote sensing and medical imaging.

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Keywords: fusion factor; fusion index; fuzzy logic;fusion symmetry; image quality inde; mutual information measure; neuro fuzzy logic; peak signal to noise rati;, root mean square error; spatial frequency.

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1. Introduction

A two-stage image fusion method for enhanced through-the-wall radar target detection two-stage image fusion approach that includes both arithmetic and fuzzy logic-based fusion methods to enhance the detection of stationary targets in through-the-wall radar imaging applications [1]. Non-Subsampled contourlet transform for multiresolution decomposition of the source images and fuzzy logic for measuring the optimal fusion weights of the low-pass NSCT coefficients are used for fusion process [2]. Multi-level fuzzy contourlet-basedimage fusion for medical applications proposed an image fusion system for medical engineering based on contourlet transform and multi-level fuzzy reasoning technique in which useful information from two spatially registered medical images is integrated into a new image that can be used to make clinical diagnosis and treatment more accurate [3]. A Neuro-Fuzzy Approach for Medical Image Fusion addresses a novel approach to the multisensor, multimodal medical image fusion (MIF) problem, employing multiscale geometric analysis of non-subsampled contourlet transform and fuzzy-adaptive reduced pulse-coupled neural network (RPCNN). The linking strengths of the RPCNNs' neurons are adaptively set by modeling them as the fuzzy membership values, representing their significance in the corresponding source image [4]. Fuzzy Fusion Techniques for Linear Features Detection in Multitemporal SAR Images emphasis on the automatic exposure of linear facet in SAR satellite images for road network excerption [5]. A new technique by associating the idea of the interrelation between the contiguous pixels and neural networks with back propagation, in which three features are considered to determine the clear pixel and those pixels are combined to form the initial fused image. [6]. Based on principles of wavelet and curvelet transform, a method proposed for image fusion and proved that these results are better compared with other techniques [7]. In [8] various medical image fusion approaches has been examined and concluded that FIS type MIN-SUM-MOM generates improved performance over other techniques [8]. [9] Presents an application of Kalman filter for pixel-level fusion and confirm the latent of Kalman filter in remote sensing. In [10], adaptive and fuzzy weighted image fusion situated on wavelet Transform and proved that proposed method solves the unclear problems in image fusion and improves the capability of noise overriding. In [11], images are initially decomposed by wavelet transform and through maximum selection rule bands with low and high frequency are fused and the entropy is maximized using windowing technique. Compressive sensing fusion method proposed based on directionlets in which sparse matrix obtained from the directionlet coefficient sparse representation followed by fusing sparse matrices with the coefficient absolute value maximum scheme [12]. The Dual Tree Complex Wavelet Transform (DT-CWT) method proposed for image fusion to overcome the shift variance problem by the use of a reversible and discrete complex wavelet transform [13]. The pixel level image fusion using fuzzy logic approach has been analysed along with quality assessment evaluation measures and it gives a considerable improvement on the quality of the fused image [14].

2. Fuzzy Based Image Fusion

The weightage of fuzzy logic comes from the modes of human thinking and common sense reasoning. In [15] Zadeh proposed a basic elements of fuzzy logic used in many contexts, specifically in image fusion using fuzzy logic. Image fusion using fuzzy and neuro fuzzy approaches are compared and importance of those techniques are explored [16]. The algorithm proposed in this paper for iterative image fusion using fuzzy logic is to continue the fuzzy based fusion process [16] with two inputs, in which one of the inputs is the latest output and second is the required input image and transform the column form to matrix form and display the fused image. Three membership functions mf1, mf2 and mf3 and six rules are used in the proposed algorithm.

Rules used in the proposed method as follows:

1. if (input1 is mf1) and (input2 is mf2) then (output1 is mf1)
2. if (input1 is mf2) and (input2 is mf2 then (output1 is mf2)
3. if (input1 is mf2) and (input2 is mf2) then (output1 is mf2)
4. if (input1 is mf3) or (input2 is mf2) then (output1 is mf3)
5. if (input1 is mf1) and (input2 is mf3) then (output1 is mf1)
6. if (input1 is mf3) or (input2 is mf3) then (output1 is mf2)