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# A Novel Image Fusion Method via Ratio Weighted and Condition Weighted Based on Shearlet Transform ⋆

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**Abstract**

In this paper, a new image fusion method is proposed based on the shearlet transform. The new image is reconstructed by image fusion, which provides richer visual information than the original images. The image could be decomposed by shearlet transform in any scale and any direction, and the detail information can be caught easily. The multi-scale and multiple directions decomposition coefficients are obtained through shearlet transformation. The fusion results are analyzed and compared with the measurement of human visual system and objective evaluation. The experiment results show the advantages of the new fusion method compare to other classical fusion algorithm. The simulation results of the multimodal images are adopted to demonstrate that the algorithm based on shearlet transform is able to obtain fused images of higher clarity and complementary information compared with any other methods.

*Keywords*: Image Fusion; Shearlet Transform; Condition Weighted; Edge Features

# 1 Introduction

Image fusion is a process of combining two or more source images to form a new one with more sharpness and reliability. Through utilizing a certain algorithms, image fusion produces a result image with the best aspects of the source images. The fused image reflects the multifaceted information of the source images and is more suitable for human visual perception or computer

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processing [1]. Image fusion will become a power subject that integrates technologies such as multi-sensors, signal processing, and image processing. It has been widely used in target object tracking, edge detection, identification and other agriculture areas. As the same, it can be widely used in medical imaging and diagnostics, security and surveillance, intelligent transportation and other civilian areas. In the actual clinical application, a single mode of image cannot provide enough information to doctors in need, often need different modes of image fusion together, to get more abundant information for better understanding the comprehensive information of diseased tissue.

At present the research of image fusion technology can be roughly divided into two categories: spatial domain fusion algorithm and multi-resolution frequency domain fusion algorithm [2]. Many scholars abroad for multimodal image fusion technology has also made a related study, such as image fusion methods based on curvelet transform [3–5], based on vision [6, 7], based on discrete wavelet transform [8–10]. The associated system forms an affine system, the transform can be regarded as matrix coefficients of a unitary representation of a special group, there is an MRA-structure associated with the systems. The shearlets satisfy all these properties in addition to showing optimal behavior with respect to the detection of directional information. Shearlet transform [11, 12] is a image representation of multi-resolution, local area, and multi direction. It inherited the anisotropy of shearlet transform scales relationship, in a sense, it can be thought as the digital realization way of curvelet transform approximation. Shearlet transform is a real 2D image sparse representation, good directivity and anisotropic characteristics, to better the image of the edge profile information capture the different scale and the direction of the subband in [13], is effectively used in the field of image fusion. In this paper, based on the research of the image fusion technology and shearlet transform, this paper proposes a new image fusion method based on shearlet transform ratio weight and condition weight fusion algorithm.

# 2 Basic Shearlet Theory [14]

The basic idea for the definition of continuous shearlets is the usage of a 2-parameter dilation group, which consists of products of parabolic scaling matrices and shear matrices. Hence the continuous shearlets depend on three parameters, the scaling parameter $a > 0$, the shear parameter $s \in R$ and the translation parameter $t \in R^2$, and they are defined by Eq. (1):

$$\psi_{a,s,t}(x) = a^{-3/4}\psi(D_{a,s^{-1}(x-t)}), where D_{a,s} = [a, -a^{1/2}s; 0, a^{1/2}]. \tag{1}$$

The mother shearlet function $\psi$ is defined almost like a tensor product by Eq. (2):

$$\psi_{\xi_1,\xi_2} = \psi_1(\xi_1)\psi_2(\xi_2/\xi_1), \tag{2}$$

where $\psi_1$ is a wavelet and $\psi_2$ is a bump function. The figure on the right hand side illustrates the behavior of the continuous shearlets in frequency domain assuming that $\psi_1$ and $\psi_2$ are chosen to be compactly supported in frequency domain.

The associated continuous shearlet transform again depends on the scaling parameter a, the shear parameter s and the translation parameter $t$, and is defined by Eq. (3):

$$SHf(a, s, t) =< f, \psi_{a,s,t} > \tag{3}$$