Efficient Multi Focus Image Fusion Technique Optimized Using MOPSO for Surveillance Applications

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ABSTRACT
This article describes how image fusion has taken giant leaps and emerged as a promising field with diverse applications. A fused image provides more information than any of the source images and it is very helpful in surveillance applications. In this article, an efficient multi focus image fusion technique is proposed in cascaded wavelet transform domain using swarm intelligence and spatial frequency (SF). Spatial frequency is used for computing the activity level and consistency verification (CV) based decision map is employed for acquiring the final fused coefficients. Justification for employing SF and CV is also discussed. This technique performs well compared to existing techniques even when the source images are severely blurred. The proposed framework is evaluated using quantitative metrics, such as root mean square error, peak signal to noise ratio, mean absolute error, percentage fit error, structural similarity index, standard deviation, mean gradient, Petrovic metric, SF, feature mutual information and entropy. Experimental outcomes demonstrate that the proposed technique outperforms the state-of-the art techniques, in terms of visual impact as well as objective assessment.

KEYWORDS
Consistency Verification, Discrete Wavelet Transform, Image Fusion, Multi Objective Particle Swarm Optimization, Spatial Frequency, Stationary Wavelet Packet Transform

1. INTRODUCTION
Image fusion is the method of combining multiple images into a single image and making it appropriate for visual perception and further tasks such as feature extraction, segmentation and target detection (Drajic & Cvejic, 2007) (Huafing et al., 2013). Effective focusing of all objects in a scene is not feasible due to limited depth of the cameras in sensors. A popular way to solve this problem is image fusion, in which one can acquire a set of images of the same scene from diverse viewpoints and fuse them for obtaining a more informative image (Zhang, & Blum, 1999).

In the recent years a lot of algorithms have been developed by researchers for multifocus image fusion. These algorithms can be classified into spatial domain and transform domain (Mitianoudis & Stathaki, 2007). In spatial domain technique, the images are fused by measuring the spatial features, such as mean, variance and standard derivation. For transform domain techniques, the images are

DOI: 10.4018/IJIIT.2018070102

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projected into localized bases that are basically designed for providing the sharpness and edges of the images (Mitianoudis & Stathaki, 2007).

With the development of various transforms, several types of multi resolution transforms have been developed and used for image fusion, including discrete cosine transform (DCT), discrete wavelet transform (DWT), stationary wavelet transform (SWT), etc. The procedure for the general multi resolution image fusion techniques contains three steps. Initially the source images are decomposed by applying the transforms. Further, the decomposed coefficients are fused as per the user defined fusion rule. Finally, the fused image can be generated by applying the inverse transforms. Research results shows that the wavelet based techniques have more advantages than pyramid schemes such as increased directional information, no blocking artifacts that often occur in pyramid based techniques, better signal-to-noise ratio, improved perception and so on (Pajares & Cruz, 2004). The principal applications of image fusion include medical diagnostics, surveillance, marine sciences and computer vision.

In this work, an image fusion technique is proposed in multi transform domain by incorporating multi objective particle swarm optimization (MOPSO) and activity level measurement. Further consistency verification (CV) is utilized as the criteria for forming the constructive fused image. The final fused image combats the unwanted outcomes such as contrast reduction, blurring and blocking artifacts. The rest of the paper is organized as follows: Section 2 gives a brief account of related works. Section 3 explains the proposed image fusion framework in detail with the schematic diagram. Experimental results are discussed in section 4, followed by conclusions in section 5.

2. RELATED WORKS

Xia Xiaohua et al. (2014) have used a global mapping model for initial registration as it one of the essential pre-processing step of image fusion. Focus measure operator was used for searching the best focused pixels in the sequence of images. Probability filtering is used for enhancing the robustness of focus measure and an accurate registration is performed for extracting the common features of the focused regions. Even though this method yields better results, it has high complexity due to repeated registration. Chandrakanth et al. (2014) have discussed an image fusion system for multi sensor and multiband remote sensing data. This image fusion system focuses on selection of data, pre-processing, registration and fusion for multi sensor and multiband images. A robust image registration method and appropriate fusion techniques are analyzed. The discussed technique yields better performance when compared to well-known techniques. Bai Xiangzhi et al. (2015) have presented a quad tree based decomposition methodology. In this strategy, the input images are decomposed into blocks with various sizes and focused regions are detected by using Sum of the Weighted Modified Laplacian (SWML). Akinlar Mehmet Ali et al. (2013) have analyzed a hybrid method for deformable matching of magnetic resonance (MR) images using the benefits of both wavelet and variational calculus. This method is implemented based on the Gabor wavelet energy maps of MR images. Experimental results proved that this method yields better results compared to the variation-based technique and wavelet based technique.

Jun Wang et al (2013) have performed an image fusion method which is based on NSCT and sparse representation. To express the details of the images, the source images are decomposed using NSCT. The low frequency information of the image is sparsely represented through trained dictionary with K- singular value decomposition for extracting the salient features. This method reduces the calculation cost of the fusion algorithm with the help of sparse representation using non-overlapping blocks. From the experimental results it is understood that this method outperforms single sparse representation and multiscale decomposition. The limitation of this method is that the complexity is high when compared to single transform methods such as DWT, SWT and NSCT. Agrawal Sanjay et al. (2011) have proposed PSO based technique in which the ICA bases are optimized using PSO. The independent components are obtained by splitting the input images into blocks. After that, these
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