INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: MULTI-SENSOR IMAGE FUSION USING OPTIMIZED AND ADJUSTABLE NON-SUBSAMPLED SHEARLET TRANSFORM AND MEASUREMENT OF FUSION PERFORMANCE

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SHORT ABSTRACT

Image fusion is a technique to assimilate information acquired from similar or dissimilar sources of images. Compared to the source images, fused images convey more information, and they have more clarity. However, distorted fused images are obtained in many cases, which only misinterpret the actual scene information. This happens due to the shortcomings of fusion rules, fusion framework, image decomposition techniques, and inaccurate source image registration. To address these issues, we proposed few efficient fusion techniques to generate better quality fused images for different computer vision applications.

In the proposed method presented in Chapter 2, non-subsampled shearlet transform (NSST) is used to decompose pre-registered source images into low- and high-frequency components. These low- and high-frequency coefficients are fused by using our proposed modified weighted salience and local difference fusion rules, respectively. To enrich edge information in the fused image, Canny edge detector with scale multiplication is employed. Moreover, a metric QTS is proposed to jointly measure both texture and structural information present in the fused image. The proposed metric is formulated on the basis of local standard deviation filtering, local information entropy, and local difference filtering. Both subjective and objective results validate the proposed fusion framework and the metric QTS. The proposed method can deal with noisy source images due to the deployment of anisotropic diffusion filtering. However, proposed method is unable to produce state-of-the-art results in case of multifocus images due to non-optimal frequency response of NSST filters and lack of additivity in fusion rules. Moreover, there is still a scope of formulating a new metric to measure other attributes of fused images.

In Chapter 3, an optimized non-subsampled shearlet transform (NSST) is developed, which is applied to decompose source images into low- and high-frequency bands. The low-frequency bands are fused using proposed descriptor obtained by the superposition of scale multiplied Canny edge detector features and Hessian features. The high-frequency bands are fused using unsharp masking based fusion rules. Moreover, a metric QE is formulated on the basis of Karhunen-Loeve transform (KLT). The information of image pixel variance for both source and fused images

can be measured by using the proposed metric QE, and it gives an indication of the amount of variance information transferred from the source images to the fused image. Both subjective and objective analysis show the efficacy of the proposed fusion structure and the metric QE. The improvement in performance is due to the deployment of more complex optimized NSST and fusion rules. However, the multi-scale transform (MST) or multi-geometrical analysis (MGA) tools (such as NSST, curvelet, contourlet, etc.) based low-frequency band fusion sometimes under perform as compared to the sparse representation based low-frequency fusion.

MST and sparse representation based image fusion techniques are very popular. However, existing fusion methods cannot perfectly capture significant details, texture and fine information of the source images due to few limitations of MST- and sparse representation based techniques. Moreover, for objective evaluation of fusion algorithms, it is quite important to simultaneously measure both singularities and structural information of the source images preserved in the fused image. So, a metric which can efficiently measure both singularity and structural information of the fused image is much needed for fair comparison of existing fusion methods. To address these issues, a modified Meyer window based adjustable non-subsampled shearlet transform (ANSST) is proposed to decompose the pre-registered source images into low- and high-frequency coefficients in Chapter 4. The low-frequency bands are fused using convolutional sparse representation (CSR) modeling. The high-frequency bands are fused using proposed Information Entropy, Standard Deviation, and Range (IESDR) descriptor, which considers entropy, standard deviation, and range filtering features, respectively. Moreover, a metric QSS is proposed to jointly measure both singularities and structural information present in the fused image. The proposed metric is formulated on the basis of the proposed native division and native difference filtering. To show the applicability of the proposed ANSST, the proposed ANSST is applied for image denoising. Both subjective and objective results validate the proposed fusion framework and the metric QSS . The main limitation of this method is that it is more computationally complex than the methods proposed in Chapter 2 and Chapter 3. In Chapter 2, we proposed local difference features to fuse high-frequency information.

To show one application of our local difference features, an image mosaicking framework is proposed with the help of these features. A local difference-based modified Harris detector is proposed to increase time efficiency of image mosaicking algorithms in Chapter 5.