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MULTI-FOCUS IMAGE FUSION USING WATERSHED TRANSFORM AND MORPHOLOGICAL WAVELET CLARITY MEASURE

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Abstract. *Optical imaging cameras suffer from the problem of finite depth of field, which cannot make objects at various distances (from the sensor) all in focus. Practically, the image fusion technique is usually used to solve this problem. In this paper, we proposed a region-based image fusion method which is similar as the manual cut-and-paste method the fused image from which is often seen as the 'ideal' everywhere-focus image. In order to reduce the computational complexity, the watershed transform is employed to achieve image segmentation, and the morphological wavelet transform coefficients are used as the clarity measurements. The proposed method is compared with a pixel-based wavelet transform method and a region-based Laplacian pyramid method. Experimental results show that the proposed algorithm performs the best.*
Keywords: Image fusion, Watershed transform, Image segmentation, Morphological wavelet

1. **Introduction.** In applications of digital cameras, particularly as it relates to film and photography, image blurring is unavoidable under normal viewing conditions because of the depth of field limitation of the lens. A practical way to resolve this problem is the image fusion technique, in which one acquires a sequence of images focused on different objects of the same scene and fuses them to produce an artificial image with extended depth of field. The fused image would make many vision-related processing tasks, such as edge detection, image segmentation, image enhancement and stereo matching, easier [1-5]. Over the past two decades, various image fusion methods have been proposed and in all of those methods, the multiscale transform based algorithms attract a great deal of research attentions [6-10], because that there are evidences that the human visual system performs a similar multiscale decomposition in its early processing. Except the multiscale transform, other techniques, such as artificial neural networks [11,12], log-Gabor transform [13], sparse representation [14], variational model [15] and so on, are also used to resolve the multifocus image fusion problem. Most of those methods can improve the fused results in some degree. In fact, most of those methods perform the fusion process on image pixels. However, it is more meaningful to combine regions rather than pixels in fusion process [16,17]. This is because that most interested features usually contain in the image regions rather than the pixels. Compared with the pixel-based methods, region-based methods can overcome the problems such as sensitivity to noise, blurring effects, mis-registration and so on.

The region-based fusion methods proposed [16-19] in the past usually follow a general pattern of initially decomposing the source images using a multi-resolution transform such as pyramids or wavelets. The source images are segmented according to image features extracted from the transform coefficients. The regions are then fused using some fusion