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INTELLIGENT ADAPTIVE SUBBAND-BASED MULTI-STATE MEDIAN FILTER IN LOWLY-CORRUPTED IMAGES

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Abstract. *This paper presents a novel method to reduce random-valued impulse noise by adaptive subband-based multi-state median (ASBMSM) filtering for lowly-corrupted images. Most reported noise filters can effectively reduce impulse noises that are distributed over the low-frequency area but hardly filter those noises that are distributed over the high-frequency area in an image. To overcome the above problem, the paper develops an adaptive subband-based filtering scheme, in which an image is divided into low-frequency and high-frequency blocks of size* $8*8$ *by using PSNR (peak signal-to-noise-ratio) checking. Then, different blocks use different masks for filtering. In addition, to enhance restoration of the original information, another filtering process is required if the PSNR value of the previously filtered image is lower than a threshold. Experimental results manifest that the proposed impulse noise filter is superior in PSNR performance to other switching-based median filters when the corruption ratio is below 30%.*
Keywords: Impulse noise, Multi-state median filter, Adaptive filter, Subband filtering

1. **Introduction.** Impulsive noise is very noticeable by human eyes and it also affects some subsequent processings [1-3], such as edge detection, image segmentation, object recognition, etc. The median filter is initially introduced to suppresses impulse noise, but it always causes artifacts of edge-jittering and streaking due to the fact that those uncorrupted pixels are usually altered [4-6]. Therefore, the noise-detection-based approach which discriminates the uncorrupted pixels from the corrupted ones prior to filtering is motivated [7-17]. Basically, the main issue of those noise-detection-based filters is focused on building a decision rule of noise detection as correctly as possible. To obtain a better performance of salt-and-pepper impulse noise reduction in highly corrupted images, a progressive switching median filtering strategy in which both noise detection and noise filtering procedures are progressively applied through several iterations is introduced [8]. By using a simple thresholding operation to adaptively switch among those of a group of center weighted median (CWM) filters with various center weights, a generalized framework of switching scheme for median filtering, called multi-state median (MSM) filter, will provide superior performance in noise suppression and detail preservation to other median based filters [9]. Based on the minimum absolute value of four convolutions obtained by using one-dimensional Laplacian operators, an improved impulse detector for switching median filters is directed toward line preservation [10]. A conditional signal-adaptive median (CSAM) filter with flexible thresholds based on homogeneity level information is proposed for improving the impulse noise detection and the decision-making scheme can