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DECISION-BASED ADAPTIVE LOW-UPPER-MIDDLE FILTER FOR IMAGE PROCESSING

Tzu-Chao Lin[1,*] and Chao-Ming Lin[2]

[1]Department of Computer Science and Information Engineering
[2]Graduate School of Opto-Mechatronics and Materials
WuFeng University
No. 117, Sec. 2, Chiankuo Rd., Minhsiung, Chiayi 62153, Taiwan
[*]Corresponding author: tclin@wfu.edu.tw

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Abstract. *In this paper, an adaptive filter is proposed for improving the performance of median-based filters by preserving image details while effectively suppressing impulse noise. The proposed filter is composed of a noise decision-maker and an adaptive low-upper-middle (LUM) filter. The proposed filter uses a novel approach to judge whether the input pixel is noisy. If a pixel is detected as corrupted, it is classified into one of M blocks, with each block having its own central weight for the LUM filter. Otherwise, it is kept unchanged. The observation vector space is partitioned, and then a learning approach is employed to obtain the adaptive center weight of each block. Based on the least mean square (LMS) algorithm, an iterative learning rule is derived to minimize the mean square error of the filter output. Extensive experimental results demonstrate that the proposed filter outperforms existing median-based filters.*

Keywords: Impulse noise, Median filter, Center weighted median filter, Least mean square

1. **Introduction.** When images are transmitted, they are often corrupted by impulse noise due to faulty sensors or noisy channels [1,2]. Hence, noise cancellation that does not degrade the quality of fine details is a major challenge in the field of computer vision and image processing [35]. For removing impulse noise, nonlinear filters outperform linear filters [3]. The median filter is a well-known nonlinear filter used for suppressing impulse noise. However, it tends to blur fine details and often destroys edges while filtering out impulse noise. In recent years, some modified median-based filters, such as weighted median (WM) filters and decision-based median filters, have been proposed to improve performance [4-13,31-34].

The main idea behind WM filters is to take the median value out of a signal group consisting of duplicated input signals chosen from the sampled filter window [4]. However, it is difficult to set the weights in actual signal processing; the computation is slow even when the weights are large. The center weighted median (CWM) filter is a special case of the WM filter where only the signal currently being processed in the filter window is duplicated [5]. CWM filters can be controlled by the center weight to balance noise reduction and detail preservation. Moreover, these approaches are location-invariant in nature, and thus they tend to alter noise-free pixels [9]. A detection-suppression strategy can be used to avoid the unnecessary filtering of noise-free pixels. Decision-based median filters mainly use decision-making processes with threshold functioning to control the median filter so that it is activated only for noisy pixels. Noise-free pixels are left unchanged. Sun and Neuvo proposed switching schemes (SWM-I and SWM-II) in which the final output