CERTAIN INVESTIGATIONS ON IMPROVED DECISION BASED NONLINEAR FILTERS FOR REMOVAL OF IMPULSE NOISE IN DIGITAL IMAGES

An image is the collection of information, which is acquired from digital cameras and the noise present in images causes degradation in the quality of images. Noise occurs in the image during image acquisition from cameras, while transmission and storage of images, due to camera movement, out of focus problem with the cameras, hazy weather, atmospheric turbulence, during sampling and quantization process and also due to faulty sensors. Therefore, image denoising is required to get better quality images for more accurate interpretation. It becomes an essential preprocessing task, since denoising is taken as the first necessary step before the image data is analyzed for further post image processing operations such as image segmentation, image compression and image representation.

The sudden change in intensity values occur while transmitting the digital image, which has two extreme values (salt noise with extreme intensity value of 255 and pepper noise with intensity value of 0 for a gray scale image) is called fixed impulse noise. Many filtering algorithms for removal of impulse noise in digital images is proposed by many researchers and is available in the literature, with its own advantages and limitations. In this thesis, five improved decision based nonlinear filtering algorithms are proposed for removal of impulse noise in gray scale, color images and video sequences. The Performance of the proposed filtering algorithms are compared with the performance of some standard existing filters such as Standard Median Filter (SMF), Adative Median Filter (AMF), Progressive Switching Median Filter (PSMF), Decision Based Algorithm (DBA), Modified Decision Based Algorithm (MDBA) and Modified Decision Based Unsymmetrical Trimmed Median Filter (MDBUTMF). The performance of each algorithm is based on the capability of noise removal and preservation of edges and fine details. Analysis is carried out by using the quantitative metrics Peak Signal to Noise Ratio (PSNR), and Structural Similarity Index Metric (SSIM). Qualitative analysis is carried out by visually inspecting the original image and denoised image.

The objective of the thesis is to propose and analyze the following algorithms for removal of impulse noise in digital images and video sequences, namely Lone Diagonal Sorting (LDS) Algorithm, Neighborhood Pixel Comparison (NPC) Algorithm,LDS based Median and Non Local Mean (LDSMNLM) Algorithm,Improved Unsymmetrical Trimmed Median and Non Local Mean (IUTMNLM) Algorithm and Neighborhood Pixel Comparison and Corner Pixels Averaging (NPCCPA) Algorithm.

The LDS algorithm, which uses the sliding window of size 3x3 and simplified right diagonal sorting approach, to obtain better results in terms of quantitative metrics such as PSNR and SSIM. The algorithm has been tested for various gray, color images and video.

The NPC Algorithm which compares the 4-point neighborhood pixels, instead of sorting all the pixels in the selected mask and avoids many comparisons. The absence of sorting saves much time and number of operations, which in turn increases the speed of operation. It provides higher value of PSNR and SSIM (upto 70% noise density) than the other filters with better preservation of crucial information and details.

The LDS based Median filter and NLM filter are combined. First, the LDS based Median filter removes the noise efficiently in the case of low noise density level, whereas it lacks in performance for high density noise levels due to the redundancy of noisy pixels. In order to improve the LDS based Median filter, the NLM filter is applied to reduce the redundancy.

The Improved Unsymmetrical Trimmed Median (IUTM) filter combined with NLM algorithm. The merits of both algorithms are exploited to get better denoising performance. This filter is

advantageous compared to LDS, NPC and LDSMNLM algorithms, since the IUTMNLM filter is effectively works for high noise density beyond 70%.

The NPC Algorithm is combined with Corner Pixel Averaging (NPCCPA) algorithm. This algorithm has two stages, i.e NPC followed by CPA. NPC algorithm avoids sorting and makes the process simple and results with lower computations and the subsequent second stage CPA involves only four corner pixels of 3x3 sliding window.

The proposed LDS algorithm and NPC algorithm have many advantages and perform better when compared to standard existing filters for low to medium noise density levels. However, they lack in performance for high density noise removal. But, LDSMNLM and IUTMNLM algorithms effectively handle and avoid the repetition of noisy pixels due to similar patterns by performing the denoising task at a single stroke,which could be sufficient enough to replace the target noisy pixel by the weighted average of the neighborhood of the target pixel. The weight assignment of the neighborhood pixels is based on the similarity between neighborhood pixels and other remaining pixels in the image. Hence, those algorithms performs better for all noise density level, especially for high noise density levels, but with a moderate increase in computational complexity and CPU operating time. Finally, the NPCCPA algorithm provides good improvement in terms of quantitative metrics by providing significant increase in the value of PSNR and SSIM values at the cost of increase in computational complexity and CPU operating time. The qualitative assessment by visual inspection shows better reconstruction quality of images and video sequences.