CHAPTER 7

CONCLUSION

The research work in this thesis primarily focuses on removal of impulse noise in digital images. Various spatial domain filters are proposed to suppress the impulse noise, both SPN and RVIN, at very high noise densities. The performances of these filters are compared with some of the popular existing filters which are available in the literature. This thesis focuses only the removal of impulse noise in digital images. Generally transform domain techniques are suitable only for removal of gaussian and speckle noises and hence it is not compared in our proposed works. The inferences from the contributions made in this research work are summarised in this chapter.

Three novel algorithms are developed for suppressing SPN viz., MAUTMPF, TSMPF and NEWTMPF and two algorithms are proposed for removing RVIN viz., ATIRF and XYZDF in this thesis. Experimental evaluation of proposed algorithms reveals that, NEWTMPF exhibits superior performance in suppressing SPN and XYZDF show better performance in suppressing RVIN. The performance of the proposed filters is evaluated both by quantitative standards as well as visual quality. The metrics that are used as quantitative measures in the thesis are viz., PSNR, MSE, SSIM and IEF. The qualitative analysis of the restored images is observed by the human eye and the valuation focuses on the clarity of the image, presence of noise patches and preservation of edges and fine details.

7.1 SPN ALGORITHMS

The performance of the proposed filters for suppressing SPN are tested with different standard 8 bit gray scale images of size 512 x 512. Colour image of
lena is used for processing colour images. The proposed and the existing filters considered for comparison are implemented in MATLAB 7.8 on a PC equipped with 2.6 GHz CPU and 2 GB RAM memory for evaluation.

From the experimental results of MAUTMPF proposed in Chapter 2 it is seen that the MAUTMPF demonstrates significant better performance in terms of PSNR improvement and MSE reduction compared to approaches mentioned in the literature for Lena image both at high and low NDs. The performance of MAUTMPF in terms of SSIM show significant improvements when compared to the previous approaches at 70% noise density irrespective of the nature of the input image. Also it is inferred that the IEF values of proposed MAUTMPF is significantly better both at low and high NDs irrespective of the nature of input.

The qualitative performance of the MAUTMPF algorithm in terms of subjective visualization for various standard test images reveals that it can remove salt and pepper noise from the corrupted images effectively while preserving edges and image details very well at various NDs irrespective of the nature of the input image. Also it is inferred that the filter performs very well even for very high noise densities up to 95 %.

In Chapter 3, a modified version of midpoint filter viz., TSMPF is proposed in which filtering is done at two stages. The restoration performance of the TSMPF is tested against the standard test images and it is observed that the TSMPF algorithm outperforms all other previous algorithms in terms of PSNR irrespective of the nature of image both at low and high NDs. It is also witnessed that PSNR improvement of 2dB to 10 dB is achieved when compared with approaches mentioned in literature and 1dB to 3dB against MAUTMPF.
The visual quality of the restored images using TSMPF is better compared to the output images processed by all other algorithms used for comparison. Also, it is noticed that the edges and fine details of the output image, processed by TSMPF are well preserved when compared to the output images processed by other existing algorithms.

The measure of SSIM values of output images processed by TSMPF is found to be significantly better for all the test images especially for higher NDs above 70%. It was inferred that TSMPF performs well in sustaining the structural similarity as of the original image and it is observed that the values are improved by 23% to 38% for lena, pepper, baboon, boat and bridge images. The performance analysis of IEF of TSMPF shows significant improvement particularly for higher NDs. It is noticed that the improvement is high as 60% when compared to the best of the designs used for comparison. It is also observed that the performance of TSMPF and MAUTMPF with respect to SSIM and IEF are indistinguishable.

In Chapter 4, a new and novel eight window method (NEWTMPF) is proposed to suppress SPN. Since the size of the window is fixed by 3 x 3 and filtering is carried out using suitable neighbourhood windows, effective preservation of edges and fine details are achieved. The subjective visual quality of the restored images using NEWTMPF is extra-ordinarily good and also it is observed that, the filter performs well even at very high density of 95% ND.

NEWTMPF shows excellent performance in terms of PSNR values and it is observed that the improvement goes up to 14dB even at higher NDs for lena, pepper, baboon, boat and bridge images. It is also observed that an improvement of 4dB to 9dB is achieved against MAUTMPF and 2db to 8dB is achieved against TSMPF for different NDs and test images. The performance of NEWTMPF in terms of SSIM reveals significant improvement of 40% for
lena image and 25% to 37% improvement is witnessed for other test images even at higher NDs when compared to the best of the designs from the literature. Also it is noticed that NEWTMPF show superior IEF performance against previous approaches irrespective of the nature of the input image.

In all the proposed algorithms viz., MAUTMPF, TSMPF and NEWTMPF, detection mechanism is used to detect the noisy impulses before applying the filtering technique, hence the proposed algorithms gives better denoising results in the case of impulse noise removal than the other types of noise such as guassian, which is signal independent.

It was inferred from the above discussion, NEWTMPF performs extra-ordinarily well in suppressing salt and pepper noise and also efficiently preserve edges and fine details of the images both at low and high NDs. In addition it outperforms MAUTMPF and TSMPF in quantitative measures and visual quality.

7.2 RVIN ALGORITHMS

The performance of the filters for suppressing RVIN proposed in Chapter 5 and Chapter 6 are tested with different standard 8 bit gray scale images of size 512 x 512. The proposed and the existing filters considered for comparison are implemented in MATLAB 7.8 on a PC equipped with 2.6 GHz CPU and 2 GB RAM memory for evaluation.

An adaptive threshold intensity range filter is proposed in Chapter 5. The proposed ATIRF demonstrates significant improvement of PSNR value when compared to the best of the all filters taken for comparison. It is witnessed that an improvement of 3dB to 8dB is achieved irrespective of the nature of the image at 60% ND. In addition, ATIRF demonstrates better SSIM values for all test images and with an improvement up to 16%. From the IEF
comparisons, it is seen that ATIRF is found to perform better even at 60% ND. Additionally the fault detection performance of ATIRF is found to be better which reveals its better corrupted pixels detection.

The visual quality of the denoised images processed by ATIRF shows that ATIRF suppresses RVIN very effectively and efficiently. Even at high noise density of 60%, the filter preserves edges and fine details of the image irrespective of the nature of the image.

In Chapter 6, a novel directional detection technique is introduced for effective detection of corrupted pixels and to suppress RVIN. The novelty of this proposed filter is the direction of scan being the shape of alphabets X, Y and Z, which helps to preserve edges and fine details in the restored images.

The proposed XYZDF demonstrates significant PSNR improvement of 3dB to 9dB when compared to the best of the filters taken from literature and 1dB to 2dB improvement against ATIRF irrespective of the nature of the image. Additionally, XYZDF demonstrates better SSIM values even for high NDs irrespective of the nature of input when compared to approaches used for comparison and proposed ATIRF. The IEF result reveals that images processed by XYZDF shows significant improvement of 42% to 45%, when compared with filters from literature and proposed ATIRF. The detection performance of XYZDF algorithm is better irrespective of the input image and hence effective filtering is also achieved even for high NDs. The number of miss detection and false detection is significantly decreased. Also it is noticed that the proposed XYZDF approach produces better image quality even at higher NDs and also preserve edges and fine details well.

It is inferred that, the performance of XYZDF both in terms of quantitative measures and visual quality is superior when compared to some
of the popular benchmark filters and ATIRF. The visual quality results in addition reveal that XYZDF is extremely good in preserving edges and fine details of the image. The miss and false detection of pixels are reduced significantly in XYZDF, thereby effective filtering is achieved.

The validity of the above research work contributions are supported with few publications.

7.3 FUTURE WORK

The algorithms proposed to suppress RVIN viz., ATIRF and XYZDF uses different threshold values which are obtained by trail and error method. To estimate the optimum threshold value, advanced computational methods like particle swarm optimization, bee colony optimization, etc. can be implemented. Further, this research work may be extended for various other noises like Gaussian noise and Speckle noise after making suitable modifications in the proposed algorithms.