CHAPTER 7

CONCLUSION

Image signals are 2 D information bearing signals. The quality of the image is degraded due to noisy communication channel or faulty image sensing systems. Additive Gaussian noise occurs due to electronics in the imaging system, impulse noise is due to faulty camera and multiplicative speckle noise occurs due to coherent reconstruction of remote sensing images. In image signals, the statistics vary from application to application. The noise statistics vary in various regions of the image. The characteristics of channel noise in the transmission lines and atmospheric noise in satellite images vary in application from one image to another. Edges and fine details are important information bearing features of an image. In this thesis, improved adaptive non linear strategies, based on order statistics are introduced for suppressing a mixture of additive Gaussian noise, impulse noise and multiplicative noise with reduction in blur along with the preservation of fine details and edges.

Six adaptive non linear filters are proposed, namely, Modified Adaptive Trimmed Mean Filter (MATMF), Adaptive Max/Median Filter (AMMF), New Filter I, New Filter II, New Filter III and New Filter IV. MATMF eliminates additive Gaussian noise mixed with impulse noise. The output of the filter is derived from the LMMSE estimate of the signal and noise statistics. The blur caused due to the averaging of the pixels is compensated by properly adapting the parameter ‘alpha’ in an alpha trimmed mean filter. Noise in the homogeneous region is removed by adaptive alpha
trimmed mean filter and noise in the heterogeneous region is removed by median filter. The algorithm is tested using two test images of different mean values. The quantitative and qualitative analysis shows the superior performance of the proposed MATMF.

AMMF is introduced to eliminate a mixture of additive Gaussian and impulse noise with the preservation of low spatial information. The low temporal order information is preserved by a multi stage median algorithm called max/median whose operation changes adaptively based on the presence of noise in the homogeneous region or heterogeneous regions. The noise in the homogeneous region is removed by averaging of the intensity values within the window. The performance of the filter is evaluated using MSE/pixel, IEF and PSNR and is compared with the performance of the mean, median, SAM filter and MATMF. A higher value of PSNR shows superior performance of the AMMF and the subjective results show its excellent detail preservation properties. From quantitative analysis, it could be inferred that the filter exhibits relatively lower value of IEF.

New Filter I has ATMF, NAF and a combiner algorithm. The computation time is reduced by processing the corrupted pixels separately and combining the outputs by a combiner algorithm. Even though the objective analysis shows better results, the subjective analysis shows blurring in reconstructed images. New Filter II has three stages namely a stage 1, stage 2 and stage 3. Stage 1 is used to detect and remove impulse noise. Edges are detected and removed by stage 2. Blur and Gaussian noise are removed by stage 3. The test images are corrupted by various noise types at different intensity levels. The results are compared with various adaptive filters and higher value of IEF shows the removal of noise with edge preservation even at a larger window size.
The adaptive filtering algorithms MATMF, AMMF, New Filter I and New Filter II work well for the simultaneous removal of additive mixture of Gaussian noise and impulse noise. Even though they are adaptive in nature, it has been found that they do not perform well in removal of speckle noise. In order to remove speckle noise which is multiplicative in nature and which contaminates a remotely sensed image, a non linear adaptive filtering algorithm, New Filter III has been proposed. The new filter is based on the local order statistics and the qualitative results show that it removes speckle noise in a remotely sensed image with excellent preservation of edges. The test images are corrupted by speckle noise of various intensities. The speckle noise is removed by a 3 sigma filter which uses the local statistics such as mean and standard deviation of the noise corrupted signal. The adaptive filter provides edge preservation by using an edge detector which is a high pass filter and the replacement of the corrupted edge by the neighbourhood uncorrupted signal. The reconstructed filter algorithm combines the filtered signal from the 3 sigma filter and the edges are extracted from the signal to provide a noise free and sharp image. SAR images are corrupted by speckle noise and it is proved that the proposed algorithm works very well for the remotely sensed image in comparison with natural images.

New Filter III does not improve the quality of the image if the images are corrupted by a mixture of additive Gaussian noise and impulses mixed with multiplicative speckle noise. Hence New Filter IV, an efficient algorithm to remove all these kinds of noise is developed. The test images are corrupted by speckle noise at different densities and additive Gaussian noise mixed with impulse noise. The evaluation measures are compared with that of adaptive filters and generalised homomorphic filters. The improved IEF offered by the proposed filter shows its superiority in performance. Even though the IEF of the proposed algorithm decreases with an increase of the speckle noise variance, the decrease in their MSE shows a better speckle
noise elimination. The adaptive algorithm with variable threshold excludes the pixels whose mean lies above the threshold. This helps in removing the impulses and the preservation of edges. The algorithm is based on the local order statistics in spatial domain and hence the degradation of images due to any transformation is found to be less.

7.1 SCOPE FOR FUTURE WORK

Even though the proposed adaptive filtering algorithms based on order statistics eliminate the mixture of additive Gaussian noise, impulse noise and multiplicative speckle noise, there exists a research problem of interest. Adaptive non linear order statistic filters for image restoration in the presence of mixed noise at higher amounts of speckle noise is a topic of considerable research interest.

In conclusion, this thesis has presented several improved adaptive non linear filtering techniques based on order statistics and has demonstrated their performance. The filters show improved performance in removing a mixture of additive Gaussian noise, impulse noise and multiplicative speckle noise while reducing blur and preserving fine details.