Images and videos are often corrupted by noise and degradations due to faulty communications or noisy channels or faulty camera in the transmission of images and videos over channels. Noise removal is one of the most important and challenging tasks in signal and image processing. In images, high frequency components carry valuable information’s like edges and fine details. In the presence of impulse noise, reasonable noise suppression can be achieved by nonlinear filters where linear filters will smear the edges while smoothing noise. Linear filters fail in preserving edges in images corrupted by non-Gaussian noise. Nonlinear filters are effective in the removal of non-Gaussian noise with edge and fine detail preservation. One of the most popular nonlinear filters for impulse noise removal is order statistic filters. There are large numbers of nonlinear filters and their extensions are under research. The most commonly used order statistic filter is median filter since it is easy to implement and removes impulse noise while preserving edges. This thesis introduces some nonlinear filtering schemes based on order statistics. New median based algorithms are proposed to address problems in image denoising such as detection and removal of impulse noise without disturbing edges and fine details.
A nonlinear adaptive decision based Median-Mean algorithm for the removal of impulse noise in images and videos is proposed. The algorithm performs two operations, namely detection of corrupted pixels and estimation of new pixels for replacing the corrupted pixels. The algorithm uses an adaptive length window whose maximum size is 5×5 to avoid blurring due to large window size. The main advantage of the algorithm is that an appropriate filter is used for replacing the corrupted pixel based on the noisy pixels present in the processing window. This leads to reduced blurring and better fine detail preservation even at higher noise densities. The performance of the algorithm is analysed in terms of Peak Signal to Noise Ratio, Mean Square Error, Image Enhancement Factor and Mean Structural Similarity Index. Improved performance of the algorithm is demonstrated.

A switching bilateral filter for the removal of Gaussian noise and impulse noise is proposed. Bilateral filter is a nonlinear filter, which removes gaussian noise. Each pixel is replaced by a weighted average of the intensities in the window. The bilateral filter performs well in removing Gaussian noise with edge and fine detail preservation, but it is difficult to remove impulse noise. The algorithm contains two stages, detection followed by filtering. In this algorithm, a scheme called as quadrant median vector is used, which contains the important features, like edges and fine details. The quadrant median vector is used to find a new value called as reference median, which is
then used to classify the current processing pixel as noise-free pixel, or pixel corrupted by impulse noise or Gaussian noise. Based on the classification a range filter switches between the Gaussian and impulse noise models. The noise detection and classification rate is high for this algorithm. The switching bilateral filter uses the existing bilateral filter for impulse noise removal without adding another weighting function. The performance of the algorithm is evaluated in terms of qualitative and quantitative criteria on various test images under different noise conditions.

An adaptive robust statistics estimation filter to remove high-density impulse noise with edge preservation in digital images is proposed. The algorithm detects the pixels corrupted by salt and pepper noise and replaces with a new value estimated using the proposed algorithm. The algorithm uses an adaptive length window. The length of processing window changes based on the noise density. The maximum size of the adaptive length window is fixed as 7×7. The proposed method removes noise effectively even at high noise densities and preserve the edges and fine details with reduced streaking. The proposed algorithm produces better results visually and also PSNR, MSE, IEF and MSSIM are better when compared to other noise removal algorithms.

A new switching based median filtering scheme and algorithm for restoration of images that are highly corrupted by salt and pepper noise is
proposed. An algorithm based on the scheme is developed. The new scheme introduces the concept of substitution of noisy pixels by linear prediction. The new algorithm shows significantly better image quality with good PSNR, reduced MSE, good edge preservation and reduced streaking. The better performance is achieved with reduced computational complexity. The better performance of the proposed scheme and algorithm over existing algorithms is compared in terms of visual and quantitative results are demonstrated.

A new decision based unsymmetric trimmed median filter, which is very useful for recovering the images contaminated by impulse noise with noise density as high as 90% is introduced. The unique feature of this filter is that, it uses a fixed 3×3 window. The filter checks the possibility of a noisy pixel and replaces with an estimated value. In this algorithm, if the current processing pixel is a noisy pixel then it is replaced by a median value of the pixels in the current processing window calculated after trimming the impulse values. This filter has lesser computational complexity and processing time. The proposed filter is evaluated by different noise density levels of impulse noise using fixed 3×3 window. The results obtained are presented and discussed.

The salient features of the proposed filtering algorithms are highlighted and the results are demonstrated. The contribution of this research work is summarized and possible directions for future work are indicated.