CHAPTER 7

CONCLUSION AND FUTURE WORK

7.1 CONCLUSION

In order to improve the quality of the restored images and at low computational complexity, it is necessary to propose a few algorithms for effective restoration of the images. Hence, in this thesis three different neural network based restoration algorithms and a fuzzy based restoration filter was proposed and they have produced enhanced performances compared to the conventional approaches mentioned.

The proposed techniques are:

i) Modified Recurrent Hopfield Neural Network (MRHNN)

ii) Five level Modified Weight Fuzzy Mean Filter (MWFMF)

iii) Multi-layer Morphological Neural Network for colour image restoration (MLMNN)

iv) Counter Propagation Neural Network for image restoration (CPNN)

The first technique, MRHNN approach is tested with different images degraded by different type of noises like random, impulse and Gaussian. The visual quality of the image is improved ranging from 35.8% to 66.4% using the proposed MRHNN with sequential update algorithm compared to the conventional MHNN algorithm. Also, the proposed
MRHNN with n-simultaneous algorithm is 50% faster than the conventional algorithm. The proposed network converges quickly for all types of noisy images. For random noise affected images, the average improvement achieved in the quality of the restored images is about 5 db more than the conventional approach. Likewise, the Gaussian noise affected images are restored by the proposed approach were found to have a 3db improvement than the conventional approach. When the proposed approach is used for restoring the mixed noise affected images, it is found experimentally that the improvement achieved in the quality of the restored image is negligible compared to the conventional approach. It is also required to restore the images to good quality images considering for applications involving automatic machine perception like recognition of spare parts (components) in the motor car assembling using robots. The industrial robots work in a critical environment where the images of the components acquired by the cameras are subjected to mixed noises. For such applications, the MRHNN may not be suitable. So, to overcome this drawback an approach using fuzzy concepts called five level Modified Weighed Fuzzy Mean Filter (MWFMF) is proposed as second technique.

The proposed five level modified weighed fuzzy mean filter is tested with different images degraded by high impulse noise and mixed noise and the performance of the proposed approach is compared with conventional approaches like Mean filter, Median filter and the filter proposed by Lee et al (1997). From the experimental results, it was observed that the visual quality of the restored image using the proposed method was 16 times better than the conventional filter at a very high impulse noise probability of 0.9. It was also found that the proposed approach performed well for the images degraded with mixed noise and the improvement achieved was 2 db more than the conventional approach.
The first and second technique, MRHNN and five level MWFMF are used to restore gray scale images with degradations. The same techniques can also be used to restore colour images but the three level component of red, green and blue are individually processed. Hence, the computational complexity for restoring colour images is greater than the restoration of gray scale images. The average time taken to restore the degraded gray scale image by the conventional approach is 26 seconds whereas, the time taken by the proposed MRHNN and five level MWFMF approaches are 14 seconds and 11 seconds respectively.

Similarly, the time taken by the conventional approach to restore the colour images degraded by different noises is about 70 seconds whereas, the time taken to process the same images by the proposed MRHNN and five level MWFMF approaches are 35 seconds and 28 seconds respectively.

Restoring colour images by the conventional and proposed approaches takes considerable amount of time. For real time applications, the processing time must be reduced further. So, it is required to develop an approach for colour image restoration with less time complexity and good visual quality. A Multilayer morphological neural network is proposed for colour image restoration.

The third technique, multilayer morphological neural network is simple and efficient compared to the other proposed techniques. Morphological neural computation does not involve multiplications but only the operations of OR, AND, addition and subtraction. The morphology based technique is tested for all kinds of noisy images like Lena, Mandrill and parrot with all types of degradations. The visual qualities of the restored images are high when the size of the structural element increases. It is also seen that, as the size of the structural element increases, the complexity also increases considerably.
The average time taken by this approach to restore the colour images degraded by different noises is about 17 seconds when a structural element of size $3 \times 3$ size is used. The visual quality of the image is about 32 db for a degraded image of 17 db. The average time taken by this approach to restore the colour images degraded by different noises is about 66 seconds when a structural element of size $11 \times 11$ size is used. The visual quality of the image is about 38.2 db for a degraded image of 17 db. As the size of the structural element goes beyond $11 \times 11$, the performance in terms of PSNR increases but the computational complexity is high.

The three proposed restoration techniques perform well for only one particular type of noise. For example, the proposed five level MWFMF performs very well for impulse noise and produce good quality restored images. So, it was experimentally found that none of the previously explained three methods resulted in equal performance for impulse, Gaussian and mixed type of noises.

So, it is aimed to propose a technique which will equally perform well for images degraded with impulse, Gaussian and mixed type of noises. Thus, the proposed approach is based on Counter Propagation Neural Network.

The fourth technique, full counter propagation neural network is also used to restore colour images. Colour images are divided into RGB distribution. Then, each subspace can be regarded as a gray image space and is processed by counter propagation neural network used in gray images. Finally, they are combined to get a restored colour image. It is found that the quality of the image gets improved when the number of iterations are more. The restored images obtained with this approach are of good visual quality
with higher PSNR. The average time taken by this approach to restore the
degraded colour images is about 26 seconds, but the visual quality of the
image is about 3 db more than MLMNN.

The first technique, MRHNN restores images based on unsupervised
learning. The other two neural network based techniques MNN and CPN are
based on supervised learning. So, the only requirement for training is the
knowledge about the original noise free image. Once the training of the
network is completed, then the network can be used for restoration of noisy
images of different degradations.

7.2 FUTURE WORK

With the applications and development of soft computing, more and
more methods of fuzzy and neural networks have been developed to solve the
problem of removing noise from images. Recently, fuzzy neural network and
adaptive neuro fuzzy systems are widely applied in the area of digital image
restoration. They are used especially in filtering theory to remove system
distortion and impulse noises, smooth non – impulse noises and enhance
edges or other salient features of the image. For effective restoration of both
gray and colour images, new techniques based on fuzzy neural concepts can
be developed in the future.