Chapter 5

Conclusion
5.1 Conclusion:

The Hopfield network is one of the better known recurrent neural networks working as associative memory. The associative feature of Hopfield neural network has been used for storing and recalling of the graphical image patterns of English language alphabets. In this research work, there were two different set of experiments conducted. First set of experiment was to evaluate the performance of Hopfield neural network for static images with three different feature extraction techniques. In this set, Hopfield Neural Network of 900 neurons is considered for storage of 26 English alphabets. These English alphabets are considered in terms of static images. In second set of experiment we have optimize the Hopfield neural network for recalling process with sub optimal genetic algorithm.

The performance analysis of pattern storage networks has been evaluated for efficient storage and recalling for the presented prototype patterns. The traditional learning Hebbian learning has been used, which has a number of efficiency issues particularly related to the limited storage capacity and recall efficiency of the noisy prototypes. This can be taken care of by modifying the learning rule and also by adopting better methods of feature extraction. We have used three feature extraction methods namely Edge Dilation (ED), Fast Fourier Transformation (FFT) and Self Organizing Map (SOM). The hybrid learning rule has been proposed to improve the storage and recall efficiency of the Hopfield network. In this learning the characteristic of the standard Pseudo inverse rules and advantages of Hebbian rule such as locality and incremental learning are incorporated. It has been analyzed through the simulation design that the efficiency of the Hopfield network could be
enhanced with proposed hybrid learning rule instead of Hebbian rule and projection learning rule.

It has been observed that the Hopfield network performs better when the prototype patterns presented to it have been filtered through FFT and Edge Dilation (ED) methods. The two methods have almost the same results but FFT slightly outperforms ED. The proposed hybrid learning rule with considered feature extraction methods has been used to evaluate the performance of Hopfield neural network for static original images and their erroneous images.

It has been also observed that the self-organizing Map (SOM) performed with same efficiency and accuracy as the FFT and ED was performing in recalling process but the poor performance of SOM is exhibit for noisy images with respect to other two methods. The performance of SOM for preprocessed stimuli with ED exhibit more accuracy in recalling in comparison to FFT. The performance of pure FFT to make feature extraction for pattern storage and recalling is found best over the other two methods i.e. ED and SOM.

It has been also observed that as the error in original images reaches to 40% and above, the performance of recalling degraded rapidly and become constant for 40% to 50%. Thus only one or two images were correctly recalled. The recalling also degraded for 30% but more than 60% images were correctly recalled. The hybrid learning outperforms in comparison to pure Hebbian and projection learning for the noisy prototype images.

It has also been observed that the rate of occurrence of false minima in this network was quite high. When even 30% distorted patterns are entered into the
network, the network associates them to one of the pre-stored patterns, that they resemble the most. In this case also the FFT Filtered patterns produce more false minima than the ED filtered patterns. Hence the distorted or noisy patterns are associated to either their perfect counterparts or to some other patterns stored in the network.

It is being observed that the considered network is very large and the numbers of patterns are very low. Therefore the network traps in false minima during recalling process for presented prototype input patterns. The problem of false minima could minimize with the incorporation of genetic algorithm for recalling purpose. The proposed genetic algorithm starts from the weight matrix which has been constructed by the Hebbian rule. The aim is to enhance and modify the storage capacity and recalling efficiency of the network. Therefore the evolutionary searching (Genetic algorithm) has been incorporated with Hopfield neural network for effective and efficient recalling.

Hence during second phase of experiments, the genetic algorithm has employed from the weight matrix which has been constructed by the Hebbian rule. It is being observed that efficiency of genetic algorithm depends on the criteria of our fitness evaluation function. It has some variance in the mutation in sub optimal genetic algorithm that does not have any substantial impact in the performance of this algorithm but there is significant improvement is case of crossover (Local and global). In our proposed method the regression function was considered for the fitness function evaluation. Therefore, we have applied genetic algorithms for optimization of Pattern storage network in this research. The aim is to enhance the pattern association and recall efficiency of Hopfield Neural Network in such a way
that false minima are eliminated. The results from the experiment are done and quite encouraging.

It has been observed from simulation results for stored pattern with Hebbian rule, genetic algorithm perhaps better for recalling of presented input prototype patterns with noise from 10%, 20%, 30%, 40% and 50%. It is also being observed that the efficiency of genetic algorithm depends on the criteria of our fitness evaluation function. We have applied genetic algorithms for optimization of Pattern storage network whose aim is to enhance the pattern association and recall efficiency of Hopfield Neural Network in such a way that false minima could eliminated.

The results from the experiment are done are quite encouraging but still there is a need of further research in various scopes and dimensions to apply such concepts in pattern recognition of different types of objects, images etc. We can use this concept in future for various pattern recognition problems in SOM–Hopfield neural network to further improve the storage capacity and recalling efficiency.