

## Summary

The work presented in this thesis involves a study of optical character recognition techniques for Gujarati script using various Artificial Neural Networks architectures and wavelet transforms. A summary of the work presented in the thesis, in chapters 2 to 6, following the introductory first chapter is presented below:

- (a) Pattern recognition is a typical application of Statistical learning theory and includes the Optical Character Recognition as a specific area. Chapter 2 discusses the use of Statistical learning theory in pattern recognition problems and explains the architecture of a typical optical character recognition system. The chapter also discusses the complexities of Gujarati script for recognition and specifies how it differs from the Western scripts and from the other Indian language scripts. The current status of the work in Indian language OCR area is also presented.
- (b) A novel approach of approximation (interpolation) of a discrete finite length digital signal by using the Multiresolution Analysis techniques of Discrete wavelet transform [5] is presented in chapter 3. This technique (equation 3.2 of the third chapter) takes a finite length signal as an input and produces a new signal which is double in length as compared to the original signal. The new signal obtained here gives an approximation to the original signal. This process can have applications to extend available data sets of patterns for recognition. The method can be extended to two-dimensional signals like digital images. This extended method can be useful in generating more digital images for a glyph from given samples to aid in the development of the OCR systems.
- (c) Feature extraction and recognition are two major components of any Optical Character Recognition system. Chapter 4 is concerned with an application of wavelets for feature extraction and Multilayer Perceptron architecture of neural networks as classifier for digital images of Gujarati characters. The wavelet features are good in reducing the number of features while retaining the characteristics of the images. Multilayer

perceptron network architecture is then used for the classification of symbols of Gujarati script, constituting the lower and middle zone glyphs [3,4].

We have considered a non linear activation function in the hidden layer and a linear activation function in the output layer of Multilayer perceptron architecture of Artificial Neural Networks. Up on applying this architecture in the recognition of middle and lower zone characters of the Gujarati script, we have achieved the recognition accuracies of 94.46% and 96.32% respectively.

- (d) Chapter 5 explores the General Regression Neural Network (GRNN) architecture of Artificial neural network for Gujarati character recognition. This approach of ANN is a typical application of Statistical learning theory. Applying GRNN as a classifier for the printed Gujarati symbols of upper, middle and lower zones of the Gujarati script, we have achieved 84%, 97.59% and 97% of recognition accuracies [30]. These accuracies are found to be the highest as quoted in the literatures up till now for the Gujarati script.
- (e) Chapter 6 is concerned with the study and application of two kernel-based neural network architectures namely the Radial Basis Function (RBF) and Support Vector Machine (SVM). The chapter describes the various variants of the RBF networks and their advantages and disadvantages along with the experimental results as applied to the Gujarati character recognition. The later part of the chapter is concerned with the exploration of the SVM architecture, which is primarily a two-class classifier. A new approach of extending the SVM architecture to multiclass problems using the MAXNET network is described here. While the approaches quoted in the literatures like one-against-all, one-against-one, and DAGSVM are lacking uniformity of classifying two class problems and multiclass problems, the approach presented here is capable of handling multiclass problems as well as two class problems in a uniform way. This new approach provides the same number of optimal hyperplanes of pattern separation as the number of classes and is therefore uniform for two class as well as multiclass problems.