ABSTRACT

Pattern Recognition attempts to automate a class of perceptual and cognitive processes. Recognition of sensory data like speech, image or vision are major concern of Pattern Recognition. Artificial Intelligence includes knowledge representation, inference, search and learning among many other topics. Today, researchers in Pattern Recognition use techniques of Artificial Intelligence while on the other hand, major topics of Pattern recognition have become significant sub-fields of Artificial Intelligence.

Handwriting Recognition which is taken up as specific study in this work, is one of the most challenging area in Pattern Recognition. It is considered a Benchmark problem in Pattern Recognition. Recognition of handwritten symbols is trivial for human beings, but is still a very difficult task for present day computers both in terms of recognizing algorithms and time taken to recognize.

Handwritten symbols have vast variation in shapes, size, slant, thickness and connectivity between symbols due to writing habits, styles, education, region of origin, social environment, mood, health, posture adopted during writing and other conditions of writer. Recognition by computer gets further worsened due to variety of writing instruments, surface and scanning mechanism used to get the image of handwritten document.

Handwriting recognition includes signature, numeral, character, cursive word and phrase recognition. Automating handwriting recognition can be useful to solve many practical
problems such as recognition of postal address, amount on bank cheques, data on share forms, handwritten documents, signature verification and many other scientific, engineering and social applications. It, thus, forms part of a complex information processing system.

The thesis consists of research on off-line handwriting recognition with a view to make the process computationally less costly compared to existing methods. New algorithms are developed for signature verification, numerals, characters, words and phrase recognition. A modification is suggested in an existing variation measure which measures the amount of variation in a handwritten database.

Chapter 1 introduces handwriting recognition, the problems involved, methodology and fields of application. Work done by other researchers in the field of handwriting recognition is reviewed in Chapter 2. Chapter 3 forms the core part of the thesis by discussing the proposed techniques and its relation to the current research of handwriting recognition.

Section 3.1 includes a technique on signature search and verification using human perspective. Three models: 'Human', 'Machine' and 'Hybrid' are presented. These models take a global view of the signature samples and go down to the detailed view of signature samples. They start with width to height ratio of signature sample as a cursory view, followed by three different views of signature sample with increasing resolution as one looks at it more closely and finally have multiple Neural networks which give concluding decision. Neural networks are trained with model-selected training patterns and heuristic is used for faster
Section 3.2 discusses an approach for handwritten numeral recognition. Numbers are dilated and converted to two-line contour. Contour is divided into small segments which form two-directional primitive features. Higher level features are obtained by proper combination of these primitive features. Test rules are formed using size information, loop information, primitive features and higher features along with their fuzzy positional information. Certainty factor for each numeral is calculated using weights associated with each test and success value returned by a test.

A method to recognize handwritten Roman capital characters and numerals is detailed in Section 3.3. Characters are adaptively dilated to remove small variations as well as to enhance its overall shape. Centroid of the dilated character is found and is used as the center of the 2D character for normalizing it as a vector. Statistical mean and variance of each character class is obtained from training set of characters. Distance computation is done between an unknown character and each of the character classes to detect the character. Confidence values are found for each matching class to supplement word recognition process.

A technique for handwritten text recognition is addressed in Section 3.4. It is a hybrid approach using both holistic and analytical strategies. Words are divided into vertical segments and features are extracted from these segments. Features’ fuzzy values and relative positional information form word’s global representation. The matching word is found by comparing an
unknown word representation with the word representations in a word dictionary. Contextual information is then used to find matching phrase from a text dictionary.

Section 3.5 discusses development of a measure of variation in handwriting samples and how modification in 'Average Entropy Difference' variation measure, makes it more stable against rotation of frequency distribution. Variation value of real data test sets is evaluated by the proposed variation measure to investigate its effect on recognition rate of algorithms.

Experimental results for the algorithms along with data samples are given in Chapter 4. Discussion on experimental results and on proposed techniques in comparison to existing techniques is done in Chapter 5. Finally, Chapter 6 concludes the research work along with suggestions for the future enhancement.

Programs implementing the algorithms, are developed in 'C' language. Appendix I and Appendix II discusses some executable programs and Data Structures created during the research. A User Manual is provided to assist the use of these programs.