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A Review of Various Soft Computing Techniques in the Domain of Handwriting Recognition

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ABSTRACT

Handwriting recognition has been one of the most fascinating and challenging research areas in the field of image processing and pattern recognition in the recent year. Now a days the research work on handwriting recognition focusing toward evolving new techniques and methods that would reduce the processing time while maintaining higher recognition accuracy. A brief review of various Soft Computing Techniques involved in the process of Handwritten Words Recognition is described in this paper. The work done by other researchers in the domain of handwriting recognition by using Fuzzy Logic, Genetic Algorithms and Artificial Neural Networks is also reviewed and the outcome is discussed in terms of accuracy and speed.

Keywords- OCR; Soft Computing Techniques; Artificial Neural Networks; Genetic Algorithms; Fuzzy Logic

1. INTRODUCTION

This advancement of an automation process can improve the interface between man and machine in lots of applications. Finding out the addresses on envelope, signature verification, vehicle number plate recognition, credit card fraud detection, and automatic search of handwritten documents like historical documents are some of the applications of handwriting recognition. This is a very complex problem involving various issues like variability of someone's writing over time, different shapes and writing styles, isolated text or fully connected text and the similarity among characters etc. It's difficult to efficiently recognize the handwriting system having diversity in the input. There are situation when we have imprecise or insufficient input and optimization is the measure required for judging the efficiency of the handwriting recognition system.

The structure of this paper is as follows: Introduction to Handwriting is presented in section 2. In section 3 various soft computing techniques are described. Section 4

briefly elaborates the ways to solve handwriting reorganization problem using soft computing techniques and the work already done so far in this field. The paper is concluded in section 5.

2. HANDWRITING RECOGNITION

The two major classification of handwriting recognition is online and off-line. In the off-line recognition, the writing is usually captured optically by a scanner and the completed writing is available as an image. But, in the on-line system the two dimensional coordinates of successive points are represented as a function of time and the order of strokes made by the writer are also available. The online methods have been shown to be superior to their off-line counterparts in recognizing handwritten characters due to the temporal information available with the former.

A handwriting recognition system consists of image acquisition, preprocessing, segmentation, feature extraction and classification and recognition stages. Soft computing approach provides better solution for handwriting recognition problem than the traditional statistical approaches. The neural network concept can be used for the classification stage, which, is the decision making part of any recognition system and will use the features extracted in the previous stage. The neural network classifier can be used for classification in handwriting recognition problem. Fuzzy logic improves the recognition accuracy for the cases where ambiguous or imprecise data is used. The concept of genetic algorithm also helps in providing optimal handwriting recognition system.

3. SOFT COMPUTING TECHNIQUES INVOLVED IN HANDWRITING RECOGNITION

Therefore considering all aspects of handwriting recognition, soft computing techniques emerged to be best way for solving these types of problems. Soft computing (SC) is a branch, in which, it is tried to build intelligent and wiser machines. Intelligence provides the power to derive the answer and not simply arrive to the answer. The applications of Soft Computing have proved two main advantages. First, it made solving nonlinear problems, in which mathematical models are not available/possible. Second, it introduced the human knowledge such as cognition, recognition, understanding, learning, and others into the fields of computing. This resulted in the possibility of constructing intelligent systems such as autonomous self-tuning systems, and automated designed systems. The employment of soft computing techniques leads to systems which have high machine intelligence quotient (MIQ). It is the high MIQ of SC based systems that accounts for the rapid growth in the number and variety of applications of soft computing. One of the important features of SC is acquisition of knowledge or information from inaccurate and uncertain data. It is expected that combination or fusion of the elemental technologies will help to overcome the limitations of individual elements.

Soft Computing is defined as a collection of techniques spanning many fields that fall under various categories in computational intelligence. Soft Computing has three

main branches: Fuzzy Systems, Evolutionary Computation, Artificial Neural Computing. The rest of the section gives you the overview of all these branches

3.1 Fuzzy Logic

Fuzzy logic provides a simple way to get a definite conclusion based upon vague, ambiguous, imprecise, noisy or missing information of inputs. For that a fuzzy expert system is formulated which uses a collection of fuzzy membership functions and rules, instead of Boolean logic, to reason about data. The rules in a fuzzy expert system are usually of a form similar to the following:

if x is low and y is high then z = medium

where x and y are input variables, z is an output variable, low, high, and medium are fuzzy variables defined by membership functions (fuzzy subsets) defined on x, y, z respectively. The antecedent (the rule's premise) describes to what degree the rule applies, while the conclusion (the rule's consequent) assigns a membership function to each of one or more output variables. The set of rules in a fuzzy expert system is known as the rule base or knowledge base.

The basic operations of fuzzy reasoning are: (i) to compare the input variables with the membership functions on the premise part to obtain the membership values of each linguistic label, (ii) to combine the membership values on the premise part to get firing strength of each rule, (iii) to generate the qualified consequent (either fuzzy or crisp) of each rule depending on the firing strength, and (iv) to aggregate the qualified consequents to produce a crisp output.

3.2 Genetic algorithm (GA)

Genetic algorithm is one of the important and common under evolutionary algorithm class. It is a method for solving both constrained and unconstrained optimization problems that is based on natural selection, the process that drives biological evolution. The genetic algorithm repeatedly modifies a population of individual solutions. At each step, the genetic algorithm selects individuals at random from the current population to be parents and uses them to produce the children for the next generation. Over successive generations, the population "evolves" toward an optimal solution. Genetic algorithm can be applied to solve a variety of optimization problems that are not well suited for standard optimization algorithms, including problems in which the objective function is discontinuous, non differentiable, stochastic, or highly nonlinear. The three rules in GA’s are

- Selection- select the individuals, known as parents and that contribute to the population at the next generation.
- Crossover rules combine two parents to form children for the next generation.
- Mutation rules apply random changes to individual parents to form children.

3.3 Artificial Neural Network (ANN)

A complex structure of simple functioning bodies called Artificial Neurons has been tried to build as a simulation of Brain. Neural network is the study of networks consisting of nodes connected by adaptable weights, which store experimental

knowledge from task examples through a process of learning. The nodes of the brain are adaptable; they acquire knowledge through changes in the node weights by being exposed to samples. Artificial neural networks can be classified on the basis of:

a) Connection between neurons, (architecture of the network).
b) Activation function applied to the neurons.
c) Method of determining weights on the connection (learning method).

The advantage of ANN is that they are more like a real nervous system. The parallel organization of the system can give solutions to problems where multiple constraints have to be satisfied simultaneously. It is also a graceful degradation system because what it has learned has been distributed over the whole network. Neural Network is also insensible to noise and easier to handle, because it involves less human work than traditional statistical analysis. There is no competence in math, statistics or informatics.ANN has the ability to recover easily from distortions in the input data and their capability of learning. They are often good at solving problems that are very complex for conventional technologies. For example, they can solve problems that do not have an algorithmic solution or problems that an algorithmic solution is too complex to be found. Also, they are well suited to problems that people are good at solving. Neural networks learn by example. They have fewer errors because they can always respond to anything and small changes in the input normally do not cause a change in output. Also because of the parallel architecture, high computational rates are achieved. The ANN's have good scope of being used in the areas such as Air Traffic Control, Fraud Detection, Machinery Control, Medical Diagnosis, Music Composition, Staff Scheduling, Images and Finger Prints Recognition, Voice Recognition, Weather Prediction and Handwriting Recognition etc.

Apart from all these traditional techniques, the hybrid approach like neuro fuzzy or or fuzzy-neural hybrid are also in practice because it gets the benefits of neural networks as well as fuzzy logic system and it removes the individual disadvantages by combining them on the common features.

4. REVIEW OF RELATED WORK DONE

For the sake of clarity in the handwriting recognition field, in this section a brief review of the research work that is already available is presented. A number of review papers on off-line handwriting recognition have been published [1, 2, 3, 4].In their review, Steinherz, et al. [4] categorize off-line handwriting recognition systems into three categories: segmentation-free methods, segmentation-based methods, and perception-oriented approaches, in which the authors include as methods that perform similarly to human-reading machines using features located throughout the word. The authors did not compare the experimental results of approaches reviewed, as it was felt that the field was not sufficiently mature for this. However, the authors commented that one of the most integral components of a handwriting recognition system is related to the type of features used.

Systems for recognizing machine printed text originated in the late 1950s and have been in widespread use on desktop computers since the early 1990s. In [5], historical review of off-line character recognition research and development is mentioned. In the early 1990s, image processing and pattern recognition are efficiently and effectively combined with artificial intelligence and statistical technique (HMM) [6, 7].

G. Pirlo and D. Impedovo [8] presented a new class of membership functions, which are called Fuzzy-membership functions (FMFs), for zoning-based classification. These FMFs can be easily adapted to the specific characteristics of a classification problem in order to maximize classification performance. In this research, a real-coded genetic algorithm is presented to find, in a single optimization procedure, the optimal FMF, together with the optimal zoning described by Voronoi tessellation. The experimental results, which are carried out in the field of handwritten digit and character recognition, indicate that optimal FMF performs better than other membership functions based on abstract level, ranked-level, and measurement-level weighting models, which can be found in the literature.

M. Hanmandlu, O.V. Ramana Murthy[9] have presented in their study the recognition of handwritten Hindi and English numerals by representing them in the form of exponential membership functions which serve as a fuzzy model. Velappa Ganapathy, and Kok Leong Liew [10], they proposed a method in which first multi-scale neural training with modifications in the input training vectors is adopted to acquire its advantage in training higher resolution character images and then selective thresholding using minimum distance technique is proposed to increase the level of accuracy of character recognition. Saurabh Shrivastava and Manu Pratap Singh [11] describe the performance evaluation for the feed forward neural network with three different soft computing techniques to recognition of hand written English alphabets.

Yoshimasa Kimura presented [12] a work on how to select features for Character Recognition Using Genetic Algorithm. The author proposes a novel method of feature selection for character recognition using genetic algorithms (GA). The proposed method selects only the genes for which the recognition rate of training samples exceeds than the predetermined threshold as a candidate of the parent gene and adopts a reduction ratio in the number of features used for recognition as the fitness value. The handwriting recognition field has evolved in last decades and comes out to be new impetus to new researcher as the technology advances. Now a day, this field can have become a large business for many of industrial applications.

5 CONCLUSIONS

The various ways and approaches used for handwriting recognition problems during the last decades are surveyed in this research paper. This paper is also focussed on different soft computing techniques and use of these in handwriting recognition problems. This work proposes a model for applying Soft Computing techniques mainly neural networks or fuzzy set theory or Genetic Algorithms or their combinations for building intelligent handwriting recognition system.

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