A NAVAL APPROACH OF GRADIENT AND NON-GRADIENT SEARCH ALGORITHMS FOR SEGMENTATION OF HANDWRITTEN DATA

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Abstract—The paper shows an attempt of numerical simulation of a naval approach of both gradient (ANN) and non-gradient algorithms (PSO) on the cursive hand written data for its segmentation. The text of the cursive hand written data belongs to English language. The implemented method in the present paper shows a fast converging nature and found to be free from the mathematical difficulty of local minima. The data is processed thrice through the different algorithmic approaches in the order of neural networks, Particle swarm optimization and simulated annealing technique. Then each characters of scanned text image have been converted to the column vectors of 700 values which are then fed to neural networks linked to PSO and SA blocks. The efficiency of segmentation is with the help of PSO and SA is enhanced to 80% when compared to previously attempted research studies. Temperature term in simulated annealing is a significant parameter which being controlled carefully will make the solution towards global minimum. Two significant observations are found in the present numerical study one is the process is free from local minima and other is fast convergence.

Keywords—Neural networks, Particle swarm optimization, simulated annealing, pattern recognition

I. INTRODUCTION

The hand written data which is scanned is analyzed by using the computational algorithms to give the interpretation of the intelligible recognition. A good number of earlier studies have been carried out for the investigation of character recognition. In the present study a naval approach of both Neural networks and Particle Swarm Optimization is implemented. As combination is both gradient (ANN) and non-gradient (PSO) algorithms, the implemented approach may overcome some mathematical difficulties of processing method [1] [2]. By considering the combination of various number of the multilayer neural networks and different parameters of PSO, an efficient output in the present study is obtained [3].

The recent past publications reveal the application of hand written recognition through different techniques of algorithms in many languages like Telugu, Oriya and other languages [4]. The present approach is the combination which processes in a very efficient manner of getting high degree of accuracy. The various areas of applications of Particle Swarm optimization and neural networks like Real-time Face Detection, the Processing of Verbs and Nouns, Face Detection [5]. The implementation of PSO algorithms is executed with initial population methods, mooring pattern optimization, substitution ciphers and designing of reverse logistic networks has been proved to be an efficient technique in processing the analysis of hand written recognition. The modeling of handwriting recognition is implemented at various stages, analysis of segmented characters and handwritten text by using the combination of PSO and artificial neural networks [6].

In the earlier studies, artificial neural networks has been implemented for recognition and trained to extract the characters of various types of handwritings. The training the artificial with efficient supervised learning algorithm of back propagation algorithm results in fast learning [7]. Many research problems of pattern recognition are solved by single neural network. The present
The implemented technique is limited constraints to operate the technique for the extraction of characters of text and to make it into an editable information of scanned text [8].

II. METHODOLOGY

The objective of the proposal made in the paper is to innovate a new technique for recognition of handwritten data by artificial neural networks and particle swarm optimization algorithm. The process of segmentation of hand written data is executed with a novel approach of both gradient and non-gradient algorithms which is potential technique in extracting characters of the words from the handwritten text inputted as matrix form of an image. The scanned data in the form vectors has been an input to neural network algorithm. The output generated by neural networks is again processed by PSO algorithm in which the values of fitness provides provide characters in handwritten data in the model of recognition. The hand written data which is scanned has been given to the ANN as an input. The image is converted to matrix form of pixel having the value from 0 to 255. The document is read into the ANN and output is again processed by PSO algorithm as by directed by the flow chart.

In the PSO system, a swarm of individuals called particles fly through the search space. A population of individuals adapts stochastically towards successful regions in the search space and is influenced by successes of their topological neighbors. Each particle in the population represents a candidate solution to the optimization problem. Two variants of PSO algorithm are developed: one with global best which is the best particle connecting all members of the population to one another and the other variable with the local best which is conceptually seen as the ability for particles to remember past personnel successes. The particles in the solution space are affected by the best particle and the best solution.

2.1. Artificial Neural Networks

The basic equations that governs network functions are as follows. For linear neurons in the input layer, 
\[ f(x) = x \]
and for sigmoid neurons in the hidden and output layers, 
\[ f(x) = \frac{1}{1 + e^{-\lambda x}} \text{ where } \lambda = 1 \text{ typically} \]
set of Q training vector pairs: \( \tau = \{(X_k, D_k)\}_{k=1}^Q \) \( X_k \in \mathbb{R}^n, D_k \in \mathbb{R}^p \) where \( D_k \) is a vector response desired when input \( X_k \) is presented as input to the network.

2.2 Particle Swarm Optimization

The performance of each particle is measured by using a fitness function defined by the user in the optimization problems. Each particle in the swarm is represented by the following characteristics’.

- \( x_i \): The current position of the particle.
- \( v_i \): The current velocity of the particle.
- \( y_i \): The personal best position of the particle.

The \( i^{th} \) particle in the population is represented by as, 
\[ v_i = (v_{i,1}, v_{i,2}, ..., v_{i,n}) \]
The rate of position change (velocity) of the particle is represented as 
\[ v_i = (v_{i,1}, v_{i,2}, v_{i,3} ... , v_{i,n}) \]
Where D is the dimensionality of the problem.

On each interaction the velocity for each particle is updated by the equation:

\[ v_{ij}(t+1) = \omega v_{ij}(t) + c_1 r_1 j(t) - x_{ij}(t)) + c_2 r_2 j(t) \left( y^*(t) - x_{ij} \right) \]

The position of the particle is updated by the equations,

\[ x_{ij}(t+1) = x_{ij}(t) + v_{ij}(t+1) \]

Where \( y^* \) is global best and \( y^*_0 \) is local best and where \( \omega \) is initial weight, \( C_1 \) and \( C_2 \) are acceleration constants and \( r_1, r_2 \) are generated by uniformly random number generator within (0, 1) range.

2.3. Simulated Annealing Technique

The equation that drives simulated annealing, with the Boltzmann constant. Therefore, the probability of accepting a worse state is given by the equation [9].

\[ P = \exp(-c/t) > r \]

Where

- \( c \) = the change in the evaluation function
- \( t \) = the current temperature
- \( r \) = a random number between 0 and 1

The probability of accepting a worse move is a function of both the temperature of the system and of the change in the cost function.

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**Figure 1** Original cursive handwriting

**Figure 2** Data divided into the groups

**Figure 3** The segmented data

**Figure 4** Schematic diagram for ANN, PSO and SA algorithms
Steps followed in the study.
1. Initialization: Selecting the output of the neural network feed it to the initial population for the Particle swarm optimization.
2. Fitness function is computed.
3. Adjusting the position and velocity: For the correlation coefficients less than the threshold value 0.05 repeat the step
4. Evaluation of particles with fitness as directed of the assigned value
5. The fitness function is verified by SA techniques to overcome the difficulty of local minimum problem.

Figure 5. Convergence variation of PSO with SA

Figure 6. Variation of temperature in SA

Figure 7. Error analysis in simulation
III. RESULTS AND DISCUSSION

The rate of convergence is accelerated with combination of particle swarm algorithm as it is non-gradient nature. The purpose of implementing the simulated technique in the work is to avoid the local minimum effects. The figures1 to figure7 show the methodology and variation of parameters in simulation along with error analysis. The combination with simulated annealing algorithm also excels the degree of accuracy in the present proposed method of segmentation. The enhancement in the accuracy is found to be 80%. The results simulation clearly reveal the suitability of the combination with PSO and SA algorithms as the techniques are of different potentiality in driving the processing technique in the accelerated convergence and making the simulation environment free from local minimum effects. The comparison of results with and without combination of PSO reveals the rate of convergence in producing the output. Simulated annealing technique is operated to minimize the local minima that generally encountered in execution of iterative algorithms especially in gradient search algorithm. The gradual decrease of temperature parameter causes the solution towards the global minimum.

IV. CONCLUSIONS

The paper has presented an innovative technique of extracting the characters in the process of segmentation of cursive handwritten data with a unique and robust technique of hybrid approach of artificial neural networks, particle swarm optimization and simulated annealing algorithm. On simulation and results, a very high efficiency is found. The task of recognition and extraction of characters in segmentation is made easy with present proposed method. High degree of the accuracy in segmenting the data is noted in the present study. The significant observations and findings in the study are fast convergence, freeness from local minimum and high degree of accuracy.

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