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Offline Handwritten Character Recognition using MLPNN and PSO Algorithm

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***Abstract*—Classical techniques are not flexible and adaptive for new handwriting constraints. Offline handwritten character recognition for English alphabets has been proposed in this paper. The proposed system uses three layer feed forward neural network and optimized the weight using PSO algorithm. The proposed system works well with benchmark dataset from C.E.D.A.R.**

I. INTRODUCTION

Handwriting has been a method to convey and solidify information from ages. Anything before handwritten history is classified as pre-history. Handwritten text was codified into symbols which were combines using rules of linguistics to form higher level entities.

Character recognition has been an active area of research in the field of pattern recognition and machine intelligence. Accuracy of character recognition depend factors like

A. Method of Data Acquisition:Offline and Online.

B. Type of Text: Handwritten or Machine Printed.

Offline data acquisition here refers to data acquired using Optical scanning of handwritten or machine printed text. On-line refers to data acquired by writing using a digital pen on a digitizer screen. In online-data acquisition method, the data storage requirement is less as temporal data is stored i.e. the consecutive co-ordinates of the trajectory are stored as a function of time whereas in offline the complete scanned images is stored.
The reported accuracy of on-line character recognition techniques are higher than offline [1].

Figure 1 Image of Handwritten character from standard data set

II. RECOGNITION SYSTEM

A. Image Acquisition

The recognition system takes a scanned image of handwritten text as an input image. We have used benchmark data set i.e. from CEDAR(Center for Excellence in Data Analysis and Research) in Buffalo University, USA [2]. We have used 30 samples of each characters in .png format.

B. Pre-processing

Pre-processing is a sequence of morphological operations employed to enhance the features of an image. We have converted an RGB image to grey scale and employed grey scale to binary format using binarization with global thresholding method [3]. We have used a global threshold of 0.5.

C. Normalization

It is the process of equating binary array so as to extract the featured. We have cropped the image and reduces the size to fit it into 80X50 array.[4] [5]

D. Thinning

It thins objects to lines. It removes pixels so that an object without holes shrinks to a minimally connected stroke, and an object with holes shrinks to a connected ring halfway between each hole and the outer boundary. This option preserves the Euler number.[6]

E. Feature Extraction

Mean method is used to extract the features of the character. It takes the sum of all the 1s pixel and divides them with the number of pixels in each box.

III. CLASSIFICATION AND RECOGNITION

It is the most important part of the recognition process. Its accuracy depends on the quality of features. We have used artificial neural network i.e. a feed forward neural network for recognition process. It is a supervised neural network with weights optimized using PSO algorithm.

Neural network provides robustness, fault tolerance and parallel processing ability. It is a three layer feed forward neural network architecture used to recognize handwritten English characters.

```
nClass = 52; % number of classes
code = 1:nClass; % code of each class
result = zeros(nClass*(nClass-1)/2,size(features,2)); % result of each NN for each case
k = 1;
hbar = waitbar(0, 'please wait...');
for i = 1:nClass-1 % from each class
  for j = i+1:nClass % to each class
    tmp = sim(nets{k},features); % test feature on NN
    idx = tmp(1,:) > tmp(2,:);
    result(k,idx) = code(i); % if true , feature belongs to ith class
    result(k,~idx) = code(j); % else , feature belongs to jth class
    waitbar(k/size(nets,1),hbar);
    k = k+1;
  end
end
close(hbar);
result = mode(result,1); % maximum frequent class
```

The algorithm employed to recognize a character.

A. *PSO Algorithm*

Particle swarm optimization algorithm [7] [8] has been used to optimize the weights employed to train the neural network. It is a meta-heuristic algorithm but multiple training sessions result into optimal candidates.

```
function [net,wb] = psonn(inputs,targets)
% net = gann(inputs,targets) returns a feed forward neural
% network, with optimized weights and bias values for given input and
% target with Genetic algorithm.

% Creat a Feedforward Neural Network
net = feedforwardnet([6 6 6]);
% Configure for input and output
net = configure(net,inputs,targets);
% Calculate Number of Variables to Optimized
wb = getwb(net);
nvars = size(wb,1);
% Apply PSO

fcn = @(x) objective(x,net,inputs,targets);
wb = pso(fcn,nvars,[-1.*ones(1,nvars)],[ones(1,nvars)]);

% Apply New Weights and Biases to Network
net = setwb(net,wb');
end
function mse = objective(x,net,inputs,targets)
% Apply New Weights and Biases to Network
net = setwb(net,x');
% Evaluate
y = net(inputs);
% Calculate MSE
mse = perform(net,targets,y);
end
```

Here global constants C1 and C2 are used as prescribed by PSO method. A population of 200 particles is created and maximum 200 iterations can be applied to find the best candidate solution. These values of N and maxiteration are purely based on hit and trial as in genetic algorithm. Mean Square Error method is used to reduce the error in the neural network. Activation function used is sigmoidal. Gradient descent with adaptive learning is used as learning algorithm.

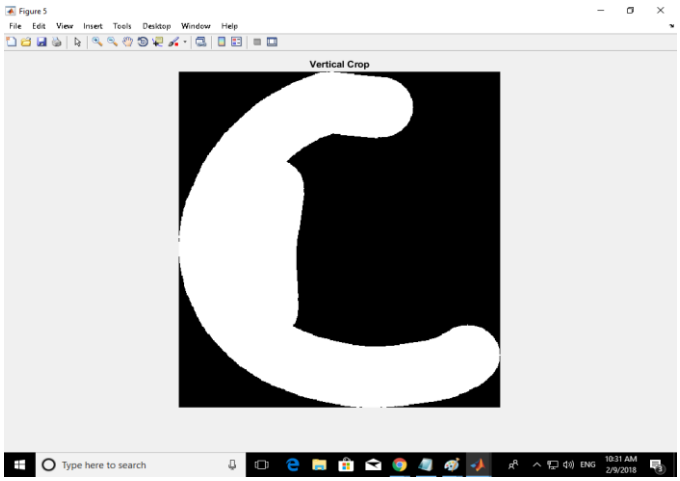

Figure 2 Vertical Crop of Character C

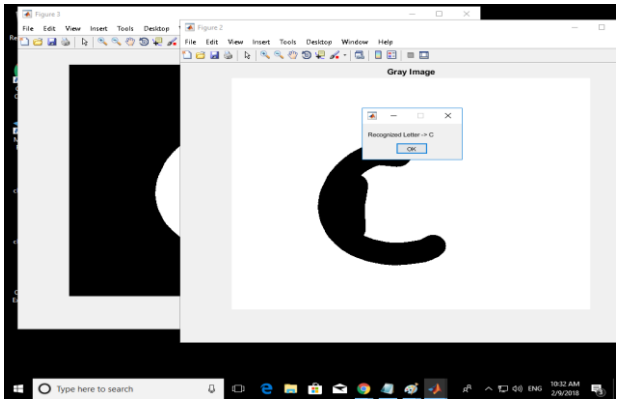

Figure 3 Recognized character Result

IV. RECOGNITION RESULT AND CONCLUSION

The neural network with 52 classes output node of 6 training algorithm gradient descent and mean square error function is employed to achieve an accuracy of 83.8462%. The network can be trained repeatedly to achieve even higher accuracy of character recognition. The result is comparable with other state of art methods of offline handwritten character recognition.

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