PRESENTING A METHOD BASED ON BACK-PROPAGATION NEURAL NETWORK FOR RECOGNITION OF HANDWRITTEN DIGITS

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Abstract

Recognition of Persian handwritten numbers has a wide application in most centers, which deal with the collection of numerical information from public such as reading the amount of check, zip code, etc… The purpose of this article is to present a set of new data for training neural network. The features applied are the study of image dents from four up, down, left and right views. In this article, the recognition of handwritten figures is done by back-propagation neural network. The reason why this model of neural network has been selected is that it could solve highly nonlinear and control problems. Tests done on database of HODA handwritten digits indicate recognition of 91.53%.

Keywords: Handwritten Farsi digits, Feature Selection, back-propagation, HODA Dataset.

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1. Introduction

In few recent decade, recognition of writing patterns including letters, handwritten digits and other common symbols in written documents in different language, by various groups of researchers has been studied [1].The results of such researches lead to the creation of set of quick and to some extent certain methods is called OCR. This set is used in order to enter existing information in documents, evidences, and books and other printed or typed and even handwritten written, into the computer [2].

Using a recognition system of handwritten digits faces same problems functionally, which the most important of them is the necessity of increasing the recognition rate. In the area of Persian language, concerning many similarities between digits as well as the different in drawing ways, establishing a recognition system with acceptable accuracy, faces some problems. So, it is necessary to develop the methods that improve accuracy. In the domain academic study, there are many published thesis and essays that most focus on the presentation of the methods for internal segmentation, processing and letter recognition; and least focus on the other parts including pre-process, post-process and internal segmentation. In the present study, HODA data set, which many researchers rely on, is used.

HODA database, which is the first dataset of handwritten Farsi digits, includes 102353 samples of black and white handwritten samples. This dataset have been developed during a M.Sc. project regarding the recognition of handwritten forms [3]. The dataset have been extracted from about 12000 registration forms of M.Sc. university entrance exam of 2005 and the continuous B.Sc. Entrance exam of Comprehensive Applied & Science University in 2004. You can see samples of this set in figure 1. The characteristics of this dataset are described in the following:

Resolution of sample: 200 dot per inch

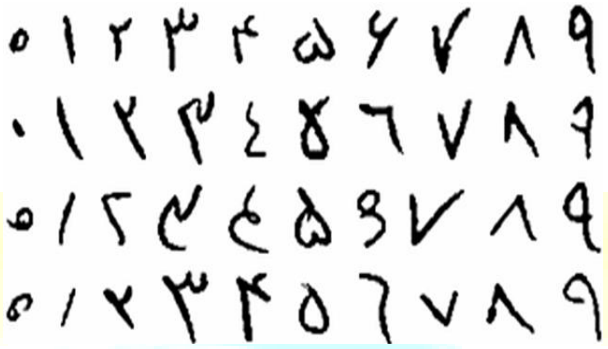
Total number of samples: 102352 samples

Number of education samples: 6000 sample of each class

Number of test samples: 2000 sample of each class

Other samples: 22352 samples

Figure 1: Different set of handwritten digits of HODA



The article structure is as follows:

In the second part, we have done a review on the related works. In the third part a pre-processing is presented to make similar set of numbers. In the fourth part, a set of characters of each digit is extracted, in the fifth part, the back-propagation neural network model is described as it has been used, in the sixth chapter the results from implementation of the proposed method is dealt with, and in the final part, the conclusion and summary are brought up.

2. Related works

Recognition of handwritten letters and digits has been always one of the interesting subjects for research. Many works have been also done on recognition of Persian and Arabic handwritten letters and digits.

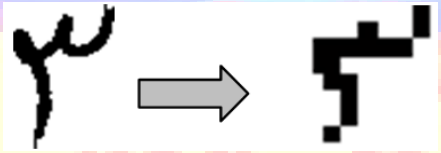
In research done by Sabri and Awaida has presented a system for automatic independent writer off-line handwritten Arabic (Indian) numeral recognition, based on a quasi-multi-resolution approach to feature extraction using SVM. The achieved average recognition rates were 99.83% .SVM recognition rates were better for all the digits [4]. In the research conducted by Darvish et al, shape matching algorithm has been used for recognition of Persian handwritten digits. For each point sampled on the contour of a shape, a descriptor is achieved based on spatial distribution of other points of the connector [5]. In another research, have suggested a method for improvement of the recognition system's operation. The main idea of the method suggested by them is the use of binary classifiers [6]. In another research, have presented a method based upon genetic algorithm for formation of a neural network group using a weighted classifier selection method based on vote [7]. The research conducted by Shahabi

and Rahmati has made use of Gabor filter bank proper for the structure of Persian handwritten texts and visual system [8]. In another work by Mr. Parvin et al, binary classifiers have been used for reinforcing this group of classifiers. Due to its higher accuracy, this group can decrease the rate of error in feature space [9]. In a research by Azmi and Kabir, moment features and Bayes' classifier have been used for recognition of Persian handwritten letters [10]. Masroori and Pour-khmene has made use of dynamic time wrapping algorithm for recognition of digits [11].

3. Pre-processing Step

Preprocessing consists of two stages of making figures size identical and framing each digit to be transformed into much less pixels. Identicalization is done through converting all figures to 90 rows and 70 columns of pixels. In addition, each frame size has been considered to be 10×10. The considered frame is moved on the image. If there are more than 40 bright pixels in each area, the pixel quantity is black; otherwise, white pixel is reflected back. So that (based on figure 3), a 90×70 image is converted to 9×7.

Figure2: Preprocessing & normalization of handwritten digit of three



4. Feature Extraction

We put together dents of each figure in four possible directions (left, right, up and down) and attain a dataset with 32 features for each digit (Figure 3). You can see the feature vector of number 3 in table 4.

Figure3: Image view of number 3 from four directions

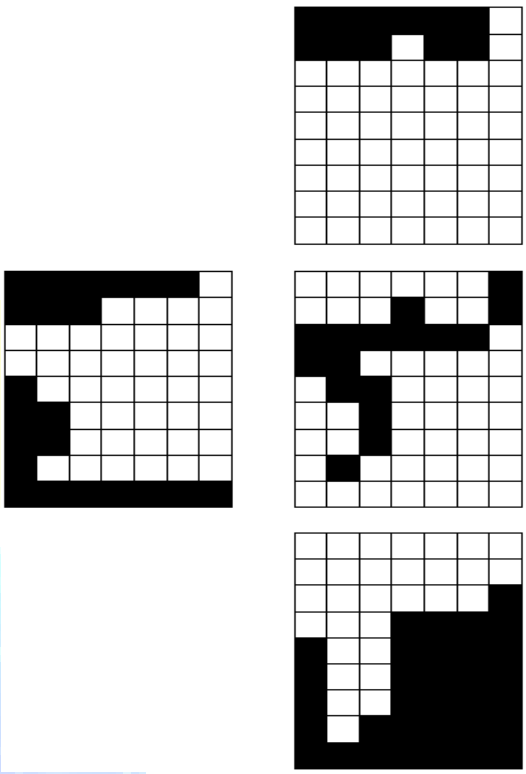
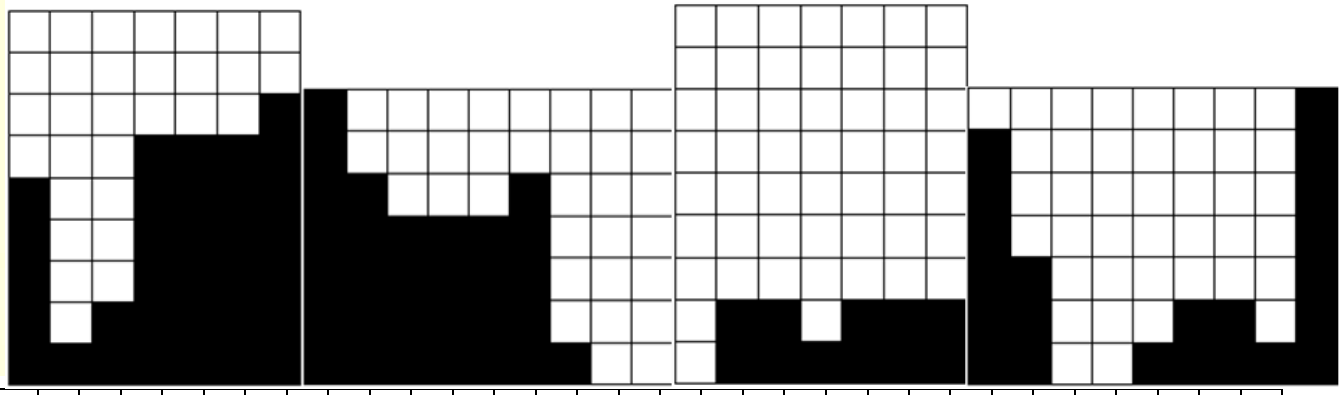


Figure4: Extracting feature vector from the image of digit '3'



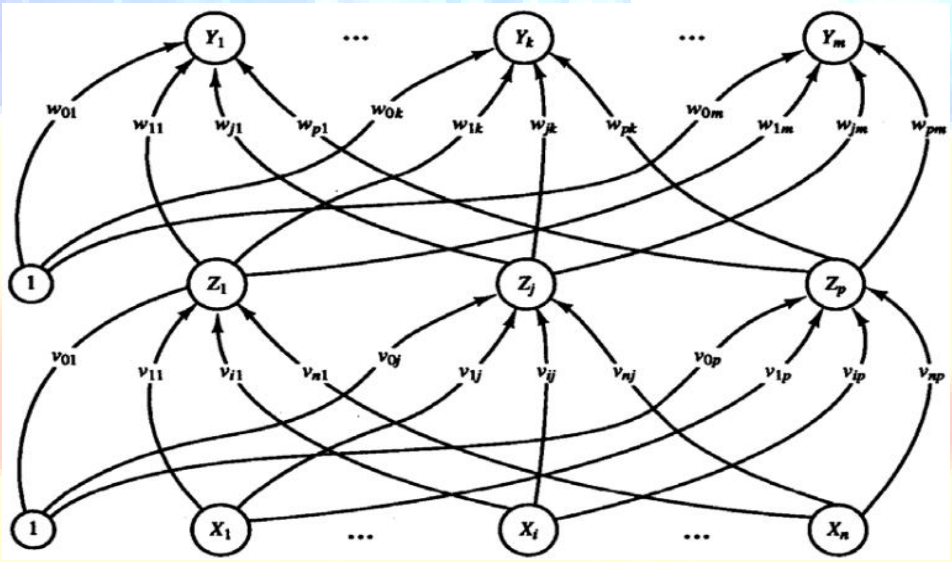
5	1	2	6	6	6	7	7	5	4	4	4	5	1	0	0	0	2	2	1	2	2	2	6	3	0	0	1	2	2	1	1

5. Back-Propagation Neural Networks

There are so many methods for training network and outbancing the weights so as to reach a significant error. One of the most famous of these mehtods is error back propagation algorithm. This algorithm which was proposed by Rommel Hart & Mac Kelly Land in 1986, are applied in feed forward neural network. Feed forward means that artificial neural neurons

have been placed in successive layers and send their output (signal) forward. Morover, the word "backpropagation" spells that the erorr is fed back into the network to outbalance the weights and to, then, reiterate the entrance to its in-route down to the exit. The backpropagation procedure on errors is one of supervisory methods which means that: the in-specimen have been tagged and the out- ones expected of each of them are already known. As a result, the network's output have been compared against these idealized exits simply inorder to calculate the error on the network. The network's weights are supposed to have been opted randomly in this algorithm from the word go. The network's output is calculated in each step to be corrected according to its discrepancy with the idealized output so much so that the said error comes down to its minimal at the end [12].

Figure5: The backward propagation network architecture (the entrance layer being X, the hidden layer being Z, and the exit layer nominated Y. w and v are weights inside the network)



As to the continuation of this work, algoritsms relating to the backpropagation neural network (figure 6) and the recognition of the pattern under evaluation in this type of network (figure 7) have been presented [13].

Figure6: Back-propagation network educational algorithm

Step 0. Set σ, α
Initialize Weights W and V with small random values
n: Input
p: Hidden units
m: Output units
Step1. While MSE done reach to a small value or for many times do step 2 – 10
Step2. Set X as input neurons
Step3. Find Zin , Z
For (j=1..p)
$Zin_j = \sum_{i=0}^{n} X_i V_{ij}$
$Z_j = f(Zin_j)$
$Z_0 = 1$
Step4. Find yin, y
For(k = 1 .. m)
$Yin_k = \sum_{j=0}^{P} Z_j W_j k$
$Y_k = f(Yin_k)$
Step5. Find δK_k
K = 1 .. m
$\delta K_k = -[t_k - y_k].\sigma.y_k(1-y_k)$
Step5. Find δj_j
j = 1 .. p
$\delta K_k = (-\sum_{k=1}^{m}(\delta K_k W_{jk}) . \sigma . Z_j . (1 - Z_j))$
Step7. Find ΔV_{ij} by:
i = 0..n, j = 1..p
$\Delta V_{ij} = \alpha . \delta J_j . X_i$
Step8. Find ΔW_{jk} by:
j = 1..p, k = 1..m
$\Delta W_{jk} = \alpha . \delta K_k . Z_j$
Step9. Find V_{ij} by:
i = 0..n, j = 1..p
$V_{ij} = V_{ij} + \Delta V_{ij}$
Step10. Find W_{ij} by:
j = 1..p, k = 1..m
$w_{jk} = w_{jk} + \Delta w_{jk}$

Figure7: algorithm to test a sample (in the very stage of bein tested) inside the neural network

Step0. Set σ, α
Initialize Weights W and V with small random values
n: Input
p: Hidden units
m: Output units
Step1. Set X as Unknown Pattern
Step2. Find Zin, Z
For (j = 1..p)
$Zin_j = \sum_{i=0}^{n} X_i V_{ij}$
$Z_j = f(Zin_j)$
$Z_0 = 1$
Step3. Find yin, y
For (k = 1..m)
$Yin_k = \sum_{j=0}^{P} Z_j W_j k$
$Y_k = f(Yin_k)$

6. Actualization Results

4500 samples of the data set of Hoda were extracted prior to the start of the simulation, the entrance data having been classified into two groups by us:

1. Educational Data: these were employed from among the lable data. Of the total number of 3000 of specimen data (i.e., around 67%) were selected at random, having been put to use as educational data. Upon the network having been educated by these data, the weights found their final measure so that the network came down to the lowest possible minimal of 3.2237 error.
2. Experimental Data: the network having been "taught" to rich its minimal level of "mistake-making", the rest of the data (1500 samples) which played no role in education, were fed into the network. And the network's respond can be compared with the desired response (the tagged ones). Thus, the network efficiency is evaluated. The results coming from actualisation have been presented in Table 1. The measuring output on the part of the algoritm parameters on the occasion of back-propagation have been shown in Table 2, too.

Table1: Results of performance and amount of correct examined samples of each class

digit	Number of correct examined samples	Number of incorrect examined samples	percentage of correct examination
0	141	9	94%
1	135	15	90%
2	126	24	84%
3	121	29	81%
4	142	8	95%
5	144	6	96%
6	137	13	91%
7	141	9	94%
8	149	10	93%
9	146	4	97%
sum	*1357*	*143*	*91.53%*

Table2: Value of used parameters

variable	Initial value
σ	2
α	0.5
n	32
p	24
m	10
Number of execute algorithm	100000 times
Wight amount (v,w)	Random amount between 0 and 1
Number of layers	3
Used sigmoid function	$f(x) = 1/(1 + e^{-x})$

7. Conclusion

It was on the Hoda data set that the suggestive algoritms set were downloaded, put into practice, and assayed. The number of neurons in the hidden layer was spotted (24 neurons) trough the method of trial-and-error. The average bundling came out to be 100% for the educational data, and about 92% for experimental data.

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