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Hand-written Urdu Numerals Recognition Using Kohonen Self Organizing Maps

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Abstract-Urdu is one of the widely spoken languages in the world. This paper presents utilization of Kohonen Self Organization Maps for hand-written Urdu numerals. A dataset of hand-written Urdu numeral, comprises 6200 numerals, was collected from undergraduate students. Half of this data set was used for training a 10 by 10 Kohenen Self Organizing Maps. The trained clusters of the Self Organizing Maps were assigned with labels manually based on the visual appearance. The whole data set was then used for testing the trained Neural Network. Results demonstrated promising performance of the proposed scheme.

Keywords: Numerals recognition, Kohenen Self organizing maps, Neural networks, Urdu.

1. INTRODUCTION

Urdu is the national language of the country of Pakistan. The other official language is English. Urdu is a language that is deeply linked to the Muslim religion, and there are around 65 million speakers of Urdu worldwide. Moreover Urdu is spoken in other renowned countries including the UK, the US, Saudi Arabia, and Bangladesh.

Character recognition is basic and vital in the field of recognition and is one of the most challenging fields of research in computer sciences. It identified a number of useful applications. It has dense areas of research because of the increase in computer interaction and humans. There are millions of people around the world who are interested in Hand written applications and in the past few decades great character development and progress has been achieved. This paper focuses on recognition of hand-written Urdu numerals which has applications in various fields including automatic number plate recognition, cheque processing, visiting card reading etc. **(Fig. 1)** shows the set of Urdu numerals. The following paragraph highlights some of the closely related work from the literature. Research on Arabic text is also included due to the close resemblance in structure with Urdu language.



Fig. 1 Urdu Numerals

The authors in (Al-Ohali *et al.,* 2003) have collected a comprehensive database for arabic hand written cheques. Their work emphasizes on some of the important features of the Arabic language, and they have proposed various methods for the construction and completion of these databases, together with segmentation, binarization and data tagging. It also includes a comprehensive description of the organization and first-class database distribution. The main purpose of these databases is to make it easy for the researchers to identify the various ways the experiments are conducted, assist them in the recognition field and compare the experimental results obtained from various recognition methods. A feed-forward network based method has been proposed by (Matan *et al*., 1995) for handwritten numbers recognition. It is an advance extension of recognition of isolated digits. In this architecture, a single numeric identifier is copied to the input. The output layer of the network is coupled to a Viterbi alignment module that picks the finest analysis of the input. Viterbi training module is used for the error propagation. In this whole process, the new feature is the function to do division in the space displacement neural network (SDNN) development, instead of using Input (pixels) spatial scale. A multi-level artificial neural network based method has been proposed by (Uddin, 2014) for Bengali hand written text recognition. For more accurate results, the text Sorborno and Banjonborno (the Bangla alphabets) were analyzed by its shape and features. The author (Al-Tanni, 2005) has presented an effective method of structural online hand written Digits Recognition system. The author has used slope estimation and normalization methods after reading the hand written Arabic digits from the user. The digits are identified and extracted based on the slope values.

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(Knerr S *et al.,* 1992) have described that a single train neural network classifier may be effectively applied to complex real classification problems, such as recognition of handwritten numbers. They have used the STEPNET practice, which breaks the bigger problems down into simpler sub-problems which are able to be resolved by linear separators. Results from two different databases: a European data base, including 8700 isolated digits, zip code database from the United States Postal Service that includes about 9000 segmented digits, were presented. A novel segmentation method for Arabic text recognition system was proposed by (Altuwaijri and Bayoumi, 1994). To achieve better performance, the Arabic character set is decomposed in four sets. The reason for decomposing the character set into subsets is to divide the bigger problem into sub problems; to achieve robustness. Some more closely related work is word spotting using dot orientation by (Shafi *et al.,* 2013) , the use of support vector machines by (Sagheer *et al.,* 2010*)* , connected component analysis by (Sagheer *et al.,* 2010) and lexicon reduction method proposed by (Wshah *et al.,* 2010).

The remaining sections of the paper are structured as follow: section 2 gives a general idea about the self organizing maps, its topology and architecture, as well as discusses the data set collection and pre-processing. Section 3 presents results while section 4 concludes the paper with future directions for research.

2. MATERIAL AND METHODS

2.1 Kohonen Self Organizing Maps

Kohonen Self Organizing maps introduced by Kohonen (1982,1990,1998) , also known as topology preserving maps is a type of unsupervised neural networks that works on principle of competition among competing neurons. During the self organizing phase, the cluster whose weight vector matches the input pattern is chosen as winner. The winner and its topological neighbours are then allowed to update their weights. The cluster units may be organized as linear, rectangular gird or hexagonal grid as shown in Figure 3. Usually, random weights are assigned initially and the learning rate alpha and neighborhood radius are allowed to decrease slowly as function of time. The initial weights may be set to reflect the prior knowledge.

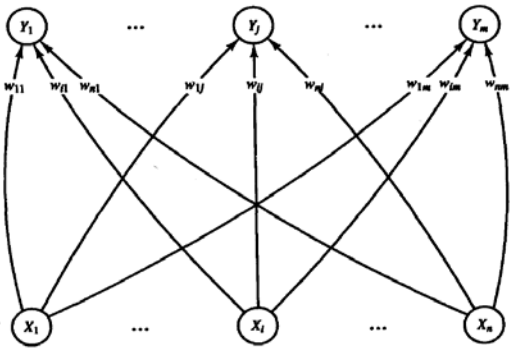


Fig. 2. Self Organizing Maps Architecture

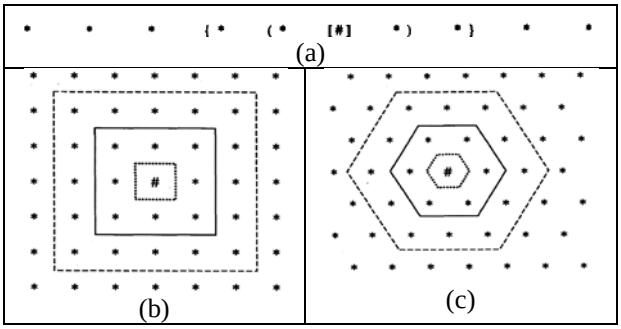


Fig.3 Topological Arrangements of Clusters (a) Linear (b) Square (c) Hexagonal

Following is the algorithm for training a typical self organizing map

Step 0. Initialize weights w_{ij} .

Set topological neighborhood parameters.

Set learning rate parameters.

Step 1. While stopping condition is false, do steps 2-8.

Step 2. For each input vector x, do steps 3-5.

Step 3. For each j, compute:

$$D(j) = \sum_i (w_{ij} - x_i)^2$$

Step 4. Find index ***J*** such that ***D(J)*** is a minimum.

Step 5. For all units j within a specified neighborhood of J , and for all i:

$$w_{ij}(new) = w_{ij}(old) + \alpha[x_i - w_{ij}(old)]$$

Step 6. Update learning rate.

Step 7. Reduce radius of topological neighborhood at specified times.

Step 8. Test stopping condition.

2.2 The Data Set And Pre-Processing

The dataset was collected from undergraduate engineering students. They were asked to write 5-7 lines of Urdu numerals on A4 sheets. To minimize biasness, they were not aware of the purpose of writing these numerals**. (Fig.4)** shows an example data collected from student. Each digit was then cropped. The cropped digit was thresholded to get a binary image and the binary values were complimented so that the background becomes black and foreground is white. These images were resized to 32 by 32 pixels in such a way that the right extreme points of the foreground are one pixel away from the border. **(Fig. 5)** shows a cropped digit and a final resized image. Each of the imageswas named such that the identity of the writer and digit number is visible. The authors feel this naming convention may be better for utilization of the data set for future research such as hand-written styles etc.

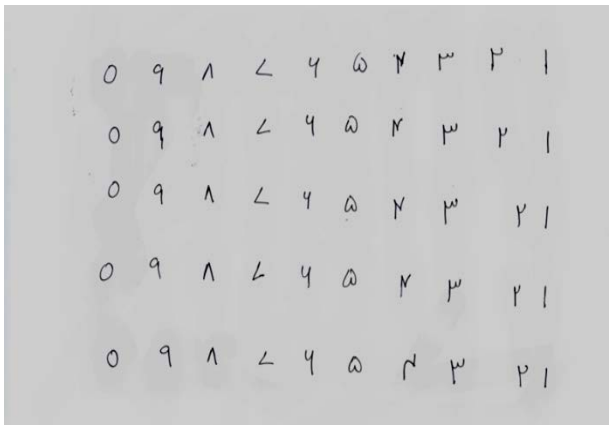


Fig. 4 Sample Collected Data

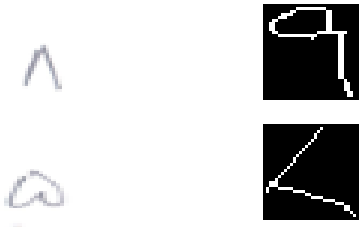


Fig. 5 Pre-processing (a) Cropped Image (b) Pre-processed Image

3. RESULTS AND DISCUSSION

A self organizing map of 10 by 10 rectangular grid was selected as shown in figure 6. The weights were unitized randomly. Partly the data set was applied as input to the neural network. The ANN converged after 2000 epochs. Figure shows the slowly converges of the ANN. Manual labels were assigned these organized. The trained ANN was tested for the whole dataset and the results demonstrated a promising efficiency of 91%.

(Fig. 6, 7 and 8) show the random initialization of weights and how the maps converge with increasing number of epochs. **(Fig. 9)** shows the final converged clusters.

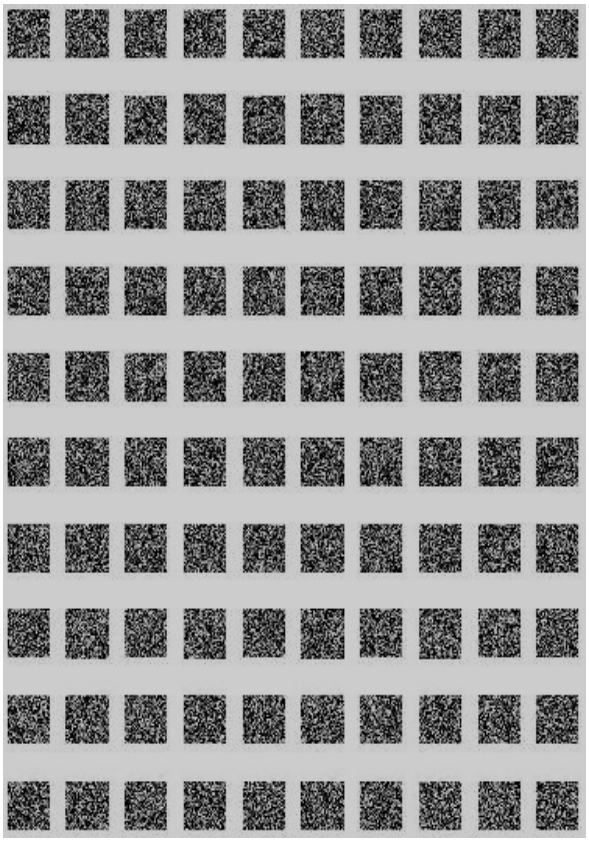


Fig.6 First Iteration

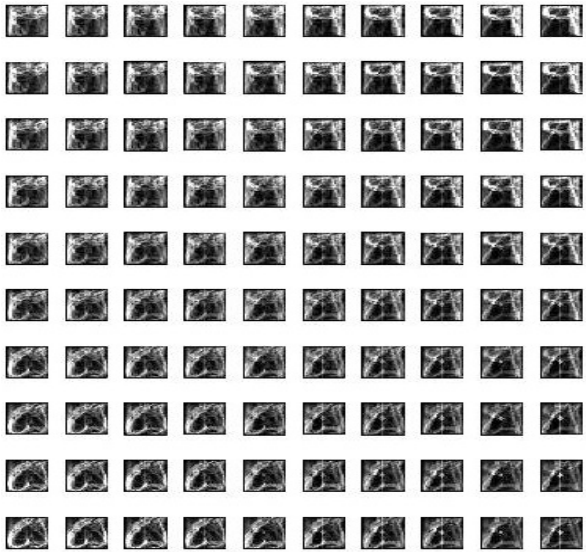


Fig. 7. 100 ephoc

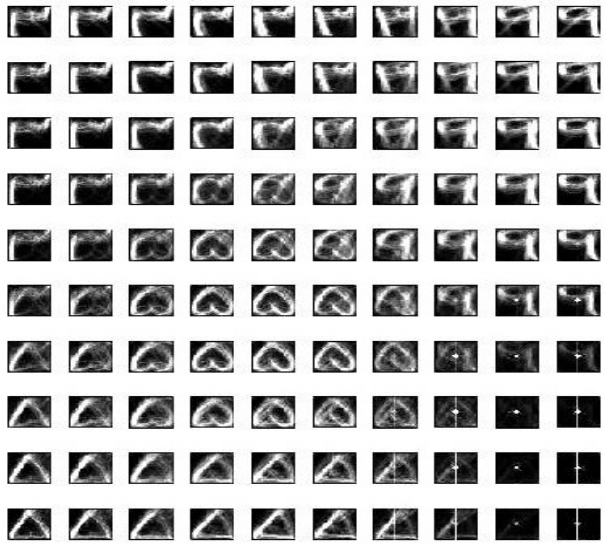


Fig. 8 500 epochs

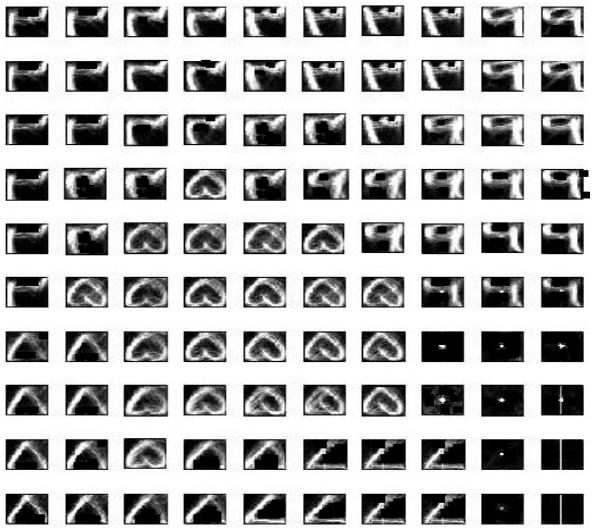


Fig. 9. Trained SOM

4. CONCLUSION

This paper presented a self-organizing maps based method for recognition of hand-written Urdu character recognition. A dataset of 6000 hand-written Urdu numerals was collected from 100 undergraduate students. Half of the data set was used for training the self organizing maps. Results of the trained ANN for the dataset demonstrated promising results. Comparing the results of the ANN with various topological structure and number of units may be evaluated as future work of the research.

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