Devnagari Handwriting Recognition using STANN

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ABSTRACT
Several approaches to recognize the handwritten characters and numerals such as online cursive handwriting and numerals recognition have been proposed. Most of them are based on neural network approaches. In this paper, a technique for continuous recognition of handwritten Devanagari characters is proposed. This approach employs a method based on Spatio-Temporal Artificial Neural Network (STANN). The proposed method is efficient in the field of online handwriting recognition because of the property of STANN to detection of spikes of the continuous input signals. The method is based on different steps of recognition. The results of signals are extracted from the input handwritten characters where the spikes signals are generated by the continuous signals of the input character. A new algorithm using STANN is proposed with results in this paper.

General Terms
Devnagari handwriting recognition, online character recognition

Keywords
STANN (Spatio-Temporal Artificial Neural Network), Preprocessing, Spiking Neural Network, Spike Detection.

1. INTRODUCTION
In the field of handwriting recognition many researcher had been proposed their work. In past several years different types of neural networks have been proposed and among these neural networks most of them have most promising results in the fields of recognitions like pattern recognition, handwriting recognition. The brief overview on these networks can be found in [1]. Work on Devanagari handwriting recognition attracted to most of researchers doing their research, as Devanagari are the script which is used to write most of Indian languages. One of the techniques which can be applied to recognize Devanagari handwriting is STANN (Spatio-Temporal Artificial Neural Network). The STANN is a new model of 3rd generation. Hodgkin and Huxley conductance based neuron model is becomes the father of spiking neurons. STANN is a type of Spiking Neural Network (SNN) [2]. Spiking neurons are powerful computing elements. These neurons use the timing of signals action potential or spikes which use to encode the information. The spiking neuron model is innately embedded in the time and these time and spatial information of spiking neurons gain fast computational power. Based on these discussions, an efficient method for recognizing Devanagari handwriting using STANN is proposed. In this paper, the proposed method is applied to recognize Devanagari handwriting. Due to Variations in Handwriting Styles, Personal or Background Factors, Situational Factors, Material Factors, Constrained and Unconstrained Handwriting, Limited Resources in Small Devices, Similarity in Shape of Some Characters and other different type of challenges recognition became difficult. During past years, several approaches have been proposed to overcome with these challenges [3].This paper is organized into five sections. In section 2, gives the overview of survey which has been done to propose this method. In Section 3, a brief introduction about the technology STANN and the method of preprocessing [4, 20] and generating signals using MATLAB. The proposed algorithm of recognizing Devanagari handwriting is presented in section 4. In section 5, the results and future scope of work is discussed. In section 6, we use a few concluding remarks to conclude the paper.

2. LITERATURE SURVEY
In several years different researchers proposed their work in different field of recognition. This section presents some of the selected recent results into the Table1 from literature of handwriting recognition systems. Most of the results given in this subsection are based on handwritten character recognition as present study is focused to this area only.

Different types of research have been done to recognize the Hindi numerals [5, 6]. In [1] the table shows the comparison between applications of different neural network models in the field of recognition. The comparison of different neural networks in recognition fields are shown in table 1 in this paper, which is as follows:

Table 1. A Survey on Proposed Work on Handwriting Recognition

Author(s)	Method Of Recognition	Year
Ashutosh Malaviya, Hartmut Surmann and Liliane peters [7]	Fuzzy Rule Base For Online Handwriting Recognition	1994
H.Bunke, M.Roth, E.G.Schukat, Talamazzini [8]	Hidden Markov Model For Off-line Recognition of Cursive Handwriting	1998
Kam-Fai Chan, Dit-Yan Yeung [9]	Flexible Structural Matching For on-line Handwritten Alphanumeric Characters	1999
S.D. Connell, R. M. K. Sinha, A. K. Jain [10]	statistical method HMM with neural network For Unconstrained Online Devnagari Characters	2000
Tay, Yong Haur [11]	Artificial Neural Network (ANN) and Hidden Markov Model (HMM) For Offline Handwriting Recognition	2002
Abdul Rahim hmad, Christian Viard-Gaudin, Marzuki Khalid, Rubiyah Yusof[12]	Support Vector Machine (SVM) For Online Handwriting Recognition	2004
A. Rauf Baig [13]	Spatio-Temporal Artificial Neuron (STAN) for Online Cursive Handwritten Character Recognition	2004
Shashank Mathur, Vaibhav Aggarwal, Himanshu Joshi, Anil Ahlawat [14]	Artificial Neural Networks and Genetic Algorithm for Offline Handwriting Recognition	2008
A.AZaidan, B.BZaidan, Hamid A. Jalab, Hamdan.O.Alanazi, Rami Alnaqeib [15]	Artificial Neural Network For Offline Arabic Handwriting Recognition	2010
Deepika Wadhwa, Karun Verma[4]	Support Vector Machine For Online Handwritten Devanagari Numerals	2012
Bhushan C. Bhokse, Bhushan S.Thakare [16]	Dynamic Time Warping Algorithm for Devnagari Handwriting Recognition	2012

3. STANN (SPATIO-TEMPORAL ARTIFICIAL NEURAL NETWORK)

STANN stands for "Spatio-Temporal Artificial Neural Network". Spatio-Temporal Artificial Neuron is an artificial neuron which codes discrete events using complex number. [17].The representation of Different types of input is illustrated in fig.1. Spatio-Temporal Artificial Neural Network is basically generates sequences of impulses on the basis of input signals. The mathematical description of Spatio-Temporal Artificial Neural Network is as follows:

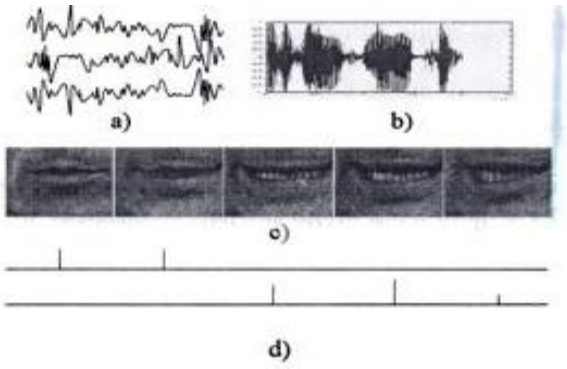


Fig. 1. Different Input Signal: a) Raw input signal b) Continuous Signals c) Sequence of image d) impulse signals Ref. [17]

An event is represented as an impulse z; the spatial and temporal aspects of z are simultaneously taken into account by coding it in the complex domain [13]. In polar coordinates (∂, θ) the magnitude ∂ gives the amplitude and the angle θ gives the temporal position (or age) of the impulse from a reference point.

$$z = \delta e^{i\theta} \quad where \tan(\theta) = \mu_T \tau$$

Hence, $$z = \partial e^{i \arctan(\mu_T \tau)}$$

When a new impulse is emitted on a given component, it is gathered together with the previous impulses. The amplitude is made to decrease with time. Hence any given event is forgotten in due course of time. The impulse of amplitude emitted at time t1 is at current time t by the complex number:

$$Z(t) = \delta e^{-\mu_s \tau} e^{-i \arctan(\mu_T \tau)}$$

Where $\mu_s = \mu_T = 1/TW$, TW is stands for Temporal Window.

TW depends on the application and represents the size of the temporal window inside which one wishes to identify sequence of impulses. When each of impulse arrives and compared with stored vector W, Output of an input and W are close enough is illustrated in figure 2. [13].The STANs are spiking neurons. The weight W of a STAN is a complex vector and it represents the sequence to be detected by it. The

comparison between X and W can be done by means of a Hermitien product V in one type of STAN and in another type it can be done by Hermitien distance D:

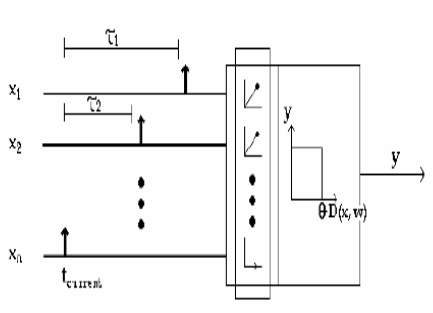


Figure 2: Arrival of impulses and comparison of stored vector W with the output of input X [11].

$$V(X,W) = \sum_{j=1}^{N} \overline{w_j} x_j$$

And

$$D(X,W) = \sqrt{\sum_{j=1}^{N} (x_j - w_j)\,\overline{(x_j - w_j)}}$$

The bar denotes the complex conjugate. In figure 2, its shows how the value of D is calculated corresponding to the input value.

4. RECOGNITION METHOD

To recognize the character using STANN is according to the following module: (1) First module is the data inputting and preprocessing phrase [2, 20] which will be done using different types of algorithm in various steps of preprocessing. (2)Second module is the combination of feature extraction of the character and the generation of continuous signals for the further steps of the proposed work. It will done using the MATLAB software and the wavelet transformation [18] to extracting the impulse signals for recognition of character input. (3) Third Module is the compression of signals to perform the recognition. Recognition is done by comparing the impulse signals to each other and the compression by which best matching is deemed to be recognized character. The proposed algorithm of recognizing Devanagari handwriting involves these steps as follows:

Step1. Input the character using mouse on the writing area of 300*300 pixels given on the screen. In this area the character can be written in any size or shape. The next step is to normalize the characters which can be performed by step 2.

Step2. In this step of normalization the size of written character is fixed into a constant frame of size:

```
begin (k is any positive integer)
    for k from 1 to appwindow size
begin
Set k of xnew to ((195.0 / (appwindow. maxX - appwindow. minX)))
   Set k of xnew to position k in xnew +300;
   Set k of ynew to ((195.0/ (appwindow. maxY- appwindow. minY)))
   Set k of ynew to position k in ynew plus 100
end;
end;
```

Step3. Find the distance between two consecutive points using following method:

```
begin (j is any positive integer)
    for j from 1 to appwindow.i-2
    Set x to Math.abs with (position in xnew - position j in xnew)
    Set j of dis to Math. sqrt with x
end;
if dis[j] > 1
missing point interpolation method is applied
else
go to step 4.
```

Step4. Resample the points by initializing the resampled point to “64”.

```
String str = "64";
int option;
If (str!  = null)
   Set appwindow.len1 to str
else
   Set option to CLOSED_OPTION
end
```

Step5. Smoothing process is done by considering two neighbor of each side of the point if three points are considered then nature of the stroke may be lost.

Step6. Due to different handwriting styles problem of slant and bend is occurred. To overcome the problem eight directional chain code methods [18] is applied to the input character. After applying this method the extracted features are stored into the .csv file.

Step7. Signals of the input character are generated by using MATLAB wavelet toolbox. A result shows in figure 3-4.

Step8. After detecting the spike signals [19] of character in step7, the character recognition process is performed by signal compression using MATLAB software.

5. RESULT AND FUTURE WORK

To evaluate the working of the proposed method of recognizing Devanagari handwriting the method is applied on different Devanagari characters. In figure 3, the results of input the character in writing area is shown and from figure 4-5, the results of generated signals and the detection of spikes of continuous signals is shown. In this proposed methods we just select some of the samples. The evolution of recognition method on different samples will be performed in future. The recognition method has works well with the recognition of Hindi numerals and some of the character of Devanagari, but it needs to be more efficient with other Devanagari characters which have similarity in nature and written with difficult strokes. The present work can be extended for recognition of the other handwritten characters.

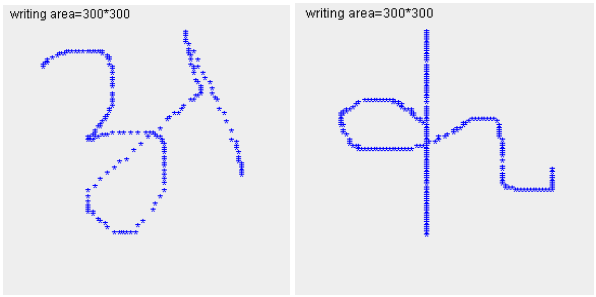
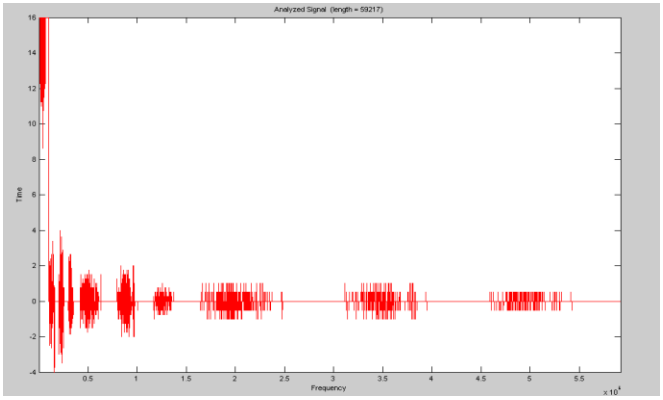


Fig. 2. Input character अ and क using the mouse on the 300*300 pixel writing area



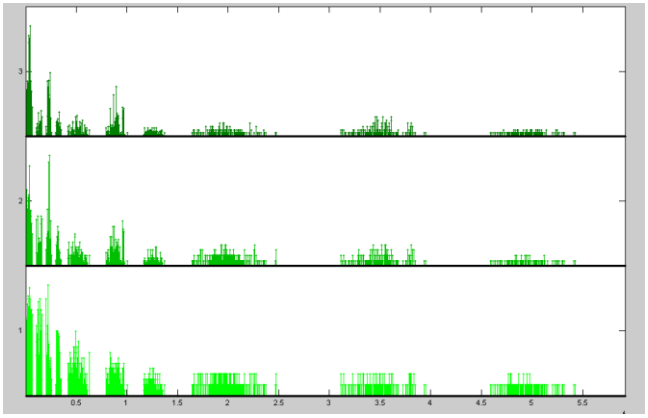
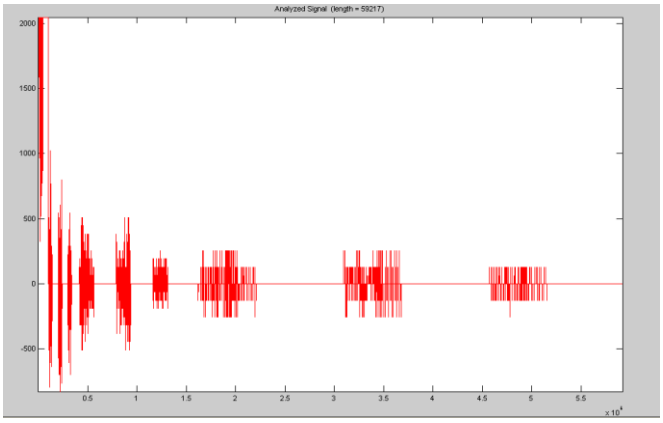


Fig. 3. Generated signal and spike detection of character "क" by MATLAB with the help of stored co-ordinates



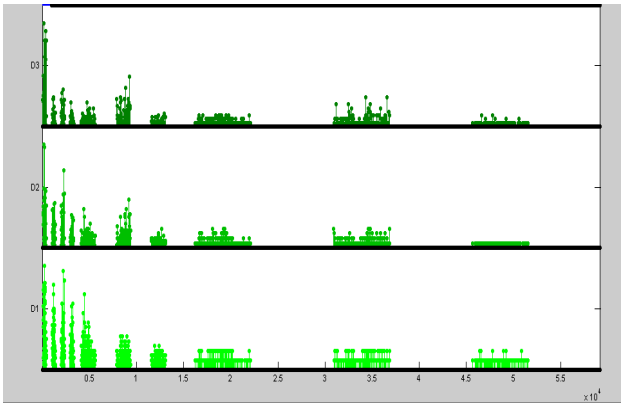


Fig. 4. S Generated signal and pikes detection of signals of character "अ" by MATLAB with the help of stored co-ordinates

6. CONCLUSION

A method of recognizing Devanagari recognition is proposed in this paper. The signals of the Devanagari character can be generated efficiently and the spikes detection of signals can be performed effectively and the comparison of these signals done for some characters but will be done for other characters in future. The work can be extended by using different type of other input and preprocessing methods for applying STANN technology. In this paper an algorithm for recognizing Devanagari handwriting is proposed.

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