Handwritten Character Recognition through Feature Extraction using Artificial Neural Networks

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Article Info
Jenitta J and Swetha Rani L (eds.), *International Conference on VLSI, Communications and Computer Communication*, Advances in Intelligent Systems and Technologies,
Doi: https://doi.org/10.53759/aist/978-9914-9946-1-2_12

Abstract - Today's computer can be fast, accurate and knowledgeable. But they are far from being intelligent; computers are still unable to communicate with human beings in natural forms like written languages, speeches, pictures and images. With the rapid development in the computer facilities users have now turned their attention to interact with computers in their local languages, so it is more user friendly. In Karnataka, HINDI is the local and official language. it is very convenient and faster to enter a HINDI document into computer by handwriting rather than by typing using existing HINDI converted English keyboard, where key combinations have to be used. This necessitates the development of an efficient online system to recognize HINDI handwritten characters or words. The concept in the online character recognition system is to capture a character as a sequence of [x(t),y(t)] points while the character is being written on a computer screen. Trajectory curvature, shape, size etc., are extracted from the characters. Each point of the input sequence is coded as a set of these features for recognition.

Keywords - Segmentation, Skew Correction, Filtering, Gray Scale, Binarization.

I. INTRODUCTION

Computers have become the part and parcel of our day-to-day life because of its ability to compute and flexibility of use. We interact with computers using English language. In recent years a great emphasis is on interaction with regional languages. Indian languages are rich in alphabets. Devanagari is a very ancient language [1]. It is basis of many languages. It has more than 600 alphabets. Many software's have been developed for this purpose like nudi, baraha etc. but there are many drawbacks in these software's. It is very tedious and cumbersome to type on a converted keyboard. If say, we want letter we need to type 'k' 's' 'h' 'a', a 4 letter combination in the converted keyboard and also depends on the speed of typing.

This necessitates the development of an efficient online system to recognize kannada handwritten characters or words. One of the most basic problems which have been dealt in the process of imitating human brain is to make computer "Recognize handwritten characters". An example is handwritten character recognition [2].

Handwritten recognition can be broken down in to two categories:
1. Offline character recognition
2. Online character recognition

Offline character recognition system scans the image from a scanner, digital camera. The image is binarized using threshold technique based on the color pattern, so that the image pixels values are represented as 0 or 1, in which cell image is present denoted as 1 otherwise 0.

Online handwriting recognition system allows us to input our handwriting in to the system. We are processing an online Hindi character recognition system which uses artificial neural network for recognition [3].

An online character recognition system consists of three stage processes as shown in fig 1.

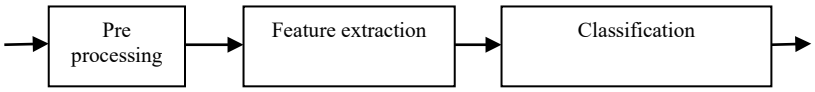

Fig 1. Online Character Recognition

Preprocessing

In preprocessing stage, processes of normalization takes place to get X and Y coordinates.

Feature extraction

A different method used for feature extraction are:

1. Wavelet transforms
2. Hidden markov model
3. Bayesian theory
4. PCA etc…
5. Wavelet transforms are used to extract features of characters of the systems.

Classification

The classifier is used for feature vector Given by the feature extractor to assign the object to a category and it is used for identifying the characters.

II. METHODOLOGY

Fig 1 shows online handwrote HINDI character recognition systems.

We have considered HINDI characters for recognition; HINDI character set has 11 vowels and 36 consonants as basic set of alphabets shows Fig 2.

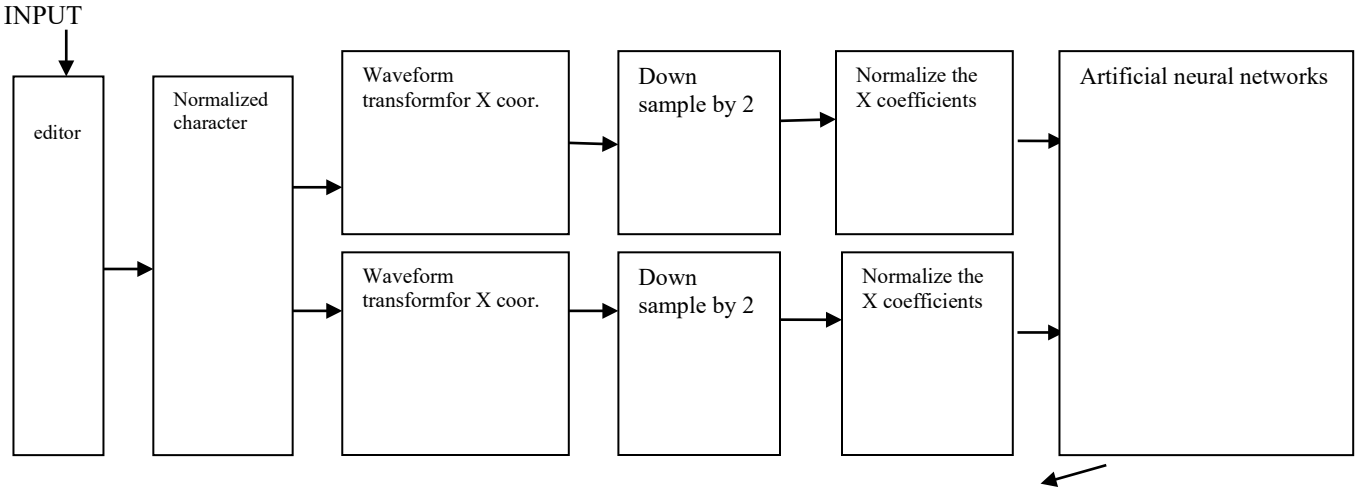

Fig 2. Block Diagram of Character Recognition

Input System

Initial step in character recognition is to build an editor. It is the graphical aid to feed the input characters to computer. Editor is created using visual basic editor, which is created using visual basics is used as input system.

The editor window consisting of a writing area, an output display and different command keys [4]. The letter that has to be trained/recognized is written in this writing area by suitably moving the pen on the tablet. The character contour is captured while writing the character and then processed.

Pre-Processing

In the preprocessing stage scanned image of the character is subjected to process of normalization. The area of textual information in the scanned image is detected and a new boundary is represented as a (x,y) coordinate system which is followed by the formation of grids. The grids are represented as matrix of (m*n).

Whereas zero represents the field where character is not present.

Here, the sequence of [x[t], y[t] coordinates of a character is captured as the character is being written on the computer screen [5]. Using these coordinates, size normalization is done to the size of matrix of [50,50] grid and resampled for definite number of points shows Fig 3.

1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0
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00000000001111000000
00000001111111000000
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11111111111110000000

Fig 3. Matrix Formation

Feature Extraction

In this process features of the characters are extracted and given to the classification stage. There are many methods for extracting features. We have considered Wavelet transform [6].

There are two types of Wavelet transform

1. The continuous Wavelet transform
2. The discrete Wavelet transform

Since the characters contours are captured as discrete points and not continuous, we will focus here on DWT. The DWT operates on discrete samples of the input signal like other discrete linear transforms, such as the discrete Fourier transform (DFT) or the discrete cosine transform (DCT) and is very useful for image processing shows Fig 4.

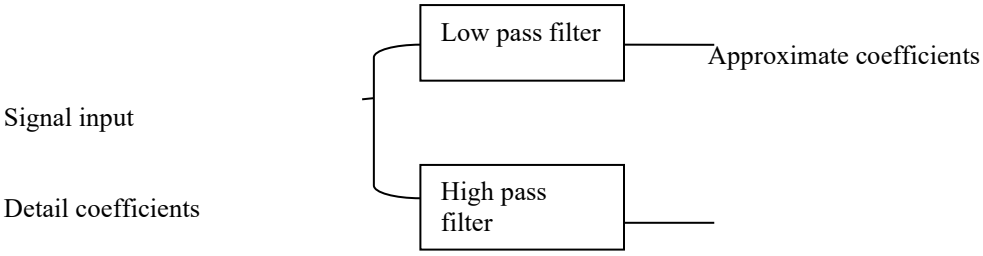


Fig 4. Wavelet Components

The figure shows wavelet components, the DWT of a signal will be passed through a series of filters. First the signals are passed through a low pass filter it gives the result impulse response. The signal is also divided using a high pass filter. The final output contains detail coefficients and approximation coefficients as shown in figure. X and Y coordinates obtained from preprocessing stage are applied to the wavelets separately and a total of 50 coefficients are obtained from each [7].

They are then down sampled to 25 coefficients. Half part from detail and half from approximate coefficients. As it cannot take 12 and a half coefficients, it has been rounded to 13 coefficients. So, a total of 52 coefficients are obtained from

X and Y coordinates [8].
The detail and approximate coefficients are given below.
X=Approximate(x)+detail(x)
= 25+25=50

This is down sampled to 25 and then rounded to 26
Y=Approximate(y)+detail(y)
So, total number of coefficients is given by,
S=X+Y
= 26+26
=56 Coefficients

Recognition
In recognition stage X – Y coordinate values of the testing character are given to the network; feed forward computation will be done then output will be displayed [9]. The output of the network varies either 0 or 1 using sigmoid function. This binary output is compared with target values of the learnt patterns. If it matches with any of the target values, the pattern is said to be recognized and it is displayed or else it is marked as unknown pattern shows Fig 5.

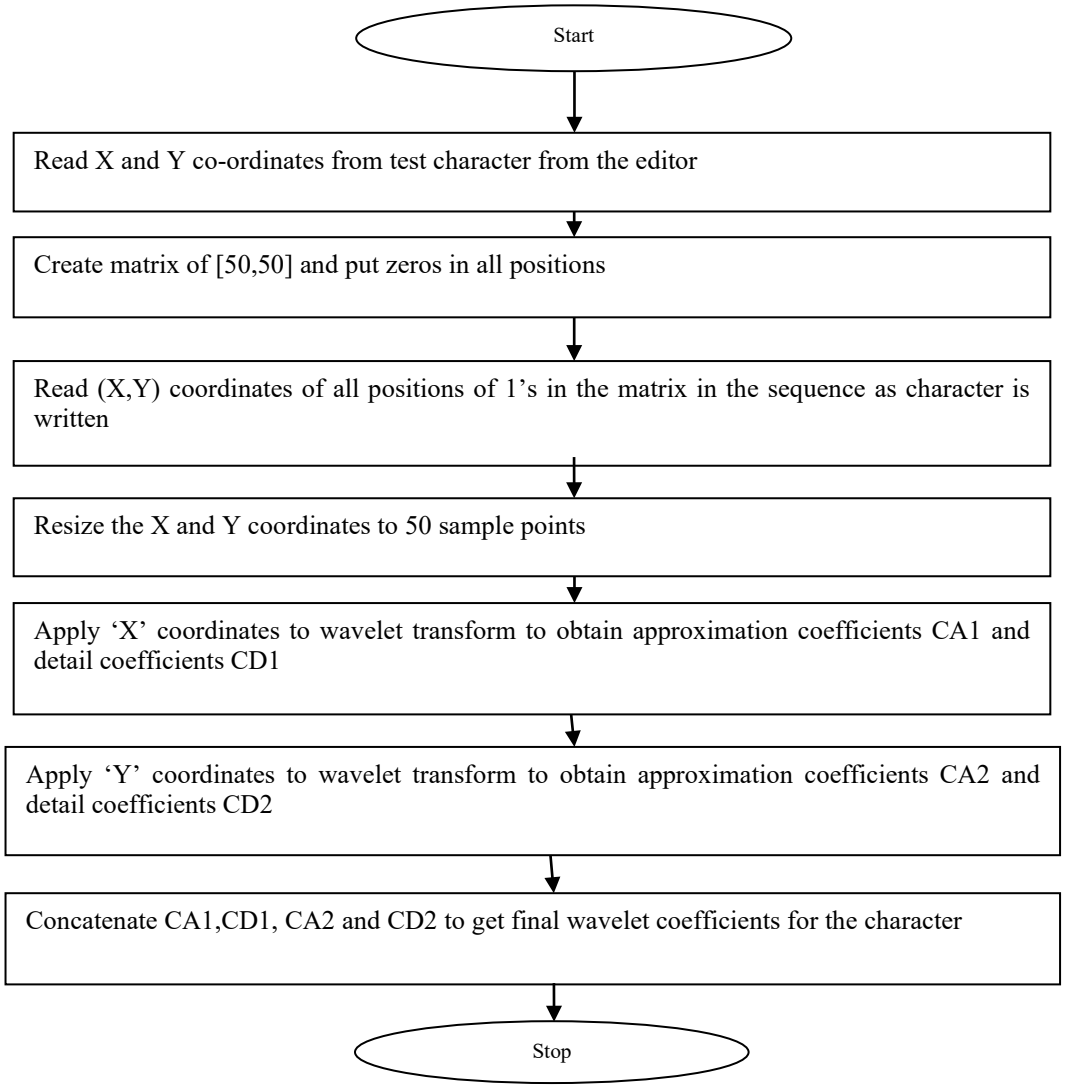


Fig 5. Feature Extraction

In feature extraction first character will be tested from x and y coordinate basis then that character will be placed in matrix , in which cell image is present denoted as 1, in which cell image is absent denoted as 0 finally getting as a sequences of 0's and 1's. then Apply 'X' coordinates to wavelet transform to obtain approximation coefficients that is denoted as CA1 and detail coefficients denoted as CD1, Apply 'Y' coordinates to wavelet transform to obtain approximation coefficients that is denoted as CA2 and detail coefficients denoted as CD2, finally concatenate CA1,CA2,CD1 and CD2 to get wavelet coefficients for the character [10].

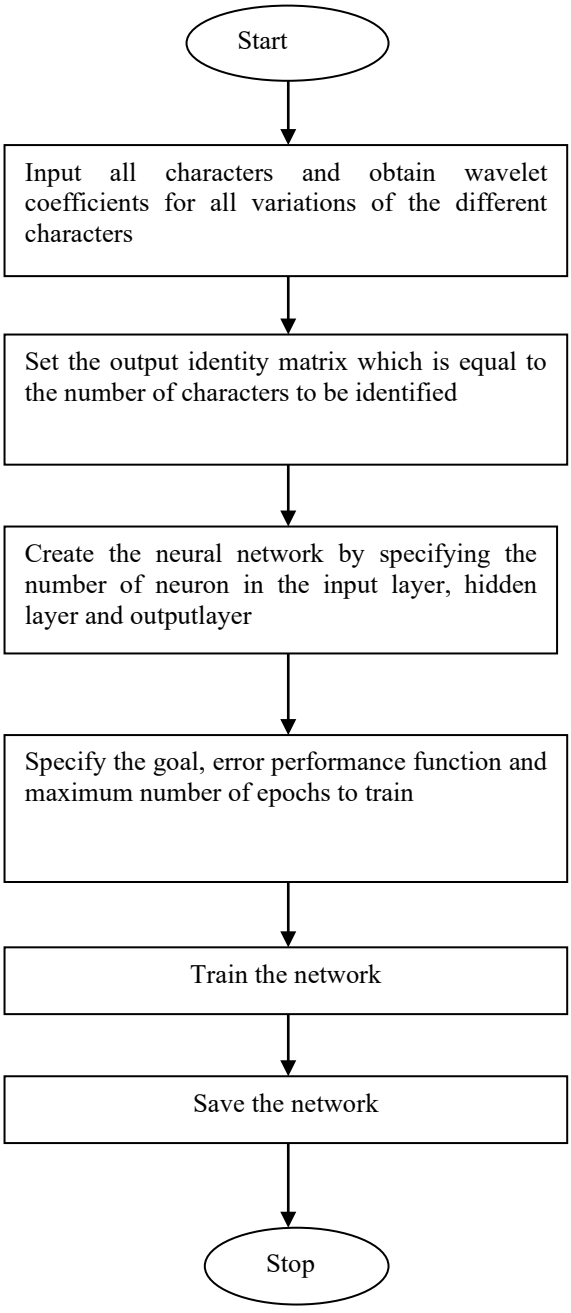
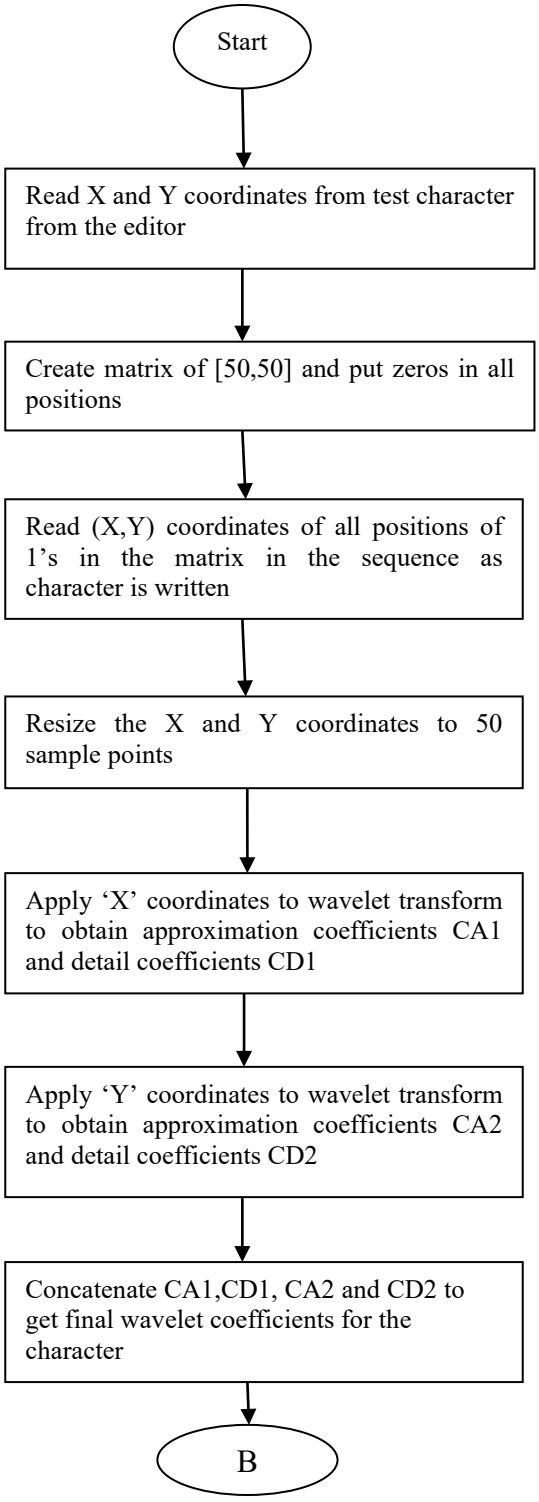


Fig 6. Training Process

In training process wavelet coefficients for all variations of the different characters will be compared, then set the output identity matrix with number of characters and create the neural network to find out the number of neuron in the input layer, hidden layer and output layer finally find out the goal, error performance function and maximum number of epochs to train and save the network shows Fig 6.


Start
Read X and Y coordinates from test character from the editor
Create matrix of [50,50] and put zeros in all positions
Read (X,Y) coordinates of all positions of 1's in the matrix in the sequence as character is written
Resize the X and Y coordinates to 50 sample points
Apply 'X' coordinates to wavelet transform to obtain approximation coefficients CA1 and detail coefficients CD1
Apply 'Y' coordinates to wavelet transform to obtain approximation coefficients CA2 and detail coefficients CD2
Concatenate CA1,CD1, CA2 and CD2 to get final wavelet coefficients for the character
B

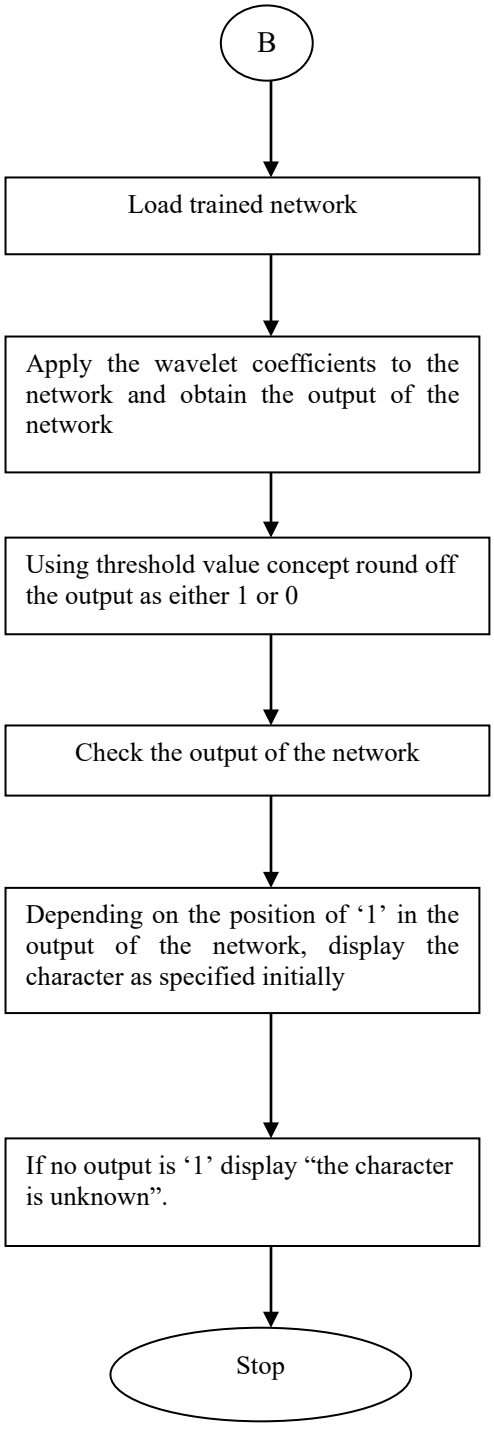


Fig 7. Character Recognition

Shows Fig 7. In character recognition first character will be tested from x and y coordinate basis then that character will be placed in matrix , in which cell image is present denoted as 1, in which cell image is absent denoted as 0 finally getting as a sequences of 0's and 1's. Resize the X and Y coordinates to 50 sample points then Apply 'X' coordinates to wavelet transform to obtain approximation coefficients that is denoted as CA1 and detail coefficients denoted as CD1, Apply 'Y' coordinates to wavelet transform to obtain approximation coefficients that is denoted as CA2 and detail coefficients denoted

as CD2, finalley concatenate CA1,CA2,CD1 and CD2 to get wavelet coefficients for the character. These points are loaded in to the trained network. Apply the wavelet coefficients to the network and obtain the output of the network. Using threshold value concept round off the output as either 1 or 0. Depending on the position of '1' in the output of the network, display the character as specified initially, If no output is '1' display "the character is unknown".

III. RESULTS AND CONCLUSION

The proposed system describes a novel procedure which uses wavelet transform, artificial neural network and structural features. We have considered the 47 HINDI characters for recognition after testing the characters for recognition, the results obtained are satisfactory. We have considered HINDI character for recognition. Hindi character set has 11 vowels and 36 consonants as basic set of alphabets. We have considered these characters for recognition. We have considered a separate training network to train recognized characters. The codes have been written for all characters or alphabets to be recognized. We have been able to clearly recognize almost all HINDI characters. The subscripts of the HINDI characters are not identified. The percentage of error can be reduced by extracting more features from input characters or by taking a greater number of samples for training.

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