

“A MULTI SCRIPT NUMERALS CLASSIFICATION USING SOFT COMPUTING”

A

Dissertation

Submitted

in partial fulfillment

for the award of the Degree of

Master of Technology

in Department of Computer Science & Engineering

(With Specialization in Information and Communication)



Supervisor:

Mr. Akhilesh Pandey

Associate Professor

SGVU, Jaipur

Submitted By:

Anshu Kumar

SGVU091143318

Department of Computer Science & Engineering

Suresh Gyan Vihar University

Mahal, Jagatpura, Jaipur-302025

June 2015

Chapter1

INTRODUCTION

In the today's world one of the critical problems is the system that not recognizes the English and Devnagri handwritten numbers. Numbers in Davnagri is not truthfully and efficiently recognized by the electronic system. For recognizing the numbers various algorithm and research work have been proposed. Numbers of process have been performed for number recognition, it's not like only single algorithm or single technique can do the recognition of the both number to give accurate result. In India, Hindi is considered as our mother tongue so the recognition of the number in Denarii is very much important. Therefore to solve complete problem the following system help to solve it in more easy and precise way. But some parts of India People are very frequent in the English. Recognition of the numbers which is handwritten is very much problem in the area of research because also it is office automation and is very important requirement. It provides recognition of the numbers in a very effective and practical way. The writing of the person depends upon its writing style or on their mood. In the process of the recognition all the structure of the numbers as well as topological and statistical information is being observed. Limited variation on the shape and the size is considered in the hindi and English numbers which is hand printed, the main focus is on the process recognition.

Researchers had been working on the recognition of handwritten numbers from last thirty five years. Public is now looking towards the technology of the recognition of the handwritten numbers or script. Now a days 100% rating for the systems which can recognize handwritten numbers or script is still not created and achieved as humans are not able to recognize every writer's handwriting without confusion, even they cannot recognize or read their own hand writing in effective manner. Therefore it is writers' responsibility to write any text which should be in readable format.

1.1 Devnagri Script

After English and Chinese language, hindi language is most common in all over the world and is approximately 500,000 people can read , write and speak this language. Script of Devnagri is the basic script for the various languages present in India. For example, we can say hindi and Sanskrit. In various other languages close variation of the Devnagri script is used. In the ancient times, Sanskrit was the common language however there is written on material still available in Arabic, French, portages, Turkish, dravadian as well English. Sanskrit is expressive language

and some word of English, portages, Turkish etc. came out of it. Devnagri script attracted lots of people attention. Pure Indian nature was the Brahminpeople who was the devnagri script holder. In the 4th century, script of brahmigupta was formed. From the script of gupta subsequent kettle come out of it in the 8th century. Later modern script of nagri came to be known as devnagriacharya. Vinobabasu says that the script came out to be known as loknagri because of the common language known by the people in the nation.it is a dialect of Hindi said by few people but it seems not to be fair since other language like hindi language also written in following script. Devnagri is considered as script whereas hindi is considered as language. Variousview of the devnagrisciptare

Table no.1

Variant	0	1	2	3	4	5	6	7	8	9
Gujarati	૦	૧	૨	૩	૪	૫	૬	૭	૮	૯
Gurumukhi	੦	੧	੨	੩	੪	੫	੬	੭	੮	੯
Kannada	೦	೧	೨	೩	೪	೫	೬	೭	೮	೯
Malayalam	൦	൧	൨	൩	൪	൫	൬	൭	൮	൯
Telugu	౦	౧	౨	౩	౪	౫	౬	౭	౮	౯

0-9 in various Indian Language

- Nagri script was called devnagri due to its nagri prevalent, whereas Sanskrit language was called denas voices.
- Due to very much use by the gujrat Brahmins, it was called Devnagri.
- It was spoken commonly in the Devnagar of kashi, so named as devnagri.

The most accurate and scientific language is the Devnagri as formatted .most of the Aryan language of india like nepali, Sanskrit, Marathi etc. Indian constitution has declared Devnagri as national dialect and hindi as national language. State language had become hindi whereas state script had become Devnagri for the state like Bihar, Rajasthan, Haryana, Uttranchal etc. Most scientific script found today is devnagri, since every script is formed from the script of brahmi therefore Devnagri script has relation with every script mostly.

० ० ०

१ १ १

२ २ २

३ ३ ३

४ ४ ४

५ ५ ५

६ ६ ६

७ ७ ७

८ ८ ८



Figure 1.1: Sample of Devnagri Handwritten numbers

1.2 English Script

English is a west Germanic language that was first spoken in early medieval times in England and is now a global lingua franca. It is spoken as a first language by the majority population of several sovereign states, including the United States, the United Kingdom, Canada, Australia, Ireland, New Zealand and a number of Caribbean nations; moreover, it is an official language of almost 60 sovereign states.

Significance

Modern English, sometimes described as the first global lingua franca, is the dominant language or in some instances even the required international language of communication, science, information technology, business, aviation, entertainment, radio, and diplomacy.

History

English originated in the dialects of North Sea Germanic that were carried to Britain by Germanic settlers from various parts of what are now the Netherlands, Northwest Germany, and Denmark.

The Old English was later transformed by two waves of invasion. The first was by speakers of the North Germanic language and the second was by speakers of Romance language Old Norman in the 11th century.



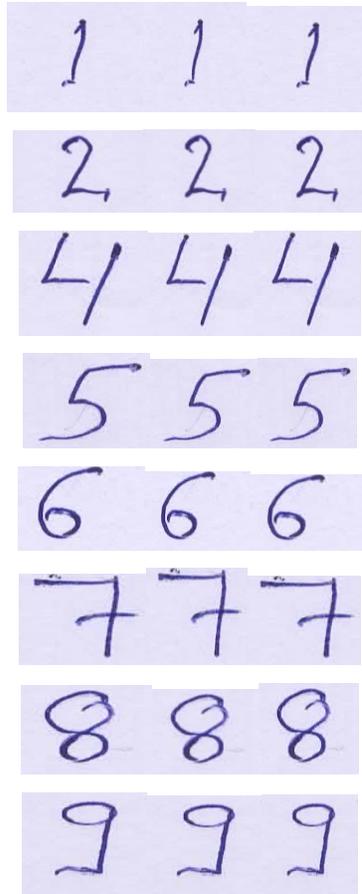


Figure 1.2: Sample English Number

1.3 Optical character recognition

Miniature form of optical number recognition is the optical character recognition. Therefore the method used here help machine to indicate number mechanically as optical mechanism. Due to this, Humans are able to identify objects in many numbers. Optical machine is the eyes whereas the activities of input are look up by the brains. The advance technology of the system OCR faced by the technologist of this system had made easier to recognize the variable. Suppose a person is allowed to read an unfamiliar language of the page, he/she may not be able to recognize the words however if the numerical value is present in those statement, it can be easily recognized and explained by the person because the number the number present are used by the people all over the world. Therefore this concludes that Is only used to acknowledge the numbers. Secondly, the size of the alphabetical and numerical signs is almost same. It is hard to study the word which is printed which appears pitch dark, backdrops either it is mentioned above

the graphics or words. The paper document i.e. document present in paper form can be easily read by human being but it creates problem for the computer to read which is a machine to learn straight report. Therefore OCR system changes the paper document into the process able shape of computer.

Machine searched pictures are reshaped and to sign in process able form of computer like ASCII of the work which is hand written and alphabet numbers are the following process of the system. Pattern recognition is one of the areas of the OCR and character which is handwritten is processed due to the motivation of having improvement in the machine and man communication. For character recognition few commercial products are currently available. Though many research had been done but the product which can perform recognition of the handwritten data are still not available. However to solve the problem, neural networks which is artificial in nature is used due to the high interest level which is recently observed. During past generation mostly the neural network development for the feature extraction make use of either approaches of statistical or pattern matching. In the field of machine learning or artificial intelligence one of its basic aims was to enable the computer to accomplish the task in such a way that which seems very natural to the people.

1.3.1 Application of number recognition

There are various numbers of recognition of number applications. They are as follows:

Work-specific readers: there is number of petition on the recognition of the number for the application of high volume where input of high level is needed arepraised by many of the readers. High price input is needed managing in one desired field consumes less time. Though document of same kind held size of same kind as well as layout. It is easier for the scanner of picture to concentrate on the whole information.

Address readers: Address reader's means delivering mail related to the system. It's target on the size of the mail as well as ZIP code and sorts the postal mail.

Forum reader: 2 graphics has been divided for the forum reading method. First one is the instruction which is printed and second one is field data. Only that part of the forum is mentioned in the system whose data is printed.

Check reader: here is the following mode of reading the picture of check is taken and goodness of the price is identified as well as information of the accounts present on the check and hence this data is used to cross check the outcome.

Bill processing system: the purpose of bill processing system generally is used to study the inventory documents, payments slips and utility bills. On the document a certain region is focused by the system where the information is located which is inspected. For example the value of the payment and number of account.

Passport readers: with the help of custom inspection the returning American passengers speed up is done by the automated readers of the passport. The date of birth, number of passport present of the traveller is read by the reader and cross checked with the records of the database which contains information of the smugglers and felons.

General purpose page readers: the page readers have two categories that is low end page readers and high end page readers. Compared to low end page readers more advance is high end page readers. The low end page is compatible with scanners of the flat beds which generally don't come with scanner in it. The low end page readers are generally used in environment of the office with work station desktop, which in the throughput of the system is less demanding. A sacrifice in the accuracy of the recognition is made in order to handle a document of broader rang. Some software of the OCR for the improving accuracy of the recognition allows the user to adopt engine for the recognition of the customer data.

1.3.2 Limitation

The 100% perfect read rate has been never achieved by the OCR. Therefore a system very much need which allow very frequent as well as accurate reject correction. A problem is always has been there is the processing of the exception item since the job entry completion is being delayed particularly the function of balancing. The data in dollar is not balanced by the system accuracy particularly for the manufacture of the hardware it is not their responsibility to make device of the OCR which can accurately read the data without any substitution.

It mostly depends upon the item quality which is to be processed. The OCR main purpose from last many years is given as:

The accuracy of the reading is increased i.e to reduce substitution and rejects.

Eliminate the especially front or character which is designed and also the characters which are handwritten.

Sensitivity of the scanning is reduced so that it can read input which is less control.

The limit given above to the most of the application is not objectionable and the users which are dedicated to the user of the system of the OCR is increasingly every year. To create a system which is not special is not special is by itself not sufficient. OCR system is a saver of time , but then also it is not perfect.

The accuracy of 99.9% level is rarely reached by it.

Problem is faced by it with printed newspaper.

With material of heavily bound it faces the problem.

1.2.3 Different phases of Hindi and English character recognition

Hindi and english script process is divided into different phases as shown in the diagram 1.1 and all the phase is explained.

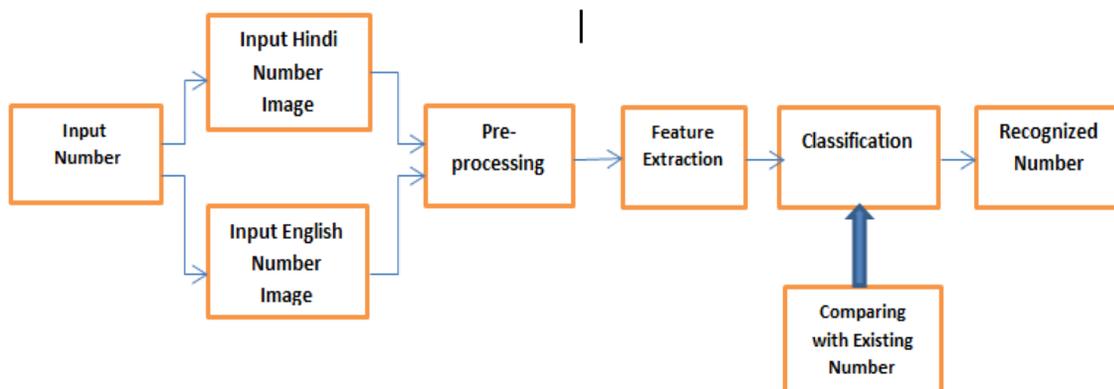


Figure 1.3: Block Diagram of HDCR

1.2.3.1 Pre- processing

The family of procedures for cleaning up, enhancing, smoothing, filtering and otherwise digital image messaging in order that frequent algorithm along with the road to the classification of final to make it more accurate and simple is the name given to the pre-processing.



Figure 1.4: Database Image of Offline Handwritten Devanagari N

- Binarization- binarization/theresolding is the process where the grey scale image is converted into the binary image. Two division of thresolding are as follows:
 - Global, which form the image of the entire document picks one of the threshold which is background level estimation value based from the histogram image intensity.
 - Aoloptine, according to the information of the local areas uses each pixel different value.
- Noise removal- the main aim of the noise removal is to discard any unwanted pattern of bit, which in the output doesn't have any significance

Original Image



Dilate

Skelton

Erode

Figure 1.5: Noise Reduction

Skeletonization- skeletonization is also known as thinning. In this process the width of the line is reduced. For example from various pixels of the object to just in a pixel of image. In the process irregularities of the letter is removed which in turn make algorithm of recognition simpler since only on character stroke it have to be worked, which is wide only by one pixel. It also decreases the space of the memory which is required to the store the input characters information and therefore also reduces the time of processing.

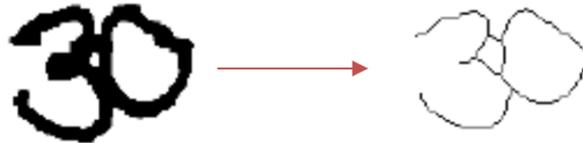


Figure 1.6: Skeletonization of Image

Smoothing: the process of smoothing is to smooth the character which is broken as noisy.

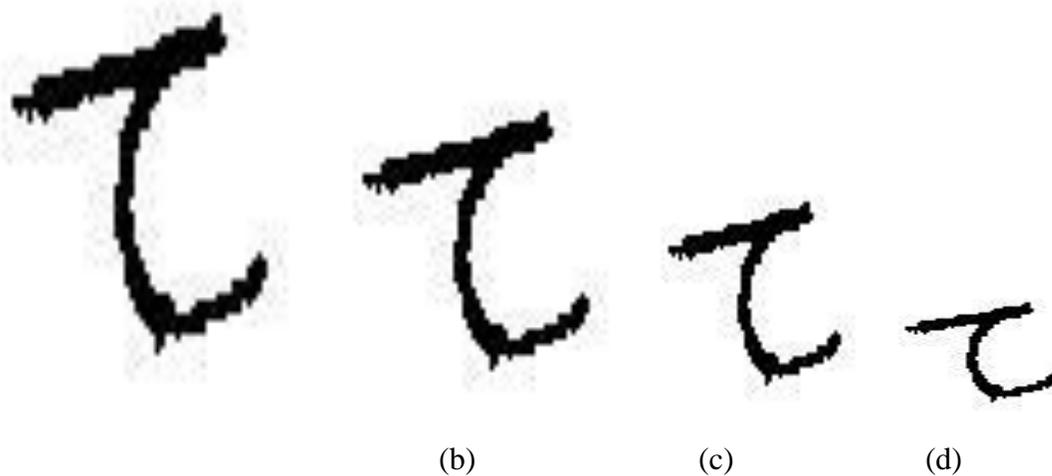


Figure 1.7: Smoothing of Numbers at different Numbers Levels

Original Image

32 x 32 resolution

16 x 16 resolution

8 x 8 resolution

Contour smoothing: the process of counter smoothing is smoothening of skewness input characters which is broken as noisy.

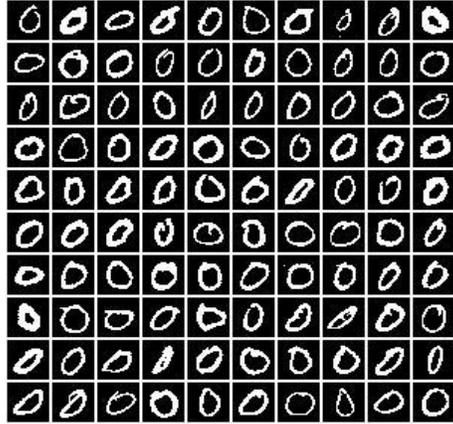


Figure 1.8: Original Image

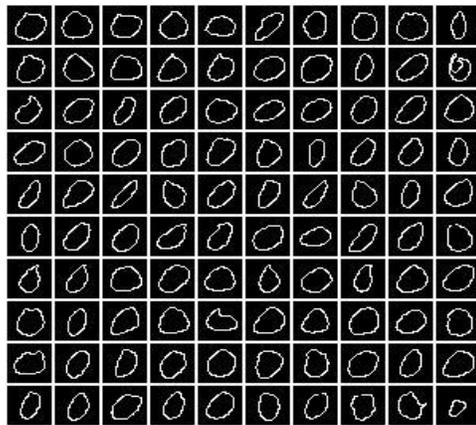


Figure 1.9: Contour Image

Skewness: skewness is caused due to the reason if the paper is not fed in the scanner straight. It is referring to the process where to the tilt in the image of the bit mapped of the paper scanned for the recognition of the character system. Most of the algorithm of the character recognition is orientation sensitive of the input range, which can correct and can detect the skewness automatically.

This is a document image that will present you the common problems of OCR

The non-parallel text line is a very usual problem making difficult the skew angle estimation

The hill and dale writing is also not as well as the slanted and connected characters.

This is a document image that will present you the common problems of OCR

The non-parallel text line is a very usual problem making difficult the skew angle estimation

The hill and dale writing is also not as well as the slanted and connected characters.



Figure 1.10: Correction of Skewness

Segmentation

When former stage a clear picture that partition processing is used to move forward towards the stage is produced. This let to try to find images and pictures of single-line wise signs by working the numbers.

In many ways, the quality of work can be divided on the bases and plans as properly based with divisions and remove all classified document after check, background sound emissions and slant of ways bit map images to improve document production work of pre-processing is put through.

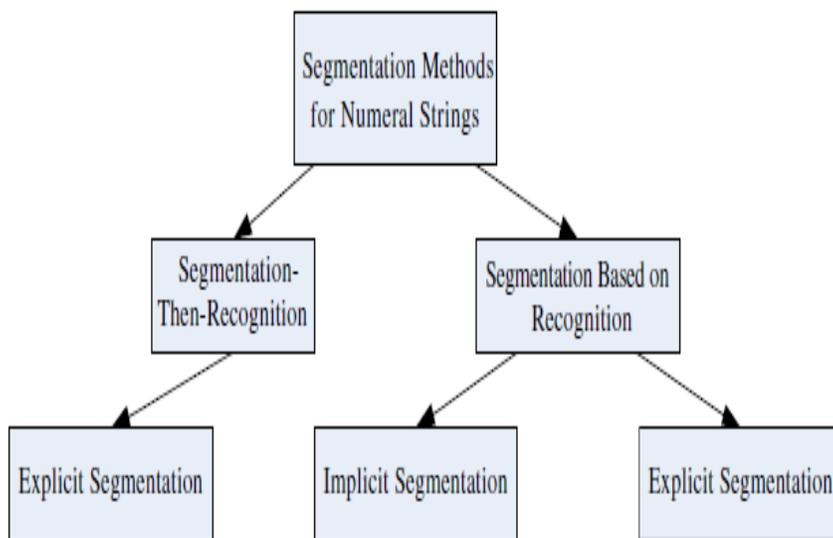


Figure 1.11: Segmentation and Recognition of Numeral

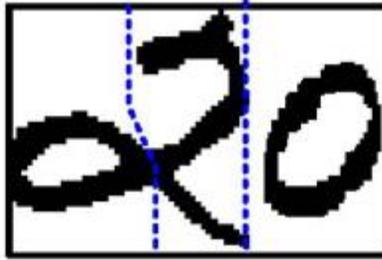


Figure 1.12: Segmentation of 2 and 0

1.2.3.2 Feature extraction and Classification

In many ways, the quality of work can be divided on the bases and plans as properly based with divisions and remove all classified document after check, background sound emissions and slant of ways bit map images to improve document production work of pre-processing is put through. In many ways, the quality of work can be divided on the bases and plans as properly based with divisions and remove all classified document after check, background sound emissions and slant of ways bit map images to improve document production work of pre-processing is put through. There are two levels of feature extraction and classification. Feature extraction of evaluate the system responsible for the family after making an ornament in the appropriate data intelligence, was named the assignment of data classified by the Administration to make it easy. Text block explicitly marks the property dividation can be identified by squeezing a text block and features that me. .

Thereare two types of recognition systems-

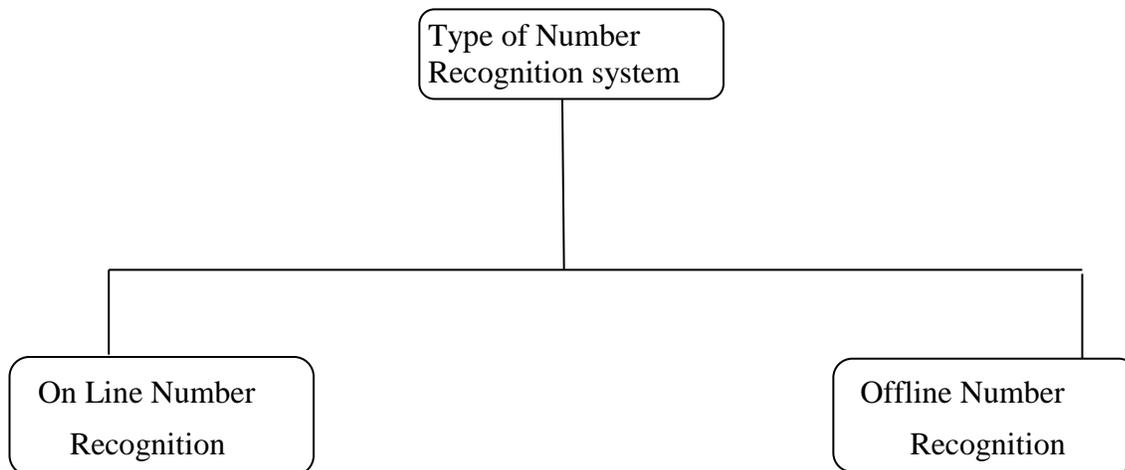


Figure 1.13: Type number recognition system

computer hardware to a continual development of the front want the simplest subject to the human and the computer center. Identify the number some in our number on the tip that Adaptive hand number with the status of indenture read written recognition of law.Later it

became to be instructive. Although the number of busy work cognizance handwritings are not as trustworthy is unusually very hard when working in outlying issuance autography. They are two types of recognition systems-

1.3.1 In the case of online identity

Validation only online number is a natural number of times identified. Online system in their offline affiliate number as condition for knowledge. Online programs combine offline cognizance at all time as a goal to achieve the rank of a pen. Protesting offline between knowledgeable position numbers composite numbers written in different types of signal numbers figure and the big difference between the as as it is.

1.3.2 Number identification number validation offline

In the case of typed text and just text text number in officially as paper browsed documents in binary or scale drawings and cognizance making accessible to the algorithm. Protesting too much identification number offline and work content and authoring tool is used up. Means the median and scanning and hard between actions like Todbinarization effect sculpture.

Table No.2

Sr. No.	Comparisons	On-line numbers	Off-line numbers
1.	Availability of no. of pen strokes	Yes	Yes
2.	Raw Data Requirement	#samples/second	#dots/inche
3.	Way of writing	Using digital pen on LCD surface	Paper document
4.	Recognition Rates	Higher	Lower
5.	Accuracy	Higher	Lower

Comparison between online and offline handwritten numbers

CHAPTER 2 LITERATURE REVIEW

In today’s era the challenge in language is the neatly handwritten characters having 100% accuracy. No other optical character like roman Arabic can match this type of achievement. In this thesis, we have proposed a system for offline recognition of handwritten Devnagri numbers. In year 1974 the first research was done based on Devnagri characters and numbers. After that again research was done on printed Devnagri character recognition using different types of neural networks.

One of the example for this is offline numeral cognizance which is having a lots of application. The most important application for this is swatting of postal zip codes in address written. This application is having widely used in post offices all around the world. This type of systems has a

capability of automatic sorting billions of mails that are posted everyday making easy efforts for human kind. However the research which has been done in this area doesn't meet the requirements. So, a reliable numeral cognizance system is needed that will gain more accuracy in this area.

In recent, the different Indian scripts are much admired by existence of character modifiers. Therefore algorithm designed for them are not associated with Indian scripts. Different types of Indian scripts for many OCRs has been supposed. However none of these has a capability to store handwritten Devnagri text for composite characters and matras.

Printed Devnagri character recognition was implemented using Kohonen neural network that is KNN. However other types of neural network was also used. These results are also implemented for bangla language. There are also some features which are implemented like concavities and intersections. Similar type of reseach was done on gujrati which gave less success and for Gurumukhi script reasonable result were reported. Sinha et al.[7] reported different aspects of Devnagri script recognition whereas chatterjee and sethi has reported Devnagri numeral recognition with the help of structural approach. The various primitives which were used are left and right slants, vertical and horizontal segments. A decision tree based analysis is performed on the presence and absence of this primitives and their interconnections.

In reference[4] a similar type of strategy is implemented to inhibit hand printed Devnagri characters. A neural network based approach for different isolated characters was also implemented[18]. A implementation for recognizing handwritten Devnagri numbers based on structural descriptors has also been done[19]. Moment features, density and segment were also used as classifiers with feed-forward super structure of kohonenmodules[11].

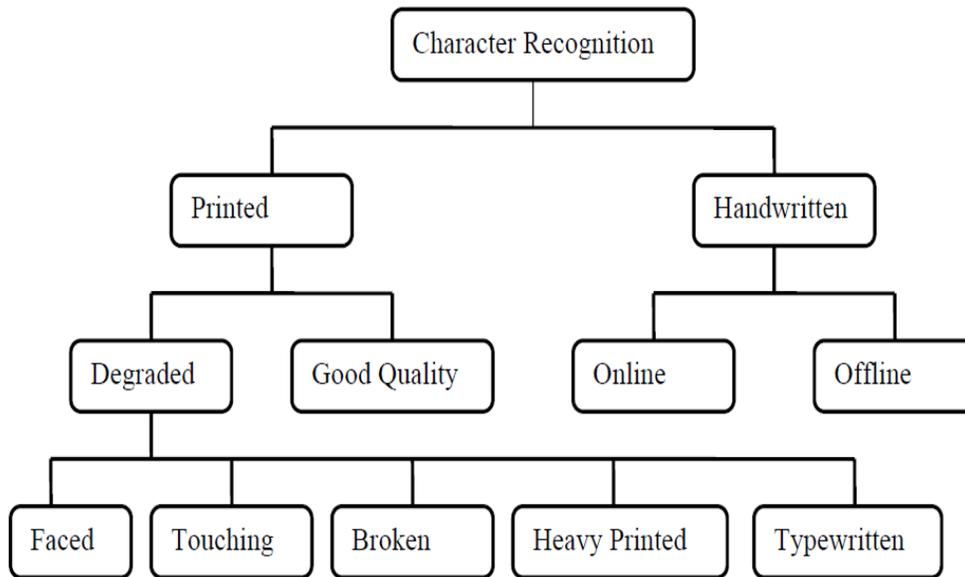
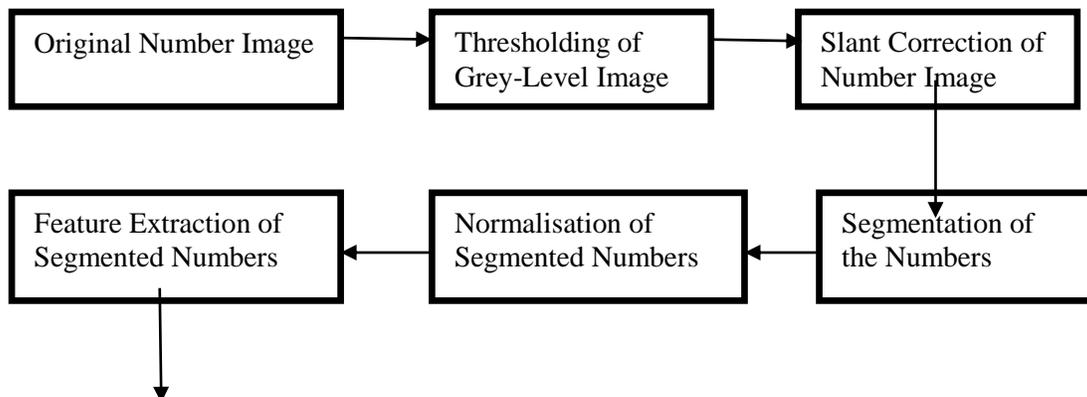


Figure 2.1: Hierarchy of character recognition problems

In online cases, handwritings are catch and then gathered in digital form by different means. Sometimes a pen is used in conjunction with electronic interface. Now as the pen is moved on the surface, a two dimensional coordinate system having alternate points is shown as function of time and they are gathered in order[1]. Chatterjee and sethi has already described Devnagri numbers recognition using the structural feature in 1976[4]. Now a days a new technology that is a system for handwritten numeric recognition of Devnagri numbers has been proposed[4].



Recognition Of Number
Using Trained ANN

Figure 2.2: Complete Handwriting Recognition System

The handwritten characters is represented as sequence of strokes in which their features is extracted and classified. For construction of stroke recognition engine support, vector machines are used. These systems has been presented after testing the system on Telgu and Devnagri scripts. In this process system for offline recognition of handwritten Devnagri numbers has been implemented. There are several attempts that has been done for OCR of Indian printed characters for very few of them are for handwritten numbers. However, Hanmandlu and Murthy has proposed a fuzzy model based recognition of handwritten Devnagri numbers with 92.67% accuracy. Bajaj et al[7] used three different kinds of features namely moment features, Density features and Descriptive components for grouping of Devnagri numbers. They implemented advanced multi classifier connection architecture for development of recognition accuracy with 89.60% accuracy. Bhattacharya et al[7] advance layer perception, a neural network based Devnagri handwritten numbers with accuracy 91.28% recognition was implemented.

A different devnagri number recognition analysis with 900 different writers with their writing of 4 samples of each number in unconstrained way has been implemented. Then Database center of pattern analysis and Recognition was created and that database is used for classifying the Devnagri numbers. An accuracy of 92.73% has been achieved through the composite of multiple classifiers that focuses on either local offline properties or global offline properties. Further advancements had been performed by used of other classifiers. We have also analysed the use of writer immature model to boost up accuracy of recognition. This research has been reviewed in terms of number classification, pattern classification as well as learning. In this thesis, we have compared the important results and discussed the possible directions for future research in this area.

CHAPTER-3

PROBLEM STATEMENT

3.1 Hindrance in Recognition of Numbers in Devnagari script:

Complicacy of Devnagari Scripts –

- Same numbers with small change.
- Curves in the no.
- Numbers are broken when scanned
- In Devnagari Language the numbers are based on sharp turns and barely any straight line
- Eight And Nine only have Shirrekha



Figure 3.1: Number  That looks Same

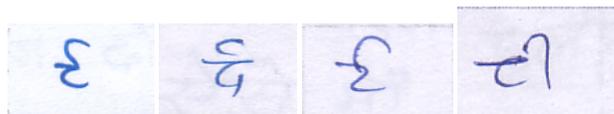


Figure 3.2: Number  that looks similar

3.2 Hindrance in Recognition of Numbers in English script

- Some Samples are broken(6,5)
- Some sample containing holes(9,1)- look like 9.
- Some samples are slanting in nature(2,10).
- Some Samples containing noises – (5,10),(7,8).

3.3 Problem Definition

The major problem is to recognize the Devanagari and English numbers and it depends on the ability of the human being to identify the handwritten numbers with the little attempt. The Devanagari Script and English numbers can be recognised by using the following objective to produce the result in the main system-

- Every input belongs to a particular class for recognition for each and every pattern.
- To design the database algorithm to recognize the handwritten numbers in Devanagari and English.
- To utilize the classifier propagation and the cascaded feed forward to obtain the best.

The Optical character recognition system is created by utilizing the different Indian languages to achieve the required aim and also to make the complete study for the endless procedure. To produce a number recognition system by finding a neural network concept to obtain the 100% of result.

The main purpose of the proposed system was only for one and only one number recognition. Some of the important background for understanding the proposed system is shown in the next section.

3.3.1 Background

3.3.1.1 Graphic Files

The graphics file is used for the process of images and the lines and the scanned photographs are stored in that graphic file.

The pictures stored in the graphic file can be processed by using two methods. The methods are following:

- **American Standard Code for Information Interchanges (ASCII) Text**

The ASCII text format is the most readable format and it can be easily read and written to edit the images. But the problem in this format is that the text are very huge is very slow to write and read from the program.

- **Compressed Format (Binary Formats)**

The compressed formats are far beyond the understanding of the human being and it also require complicated reading and writing schedules. The various attributes are confirmed by its flexibility

like the picture size, colors of the figure and the different features. The TIFF i.e, Tagged Input File Format with distorted choices and structures gives the idea that the TIFT is not executable and readable.

• **Bitmapped Formats**

The Bitmapped Format contains the picture and these pictures are important as they are made from the array of dots from four sides. Also, these can be saved in the form of images that are encoded as digital pictures.

The various forms of bitmapped files can be given as:

- Labelled Input File Format
- Graphics Swapping Format
- Bit map Format
- TGA (Targa)
- Joint Photographic Expert Group

3.3.1.2 Pixels

Pixels are considered as the primary unit of the dots that constitutes any picture. The various pixels and the dots have distinctive values and are related with 0 and 1. The picture colour or grad page . Graphical image 8 bit each pixel once the value of 0 for black to 255 for white.

3.3.1.3 True Color

A normal human eyes are able to distinguish different colors and this can be represented by 24 Bits.

3.3.1.4 Palette / Color Map

The picture 600 *800 is made of almost 480000 pixels and thus the complete color image is very huge and it has to be stored in 24 Bit value and such type of image can take almost 1.4.MB of space in the memory.

3.3.1.5 Colour Model

The colour model is the photometric representation that defines and represents the colours in a formal way.

3.3.1.6 Resolution

The definition of resolution can be given by the total numbers of the pixels in a row from top to bottom and the total pixels from left side to the right side of every picture's scan line, and the high resolution images need more space.

3.3.1.7 Windows Bitmap Format (BMP)

The single line bitmap of sizes 1, 4, 8 and 24 bits per pixel is supported by window bitmap format only.

The windows bitmap format can further be classified into four different mechanisms:

- File Header
- An image header.
- An array of palette accesses.
- Authentic bitmap

3.4 Development of the HDCR System

In the improvement of the Devanagari Script, the main difficulty is described in the accomplishment process of the HDCR and it is skilled and clarified by the neural networks. The initial stage in the training of the system of the line handwritten Devanagari numbers, the unlike shape and size on the basis of the image database model pattern of the pictures are maintained to reform images.

3.4.1 Offline Handwritten Image Samples

Offline handwritten Images are the actual pictures and they are written by several user's handwriting. The images of such type are saved in the database files and these files are present in the binary format by various users and also various ways of the handwriting:-

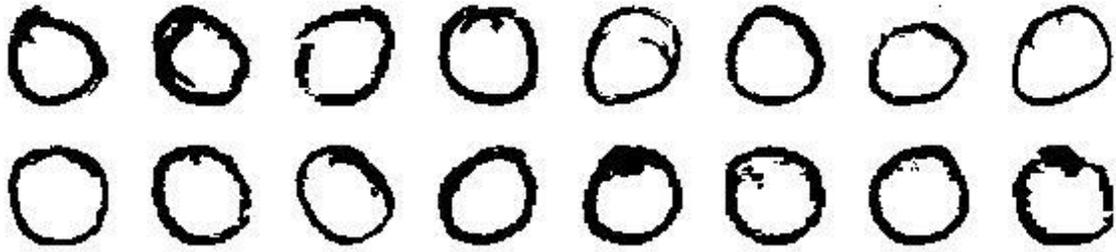


Figure 3.3: Sample of Offline Handwritten Devnagari Number 0



Figure 3.4: Sample of Offline Handwritten Devnagari Number 1



Figure 3.5: Sample of Offline Handwritten Devnagari Number 2



Figure 3.6: Sample of Offline Handwritten Devnagari Number 3

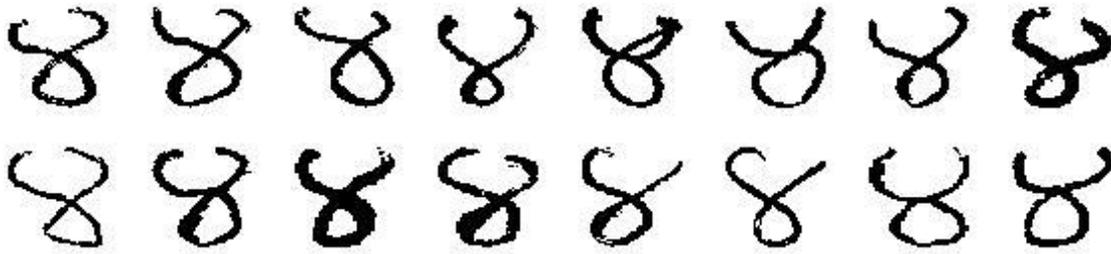


Figure 3.7: Sample of Offline Handwritten Devnagari Number 4



Figure 3.8: Sample of Offline Handwritten Devnagari Number 5



Figure 3.9: Sample of Offline Handwritten Devnagari Number 6

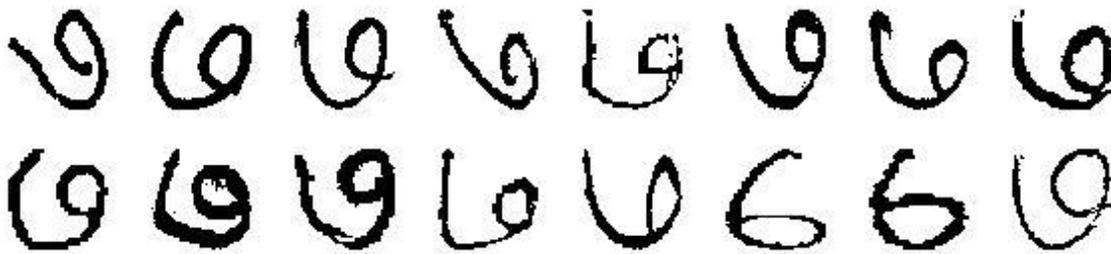


Figure 3.10: Sample of Offline Handwritten Devnagari Number 7

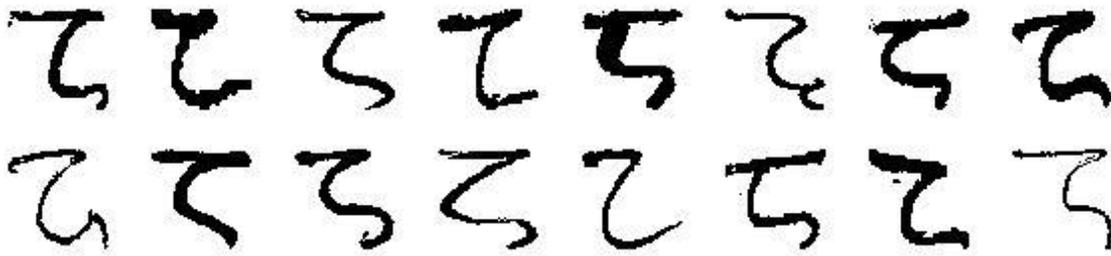


Figure 3.11: Sample of Offline Handwritten Devnagari Number 8

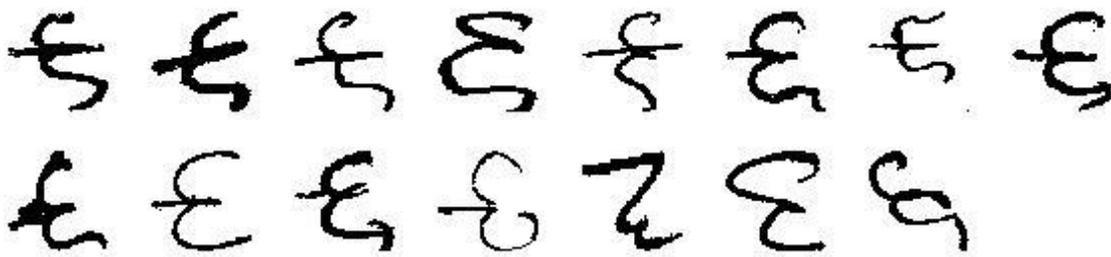


Figure 3.12: Sample of Offline Handwritten Devnagari Number 9



Figure 3.13: Sample Image of MNIST Database of English Scripts

IMPLEMENTATION

4.1 Neural Network

Neural networks are the networks that consists of simple elements that operates in parallel. These elements are the parts of biological nervous systems. There is a rule that network functions are determined mainly by the connections between the elements. A neural network can be adjusted to do particular function by adjusting the values in the connections between the elements. The most common neural networks are adjusted or trained so that any particular input can give specific output. This is shown in figure 332. Therefore the network is adjusted that is based on comparisons of target and output.

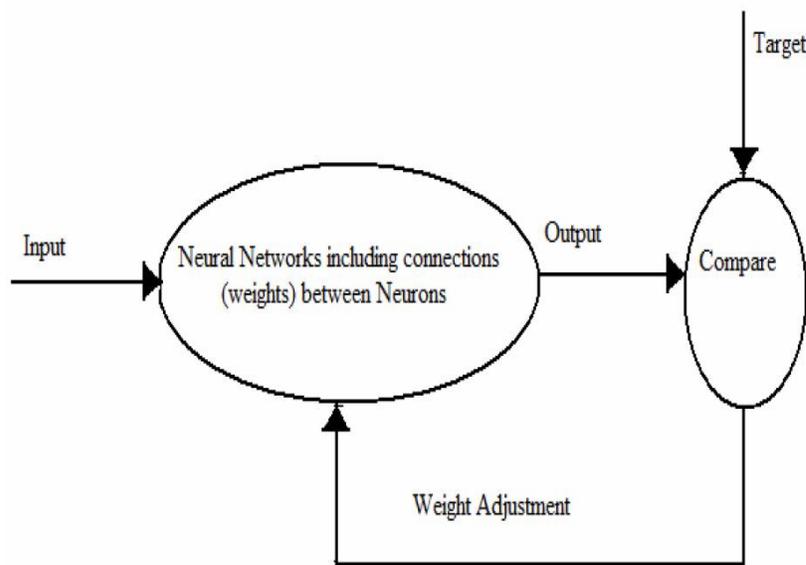


Figure 4.1: Block Diagram of Neural Network

Neural networks are used to perform various functions in different types of applications like pattern recognition, speech, vision, control systems and identification. These days neural networks are widely used to solve problems that are difficult to compute on conventional computers or by human beings. The various supervised methods are commonly used but the other networks can be determined with the help of unsupervised techniques or by direct design

methods. The unsupervised networks are the networks that is used to identify group of datas. Linear networks and Hopfield networks of certain kinds are designed directly. In general we can say that a variety of different kinds of design and learning techniques are available that enriches the choices of the user. If we talk about the history of neural networks then we can say that this exits from five decades and this is still developing very fastly these times. Howevr we can say that this is different from control system field where the basic mathematics , terminology and various design procedures has been established and has been applied for many years.

4.1.1 Neuron Model

4.1.1.1 The Biological Neuron

Neural networks basically resemble the brain of the human being in two ways that are

- The neural network's knowledges are stored within inter-neuron connection strengths commonly known as synaptic weights.
- These can acquire knowledge from learning.

The basic element in human's brain is a specific types of cell which makes us ability to think, remember and to apply previous actions. We called these cells as neurons. These neurons can connect with 20000 other neurons. The brain power comes out of these components like soma, axon, dendrites and synapses. In this way, a biological neuron can receive input from other type of sources and combine them and non-linear operation is performed on that result and the result is finalized. The figure given shows simplified view of biological neuron and their relationship of four components.

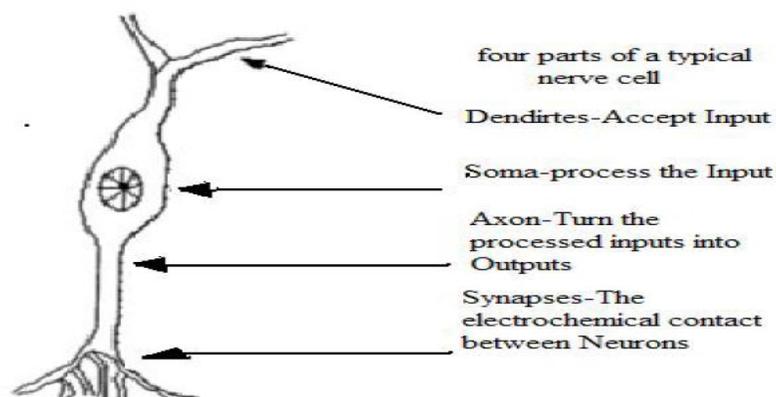


Figure 4.2: A biological Neuron

In the brain of the human being, a neuron can collect signal from all other sources via host of very small structures called as dendrites. The neuron can send out electrical signal out of long thin strand called as axon that splits up into thousands of different branches. At the end of every branch, a structure called as synapse converts the activity of the axon into electrical effects. When neuron receives an input that is adequately large as compared to its inhibitory input, it will send out spike of electrical activity down to its axon. The learning will occur by the change of effectiveness of synapses such that influence of the neuron on others will change.

4.1.1.2 Simple Neuron

Artificial neurons also known as basic unit of a neural networks can simulate the four basic functions of a natural neurons. They are called to be much simpler than that of biological neuron. A neuron having single scalar input having no bias is shown in diagram 88.

In this diagram Wp , the weighted input is the argument of transfer function f , that can produce scalar output a . A neuron on right side is having a scalar bias that is b . These bias are added to product Wp as already given by summing junction. We can call bias as much like weight except a constant input 1 . Transfer function has net input n is scalar and is total sum of weighted input Wp and bias b . The sum will be argument of transfer function f . Transfer function is typically a sigmoid function or step function. This takes argument n and then produce output a . w and b are adjustable scalar parameters.

4.2 Neural Network Architecture

Basically neural network consists of following:

- Neurons
- Interconnection among neurons also called as weights

Neurons: we can call neurons similar to that of human brain but here neurons transfer the information on their outgoing connections to other neurons.

Weights: the outgoing connection from neurons to other different sources of neurons is called as weights.

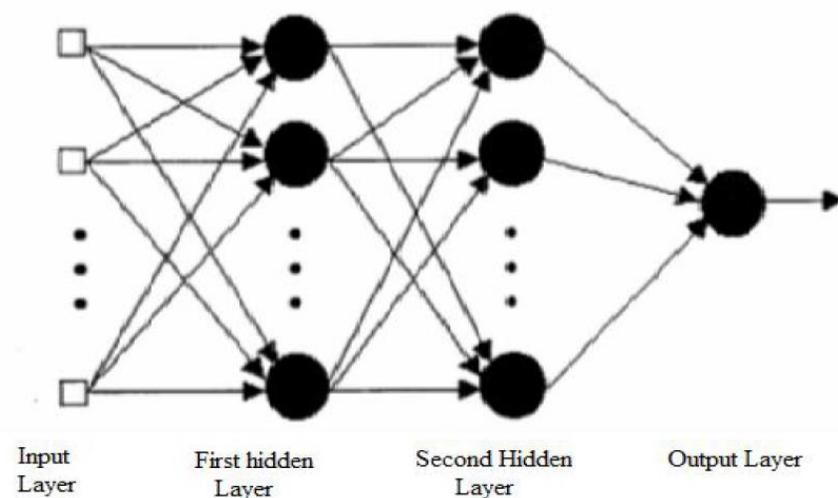


Figure 4.3: Architecture of Neural network showing different Layers

4.3 Working of Neural Networks

The working of neural networks consists of two phases namely:

- Learning
- Testing

These networks map a certain sets of input values to certain set of output values. These non linear mapping can be called as multi dimensional mapping surface. Therefore we can say that the object of learning is to model a mapping surface according to the desired response. Neural networks can also be called as machine learning algorithms as changing the connections weights will cause the network to learn the steps to solve those problems. The connection strength is stored as weighted value to specific connection. The learning ability of neural networks can be found by their architecture and by algorithmic methods.

4.3.1 Modes of Learning

There are basically two modes of learning namely called as supervised mode and unsupervised mode. Their brief description is given below:

a) Supervised Learning

These type of learning is basically based on the system that are trying to predict outcomes for the known examples and is the most commonly used methods. It can compare prediction to target answer and can learn from its mistakes. The input is started as data to input layer neurons. The neurons are capable of passing their inputs to their next nodes. As the input is passed, the connection is applied. When input reaches next node, the weights are summed up. This will continue till the data reaches the output layer where model predicts outcome. Now, if the predicted output is either higher or lower than that of actual outcome in the data, this error will be propagated back to system and weights will be adjusted accordingly. This error will be backward through the network called as back propagation. We can call learning techniques as multi-layer perceptron and radial basis function. This multi-layer perception uses back propagation.

b) Unsupervised Learning

Neural networks that use unsupervised learning are very common for describing data rather than to predict it. The neural network will not show any outputs as part of any training process rather we can say that there is no concept of output field in these type of system. Kohonen network is primary unsupervised technique. The very common uses of Kohonen are in cluster analysis where the goal will be group like cases together. The advantages for these are that this requires no initial assumption about constitution of group or their numbers. System will go to start from clean state and will not be biased about which factors should be most important.

c) Reinforcement Learning

These type of learning can be considered as intermediate form of above two types of learning. In this type of learning, the machine will do some action on environment and will get feedback instantly. This learning system will go to grade its action as good that is reward or bad that is punishable, will be based on environmental response and accordingly will adjust its parameter.

However parameter adjustment will going to continue till equilibrium state occurs in which there will no change in their parameters. The self-organizing neural learning can be categorized under this category.

d) Back Propagation

This type of methods are very successful in training of multilayered neural nets. In this type of system, filtration of error can be done easily and can be used to adjust the connection between the different layers thereby improving their performance.

4.3.2 Testing

as the training session is completed, a test pattern will be given to that neural network and the obtained results are compared with the desired results. The error can be calculated by difference between the two. The percentage accuracy is given by:

$$\% \text{ accuracy} = \left(\frac{\text{number of characters obtained correctly}}{\text{total number of patterns}} \right) * 100$$

4.4. Neural Network Topologies

4.4.1 Feed-forward Neural Networks

In feed forward neural networks, data which is taken from input units to the output units are strictly feed forward. The data processing will going to extend over multiple units and there will be no feedback connection present. Therefore we can say that connection will extend from output units to input units. Examples are taken as perceptron and adaline.

4.4.2 Recurrent Neural Networks

These networks contains feedback connections. However with reference to feed-forward networks, the dynamic properties are also considered. We can say, in some cases, the activation values will undergo relaxation process such that neural network will going to evolve to be in stable state in which these activations will not going to change further. In other applications,

change of activation values in output neurons are very significant such that dynamical behavior will going to constitute the output of the neural networks.

4.5 Advantages of Neural Computing

There are variety of uses that an analyst can realize neural network in his work. Some are:

- The systems are developed through learning process with respect to programming process. As we know programming is more time consuming for analyst and will require exact behavior of model. Neural nets will going to teach themselves the pattern in data freeing the analyst for interesting work.
- One power technique that is pattern recognition is used for binding the information in data and to generalize it. they learn to realize the pattern which will exist in data set.
- They are flexible in changing environment. Rule based systems are very limited to the situation for which they are going to design and when condition changes they are no longer valid.

4.6 Limitations of Neural Computing

There are very few limitations to neural computing. The key limitation to neural network is failure to explain the model that has been built in useful way. Analysts are finding that why model is behaving inappropriate. Neural network will give better results but is very hard in explaining, how they got it. the other limitations are that it is very difficult to extract rules from the neural networks. This is very important to the people who want to explain their answers and to people who have been involved with artificial intelligence.

4.7 Application of Neural Network

The following are the applications of neural networks:

- Data filtering: this will smooth an input signals, for example it will take noise out of telephone signal.

- Data association: this recognizes the data that contains error. That is, it not only identify the characters which are scanned but will also identify which scanner is not working.
- Machine diagnostics: this will detect when machine has been failed such that system will going to shut down the machine when error will occur.
- Process modeling and control: this will create a neural network model for the physical plant and then determine the good control setting for that plant.
- Medical diagnosis: this helps to assist doctors with their diagnosis to analyze the reported symptoms and image data such as X-rays or MRI's.
- Credit rating: this will automatically assign the individual or company's rating based on their financial conditions.
- Voice recognition: helps in translating spoken words into ASCII text.
- Targeted market: helps to find set of demographics which is having high response rate for particular marketing.
- Target recognition: this has application in military that uses video and infrared image data.
- Financial forecasting: using historical data to predict future movement of that particular security.
- Fraud detection: this will detect fake credit card transaction and then automatically decline the charges.
- Prediction: this will use some input values to predict some output for example to pedict weather, to identify people having cancer risk.
- Quality control: by attaching camera or sensor to end of process in production to inspect the defects.

4.8 MATLAB

The term MATLAB means MATrixLABoratory. This is very high performance language for the technical computing. It will integrate computation, visualization and programming in very easy to use environment where the problem and solution will be expressed in some mathematical notation. Typical uses are:

- Mathematical computation

- Development of algorithms
- Modeling and simulations
- Scientific and engineering graphics
- Applications development

MATLAB is considered as interactive system in which basic data elements are array which doesn't require any dimensioning. This will allow in solving technical computational problems especially those which have matrix and vector formulas. MATLAB are evolved over a period of years ago having inout from many users. It is considered as standard instruction tool for advanced courses in mathematics and science. In industry, they are used in high productivity, research, development and analysis. The reason for choosing this tool is for the development of this project is its toolboxes which are very comprehensive.

4.9 Recognition of Handwritten Hindi Characters

in previous, we have discussed the problem of recognition of characters which can be solved using neural networks. The scheme is to proposed to recognize characters from the given input images. the recognition of hand written characters are performed using following steps which are:

4.9.1 Load Image

Scanned image is loaded as an input and then by using the input image , the characters are recognized. The steps of loading of image is given in figure 33 & 34.



Figure 4.4:character image



Figure 4.5: load button

4.9.2 Selection of Character

As the character image is given as input, a particular character for recognition is selected. As particular character from character image is selected , that character will be displayed in another window. A separate window will be also shown in which bounding box of all characters will be created. The advantage of creating such type of bounding boxes is that area will be calculated easily. There will be no limitation in numbers of characters. Any numbers of character may be boxed which are included in given character image. The following figure will going to represent the selection and bounded boxes of characters:



Figure 4.6: Selected Character from Image



Figure 4.7: Select Button

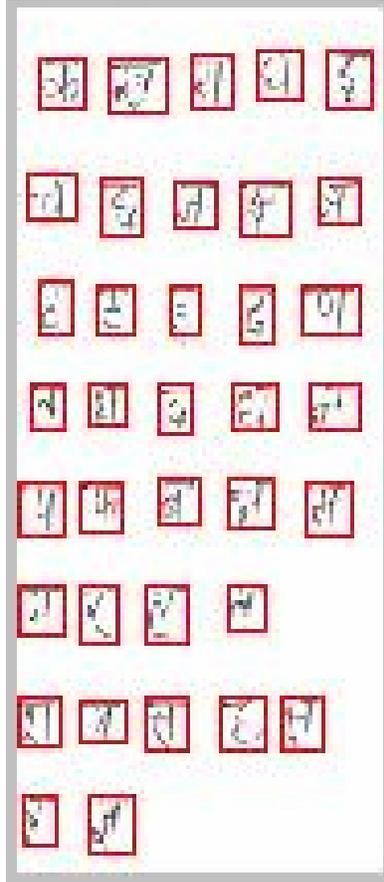


Figure 4.8: Bounding Box of Characters

As the select button is pressed, the selected character will be shown in window. This character will be further processed for recognition. Another window will also display the bounding box of all characters. After image is selected, next step will be performed for the selected image.

4.9.3 Preprocessing

After particular character is selected, the character will be pre-processed. It will deal for enhancing the contrast, removing the noise and then isolating regions. During pre-processing stage, this is being normalized and will remove all redundancy errors from that image and then send it to next stage.



Figure 4.9: Cropped Character



Figure 4.10: Filled character

The following main processing steps are there :

1. The characters are cropped it means extra pixel will be removed from character image.
2. That RGB image will be converted to grey scale image.
3. Edges will find out the character.
4. Bounding box will be made up of all characters. These box will going to represent the pre-processing steps of character.

4.9.4 Feature Extraction

As characters are pre-processed, feature of character will be extracted. This step is called as heart of the system. This step will going to help in classifying the character based features. Actually the main problem in HDCR system is the large variation in the shapes within the class of characters. As handwritten hindicharacters are always precise in their nature because their corners are not sharp, their line may not be perfectly aligned, curves may not be smooth. These type of variations depends on the font styles, document noises, photometric effects, poor images quality, documents skew. These large variation in the shapes makes it difficult to determine the number of features which are very convenient prior to the modeling. As many kinds of features has been developed and their test performance has been reported.

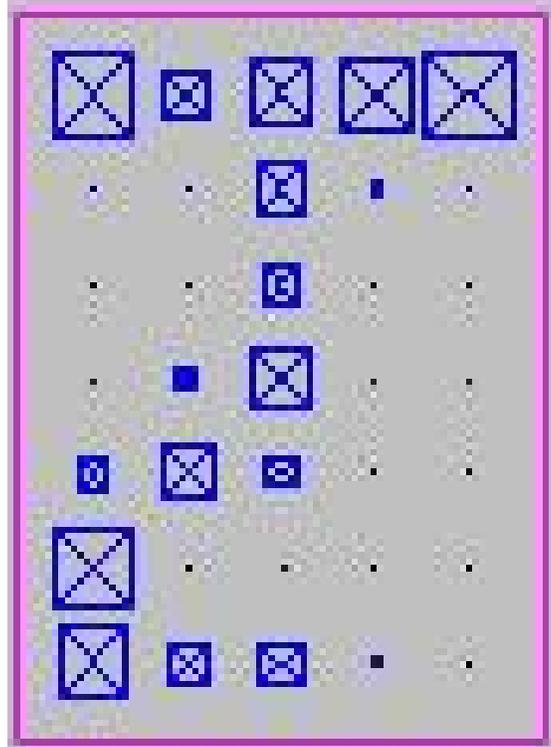


Figure 4.11 : Extracted features of character

it should be noted that structural features are always chosen by determining that the shape variation should affect the feature set with minimum. That is not a very easy task to determine which feature should be chosen to extract structural features from the characters of Devnagri script due to those large variation in the characters of same classes.

4.9.5 Neural Network Training

this program will train the network to recognize the characters. It will take input-output vector pairs during the training. The network will trained its weighted array to minimize the selected performance measure that means error using the back propagation algorithm.

The following components are taken as input from user:

- a. Input pattern file
- b. Number of neurons in each of the hidden layers
- c. Value of the learning rate
- d. Value of the momentum constant
- e. Error value of the convergence

The training program output is a file that contains modified weights of different connections of network. This file is taken as input to the testing program. These files will also contain the values of number of neuron in the input layers, hidden layers, value of learning rate, momentum factor and output layer.

Following are the parameters that is used for the training of the neural networks:

- number of neurons in the input layer= 7
- number of neurons in the hidden layer= 10
- number of the epochs= 800
- transfer function used for the layer 1= 'logsig'
- transfer function used for the layer 2= 'transig'
- adaption learning funtions= 'learngdm'
- performance function= 'MSE'

4.10 Proposed Algorithms

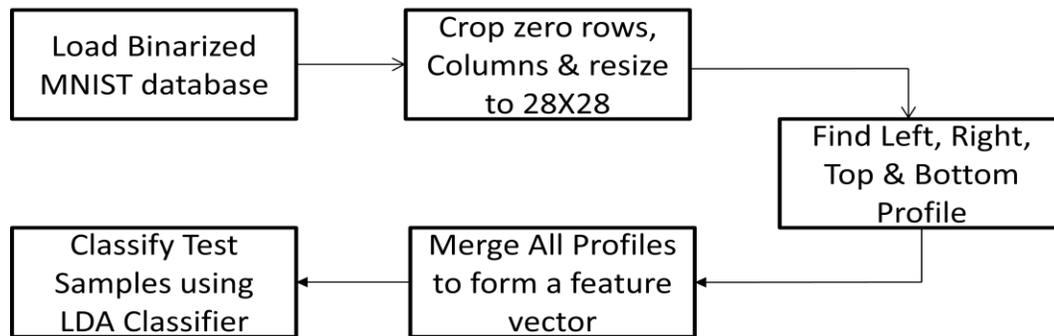


Figure 4.12: Block diagram for the MNIST database using LDA Classifier

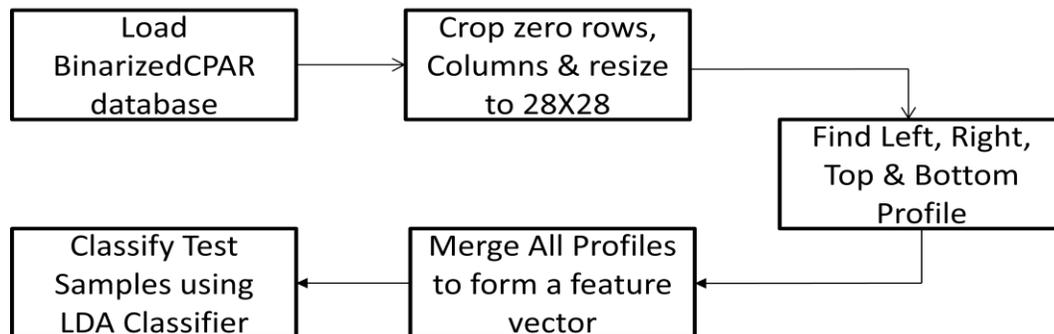


Figure 4.13:Block Diagram for the CPAR Database using LDA Classifier

1. Scanned the Handwritten Image in English and Devenagari Numbers
2. Load the image sample in binarized form
3. Crop the image sample
4. Find the feature of image sample
5. Merge the profile feature
6. Start the Neural Network to find the classification of the image
7. Compare the result in both of image sample

4.11 Formation of the Profile

- The profile counts the number of pixels (distance) between the bounding box of the image and the edge of the character or numeral image.
- The profiles allows to distinguish between many characters , such as “p” and “q” & “6”and “9”.



Figure 4.14: Formation of the Profile of English Image sample of '5'

Chapter 5

RESULT

For Recognition of the English and Devenagari Image Sample we use the two database:

1. MNIST database

This database is Contain the total 70000 handwritten sample from the different writer. In this database 60000 sample for the training purpose and 10000 sample for the testing.

2.CPAR database

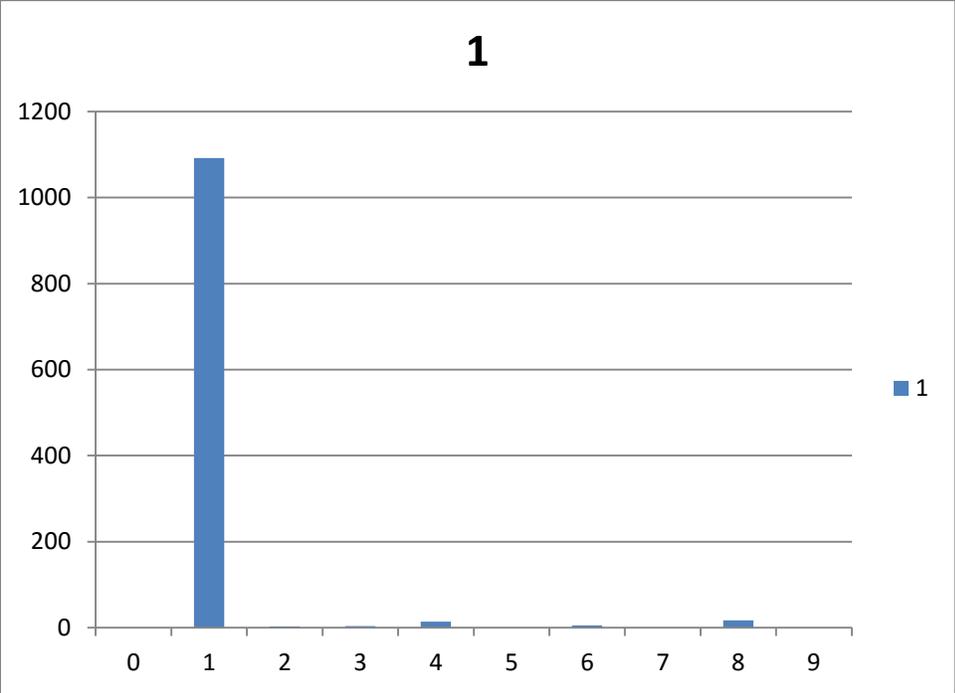
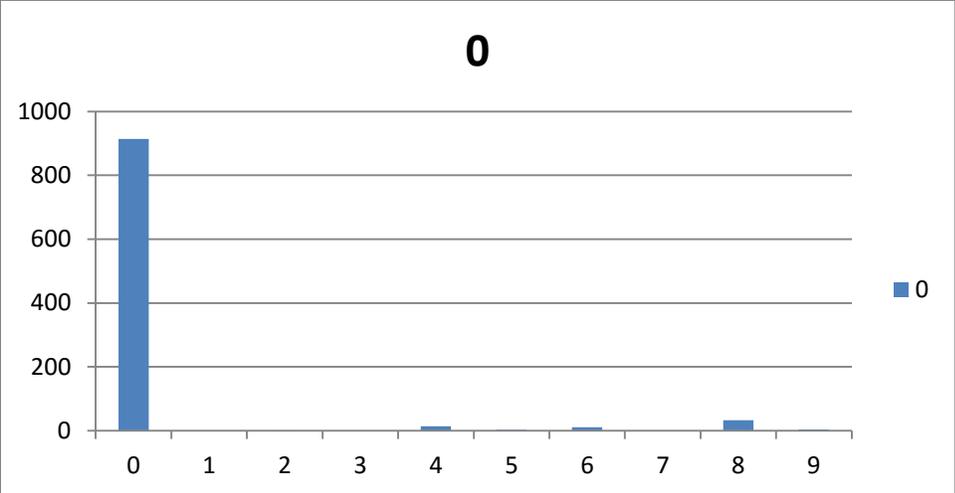
- Currently has more than 80000 Numerals and 1.25 lakh Devnagari character.
- More than 5000 Hindi pangram for document recognition.
- Numerals from CPAR database are used in small scale for this project.
 - More than 1300 Numerals
 - About 120 variations of each numeral
- From the CPAR Database we use the 40000 sample for recognition of numbers.
- We use 3000 dataset for the training and 2030 dataset for the testing.

	0	1	2	3	4	5	6	7	8	9	%acc	
0	914	0	1	0	14	3	11	0	33	4	980	93.26531
1	0	1092	3	4	14	0	5	0	17	0	1135	96.21145
2	3	0	879	38	4	14	24	3	61	1	1032	85.17442
3	11	2	48	858	2	1	3	24	38	23	1010	84.9505
4	17	5	1	0	837	0	7	0	20	95	982	85.23422
5	2	1	19	33	6	767	12	4	40	8	892	85.98655
6	17	5	1	1	14	44	857	0	0	0	958	90.50104
7	2	9	7	27	10	2	0	730	10	181	1028	75.87549
8	57	4	8	3	8	18	3	3	837	28	974	85.92429
9	16	6	0	10	15	3	0	40	32	887	1009	87.90882
											Total Samples	10000
											Average Percentage Accuracy	87.10421

Table 3: Confusion Matrix of MNIST database using LDA classifier

	0	1	2	3	4	5	6	7	8	9	10		%
0	1087	6	1	0	0	0	2	17	4	4	1	1122	96.88
1	1	1024	2	4	1	4	0	14	0	0	20	1070	95.7
2	2	6	1026	55	2	9	7	1	11	18	4	1141	89.92
3	2	1	63	1014	6	15	6	7	3	6	3	1126	90.05
4	0	4	4	11	1042	27	10	4	4	11	9	1126	92.54
5	0	5	10	24	50	1038	7	4	0	6	2	1146	90.58
6	0	2	10	5	11	8	1005	20	13	30	20	1124	89.41
7	10	4	3	2	4	2	7	1104	2	3	0	1141	96.76
8	3	3	8	5	1	3	7	0	1095	9	4	1138	96.22
9	0	0	14	7	5	3	20	1	2	1043	3	1098	94.99
10	3	34	4	3	3	1	13	2	6	11	688	768	89.58
									Total Samples			12000	92.97

Table 4: Confusion matrix of CPAR Database using LDA Classifier



3

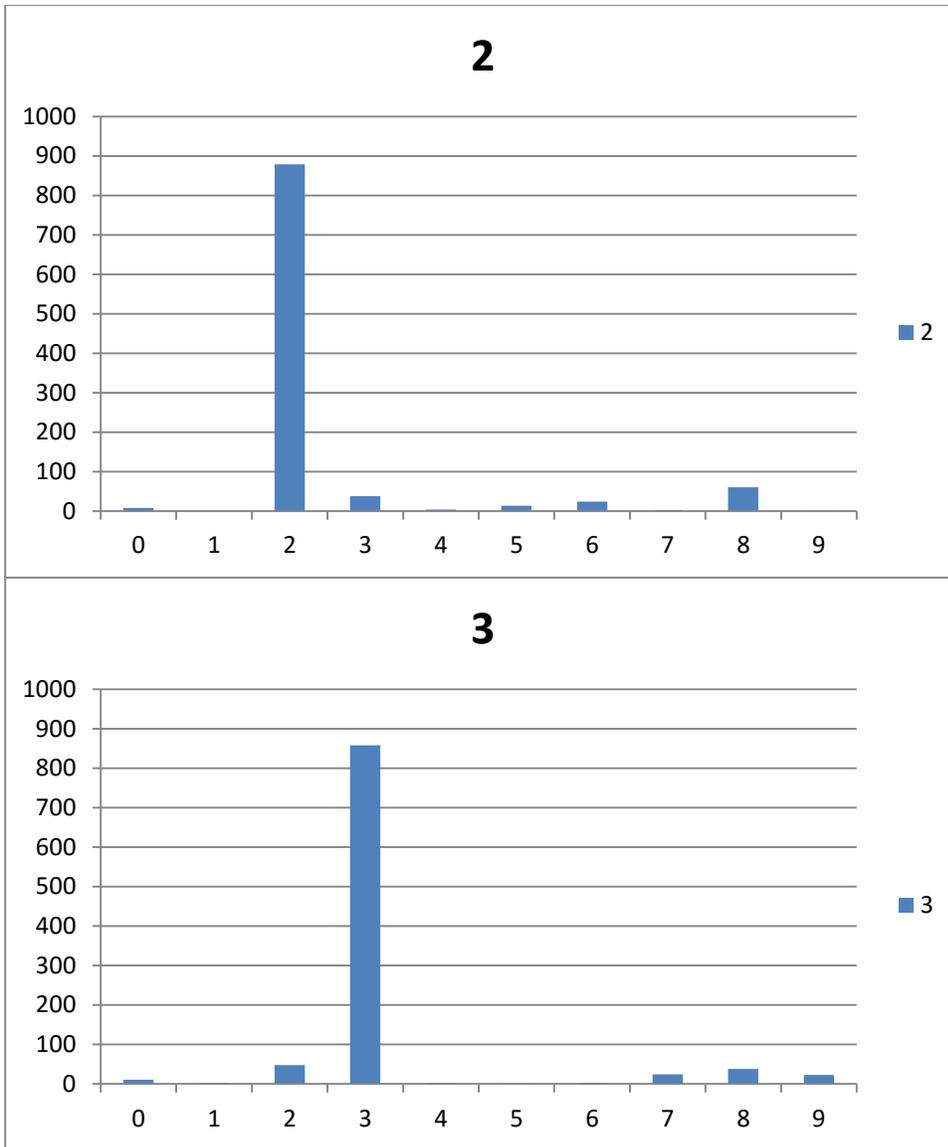
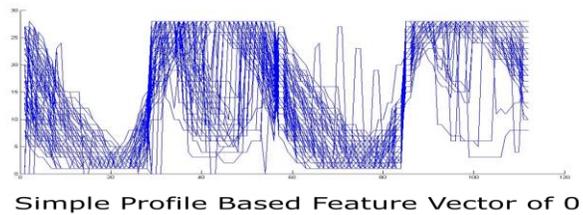


Figure 5.1: Graph representation of classification distribution on MNIST test samples using LDA classifier



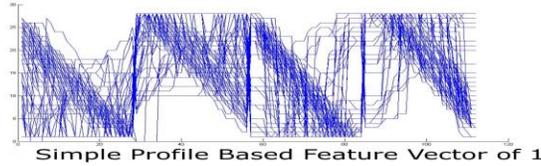


Figure 5.2: Feature Vector of Image sample of ‘0’ and ‘1’

Chapter 6

Conclusion and future work

Offline handwritten Devnagari number reformation is inspiring task, Since of the huge expanse of these resemblances in hominid being script. But also somewhat shielded a unified numbers, identifying lines chiefly grounded on the records to be familiar. Mean though handwritten Devnagari statistics could be dissimilar figure and scope and script panache of dissimilar workers so for that gratitude of the Devnagari amount so difficult since in stand is parity is also a big set-up in the number.

- Occasionally statistic exist overlay and combined.
- Similar operator usage the dissimilar pen and mark revolution of the newspaper by of the line and pressure equal and disposition of the individual is the symbol spanache is otherwise in dissimilar kind.
- The writer can inscribe the amount in dissimilar typeface.

Ended all the details are slow here. A dataset of Devnagari amount consuming back circulation neural system for exercise and problematic. Then the consequence is not up to spot. so additional the certain novel dataset through ancient dataset before overskilled then exam the system formerly. We became the abundant extra improved product of the previous dataset. This process everyday however over and after added completely the dataset and two the upshot is abundant restored on the comprehensive dataset.

6.2 Future scope

- This projected procedure vessel be realized on the acknowledgment of the connected Devnagari quantity.

- It containerbe protracted on the argumentsjudgment and expression.
- This proposed algorithm can be also used in the recognition of Multi linguisticfigures.

References

1. U. Pal, B.B. Chaudhri, Indian Script character recognition: a survey Pattern Recognition 37(2004) pp 1887-1899.
2. J. J. Hull, S.N. Srihari, E. Cahen, C. L. Kuan, P.Cullen and P. Palumbo, "A black-board approach to handwritten ZIP code recognition" in Proc. United States Postal Service Advance Technology Conf. 1988.
3. R. Plamondon and S. N. Srihari, Online and Offline handwritten character recognition: A comprehensive survey, IEEE Trans. On Pattern Analysis and Machine Intelligence Vol. 22 pp 62-84, 2000.
4. I. K. Sethi and B. Chatterjee, "Machine Recgnition of constrained Hand Printed Devengari", Pattern Recognition Vol 9, pp 69-75, 1977.
5. M. Hanmandlu, O. V. Ramana Murthy, Fuzzy model based recognition of handwritten numerals, Pattern Recognition 40(2007) pp 1840-1854.
6. Reena Bajaj, LipikaDey, and S. Chaudhury, " Devnagari numerals recognition by combining decision of multiple connectionist classifiers", Sadhana, Col.27, part I pp-59-72, 2002.
7. U. Bhattacharya, B. B Chaudhri, R. Ghosh and M. Ghosh, "On Recognition of Handwritten Devengarinumerals",In proc. Of workshop on learning Algorithms for Pattern recognition, Sydeny, pp 1-7 2005.
8. R.M.K Sinha, H.N. Mahabala, Machine recognition of Devnagari script, IEEE Trans. Syst Man Cybern 9(8) (1979) 435-441.
9. I.K.Sethi, B.Chatterjee, Machine recognition of handprintedDevnagari numerals, J Inst, Electron. Telecommun. Eng 22(1976) 532-535.
10. V. J. Dongre, V. H. Mankar, A Review of Research on Devengari Character Reconition, Vol 12 No 2 (2010).
11. M. Hanmandlu, K.R Murali Mohan, H.Kumar, Neural based handwritten character recognition, in Proceeding of fifth IEEE Internation Conference [1999] pp 241-244.