Handwritten Character Recognition Using Neural Network

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A thesis submitted to the Department of Computer Science and Engineering in partial fulfillment of the requirements for the degree of B.Sc. in Computer Science

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Declaration

It is hereby declared that

1. The thesis submitted is our own original work while completing degree at Brac University.

2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.

3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.

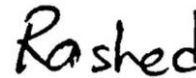4. We have acknowledged all main sources of help.

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Abstract

Handwritten character recognition is a process of a system to access handwritten material from various sources such as paper records, photographs, touch screen apps, etc. The identification of handwritten and electronic character is a growing area of study and has wide uses in banks, offices and industries. Our Main purpose for this initiative is to develop an professional framework for the defense Indus tries. In this method a specific character of languages can be effectively identified by following a sequence using neural network. Neural computers in corporate data parallelism, and run from the processing of an ordinary computer in a special way. Developments of a certain desirable quality which classifies the input data into classes are made by neural computers after the starting state information is obtained.

Keywords: Character recognition; Handwritten character; Professional Frame-work; Security Parallelism; Neural Network

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Nomenclature

The next list describes several symbols & abbreviation that will be later used within the body of the document

ANN Artificial Neural Network

GUI Graphical user Interface

HCR Handwritten Character Recognition NCGF

normalization-cooperated gradient feature OCR

Optical Character Recognition RAD Role Activity

Diagram

RGB Red Green Blue

UML Uni ed Modeling Language

Chapter 1

Introduction

Handwritten character recognition is a process of a computer to access handwritten material from various sources such as paper records, photographs, touch screen apps, etc. The identification of handwritten and electronic character is a growing area of study and has wide uses in banks, offices and industries. Our Main purpose for this initiative is to develop an professional framework for the defense Indus tries. In this method a specific character of languages can be effectively identified by following a sequence using neural network. Neural computers in corporate data parallelism, and run from the processing of an ordinary computer in a special way. Developments of a certain desirable quality which classifies the input data into classes are made by neural computers after the starting state information is obtained.

Now a days, Handwriting recognition has become the most influential field over the last few years. In the field of character recognition there was a lot of work done but not many to review a whole paper and not have the optimum precision. We educated our computer by using Neural computation to provide more accurate tests.

1.1   Project Statement

The aim of this project is to train our computer by English handwritten data in which it will take as its input data and do all its process to recognize the character. The project aims to build software which can facilitate to grasp English character. This project is limited to identify the character and numerals only in English. it's going to grow additional in recognizing the character of various languages. This encroaches on the neural network definition. Using the neural network is one in every of the key by which machines are provided with human capabilities. Neural Network is specially useful in detecting error which may not articulated with sequence of method which are pattern recognition, cluster classification, object prediction.

For neural network pattern recognition familiar application. A classification qualified neural network is programmed to require samples from inputs and divide them into classes. Despite well outlined borders, this class may be fuzzy. therefore this project is specially about the identification of free written character.

1.2   Methods

In this project the proposed method is consist of 4 phases

1. Pre-Processing

2. Fragmentation

3. Feature Extraction

4. Classification and Recognition

1.3   Utility of Character Recognition

Neural Network definition in HCR will give us a character reading based hybrid writing style. It will also serve to reduce noise on the original character. HCR can be an essential form of forensic technology collecting evidence. Our method sets accuracy in the recognition of characters in the divert font and size.

1.4   Applications for HCR

HCR deals for neural network in a few steps, such as pre-processing, segmentation, selection of information, and identification. Re-asses involves several methods to be worked on text to prepare it for segmentation. Throughout segmentation, the text image is segmented into individual character or numeric form, and the technique of extraction of features is then applied to character form. Eventually the vector of the function is given to the chosen algorithm for recognition. The text image is segmented into individual character or numeric type during the segmentation, and the attribute extraction technique is then applied to character structure. The function vector is finally given to the algorithm chosen for recognition.

1.5   Related Theory

Artificial Neural Network

It sought to simulate the action of "neurons" consisting of biological systems Artificial Neural Network is theoretical representation which is motivated through the neurological part of humans and animal. This is capable of both learning machines and identification of patterns. Such posed as integrated "neuron" network that could measure values from inputs. It consists of a large number of highly integrated processing elements (neurons) working together to solve specific issues. ANN at first train itself from the input as like as our brain then recognize the pattern from the image and then analyze the result with accuracy[14].

Purpose of Using ANN

Neural networks are applied for identifying characters easily which is not easy for normal human being and normal system .A qualified system may be called a extraordinary part in the eld of information that has been given for assessment. Then this
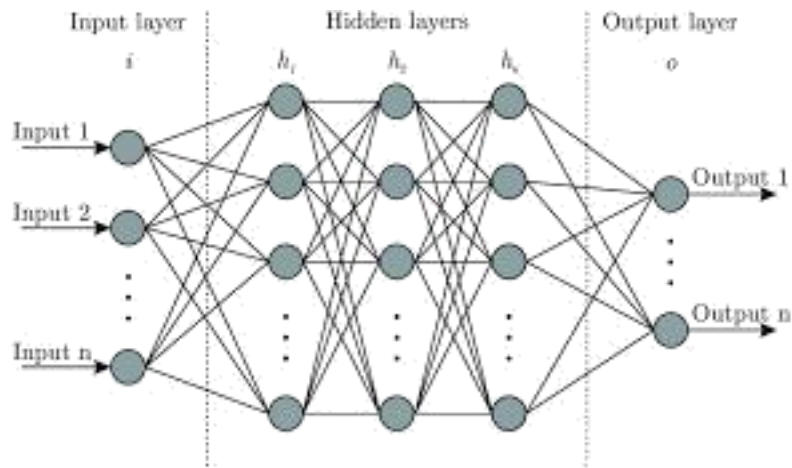
Figure 1.1: Artificial Neural Network Architecture

expert can be used to include forecasts and answer doubt-able questions provided new circumstances of interest. Neural Network is specially useful in detecting error which may not articulated with sequence of method which are pattern recognition, cluster classification, object prediction. In the above, Figure 1.1[14] represents how the nodes are connected with each other. Because of this extraordinary design neural network is suitable for recognition

The other advantages which ANN carries are it has the ability to learn how to do a task through its previous training. ANN can create self-organization by the in-formation which it gain from the learning time. This computations can be done in parallel, and special hardware tools that take advantage of this capability are being developed and manufactured. It has the capacity of fault tolerance via redundant information training.

1.6   Objective

1. Providing an simple user interface to enter a target image.

2. The file will be upload-able to the customer.

3. For deleting context program has the ability of re-assessing given data.

4. Program can find areas of text in the picture.

5. System can capture and display text in the picture to the user.

1.7   Thesis Orientation

The rest of the thesis is organized as following order:

1. Chapter1
   In our introduction section we discussed how we are can develop a framework for the defense industries , which is clearly explained in the project statements. Methods and projects phases are also given for better understanding as well as utility of character recognition and need of application of HCR are also

included. Related theory involves the explaining of Artificial Neural Network and purpose of using such network.

2. Chapter2

   Literature Review ,where we thoroughly studied previous works which involved many problem areas related to our research work. Objective and requirement analysis are very clearly explained in this chapter.

3. Chapter3

   The proposed approach and techniques used in the proposed model for better outcomes are clearly explained in this chapter.

4. Chapter4

   In this chapter we discussed the experimental results and how we trained the Neural Network using the data set and training function. How the pre-processing module works along with Matlab image processing toolbox and neural network toolbox, are clearly explained in this chapter. In our research work we carried out many testing and the results from the testing are tabulated in this chapter.

5. Chapter5

   In conclusion we inclusion we include the gist of our work and how large data set can be used to enhance the outcomes of the results in future.

Chapter 2

Literature Review

1. Character Recognition has been a lively space of analysis within the past and due to its numerous applications it continues to be a difficult analysis topic. In this referenced paper "Offline Handwritten English Numeral Character Recognition method", author Anshul Gupta, Manishs Srivastava and Chtralekha Man hanta centered particularly on offline recognition of written English words by first police investigation individual characters. the most approaches for offline hand written word recognition will be divided into 2 categories, holistic and segmentation based mostly. The holistic approach is employed in recognition of restricted size vocabulary wherever world options extracted from the complete word image square measure considered. because the size of the vocabulary will increase, the complexness of holistic based mostly algorithms additionally will increase and correspondingly the popular-ity rate decreases quickly. Post process technique that uses lexicon is utilized to Improve the general recognition accuracy[7].

2. The paper that is allowed by J.Pradeep outlines associate degree letter Recognition device that's written o -line victimization many layer feed for Ward neural network. to get rid of the options of the written alphabets, a New method, name, diagonal-based extraction operate is enforced. Fifty Data sets square measure accustomed train the neural network, every containing twenty six alphabets Written by totally different people and twenty different written alphabets characters square measure used for testing. The planned recognition theme Performs all right with higher rates of preciseness of identification compared to The systems victimization ancient horizontal and vertical strategies of extraction of information[8].

3. This paper explains the difference of the structural options to written Character applied math recognition. it's been shown that an entire definition Of the characters will be obtained, supported the compound of seven completely diffferent Family of options, which constant general- structural / applied math feature Vector represented most of the time productive and someday powerful on numerous Categories of written characters like digits, character letters and graphs[1].

4. Salvador Espa~na-Boquera, analysts proposed using hybrid or half plus half secret markov display to interpret handwritten information in disconnected mode. The basic part of the optical model was prepared using markov chain

technique and even a multi-layer perceptron was used to gage the probabilities[6].

5. At this article, Na z Arica provided the methodology as a result of it absolutely was less challenging to retain a strategic distance from the pre-processing stage on These lines, that reduced the loss of imperative results. the most effective one offered Was power division estimation. On the opposite hand, the various strategies this estimate were victimization neighborhood maxima and minima, moreover as others like stroke tallness that clad to be optimum and, severally, character limit and a grey scale image these were connected entirely. victimization this strategy, the superfluous division was reduces bit by bit[3].

6. During this paper of author Chen Lin Liu recommend a replacement feature extraction technique, called normalization-cooperated gradient feature (NCGF), that maps the gradient direction parts of the initial image to the trail planes while not producing the normalized image, to mitigate the result of stroke path distortion induced by form social control and supply higher recognition accuracies. And this can be paired with numerous types of social control. Experiments accessible written Japanese and Chinese character repositories indicate that, once combined with pseudo-two-dimensional standardization, the NCGF decreases the identification error rate by factors starting from 8.63% to 14.97% with a high conviction of importance[5].

7. During this paper author centered on the popularity of Devnagari language that is very advanced to acknowledge and preferred in India. The characteristics used for reconnaissance purposes are based primarily on spatial knowledge obtained from the gradient's arc tangent. To urge the feature, they used (n*n) mean filtering (2*n) times on the grey level image and on it image normalization was done. Then the social control image segmental into blocks. Next, the gradient arc tangent (direction of gradient) is at the start quantity in several directions, and therefore the gradient intensity is accumulated for every of the quantity directions. Finally, the blocks and directions square measure sampled down using Gaussian filter to urge a operate vector of 392 dimensions. For recognition functions a modified quadratic classifier relies on these options. Using-fold cross validation technique, they used 36172 handwritten information to check our program and obtained nice accuracy[12].

8. The method of identifying hand written character mechanically is extremely troublesome as it carries numerous carve and cursive method, they may be additionally in several size, in different thickness, completely different orientation, format and dimension. In this paper to spot the offline character author use Neural Network to justify his work. Neural network is insensitive to its missing information thus it provide correct result identify the character. during this paper the method is approached in few stages like Scanning, Pre-processing, Feature Extraction and Recognition that square measure the base stage of Neural Networking. Pre-processing is employed to cut back noise reduction, binarization and for dilution. Feature Extraction accustomed normalize the character image. The feature vector embraces of the pixel from the

normalized character image. The rear Propagation is employed for classification which gave additional accuracy[10].

9. K. Gaurav and Bhatia P. K, recommended multiple pretreatment programs related to the character identification. From an easy picture-based analysis to a hued and changed powers like core, the technique took an endeavor at the different types of footage. Completely different pre-processing and standardization professional grams were counseled, like skew answer, separate removal, commotion expulsion and numerous alternative update procedures. They reached the choice that for the pre-processing of the image a solitary procedure can't be connected. to boot, though, there have been many variations that the utilization of these strategies still can't bring home the bacon the best preciseness[11].

10. Work administered from Grimsdale in the year 1959 within the space of word comprehension is that the 1st plan to interpret the written character. This mid-sixty work demonstrated however the hybrid technique recommended by the Eden in 1968 used check. He showed that the quantity of schematic high-lights is proscribed to one written character. This idea was later incorporated in the character identification field collectively of nearly all strategies for auxiliary methodologies[2].

2.1 Requirement Analysis

In software engineering, analysis of requirements pay particular attention on activities which evaluate the needs or conditions to fulfill a new or every other ser-vice, taking into account the potentially competing requirements of the different stakeholders, evaluating, recording, validating and handling software or program specifications. On the other hand we can say that, Requirements Analysis is the method of determining the users' specifications for an application to be created or updated. Examination of specifications includes all the actions undertaken to deter-mine the needs of the various stakeholders. Analysis of specifications also involves the analysis, reporting, testing and maintenance of program or device specifications. The high quality criteria are recorded, actionable, observable, testable, traceable, help recognize market opportunities and are specified to promote the design of the program[15].

2.2 Requirement Analysis Process

Requirement Modeling

The specifications are typically recorded in various ways in Specifications modelling, such as use cases, product accounts, natural language documentation or method specification.

Analyzing Requirement

This move helps in deciding requirement efficiency. This requires the definition of undefined, incomplete, uncertain and conflicting criteria. These issues were addressed before going into the next move[13].

Electing Requirements

This step helps in deciding requirement efficiency. This requires the definition of undefined, incomplete, uncertain and conflicting criteria. These issues were addressed before going into the next move.

Review and Retrospective

This step is carried out in order to focus on the previous iterations of the collection of specifications in a attempt to enable more changes in the process.

2.3   Types of Requirement

Functional Requirement

Functional specifications clarify what needs to be accomplished by defining the duties, acts or events that need to be carried out.

1. The system should identify the character from the image given to it.

2. The system will give error massage when the given input is not appropriate or such kind of input for which it did not train.

3. The system must provide the result after comparing the input.

4. The system will display a clear image of the character even though the input is blur.

Non-Functional Requirement

Non-functional specifications are standards that de ne parameters rather than actual actions that can be used to determine the performance of a program.

1. According to the performance the system will give up to 90% accurate result.

2. the system will take minimum 40sec run time to give its result.

3. The device only recover the handwritten text part from the input image.

4. The software is very user friendly and reduces work.

Structural Requirement

The Structural Requirement clarify what needs to be achieved by defining a system's required framework

1. The system have the training session where it will train itself from the given data.

2. The system have the method Pre-processing which is the entry method for character recognition and is very critical when determining the recognition quality.

3. the system will perform the segmentation and Feature extraction part which will allow the extraction of patter that is important to identify character.

4. At last the system will perform the recognition part and display the result.

2.4   Requirement Analysis Techniques

2.5   Flowchart

A flowchart represents the serial ow and control structure of a series of connected operations. Flowcharts are distributed in different formats including cubic, cross-functional, and top-down. The flowchart can reflect connection with the system, data flows etc. Flow maps are easy to grasp and can be used by all members of the technical sta and non-technical team. A flowchart strategy aims to highlight a process's vital qualities.

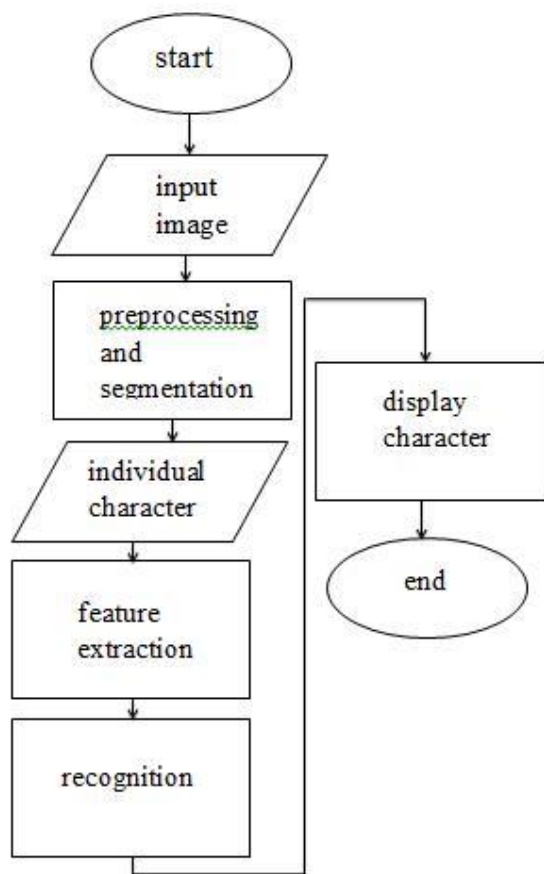In the Figure: 2.1[6], The flow chart shows how the system will work. At first it will

Figure 2.1:   Flow chart

take inputs then it will perform pre-processing and segmentation part to normalize the strokes of the characters and covert the image into single characters to identify properly. In the next part it will recognize the character from its previous memory. At last it will display the accurate character.

2.6   Use Case Diagram

Use Case Diagram
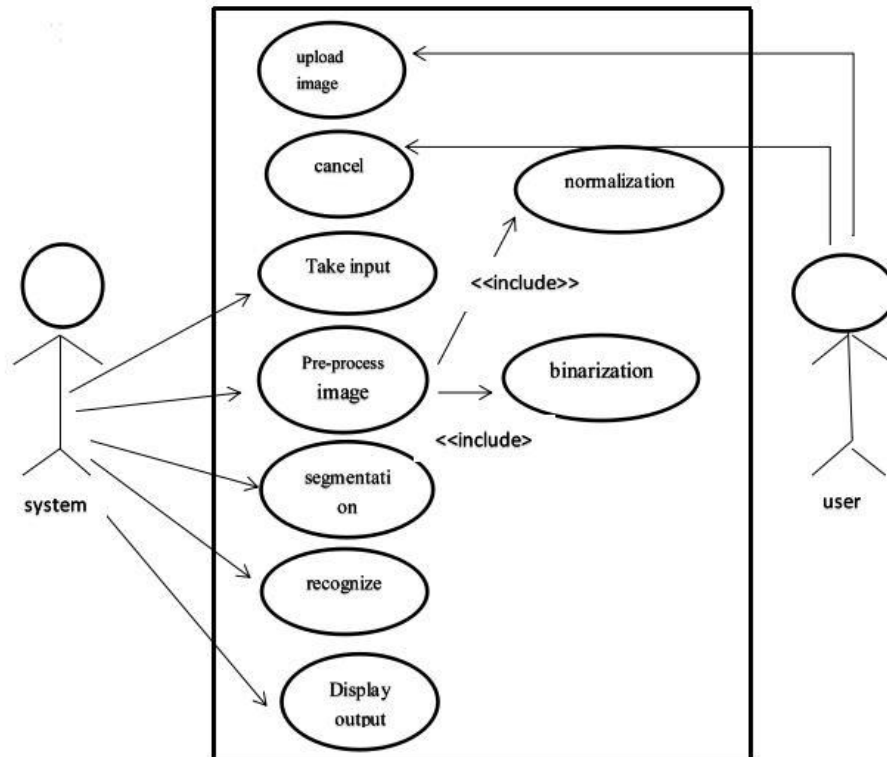
Figure 2.2: use case diagram

Figure 2.2[6] represents use case diagram which explain that how user in connected with use cases and how system is connected with the use cases. And how the system is connected with the user. Module of the user and Module of pre-processing point which is given bellow describe more about the use case.

Module of the user

The user are basically the actors in this case and the user must have an input image in order to carry out the character recognition process. If the image is available , the user just needs to upload it and the image should be able to accordant or suitable otherwise, it will not be uploaded. Once the image is suitable it will be uploaded successfully.

Module of pre-processing

In this case the actor is the system itself and there must be uploaded image in order to carry out the pre-processing operation. The pre-processing operation is conducted by changing the image to RGB to binary format which can be handled

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by the neural network.

Module of segmentation

Here, the actor is again the system itself and there should be a pre-processed image to carry the segmentation process and with the help of labeling process segmentation is carried out in the pre-processed image. The image is segmented into separate and distinct character and each character is then assigned a number. Labeling process is used as it helps to collect the number of characters in the image and also helps to resize the individual character into designated pixels.

Sequential Diagram
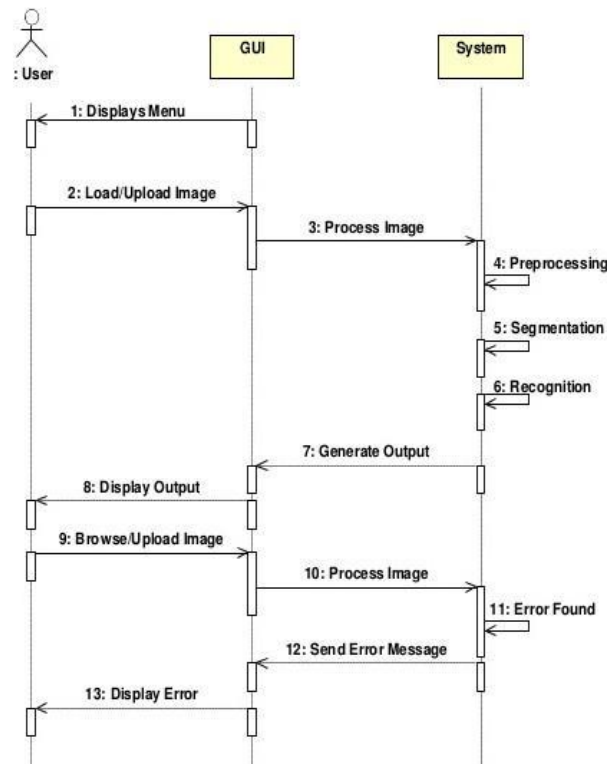
Figure 2.3: sequential diagram

The Figure 2.3[1] represents sequence diagram it is one kind of diagram which represents, according to time how the system will work. This diagram shows how the system will react in every step. The contact ow is visible here. The connection between user with Graphical user Interface and system are visible.

Activity Diagram
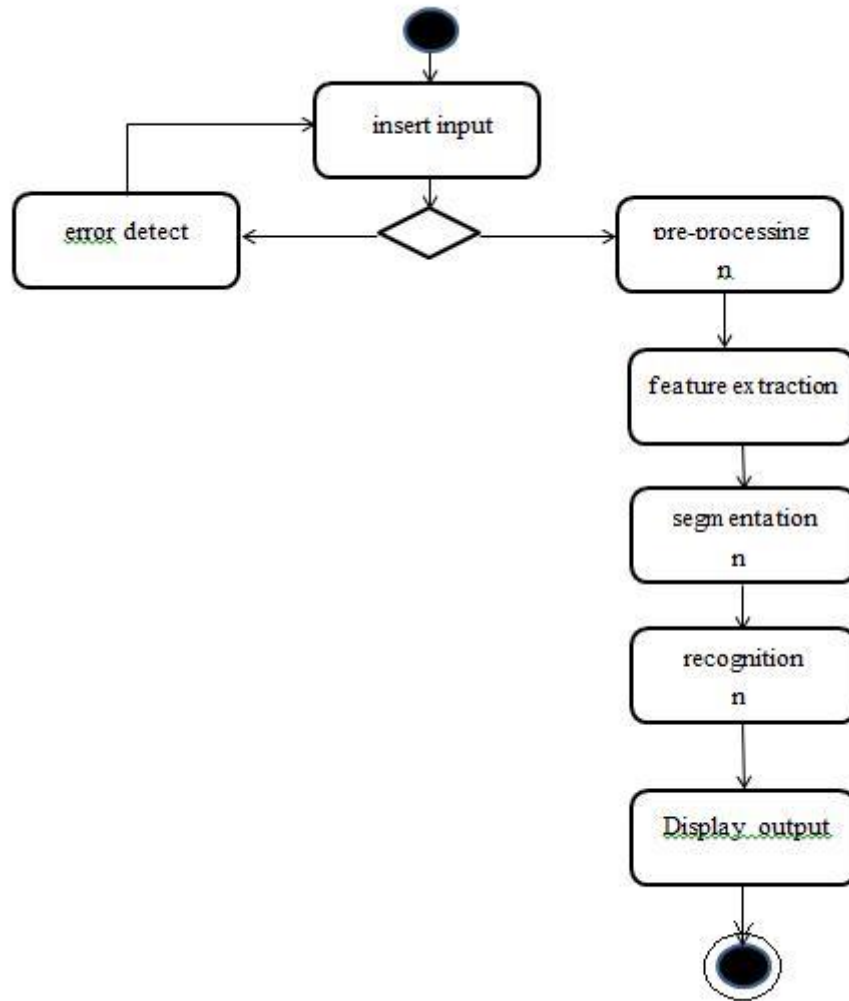
Figure 2.4: activity diagram

In Figure 2.4[5] the activity diagram represents how the system will work if the order matches the condition then it will go to the next step pre-processing and will perform other step like pre-processing then segmentation then feature extraction at last it will display output step and show the result. If the condition didn't match then it went to the error detected step and back to the input image or previous step.

2.7 Architectural Model of System

Handwriting Training Data

Charecture pre-processing

Feature extraction

Handwritten sentences

Segmentation

Display image
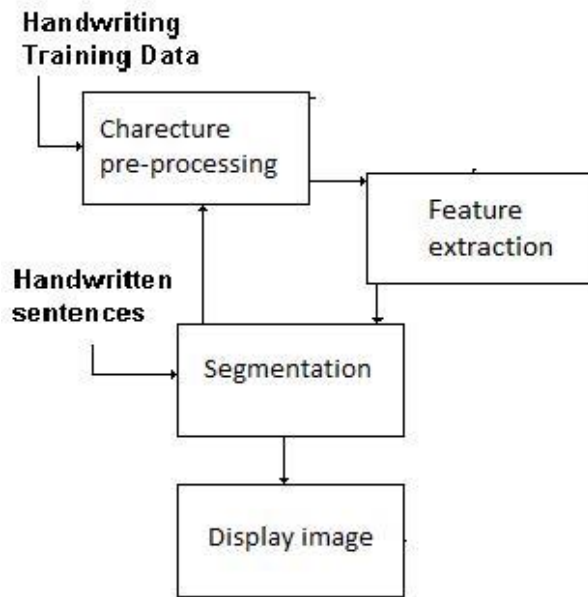
Figure 2.5: architectural model

Figure 2.5[4] is the architectural model, it represents how the system will perform its 4 phases step by step. At first the system will take input from the user and train itself then it will pre-process the character to reduce noise, to apply normalization, binarization then it will perform the segmentation part to mane the image input into single character. After that it will finally display the image.

Chapter 3

Proposed Model

Supervised learning is being used in our proposed model and for supervised learning decision tree algorithm is suitable to use in this case. This is because the decision tree algorithm helps to generate a training model which can then be used to generate a training model which can be used to anticipate class or magnitude of the desired output. The decision tree algorithm can quickly grasp the simple decision rules by deducing from the training set.

The root node is considered to be the data set which is then broken down to several sub-node. This breakdown of nodes require several algorithm discussed further in our proposed model. The break down or division of root node is such that it is carried out on all obtainable or accessible chances and accepts that split pattern that results in similar sub-nodes.

3.1   Purpose

The purpose of our paper is to overview how the architectural design is logically functioning , which includes, UML diagrams (data flow, sequence diagrams) of the application. And with the help of these resources an evaluation on how the system is operating functions is generated.

3.2   Scope

The scope of our paper is to establish certain functionalities of the application, which includes: The proposed method has four phases:

1. Pre-processing the image

2. Features Extraction

3. Segmentation

4. Displaying the characters that the image contains

3.3 Diagrams and Algorithms

In this section, more emphasis is given on methods to exclude background noises and features extraction to efficiently obtain and determine the text that is handwrit-ten. There are 4 stages in this methodology: pre-processing, segmentation, features extraction and classification and recognition.

Insert Image

Pre-processing

Segmentation

Feature Extraction

Displaying the characters that the
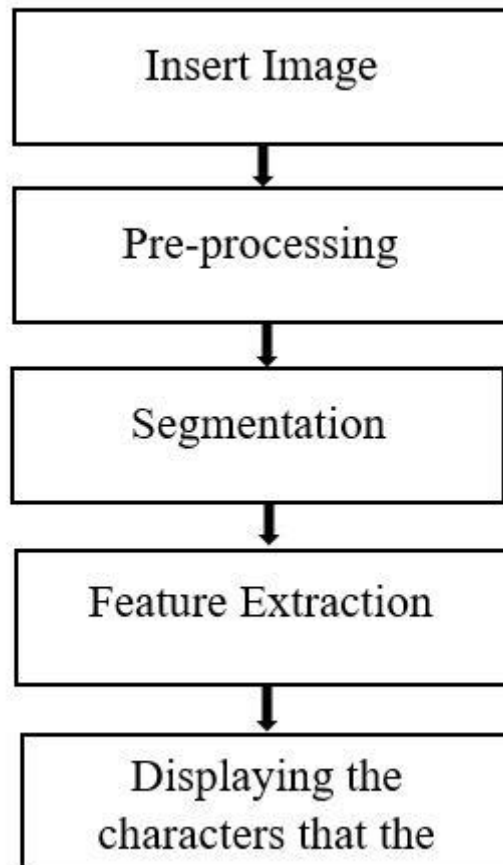
Figure 3.1: Diagram of HRC

Figure 3.1[13] illustrates the stages we follow from inserting the image to classifying the characters in the image through a block diagram.

3.4 Pre-processing

The first function to be executed is pre-processing. A number of operations are executed, which includes noise reduction and filtering, on a scanned image. Binarization is done first-hand which converts a gray scale image to binary images using global thresholding technique. Sobel technique is then used to produce the dilation of edges. Finally, the last two stage concerns the dilation of images and filling the holes present in it. Then the binary images are handed over to the next stage, that

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is, the segmentation stage.

3.5 Segmentation

The most important stage of our paper was the segmentation stage. In this stage, individual characters are achieved from the pre-processed input image. They are then isolated and given a number to keep track of the sequence, using a labelling process. The character are then uniformly resized into pixels. Then, the size of the characters are normalized.
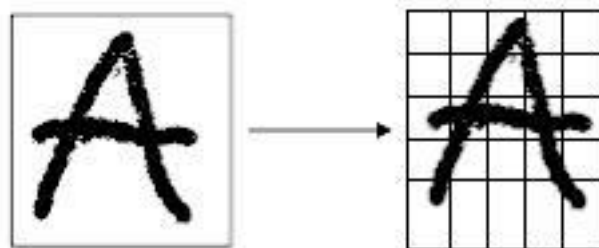
Figure 3.2: Segmentation

In figure 3.2[13] it shows how the letter 'A' is segmented after it is pre-processed.

3.6 Character-Extraction Algorithm

1. Make a table of pixels that counts the total number of pixels that has been traversed But this table is null at first.

2. Go through all the pixels in every row.

3. If a black pixel is found match it with the ones on the table, if it is found there ignore it and deploy Edge Detection Algorithm.

4. Put the pixels obtained from Edge Detection Algorithm to the table made in stage 1.

5. For every row now follow stage two to five.

3.7 Edge-Detection Algorithm

There is a table in this Algorithm known as the TraverseTable. In this table pixels that are traversed by this algorithm are placed. EdgeDetection (a,b,TraverseList);

1. The present pixel is placed in the TraverseTable.Now the present position:(a,b)

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2. RenewedTraverseTable= TraverseTable + present position of pixel is (a,b). Whenever pixel at (a-1,b-1) then Match to see if it is found in the Traver-seTable.

   EdgeDetection(a-1,b-1,RenewedTraverseTable); end if If pixel at (a-1,b) then Match to see if it is in the TraverseTable.

3.8   Feature Extraction

In order to efficiently train the neural network, we can deploy two techniques:

1. Feature Extraction based on Character Geometry

2. Feature Extraction using gradient features

3.9   Feature extraction based on character geometry

It identifies the lines and curves of a handwritten character and matches it with the ones stored in the database. The proposed system then uses a trained Neural Network to test the characters.

3.10   Universe of Discourse

The shortest box that can accommodate a fully sized character structure. It is chosen above all because it contains only the necessary information (line segments, intersections etc) needed to identify a character. All other background noises are filtered. Thus, every character becomes independent of their image size.
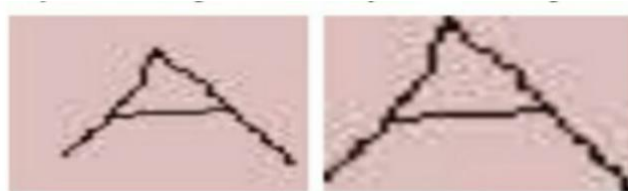

Figure 3.3: Universe of Discourse

Figure 3.3[9] shows how a character appears when it is extracted. The second one shows how it appears in the universe of discourse.

3.11   Zoning

After choosing the universe of discourse, equally sized windows are made by dividing the image, and the feature is implemented on each window individually. There were

two types of zoning we used in our paper. Nine equally sized windows were zoned from the image. Feature extraction was implemented on 9 zones individually. This helped to get more detailed information about the character structure. If zoning is implemented positions of each line segments in a character becomes a feature. This is because, the occurrence of a line segment of a character in a particular zone is almost similar. In a specific zone, if different line segments were to be extracted, the whole structure in that area should have been traversed. This causes certain pixels to be identified as starters, intersections and minor starters.

3.12   Starters

Pixels with one neighbour in the character structure are called starters. Every starters are gathered in a table before enhancing character traversal.

Figure 3.4: Starters

In Figure 3.4it [9] illustrates the pixels circled in red are the starters.

3.13   Intersection

A pixel must possess more than one neighbour to be an intersection. For every pixel a new characteristic called a true neighbour is classified . Whether a pixel is an intersection is not is determined from the number of true neighbours it acquires. Figure 3.5[9] illustrates the pixel circled in red are intersections.

3.14   Minor Starters

Pixels that acquire more than two neighbours and are discovered along the path of traversal of a character structure are called minor starters. Figure 3.6[9] shows the pixel circled in red are Minor starters.
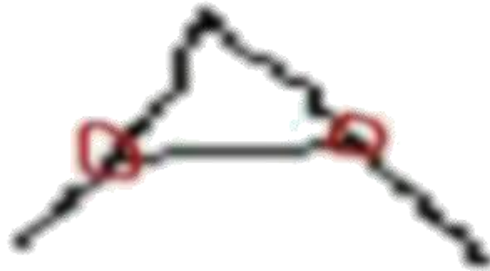
Figure 3.5: Intersection

Figure 3.6: Minor Starters

3.15   Improving zoning techniques

In order to improve the zoning technique, firstly, the image will be broken down into nine zones. The nine zones will be plotted by subplot function and nine plots will indicate the nine zones on one window from the image of the character we have taken into consideration.

Then we will use Euler number to determine the character. Euler number is achieved by subtracting the total number of holes that the character has, from the total number of character that the image contains.

Lastly, after the image is zoned, features from each zone is collected, characterized and are stored for classification. The proposed paper uses two types of zoning method:

3.16   Static zoning method

Local areas with fixed structure, size and locations are created in this zoning method.

3.17   Dynamic zoning method

This zoning method uses statistical specification of the character, we are working on, to identify the character.

3.18   Gradient feature extraction

In order to get high recognition performance in recognition of character gradient it highly required to Choose an feature extraction that is very much efficient. An efficient feature extraction will get information from raw data , which is very helpful for both categorizing and classification purpose. The technique being used is very successful in implementing hand written character recognition for English and Chinese . Directional information of the character is used as feature extraction and very promising and accurate results are obtained when it came to computing time. We know that the gradient is not a scalar quantity that means it has both magnitude and direction. The component of direction is calculated by using the derivatives it possess in either horizontal or vertical or in both direction. In case of an image the operator of gradient produce a 2 dimensional vector at every point of each image in such a way that the vector points in the direction where there is maximum increase in intensity and the size matches to the change of rate in that particular direction. The gradient can be calculated by either Sobel operator or prewitt operator. How-ever, we have used the Sobel operator for our work in order to find the gradient vector[12].

Figure 3.7[12] shows the sobel mask operator for vertical and horizontal mask for computing the horizontal and vertical components of gradient.
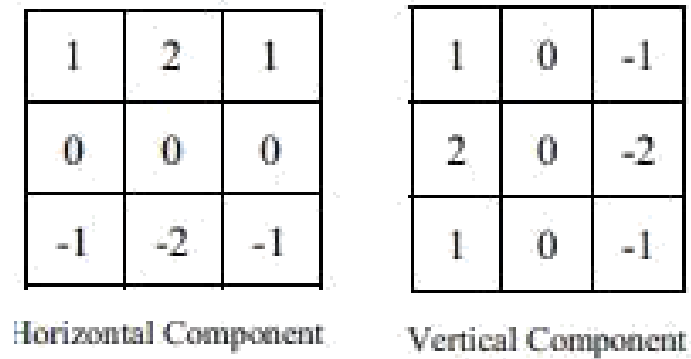
Figure 3.7: sobel mask

3.19 Image Processing Toolbox

Image processing tool box is an efficient tool that generates function, visualization , analysis and app for image processing as well as brings in the improvement of algorithm. In this toolbox the image can be enhanced and feature can be detected as well. Image deblurring , Image segmentation as well image registration and noise reduction are a great deal of challenge faced . Image processing toolbox helps to face this challenges efficiently. One the most important role of this tool box is such that it allows different types of image including giga pixel resolution and tomography etc.

The algorithm generated by the toolbox helps to backup image that are degraded and examine shapes and texture as well as bring in an adjustment in color. The visualization helps in detecting the pixel in a particular point in the image and the contrast of the image can be adjusted too.

3.20 Neural Network Toolbox

Complex system like system that are not linear and cannot be modeled easily with the help of simple equations are very well handled by neural network toolbox. The toolbox provides a great deal of function and apps in order to make things less complex and reduce the computation time in many cases. Both supervised and unsupervised learning is supported with feed forward and dynamic networks along with competitive layer like multi layer perception. Moreover , it also helps in training the neural network as well as simulate the network providing with the desired output from the data set.

3.21 Improvement in Proposed Model

1. Success rate of the procedure that applies feature extraction using character geometry and gradient technique from scanned image containing text written by hand are presented.

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2. Feature extraction techniques have been implemented correctly in classification as passed to the neural network and pre-processing of image by applying edge detection and normalization are the best procedure for unclear noisy image.

3. Procedure of training the neural network with extricated features from test picture of each character has detection precision which can be comparable to something prominent.

4. The work plan has shown beneficial outcomes for image consisting of hand-written text in various styles, distinctive size and arrangement with shifting backgrounds. It groups the majority of the manually written characters effectively if the picture contains less noise in the characters and in the image itself. Letters composed with neat handwriting are distinguished with greater precision.

5. The interface is created in MATLAB and proposed for several test image consisting of text, which were written by hand. .

6. Feature extraction procedures, for example, gradient method and character geometry in the procedure make no changes in characterizing letters in other languages, this technique can be expanded for language independently collecting or extracting from the image of different dialects with slight alterations. The implementation of this technique was carried out in classifying of English handwritten capitalized characters, yet requiring further investigations.

7. To attain greater precision rate, and to make results more accurate, segmented characters can be refined.

8. Besides the existing features, some more can be added to increase the performance of the neural network.

Chapter 4

Experimental Results

MATLAB is effective to use as it has very efficient at handling technical problems that require calculations and programming . It is basically a matrix laboratory that gives access or reach to matrix software. The MATLAB language contain various characteristics. This helps in 'programming in the small 'and 'programming in the large to provide' to discard any anomalies and to provide large application program. The interface of Matlab provides the essential material for dealing with variables and importing or exporting data as well as debugging and pro ling M- les.

4.1   MATLAB Image Processing Tool Box

The tool box being used that involves changing the quality of image such that it provide with better information of the image which helps in both human interpretation and perception. The tool box also gives an extra edge for the MATLAB numeric computation environment. The functions and support of the toolbox on image are as follows:

1. Filtering, designing filters, enhancement of both image and contrast

2. Segmentation and feature detection

3. Multidimensional image processing

4.2   Neural network Toolbox for MATLAB

M- le is being generated by the saved GUI layout that can be used to carryout the GUI functionalities. The M- le itself produce code in order to initialize graphical user interface and contains an interface that carries out an action in response to any event. This is quite user friendly as it execute an input like a keyboard being pressed . In order to obtain the output or desired function the correct code can be added to the interface with the help of the M- le editor. Homepage of the frond end:

1. Display of user interface with different manipulations.

2. user can attach picture from device he or she will be using, that option is also there.

3. Click the load image button in order to upload the image that acts an input.

Figure 4.1: Neural network Toolbox for MATLAB

Figure 4.1 shows the neural network toolbox for MATLAB which is the interface for user manipulation with different options like load image, the train option that is how user wants to train and option for attaching the picture.

4.3 Pre-processing Module

Here the pre-processing module (GUI) will receive the image being queried and dis-plays the image of the uploaded image. The uploaded image should be noiseless for better extraction of character from the image, so that desired output can be dis-played in doc le. The neural network can be trained either using gradient technique or geometric feature technique but we preferred to use gradient technique to train it.

Figure 4.2: Pre-processing Module

Figure 4.2 pre-processing module shows that the uploaded noiseless image, so that user is ensure correct image is uploaded.

4.4 Neural Network Training

Neural network is used in machine learning and it has very wide field. In hand-written character recognition we need the data in order to train the network. The network should be trained in such a way so that it accepts the training target data set. In order to do so a function le or training function is created and to avoid any problem feed forward back propagation is used for the classification and many trail and error methods were carried out with multi layer perception. The network can also be trained with the help of training function:

net=name of function   le (A,B)

The network is trained with twenty four English alphabets. The output image that is being displayed in the GUI is the result of computation carried out by encoding or decoding as well as with the help of index mapping. There is a necessity for encoding as targets or output for neural network cannot be assigned as a character rather it can be assigned as number. These numbers will then be translated as characters in the output image.
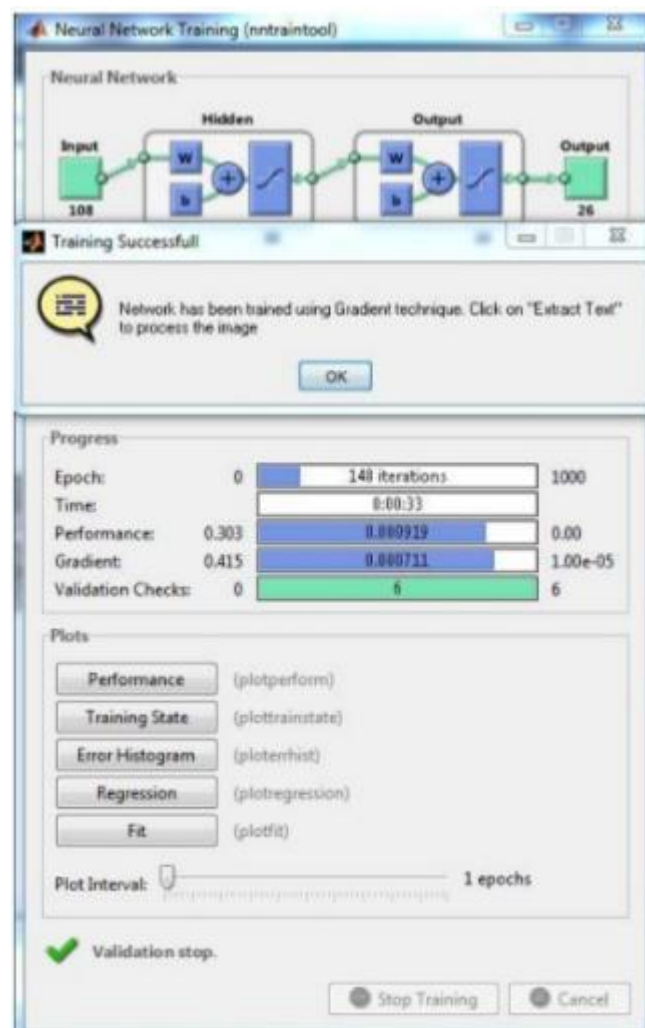
Figure 4.3: NN training

Figure 4.3 shows how neural network is trained extracting the correct image and trained by gradient technique.

4.5   Character extraction from Image

Figure 4.4: Character extraction

Figure 4.3 shows how characters are being extracted after the training phase.

4.6   Output Image
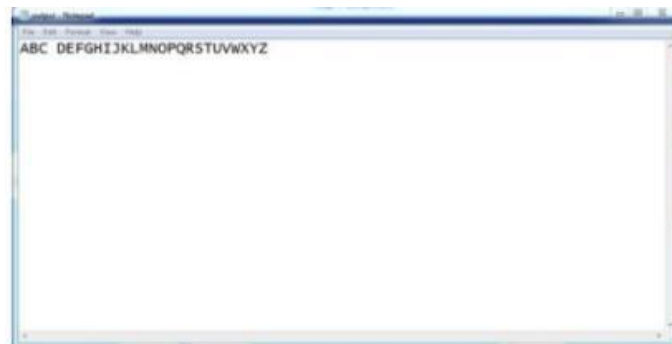
Figure 4.5: Output Image

Figure 4.3 shows how characters are being extracted after the training phase.

4.7   Results from the testing Phase

This table 4.1 decides if the system matches the acceptance standards and if the system should be accepted. It is only counted as valid, if the required output matches the actual output.

Serial number	purpose	Desired result	original result
1	upload image with valid format	upload image if supported	successfully upload valid image
2	invalid image format	display error message	display error message
3	preprocessing of upload image	Image should be pre-processed	Preprocessed image
4	Feature extraction	Calculate character features such as edges and curves	extraction of image
5	Result display	Display text of le	Display text contained in le

<div align="center">Table 4.1: verification</div>

| Test tld	Test case	Description of input	Expected output	Test Status
1	image	field box will open to select image le when user clicks on open	Image le selected and uploaded	pass
2	image processing	image passed for pre-processing	conversion from colorful to black and white image	pass
3	feature extraction	grey scale image	extraction of character feature	pass
4	output le	normalized character	text le	pass

<div align="center">Table 4.2: Validation</div>

Table 4.2 matches the text case with the expected output and if the expected output matches then pass is given in the test status otherwise, fail is given

Sl no	Event	Action
1	uploading wrong input image	Display error message and home screen to user
2	system shutdown	Cancel tasks and restart the process.

<div align="center">Table 4.3: Failure modes and action on failure</div>

Table 4.3 shows instances, when a failure has taken place, or when an invalid le is uploaded, or anything that is not supposed to happen occurs and what actions needs to be taken for such circumstances.

Epochs	Hidden layers	Configuration	Classification %
44	11	85-11-26	27.9
105	21	85-21-26	77.5
149	31	85-31-26	93.9
173	36	85-36-26	94.4
118	40	85-40-26	93.4
54	46	85-46-26	12.6
61	51	85-51-26	83.8
77	56	85-56-26	78.4
72	61	85-61-26	18.1
111	66	85-66-26	49.9
113	71	85-71-26	49.3

Table 4.4: Character geometry

Table 4.4 shows how we worked with multiple hidden neurons and con gure as well classify them while training with character geometry.

Epochs	Hidden layers	Configuration	Classification %
48	11	108-11-26	10.1
190	21	108-21-26	87.5
145	31	108-31-26	82.1
138	36	108-36-26	82.3
149	40	108-40-26	94.6
110	46	108-46-26	76.9
114	51	108-51-26	86.7
99	56	108-56-26	55.3
95	61	108-61-26	68.3
103	66	108-66-26	89.2
131	71	108-71-26	91.2

Table 4.5: gradient feature

Table 5.5 shows how we worked with multiple hidden neurons and configure as well classify them while training with gradient feature.

Chapter 5

Conclusion

The Handwritten Character Recognition framework was tried hardly any diverse filtered inputs which consisted handwritten texts in different approaches and the outcomes were profoundly favorable. The suggested plan of action executes pre-processing on the input for eliminating noise and furthermore, applies feature ex-traction for better categorization in comparison to OCR. This strategy is invaluable as it utilizes nine attributes to prepare the neural network by applying character geometry and twelve attributes by applying gradient method. Since less calculation is required in feature extraction, training and categorization periods of the process, it is very efficient. The work plan has shown a effective outcomes for pictures consisting of handwritten text in different pattern, different shape and grouping by moving backgrounds. It groups those majority for which inputs have less noise. Characters composed with neat handwriting are categorized more precisely.

5.1   Future Work Plan

To attain greater precision rate, and to make results more accurate in future , segmented characters can be refined. Besides the existing features, some more can be added like training the neural network with large data-set can increase the performance of the neural network. Therefore, it can be said that there are areas which can be worked on to enhance the current work in the future. Therefore, it can be said that this model can execute efficiently and can be expanded to work on other prospects and characters in the future.

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