Review of Online & Offline Character Recognition

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Abstract – **Image pre-processing tool, created in Matlab, realizes many brightness transformations and local pre-processing methods. The proposed solutions focus on applying Neural Network Algorithm model for character recognition. The primary function of which is to retrieve in a character stored in memory, when an incomplete or noisy version of that character is presented. The idea is to create a theoretical and practical basis of preprocessing for character recognition using forward-feed neural networks. The Feed Forward Algorithm gives insight into the enter workings of a neural network; followed by the Back Propagation Algorithm which compromises Training and Testing. Character recognition is one of the most interesting and challenging research areas in the field of Image processing. English character recognition has been extensively studied in the last half century. Nowadays different methodologies are in widespread use for character recognition. Document verification, digital library, reading bank deposit slips, reading postal addresses, extracting information from cheques, data entry, applications for credit cards, health insurance, loans, tax forms etc. are application areas of digital document processing.**

Keywords: Offline character recognition, Thresholding, binarization, Classification, OCR, On-line Character Recognition.

I.   INTRODUCTION

In general, handwriting recognition is classified into two types as off-line and On-line character recognition. Off-line handwriting recognition involves automatic conversion of text into an image into letter codes which are usable within computer and text-processing applications. Off-line handwriting recognition is more difficult, as different people have different handwriting styles. But, in the on-line system, On-line character recognition deals with a data stream which comes from a transducer while the user is writing. The typical hardware to collect data is a digitizing tablet which is electromagnetic or pressure sensitive. When the user writes on the tablet, the successive movements of the pen are transformed to a series of electronic signal which is memorized and analyzed by the computer.

Optical Character Recognition (OCR) is a field of research in pattern recognition, artificial intelligence and machine vision, signal processing. Optical character recognition (OCR) is usually referred to as an off-line character recognition process to mean that the system scans and recognizes static images of the characters. It refers to the mechanical or electronic translation of images of
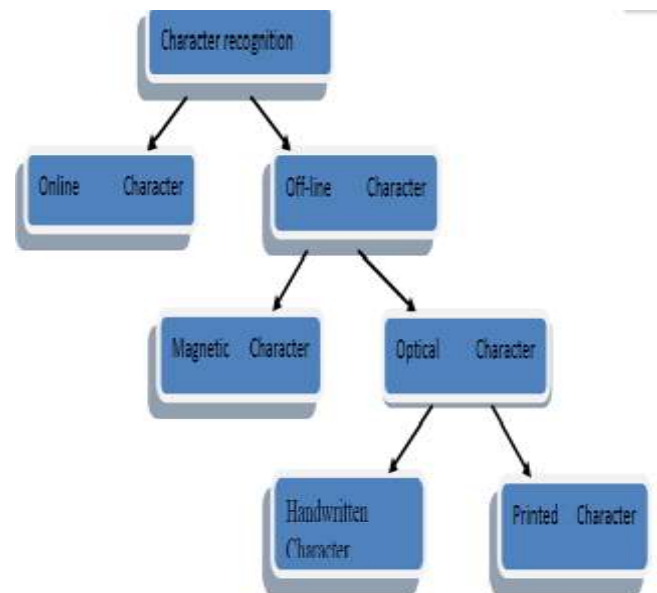

Fig .1 Types of Character Recognition

Handwritten character or printed text into machine code without any variation. OCR consists of many phases such as Pre-processing, Segmentation, Feature Extraction, Classifications and Recognition. The input of one step is the output of next step. The task of preprocessing relates to the removal of noise and variation in handwritten. Several areas where OCR used including mail sorting, bank processing,

document reading and postal address recognition require offline handwriting recognition systems, pattern recognition.

II. On-line Character Recognition System

On-line character recognition refers to the process of recognizing handwriting recorded with a digitizer as a time sequence of pen coordinates. In case of online handwritten character recognition, the handwriting is captured and stored in digital form via different means. Usually, a special pen is used in conjunction with an electronic surface. As the pen moves across the surface, the two- dimensional coordinates of successive points are represented as a function of time and are stored in order [18]. It is generally accepted that the on-line method of recognizing handwritten text has achieved better results than its off-line counterpart. This may be attributed to the fact that more information may be captured in the on-line case such as the direction, speed and the order of strokes of the handwriting.

The on-line handwriting recognition problem has a number of distinguishing features which must be exploited to get more accurate results than the online recognition problem

- It is adaptive: The immediate feedback is given by the writer whose corrections can be used to further train the recognizer.
- It is a real time process: It captures the temporal or dynamic information of the writing. This information consists of the number of pen strokes, the order of pen-strokes. The direction of the writing for each pen stroke and the speed of the writing within each pen stroke.
- Very little preprocessing is required. The operations such as smoothing, and feature extraction operations such as the detection of line orientations corners loops are easier and faster with the pen trajectory data than on pixel images.
- Segmentation is easy: Segmentation operations are facilitated by using the pen lift information particularly for hand printed characters.
- Ambiguity is minimal: The discrimination between optically ambiguous characters may be facilitated with the pen trajectory information

On the other hand, the disadvantages of the on-line character recognition are as follows:

- The writer requires special equipment which is not as comfortable and natural to use as pen and paper.
- It cannot be applied to documents printed or written on papers punching is much faster and easier than handwriting for small size alphabet such as English or Arabic.

III. Off-line Character Recognition System

Off-line handwriting recognition refers to the process of recognizing words that have been scanned from a surface (such as a sheet of paper) and are stored digitally in grey scale format.

After being stored, it is conventional to perform further processing to allow superior recognition.

The offline character recognition can be further grouped into two types:

- Magnetic Character Recognition (MCR)
- Optical Character Recognition (OCR)

In MCR, the characters are printed with magnetic ink. The reading device can recognize the characters according to the unique magnetic field of each character. MCR is mostly used in banks for check authentication. OCR deals with the recognition of characters acquiring by optical means, typically a scanner or a camera. The characters are in the form of pixelized images, and can be either printed or handwritten, of any size, shape, or orientation.

The OCR can be subdivided into handwritten character recognition and printed character recognition. Handwritten Character Recognition is more difficult to implement than printed character recognition due to diverse human handwriting styles and customs. In printed character recognition, the images to be processed are in the forms of standard fonts like Times New Roman, Arial, Courier, etc

The *drawbacks* of the off-line recognizers, compared to on-line recognizers are summarized as follows:

- Off-line conversion usually requires costly and imperfect pre-processing techniques prior to feature extraction and recognition stages.
- They do not carry temporal or dynamic information such as the number and order of pen-on and pen-off movements, the direction and speed of writing and in some cases, the pressure applied while writing a character.
- They are not real-time recognizers.

IV. Comparison B/W Online & Offline Character Recognition

s.no	comparison	Online characters	Offline characters
1.	Availablility of no of pen strokes	yes	No
2.	Raw data requirements	#samples/sec(e.g.100)	#dots/inch()e.g.300
3.	Way of writing	Using digital pen on lcd	Paper document
4.	Recognition rates	higher	lower
5.	accuracy	higher	lower

Table 4.1 comparison of online &offline character recognition

V. Implementation

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:

- Math and computation
- Algorithm development
- Data acquisition
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including graphical user interface building

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non interactive language such as C or FORTRAN. The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects. Today, MATLAB engines incorporate the LAPACK and BLAS libraries, embedding the state of the art in software for matrix computation.

MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis. MATLAB features a family of add-on application-specific solutions called toolboxes. Very important to most users of MATLAB, toolboxes allow you to learn and apply specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others.

A problem can be solved in two ways:

• By using a graphical user interface, e.g. nntool.

• By using command-line functions.

Vi. Results

Offline handwritten English character sets are taken for recognition. The steps that are followed to obtain best accuracy and efficiency of input handwritten English character image from the recognition system. First of all, training of system is done by using different training sample with different handwriting styles. And then system is tested for few of the given sample, and then result is measured.

The data set was partitioned into two parts. The first part is used for training the system and the second was for testing

purpose. For each character, feature were computed and stored for training the network. The table 7.1 and table 7.2 display the results obtained from the program.

The convergence of the network is set at 0.01 for first experiment and 0.001 for second experiment, No. of training data is 11, and 1 bitmap file is taken for testing in which letters are arranged in the form of words. After recognition a text file is generated that gives the character in text format in a notepad file. The experiment results for training of neural network in the Matlab are shown in Table 6.1. In table 6.2 number of epoch, time taken to execution of program and gradient are shown. In table 7.2 correspondingly results for the project that are required for recognition are shown.

Experiment	First Experiment	Second Experiment
Convergence Objective	0.01	0.001
Learning rate	0.01	0.05
Training method used	trainlm (Levenberg-Marquardt)	trainlm (Levenberg-Marquardt)
No. of training data	11	11
No. of testing data	1 bitmap file(handwritten + printed text)	1 bitmap file(handwritten + printed text)
No. of epoch taken to converge	236	6000
Time taken to execute	8.85275 seconds	1024.06 seconds
Gradient	0.153241	2.00145e-005

Table 6.1: The experimental results using neural network analysis for recognition

To get the accuracy % results are compared with the desired result. Difference between the two values gives the error. Percentage accuracy is found as follows:

% Accuracy = $\underline{\text{No. of characters found correctly}}$ * 100

Total no. of patterns

Consider the results shown in table corresponding to the experiments for the project.

Experiment	First Experiment	Second Experiment
Convergence Objective	0.01	0.001
No. of character images for training	26 x 11 = 286	26 x 11 = 286
Total no. of patterns taken for testing	10	50
No. of characters found correctly	9	47
Accuracy%	90%	94%

Table 6.2: The experimental results using neural network analysis for accuracy

Conclusion

In this paper, we propose the neural networks and Surf Feature Extraction technique for Character Recognition and enhancement. BPNN and Surf Feature technique will be used. The evaluation will be based on the PSNR, MSE. The proposed approach i.e., improved technique for Character Recognition using Neural Network will exhibit outcomes of noise reduction and image quality improvement, with different noise levels, which will qualify it to be suitable for image processing and Pattern matching.

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