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Performance comparison of ANN and template matching on English character recognition

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ABSTRACT

The recognition of handwritten documents, which aims at transforming the written text into machine-encoded text, is considered as one of the most challenging problems in the area of pattern recognition and an open research area. This brings the necessity to make research works on character recognition of the English alphabet not only recognizing measure and evaluate the performance of algorithms we used. A number of algorithms have been proposed for English character recognition such as a support vector machine, hidden Markov model, and neural network. In this research, the design and implementation of a character recognition system for English characters using artificial neural networks and template matching are presented. The complete system employs image acquisition, preprocessing, character segmentation, and classification and recognition. Finally, compare the performance of ANN and template matching algorithms. A data was an MNIST dataset taken from the NIST database. Overall, a recognition of ANN accuracy of 88 percent was obtained and template matching accuracy was 73 percent.

Keywords— *OCR: Optical Character Recognition, English character recognition, Artificial Neural Network, Template Matching, preprocessing, Segmentation, Handwritten recognition*

1. INTRODUCTION

Text Character Recognition (TCR), is the mechanical or electronic translation of images of handwritten or typewritten text (usually captured by a scanner) into machine-editable text. TCR is a field of research in pattern recognition, artificial intelligence, and machine vision.

This application is useful for recognizing all character (English) given as in input image. Once the input image of the character is given to the proposed system, then it will recognize input character which is given in image. Recognition and classification of characters are done by Neural Network and template matching algorithm.The main aim of this project is to effectively recognize a particular character of type format using the Artificial Neural Network and template matching approach then compare the performance of this two algorithm based on accuracy and time taken to recognition [1].

2. CHARACTER RECOGNITION

A literature review of Character Recognition (CR) for the last fifteen years, based on journal articles, conference proceedings and patents show that there are hundreds of independent studies carried out in the field, yielding dozens of commercially available products for various size and applications. All these systems can be examined in two categories:
(a) Systems classified according to the data acquisition techniques.
(b) Systems classified according to the text type.

2.1 Systems classified according to the data acquisition techniques

The progress in automatic character recognition systems is evolved in two categories according to the mode of data acquisition:

2.1.1 On-line character recognition systems: The problem of recognizing handwriting recorded with a digitizer as a time sequence of pen coordinates is known as on-line character recognition. While the digitizer captures the data during writing, the CR system with or without a lag makes the recognition.

2.1.2 Off-line character recognition systems: Off-line character recognition is also, known as "Optical Character Recognition" (OCR) because the image of writing is converted into a bit pattern by an optically digitizing device such as optical scanner or camera. The recognition is done on this bit pattern data for both printed and hand-written text.

2.2.1 Systems classified according to the text type

There are two main areas of interest in character recognition, namely:

2.2.1 Printed character recognition: The printed texts include all the printed materials such as books, newspapers, magazines, and documents which are the outputs of typewriters, printers or plotters. On the basis of the capabilities and complexities, printed character recognition can be further classified.

2.2.2 Hand-written character recognition: the ability of a computer to receive and interpret intelligible handwritten input from sources such as paper documents, photographs, touch-screens, and other devices. The image of the written text may be sensed "off line" from a piece of paper by optical scanning (optical character recognition).

3. OBJECTIVE

3.1 General Objective

The objective of this project is to identify handwritten characters with the use of neural networks and template matching approaches and compare their accuracy rate. We have to construct a suitable neural network and template matching algorithm train them properly. The program should be able to extract the characters one by one and map the target output for training purpose. After automatic processing of the image, the training dataset has to be used to train "classification engine" for recognition purpose. The program code has to be written in MATLAB and supported with the usage of Graphical User Interface (GUI)[2].

3.2 Specific Objectives

- Study the general and basic step of the character recognition system
- Understand the concept of template matching and ANN in particular.
- To address training and testing character dataset
- Selecting the best training algorithm based on literature to train both algorithms
- Implementation and developing a program to test the algorithms and make an analysis of the result.

4. LITERATURE REVIEW

Character recognition technique has been completed through studies on different characters, for example, English, Arabic, Chinese, Devanagari, Bangla, Farsi and Kannada and so on. Totally, the complete method is carried out in three-phase Preprocessing, Feature extraction and recognition[3]. In this paper only cover the study has been done on English, Arabic and Devanagari scripture.

S no.	Author, Year	Title	Dataset	Feature Extraction Process	Classifier	RESULT
1.	Vijay Patil and Sanjay Shimpi (2011)	Handwritten English character recognition using neural network		Character Matrixes	Neural network (back propagation network)	Handwritten English character recognition result indicates that the back propagation network. Provide more than 70% accuracy.
2.	N. M. Noor, M. Razaz and P. Manley-Cooke (2004)	Global Geometry Extraction for Fuzzy Logic Based Handwritten Character Recognition		Global Geometric Feature Extraction, Geometric Density Classifier	Neural fuzzy logic	Accuracy results from 50 samples of each character showing improvement in both the density and the feature classifiers when the global geometric feature vector is added to their inputs. Geometric Density 77.89% and Geometric Feature 76.44% accuracy.
3.	Dewi Nasien, Habibollah Haron and Siti Sophiayati Yuhaniz (2010)	Support Vector Machine (SVM) For English Handwritten Character Recognition	Take three datasets from NIST database considered 189,411 samples for lowercase letters, 217,812 for uppercase letters and 407,223 for the combination of uppercase and Lowercase letters. Samples are divided into 20% for testing and 80% for training.	Freeman Chain Code (FCC)	Support vector machine (SVM) kernel function	The method recognizes with the accuracy of 86% for the first dataset, 88% for the second dataset and 73% for the third dataset.
4.	M. S. Sonawane and Dr. C.A. Dhawale (2015)	Evaluation Of Character Recognisers: Artificial Neural Network And Nearest Neighbour Approach		Grid Method	artificial neural network and Nearest Neighbor	the efficiency of Neural network approach as 57.69% and of Nearest Neighbor as 61.53%
5	Majid M. Altuwaijri and Magdy A. Bayoumi (2002)	Arabic Text Recognition Using Neural Networks		a set of moment invariants descriptors (under shift, scaling, and rotation)	Artificial Neural Network (ANN)	The system has shown a high recognition rate about 90%
6.	Noor A. Jebrila, Hussein R. Al-Zoubib and Qasem Abu Al-Haijac (2018)	Recognition of Handwritten Arabic Characters using Histograms of Oriented Gradient (HOG)	a dataset consisting of more than 43.000 handwritten Arabic words (30000 used in the training stage and 13000 used in the testing stage).	Histograms of Oriented Gradient (HOG)	Support Vector Machine (SVM)	Experimental results showed an accuracy of 99%.

7.	Ashraf AbdelRaouf, Colin A. Higgins, Tony Pridmore and Mahmoud I. Khalil (2015)	Arabic character recognition using a Haar cascade classifier approach (HCC)	These classifiers were trained and tested on some 2,000 images each	Integral image, Haar-like feature extraction	Boosting of a classifier cascade	The system was tested with real text images and produces a recognition rate for Arabic glyphs of 87 %
8	N. Lamghari, · M. E. H. Charaf and · S. Raghay (2017)	Hybrid Feature Vector for the Recognition of Arabic Handwritten Characters Using Feed-Forward Neural Network	The data are divided into three Parts. From 34.000 character 70% Are used for training, 15% for the test phase and 15% for validation.	hybrid feature extraction (pixel density, resize, Freeman code, structural features, invariant moments, and Regional features.)	a feed-forward back-propagation neural network	The r system has achieved a recognition rate of 98.27%
9	Akanksha Gaur and Sunita Yadav (2015)	Handwritten Hindi Character Recognition using KMeans Clustering and SVM		k-means clustering	Support vector machine (linear kernel) Euclidean distance	Results using SVM are better than results using Euclidean distance. Maximum achieved result using Euclidean distance is 81.7%. SVM is used with linear kernel and giving 95.86% result.
10	Divakar Yadav, Sonia Sánchez-Cuadrado and Jorge Morato (2013)	Optical Character Recognition for Hindi Language Using a Neural-network Approach	Dataset size is 1000	Histogram of projection based on mean distance, on pixel value and vertical zero crossing.	a back-propagation neural network with two hidden layers	Correct recognition rate is 98.5%.
11	Gyanendra K. Verma, Shitala Prasad, and Piyush Kumar (2011)	Handwritten Hindi Character Recognition Using Curvelet Transform	The experiments are evaluated with dataset containing 200 images of character set (each image contains all Hindi characters).	Curvelet transforms	K-Nearest Neighbor	The experiments result show more than 90% accuracy.
12	Nikita Singh (2018)	An Efficient Approach for Handwritten Devanagari Character Recognition based on Artificial Neural Network	During training of neural network, 70% of dataset is used for training and 15% dataset is used for validation and testing each.	Histogram of Oriented Gradients (HOG)	Artificial Neural Network (ANN)	And able to recognize the different handwritten Devanagari characters with an average accuracy of 97.06%

5. METHODOLOGY

Optical character recognition use the following basic stapes as shown in Figure bellow data collection or acquisition, preprocessing, segmentation, features extraction and recognition.

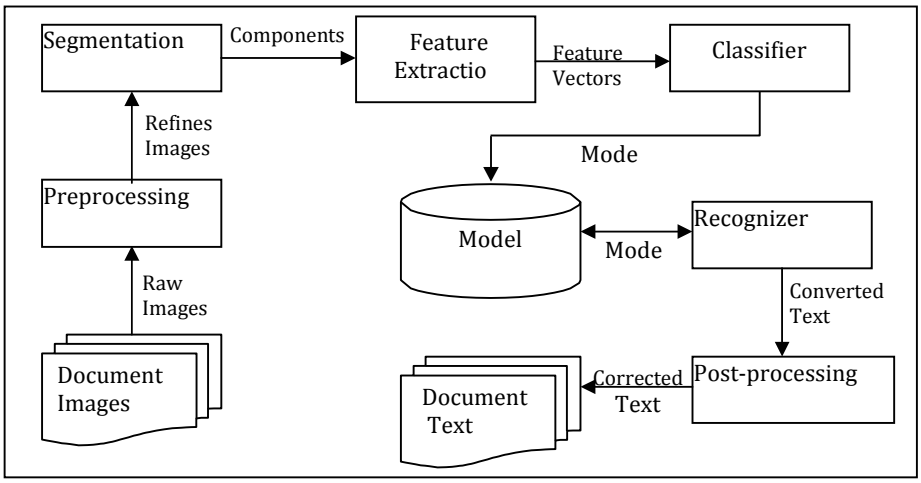

Fig. 1: Methodology

5.1 Data Acquisition

Data used from for this thesis is 28x28 pixel image format MNIST dataset is taken from NIST database. The MNIST database of handwritten digits has a training set of 60,000, and a test set of 10,000. It is a subset of a larger set available from NIST. The digits have been size-normalized and centered in a fixed-size image.

Fig. 2: Data Acquisition

5.2 Preprocessing

This stage is applied to the collected images to clean unwanted pixels and to remove background noises by using MATLAB. There are three steps in this stage: gray scale conversion, binarization, and novice removal.

5.2.1 Binarization: The images of texts need to be pre-processed so that they are in a suitable form for character recognition. This means we first need to convert RGB or gray images to black and white images, this process is known as binarization. I used the 'rgb2gray' function in MATLAB to first convert the RGB image to gray scale image. Followed by the used of 'im2bw' function that converts the gray scale image to black and white image by choosing an appropriate threshold value.

5.2.2 Removal of noise: To remove unwanted noise from the black and white images, I used 'bwareaopen' function in MATLAB to remove all small components below 30 pixels from the image. The removal of smaller components is an important step as it will help remove the unwanted noise in the image which if not removed can ultimately affect character-wise segmentation.

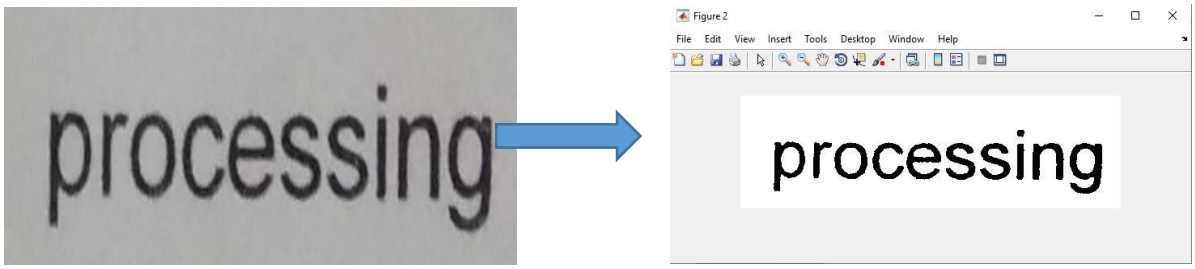

Fig. 3: Processing

5.3 Segmentation

Boxing and Cropping:-This is a process of creating a boundary around the characters identified in an image. This helps by making cropping of characters easier. After boxing, the characters are cropped out for storing them as input variables for recognition. Remove all object containing fewer than 30 pixels traces the exterior boundaries of objects, as well as boundaries of holes inside these objects.

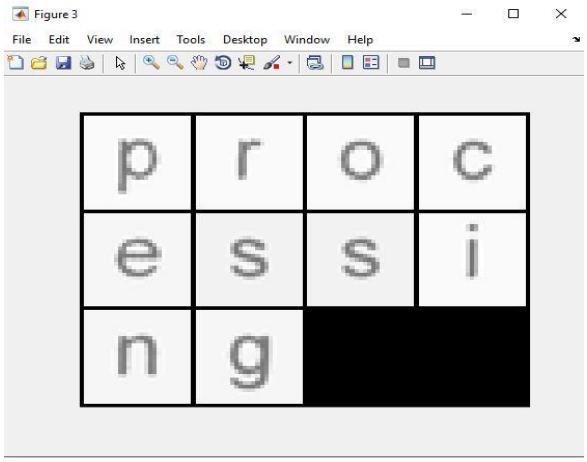

Fig. 4: Segmentation

5.4 Classification and Recognition

In this section, the network architecture, the model parameters, and the training algorithm of artificial neural network and template matching used for classifying and recognition of English characters in our proposed system are presented. First, we went to explain classifying and recognition process of ANN then Template Matching.

5.4.1 Artificial neural network result: ANNs are composed of multiple nodes, which imitate biological neurons of the human brain. The neurons are connected by links and they interact with each other. The nodes can take input data and perform simple operations on the data. The result of these operations is passed to other neurons. The output at each node is called its activation or node value. Each link is associated with weight. ANNs are capable of learning, which takes place by altering weight values. The following illustration shows a simple ANN

5.4.2 Feed Forward ANN: In this ANN, the information flow is unidirectional. A unit sends information to another unit from which it does not receive any information. There are no feedback loops. They are used in pattern generation/recognition/classification. They have fixed inputs and outputs.

The proposed artificial neural network was trained and tested by using the following experimental setup: The training set is provided as an input image, arranged in 1680 x 900-pixel mat file and 1680 x 1 label mat file. Sample binary input image in mat file format. Each input image character is 30x30 pixels, so a number of input neurons is 900. Number of characters for classification is 24, so the number of output, neurons are set to 24 Learning rate was set to 0.3,Batch size was set to 50, Momentum was set to 0.5, Epoch was set to be variable; values of 50, 100, and 150 were tested, Number of hidden layers and number of neurons in each layer was also set to variable and different values were set and tested for each Network model used was RBM, Finally the proposed network was tested using 720 x 900 pixel mat file.

5.4.3 Template Matching: To recognize the characters from the input image is carried out using the Template Matching method. After the character, wise segmented images are received, matching them with the templates of the dataset identifies the characters. This is done with the help of 'corr2' function of MATLAB. The concept of this function is to detect similarities in 2D patterns with cross-correlation method. Here, the input image is stored as a matrix in Amn while compared against a template, which is in Bmn. The return value 'r' indicates the matching ability between the input image and the template. After all comparison s, the highest correlation coefficient value of 'r' is identified as the lower case letter or selected special character.

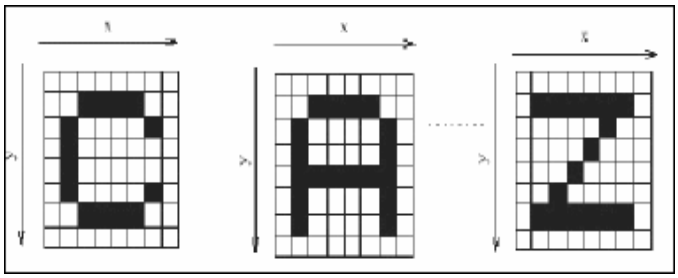

Fig. 5: Template Matching

The value of the data that was entered will be extracted from the images, comprising letters. Each character was automatically selected and threshold using methods previously described.

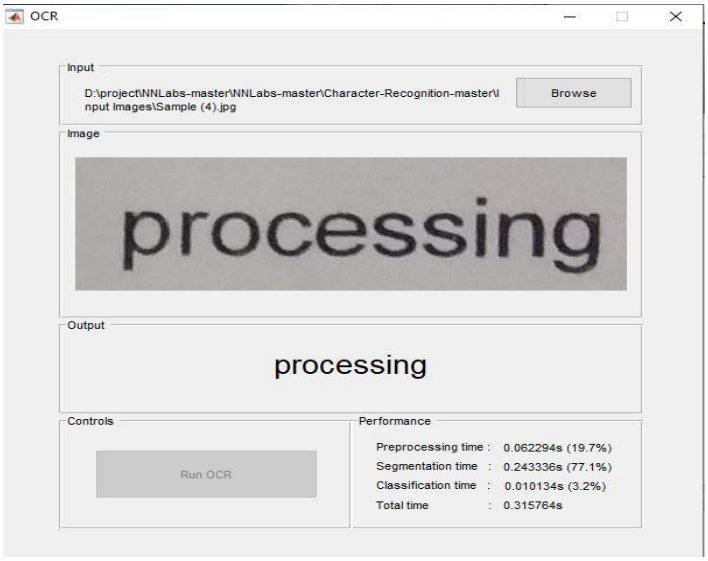

Fig. 6: Template Matching processing

6. RESULT AND COMPARISON

The two result Comparison made based on accuracy rate, time is taken to train or recognized, error rate and dataset size because these four factors will have the main effects in one recognition techniques. From this thesis what I found is an artificial neural network (ANN) is better than template matching in most cases. It was very difficult to present the comparison of the selected system with other recognition algorithms. Discussion and analysis of results are mostly based on percentage measures, and to some extent comparison with results of well-known algorithms are made wherever applicable.

Table 2: Comparison between templates matching and Artificial Neural Network

Templates Matching		Artificial Neural Network
Accuracy Rate	73%	88%
Performance Time	Take less time	Take more time
Error	27%	12%
Data Size	Less accuracy in a large dataset	Need large dataset to train

7. CONCLUSION AND FEATURE WORK

Classification of characters and learning of image processing techniques is done in this thesis. Also, a comparison of template matching Artificial Neural Network is achieved. The result which was got was correct up to most of the cases, but it would be improved at the end. This work was basically focused on the comparison of the two approaches. The Data used from for this thesis is 28x28 pixel image format MNIST dataset taken from NIST database. The MNIST database of handwritten digits has a training set of 60,000 and a test set of 10,000. It is a subset of a larger set available from NIST. The digits have been size-normalized and centered in a fixed-size image. The image was preprocessed to enhance the document images using binarization, noise removal. From these images, individual characters were extracted using boxing and cropping segmentation method to prepare the dataset for training and testing. The method I came up with gave efficient and effective result for future recognition.

As far as the future directions of research presented in this thesis are concerned, the work can be extended for handwritten character recognition of any kind of languages by using the proposed classification algorithm. Another interesting direction would be a combination of different classifiers or cascading the classifiers with the combination of improved feature sets for pattern recognition applications.

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