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Handwritten Character Recognition

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***Abstract*: The objective of this work is to convert printed text or handwritten characters recorded offline using either scanning equipment or cameras into a machine-usable text by simulating a neural network so that it would improve the process of collecting and storing data by human workers. Another goal is to provide an alternate, better and faster algorithm with higher accuracy to recognise the characters. In this context, we choose artificial neural network and make it much more tolerant to anomalies in the recorded image or data. Common optical character recognition tasks involve identifying simple edge detection and matching them with predefined patterns. In thisresearch, characters are recognised even when noise such as inclination and skewness presents, by training the network to look for discrepancies in data and relate them using vocabulary, grammar and common recurrences that may occur after a character. Images are also masked in multiple ways and processed individually to increase the confidence level of prediction.**

***Keywords*: ANN; Hand Written Characters; Edge Detection; HCR3**

1. Introduction

Handwritten Text Recognition (HCR) has its roots from converting printed text into text code so that it can machine-read, building reading devices for the blind and for recognising the telegraphic messages that are received as well as read characters and convert them into telegraphic code. HCR was commonly used in data entry applications. HCR also comes in during conversion of foreign text into another language. Handwritten and printed documents which are either scanned or photographed cannot be used well as they are in an image format which proves as a lot of hindrance and involves hard labor to convert them into computer editable data. This conversion can prove costly for organisations that handle large amounts of data and also can generate huge amounts of human errors in the resulted documents. A computer aided conversion such optical documents can prove when labor is scarce and efficiency needs to increased. People have been struggling in the past with data entering and digitisation of data. Existing techniques to overcome these problems such as OMR sheets and form data have been outdated due to the changes in type of data. To overcome these problems a neural network based approach is required to convert data of varied types in to digital information. A lot of organisations spent a lot of money, time and labor for converting information present on a paper into computer data. This small task can be easily done with little or no labor using a trained tool also making the company to focus its resources and valuable labor force on other challenges. This computerised conversion can prove very productive if done on similar types of documents saving valuable time.

2. Proposed System

A. Artificial Neural Network

It is a most widely used techniques for classification purpose. However, other techniques like Naïve Bayes, Support vector machine, Rough set are also popular tools for different classification context. Suitability of artificial neural network (ANN) as an intelligent technique lies as it strives to mimic the human like effort. ANN gives better result for complex pattern recognition tasks due to its vast information processing ability. Hence, neural network is preferred over other techniques especially for pattern recognition tasks like offline text identification.

ANN is basically defined by three types of parameters:

1. Interconnection pattern between layers of neurones
2. The learning process for updating the weights of the interconnections
3. The characteristics of activation function that maps a neurones weighted input to its output activation.

Typically, the process involves two steps. The first step is training phase where we identify the correct class of data. The features extracted from these would serve as the data to train the neural network. Once the NN is trained, new characters can be classified into known classes by extracting features from new characters. Multi-layer feed forward neural network are mostly used for this purpose that is driven by the principle of back propagation algorithm.

1) Overview

This project approaches the problem of optical character recognition in two stages, the first being training stage in which the system is provided with handwritten characters of all alphabets in ascending order and then prediction stage in which an input image is given that is split into characters and each is individually predicted by the trained neural network. In both stages characters are processed by using a gradient change based feature extraction which involves slicing individual characters into multiple equally sized zones and extracting features such as starters, intersections and end points as well the lowest and highest points in every zone. The zones are then converted into feature vectors which gives the values of all the features in the zones. These feature vectors are used for training as well as during prediction during comparison.

2) Detailed Modules

- *Document Accessing Module:*

Input: Documents that contain handwritten or printed text. Process: The submitted documents are read either using a scanner or digital camera and is converted into a PNG image. The documents are also labelled as either training data or test data or actual data. Naming conventions followed is 'TR' or 'TE' or 'AC' for training, test and actual data respectively followed by a number.

Output: The acquired set of images are stored into the directory system.

- *Pre-processing Module:*

Input: Images stored in the directory

Process: No matter the image it must devoid of noise that arises from degradation, physical damage and also borders from the scanning equipment. The image is converted into a square image by padding or removing borders, then the image is binarized for easier processing. Also averaging is done by taking multiple scans of the same image to get better quality.

Output: Image ready for mathematical operations.

- *Feature Improvement Module:*

Input: Binarised Images.

Process: Although binarisation yields good results for images of printed text, for handwritten images there further processing needed to done. There are still holes inside particles of an image which must filled and text that is extremely small must be dilated to recognise them.

Output: Images with no holes and better contrast.

- *Feature Extraction module:*

Input: Detailed Binary Images

Process: Here the image features are identifying using spaces between words and each word is segmented into characters. The characters are further segmented into multiple sub features, which are then arranged into a feature vector. The features can be either shapes, inclination, height, width, etc.

Output: Features of an image as vectors.

- *Artificial Neural Network module:*

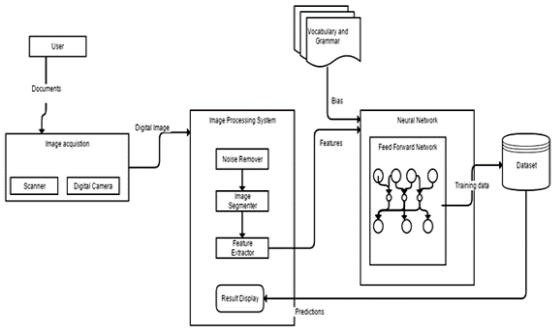

Fig. 1. System architecture

Input: Feature Vectors.

Process: The feature vectors are feed into the input layer of the feed forward network that uses log sigmoid weight function to cluster and classify the image features and determine the confidence level for each output node for a given feature. The trained dataset along with their probabilities and confidence levels are stored in directory.

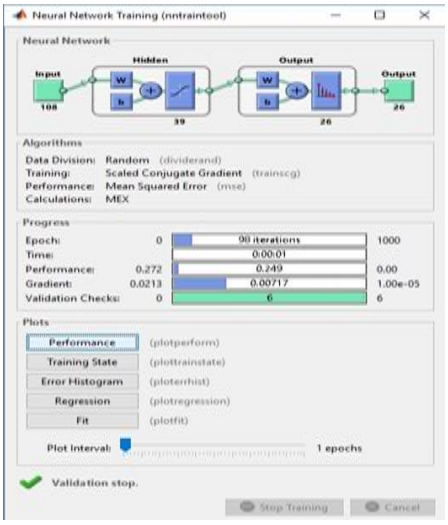

Fig. 2. Neural network training

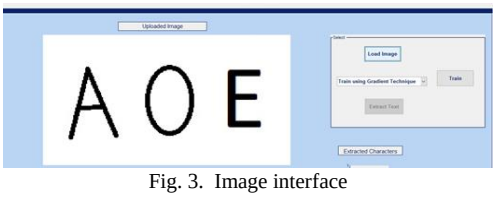

Fig. 3. Image interface

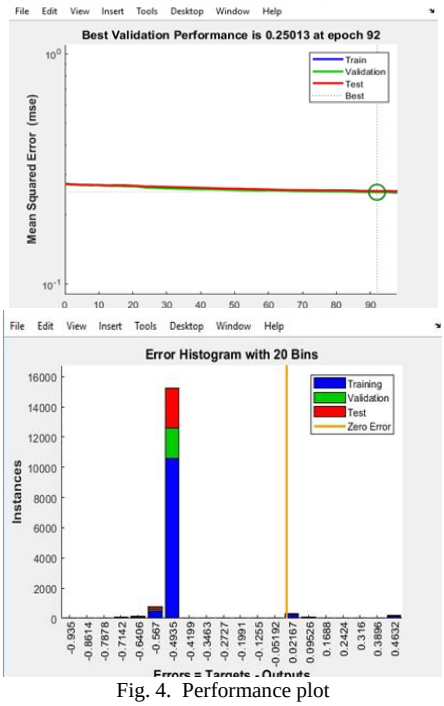

Fig. 4. Performance plot

Fig. 5. Error histogram

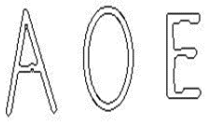

Fig. 6. Edge detection

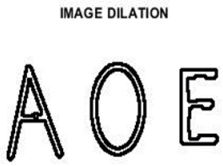

Fig. 7. Dilated image

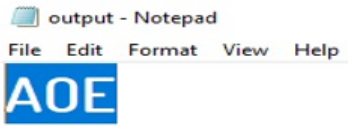

Fig. 8. Recognized characters

3. Literature survey

It has been found that character recognition is being accomplished by the help several techniques. Table 1 lists few of earlier works in this area.

Table 1
Literature survey

	Summary
Reference[1]	Parsing characters of an image diagonally offers lower amount of features by unique but high quality, easily predictable features as the vectors are formed based on the glyphs formed along each and every diagonal. It also states that features along diagonal often are not empty.
Reference[2]	Set of words to look for in a document and limiting the number of words increases the performance greatly. It also shows how identifying frequency of certain words you can look check those words at first.
Reference[3]	This work shows how changes in a pixel value along the row or a point over time can mapped in grid for every characters and this can be used to predict or match new characters. It would result it at least any of the character as result.
Reference[4]	This paper states how changes of handwritten characters points of interest such as, highest point in the column, lowest point as well the average point can be mapped inside a grid and then these profiles can be used in recognizing originality of a signature or handwriting.
Reference[5]	Each language has its characteristic Knicks and knacks and that these characteristic no matter the person writing the document follows them involuntarily and such features can be widely used to determine characters. It also shows that some characteristic are spread across multiple languages.

4. Results and conclusions

The results show that the system has performed well against all types of input. Figure 3 represents the interface of the designed system. Plot in Figure 4 shows the performance of the system in terms of mean squared error while Figure 5 is a histogram representation. Edge detection of the input image is shown in Figure 6 while the following dilated image is represented in Figure 7. The recognized characters are finally represented in Figure 8. The results show that the system has performed well against all types of input. It also shows that the efficiency has increased considerably when the image is preprocessed before features are extracted or undergo any type of processing. The results also show that Neural networks offer much more efficiency when the changes in handwriting are extreme but still follow a pattern. Much more efficient approaches and feature extraction may result in better result. The result is a proof that feature extraction is best suited for this type recognition problem. Handwritten characters can be recognized in multiple ways, however using something that mimics the nature and characteristic of human brain is bound to succeed better than any other system. The proposed method uses neural network approach for the task of optical character recognition, but it is not effective way by using features rather than wholesome comparison, which is unsuitable for handwritten documents.

In future, feature extraction method can be changed to suit the needs of multiple languages. There is also scope for such a system to use in robot vision as well as for understanding human written information. Such a work can be future extended such that it can used to read hieroglyphics and other ancient languages.

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