

Review on Offline Handwritten English Capital Letters Recognition Using Artificial Neural Network and Literature

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Abstract— Handwriting English capital letters recognition is a challenging problem researchers had been research into this area for so long especially in the recent years. In our study there are many fields concern with numbers, for example, checks in banks or recognizing numbers in car plates, the subject of digit recognition appears. A system for recognizing isolated digits may be as an approach for dealing with such application. In other words, to let the computer understand the English capital letters that is written manually by users and views them according to the computer process. Scientists and engineers with interests in image processing and pattern recognition have developed various approaches to deal with handwriting English capital letters recognition problems such as, minimum distance, decision tree and statistics. English capital letters recognition plays an important role in the modern world. It can solve more complex problems and makes humans' job easier. An example is handwritten English capital letters recognition. This is a system widely used in the world to recognize zip code or postal code for mail sorting. There are different techniques that can be used to recognize handwritten English capital letters. Two techniques researched in this paper are Pattern Recognition and Artificial Neural Network (ANN). Both techniques are defined and different methods for each technique is also discussed. Bayesian Decision theory, Nearest Neighbor rule, and Linear Classification or Discrimination is types of methods for Pattern Recognition. Shape recognition, Chinese Character and Handwritten English capital letters recognition uses Neural Network to recognize them.

Keywords- *Introduction, Related Work, Neural Network, proposed system*

I. INTRODUCTION

Recently, a lot of works was done by depending on the computer; In order to let the processing time to be reduced and to provide more results that are accurate, for example, depending on different types of data, such as characters and digits and the numbers are used frequently in normal life operation. In order to automate systems that deal with numbers such as postal code, banking account numbers and numbers on car plates. And an automatic recognition number system is proposed in this study. Digit recognition has been extremely found and studied [7]. Various approaches in image processing and pattern recognition have been developed by scientists and engineers to solve this problem.

A Neural Network is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of the NN paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. A NN is configured for a specific application, such as character recognition

or data classification, through a learning process [13]. Artificial neural network have been developed as

generalization of mathematical model of human cognition or neural biology based on the assumption:

- Information processing occurs at a simple element x called neuron.
- Signals are passed between the neurons over connected link. Each connection link has associated weight which in typical neural net multiply the signals transmitted.
- Each neuron applies to its activation function to its net input to determine the output signal [14]

That is because it has an importance in several fields and it may probably be used in checks in banks or for recognizing numbers in cars plates, or many other application. In this study, system for recognized of digits is built, which may benefit various fields, the system concerning on isolated digits, the input is considered to be an image of specific size and format, the image is processed and then recognized to result of an edited digits [9]. The proposed system recognizes isolated Arabic digits as the system acquire an image consisting digits, then, the image will be processed into several phases such as image enhancement, thinning, skeletonization and segmentation before recognizing the

digit. A multilayer neural network will be used for the recognition phase; a feed forward back propagation [3] algorithm will be applied for training the network and finally change them into numeral text. Character recognition is becoming more and more important in the modern world. It helps humans ease their jobs and solve more complex problems. An example is handwritten character recognition which is widely used in the world [2]. This system is developed for zip code or postal code recognition that can be employed in mail sorting. This can help humans to sort mails with postal codes that are difficult to identify. For more than thirty years, researchers have been working on handwriting recognition. Over the past few years, the number of companies involved in research on handwriting recognition has continually increased. The advance of handwriting processing results from a combination of various elements, for example: improvements in the recognition rates, the use of complex systems to integrate various kinds of information, and new technologies such as high quality high speed scanners and cheaper and more powerful CPUs. Some handwriting recognition system allows us to input our handwriting into the system. This can be done either by controlling a mouse or using a third-party drawing tablet. The input can be converted into typed text or can be left as an "ink object" in our own handwriting. We can also enter the text we would like the system to recognize into any Microsoft Office program file by typing. We can do this by typing 1s and 0s. This works as a Boolean variable Handwriting recognition is not a new technology, but it has not gained public attention until recently. The ultimate goal of designing a handwriting recognition system with an accuracy rate of 100% is quite illusionary, because even human beings are not able to recognize every handwritten text without any doubt. For example, most people cannot even read their own notes. Therefore there is an obligation for a writer to write clearly. In general, handwriting recognition is classified into two types as off-line and on-line handwriting recognition methods. In the off-line recognition, the writing is usually captured optically by a scanner and the completed writing is available as an image. But, in the on-line system the two dimensional coordinates of successive points are represented as a function of time and the order of strokes made by the writer are also available. The on-line methods have been shown to be superior to their off-line counterparts in recognizing handwritten characters due to the temporal information available with the former. However, in the off-line systems, the neural networks have been successfully used to yield comparably high recognition accuracy levels. Several applications including mail sorting, bank processing, document reading and postal address recognition require off-line handwriting recognition systems. As a result, the off-line handwriting recognition continues to be an active area for research towards exploring the newer techniques that would improve recognition accuracy[12].

Neural network adopt various learning mechanism of which supervised learning and unsupervised learning methods have turned out to be very popular. In supervised learning, a teacher is assumed to be present during the learning process, i.e. the network aims to minimize the error between target (desired) output presented by the teacher and the computed output to achieve better performance. However, in unsupervised learning, there is no teacher present to hand over the desired output and the network therefore tries to learn by itself, organizing the input instances of the problem. NN Architecture has been broadly classified as single layer feed forward networks, multilayer feed forward networks and recurrent networks, over the year several other NN[15]

II. RELATED WORK

Pattern recognition is an area of study that is well-established and known through years of research, especially in the field of digit recognition which is considered one of the obvious challenges and one of the significant contributors to digit recognition. However, Arabic digits recognition is considered the recent major areas that attract researcher's attention. Arabic digits recognition attracts researchers into mainly two areas; first, a hierarchical division of the input letter space to easily solve the problem. Second, a heuristically defined rule for classification or feature selection, which is depend on both the writer and the written material (data)[10].

Genetic programming techniques for hand written digits recognition was applied by on the USPS data set. Some variations appears on the selection and evolution methods which normally used accompanied by genetic programming systems such as aged members, directed crossover, inter-output crossover and node mutation. This genetic approach shows a promising result where the accuracy rate reaches 84.3% using inter- output crossover using 19 features.

The Bayesian decision theory is a system that minimizes the classification error. This theory plays a role of a prior. This is when there is priority information about something that we would like to classify. For example, suppose we do not know much about the fruits in the conveyer belt. The only information we know is that 80% of the fruit in the conveyer belt are apples, and the rest of them are oranges. If this is the only information we have, then we can classify that a random fruit from the Conveyer belt is apple. In this case, the prior information is the probability of either an apple or an orange is in the conveyer belt. If we only have so little information, then we would have the following rule:

Decide "apple" if $P(\text{apple}) > P(\text{orange})$, otherwise decide "orange" Here, $P(\text{apple})$ is the probability of being an apple in the conveyer belt. This means that $P(\text{apple}) = 0.8$ (80%). This is probably strange, because if the above rule is used, then we are classifying a random fruit as an apple. But if we use this rule, we will be right 80% of the time. This is a

simple example and can be used to understand the basic idea of pattern recognition. In real life, there will be a lot more information given about things that we are trying to classify. For example, we know that the color of the apples is red. Therefore if we can observe a red fruit, we should be able to classify it as an apple. We can have the probability distribution for the color of apples and oranges. Let w_{app} represent the state of nature where the fruit is an apple, let w_{ora} represent the state of nature where the fruit is an orange and let x be a continuous random variable that represents the color of a fruit. Then we can have the expression $p(x|w)$ representing the density function for x given that the state of nature is an apple. In a typical problem, we would be able to calculate the conditional densities $p(x|w_{app})$ for j so it will be either an apple or an orange. We would also know the prior probabilities $P(w_{pp})$ and $P(w_{ora})$. These represent the total number of apples versus oranges in the conveyer belt. Here we are looking for a formula that will tell us about the probability of a fruit being an apple or an orange just by observing a certain color x . If we have the probability, then for the given color that we observed, we can classify the fruit by comparing it to the probability that an orange had such a color versus the probability that an apple had such a color. If we were more certain that an apple had such a color, then the fruit would be classified as an apple. So, we can use Baye's formula, which states the following: $P(w|x) = \frac{p(x|w_j) P(w_j)}{p(x)}$ [4].

S.P. Kosbatwa, S.K. Pathan [5]: In this paper, use of artificial neural network in applications can dramatically simplify the code and improve quality of recognition while achieving good performance. Another benefit of using neural network in application is extensibility of the system ability to recognize more character sets than initially defined. Pattern association using back propagation algorithm is essential and helpful to optimize the association of input pattern to output pattern in the neural network. This approach can be used for pattern classification.

III. NEURAL NETWORK

Artificial Neural Network (ANN) has been around since the late 1950's. But it was not until the mid-1980 that they became sophisticated enough for applications. Today, ANN [1] is applied to a lot of real- world problems. These problems are considered complex problems. ANN's are also a good pattern recognition engines and robust classifiers. They have the ability to generalize by making decisions about imprecise input data. They also offer solutions to a variety of classification problems such as speech, character and signal recognition. Artificial Neural Network (ANN) is a collection of very simple and massively interconnected cells.

An artificial neural network (ANN), usually called neural network (NN), is a mathematical model or computational model that is inspired by the structure and/or functional aspects of biological neural networks. A neural network

consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. In most cases an ANN is an adaptive system that changes its structure based on external or internal information that flows through the network during the learning phase [8]. Modern neural networks are non-linear statistical data modeling tools. They are usually used to model complex relationships between inputs and outputs or to find patterns in data. A Neural Network (NN) is a function with adjustable or tunable parameters. Let the input to a neural network be denoted by x . This is a real-valued or row vector of length and is typically referred to as input or input vector or sometimes pattern vector. The length of the vector x is the number of inputs to the network. So let the network output be denoted by Y . This is an approximation of the desired output y , which is also a real-valued vector having one or more components and the number of outputs from the network. The data sets often contain many input and output pairs. The x and y denote matrices with one input and one output vector on each row.

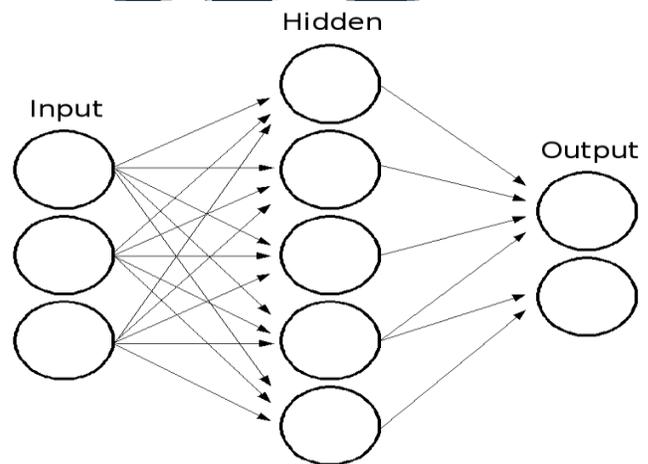


Fig1. A neural network is an interconnected group of nodes as

Input, Hidden and output.

A neural network is a structure involving weighted interconnections between neurons or units[6]. They are often non-linear scalar transformations but can also be linear scalar transformation. The following figure shows an example of a one-hidden-layer neural network with three inputs, $x = \{x_1, x_2, x_3\}$. The three inputs, along with a unity bias input, are fed each of the two neurons into the hidden layer. The two outputs from this layer and from a unity bias are then fed into the single output layer neuron. This produces the scalar output Y . The layer of neurons is called hidden layer because the outputs are not directly seen in the data. Each arrow in the Fig.2 corresponds to a real-valued parameter, or a weight, of the network. The values

of these parameters are tuned in the training network. A neuron is structured to process multiple inputs. This includes the unity bias in a non-linear way. Then, this produces a single output. All inputs to the neuron are first augmented by multiplicative weights. These weighted inputs are summed and then transformed via a non-linear activation function and as indicated from the above Fig.2, the neurons in the first layer of the network are non-linear. The single output neuron is linear because no activation function is used. The information in an ANN is always stored in a number of parameters. These parameters can be pre-set by the operator or trained by presenting the ANN with

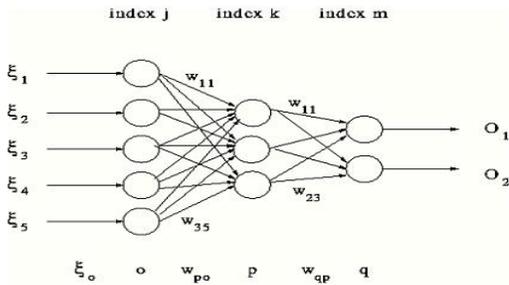
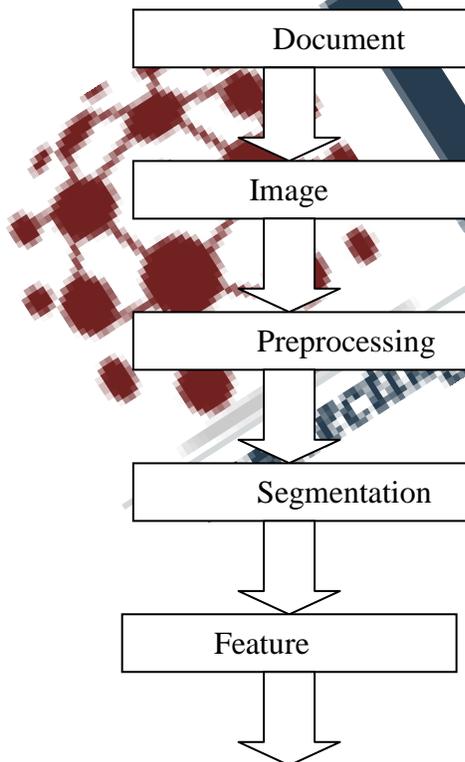


Fig 2 Feed-forward Neural Network with 3 inputs, two hidden neurons and one output neuron.

IV. PROPOSED RECOGNITION SYSTEM



Classification and Recognition

Fig 3.Proposed Recognition System

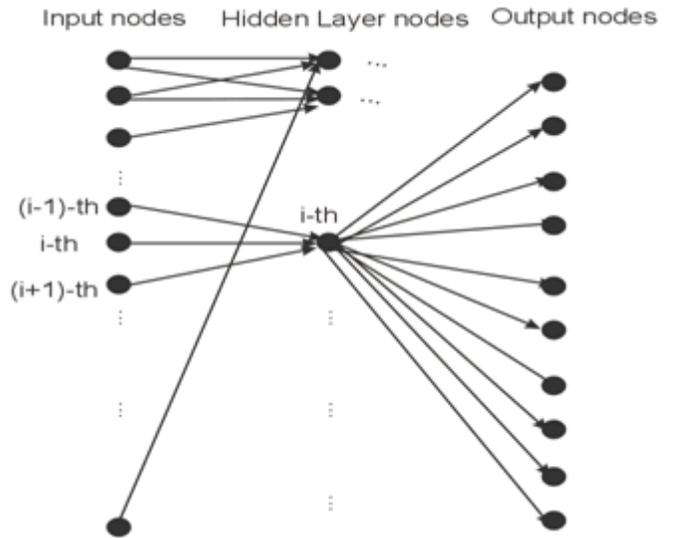


Fig 4. Proposed system Neural Network

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