

DECODING HANDWRITTEN ENGLISH CHARACTERS: A REVIEW

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Abstract: This paper represents the research made for the recognition of the alphabets of the English Language. This section of the research has been the most interesting and challenging areas in today's world. This has also been the point of focus from a very long time. This is due to the fact that the computer device or the mobile device has to learn from a number of training iterations done for a particular character. The challenging part in this is to reduce the number of iterations and reach the most correct recognised character. Different researches have been done previously to recognise the characters in the country's native language but improving the research work in English language only will help more as it is the most widely used language in the world. 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. Different technologies that are used in this research work are: Machine Learning and Neural Networks.

Keywords: Machine Learning, Neural networks, Character Recognition

1. INTRODUCTION

Picture preparing is a quickly developing region of software engineering. Its development has been energized by innovative advances in computerized imaging, PC processors and mass stockpiling gadgets. A picture might be characterized as a 2-D work $f(x, y)$, where x and y are spatial directions, and the sufficiency of f at any facilitate (x, y) is known as the force or dark dimension of the picture by then. Whenever x, y and the abundancy estimations of f are for the most part limited, discrete amounts (for example 0 or 1 for a high contrast picture), we consider the picture an advanced picture. The field of advanced picture preparing alludes to handling computerized pictures by methods for a computerized PC. A computerized picture is made out of a limited quantities of components in an exhibit, every one of which has a specific area and incentive inside that cluster. These components are called pixels. The field of transcribed acknowledgment can be characterized by the various applications. Every application requires an alternate methodology. So it is helpful to look at the field all the more intently and to distinguish its few regions.

In any case, the real division of the field is between on-line and disconnected frameworks [C. C. Tappert - 1984]. On-line frameworks get information straightforwardly from some kind of pen gadget connected to the PC. The information of a composed content are recorded during composing. Consequently, the extra planning data, for example online data, of the composing can be used to perceive words. While the disconnected acknowledgment manages the acknowledgment of words that are composed on a paper-like medium, which would be a transcribed likeness the OCR as of now broadly utilized for perusing printed matter.

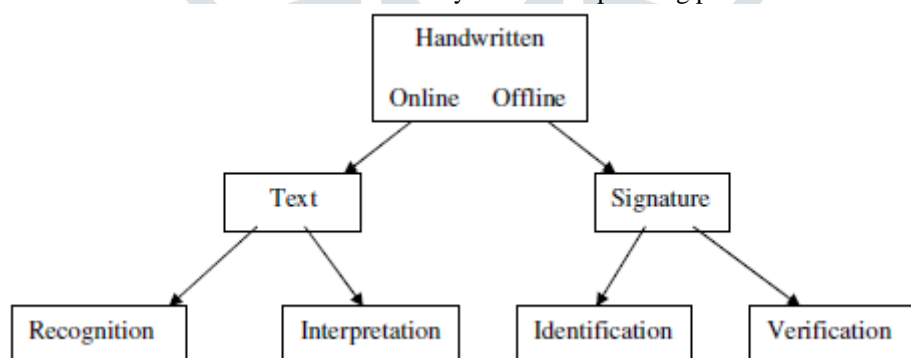


Fig 1: Subdivision of Handwritten Recognition

Albeit, numerous ground-breaking and proficient procedures are accessible for the acknowledgment of printed archives, manually written acknowledgment is as yet an unsolved issue. It is, likewise, the most troublesome piece of the CR territory, in light of the fact that relying upon the style of the author and the speed of composing, a few characters may differ fit as a fiddle, in stroke number and request (dynamic variety). Human visual framework is unfeeling toward the position, direction and size changes of characters.

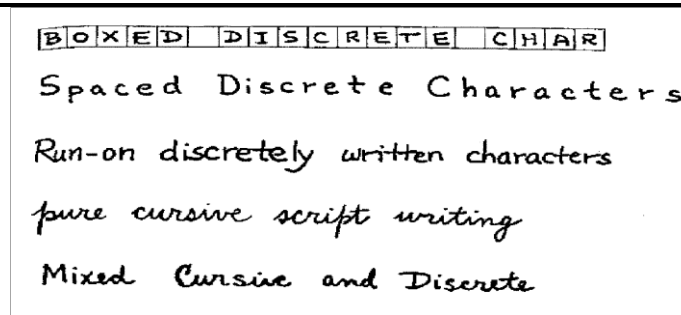


Fig 2: Different types of Handwritten Words

2. OPTICAL CHARACTER RECOGNITION (OCR)

Optical character recognition, typically truncated to OCR, is the mechanical or electronic interpretation of pictures of written by hand or typewritten content (for the most part caught by a scanner) into machine-editable content. OCR is a field of research in example acknowledgment, computerized reasoning and machine vision. In spite of the fact that scholarly research in the field proceeds, the emphasis on OCR has moved to execution of demonstrated procedures.

2.1 RECOGNITION STRATEGIES

Recognition strategies heavily depend on the nature of the data to be recognized. In the cursive case, the issue is made complex by the way that the composing is on a very basic level vague as the letters in the word are by and large connected together, inadequately composed and may even be missing. Actually, hand printed word acknowledgment is increasingly identified with printed word acknowledgment, the individual letters making the word being normally a lot simpler to disconnect and to distinguish.

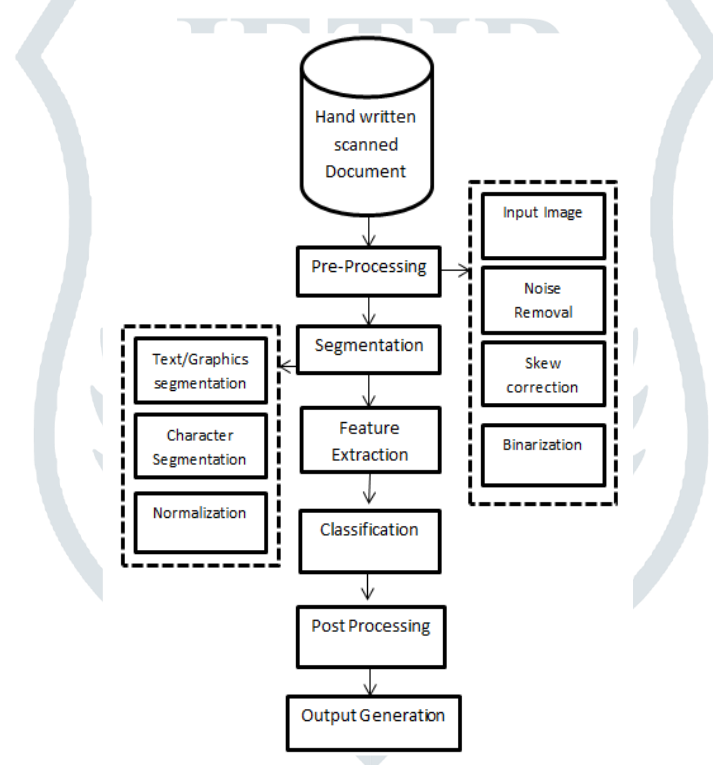


Fig. 3: Components of OCR System

Information securing for this situation comprises regularly in a digitized picture of the simple record utilizing an optical scanner. After the districts containing the content are found, every image is extricated through a division procedure. The extraction of images is followed in the greater part of the cases by a pre-handling, in order to dispense with commotion furthermore, to encourage the extraction of highlights in the subsequent stage. Highlight extraction is a standout amongst the most significant advance in the acknowledgment framework, since the element chose needs to speak to well the example in which one wishes to group. Much of the time, the measure of information chose in the component extraction is colossal, so a decrease of this information is essential.

3. STEPS INVOLVED IN METHODOLOGY:

a. PRE-PROCESSING

Pre-processing can be defined as cleaning the document image and making it appropriate for input to the OCR engine. Major steps under pre-processing are:

- Noise removal
- Skew detection/correction
- Binarisation

The Noise introduced by the optical scanning devices in the input leads to poor system performance. These blemishes must be evacuated preceding character acknowledgment. Clamor can be presented in a picture during picture procurement and transmission. Commotion can be of various kinds as Gaussian clamor, Gamma clamor, Rayleigh commotion, Exponential clamor, Uniform clamor, Salt and pepper commotion, Periodic clamor and so forth. Commotion can be expelled utilizing Ideal channels, Butterworth channels and Gaussian channels. There is a probability of revolution of picture while examining. Slant location and adjustment is utilized to adjust the paper record with the arrange arrangement of scanner. Different slant recognition systems are projection profiles, associated segments, Hough change, bunching and so on. In Binarization, shading or dark scale picture is changed over into double picture with the assistance of thresholding. Twofold picture can be accomplished utilizing Adaptive thresholding, Global thresholding, variable thresholding, Ostu's technique and so on. Morphological tasks are additionally utilized in pre-handling. Enlargement and Erosion are the morphological activities that expansion or abatement the picture estimate. Disintegration makes an article littler by dissolving without end the pixels from its edges. Each article pixel that is contacting foundation pixels is changed into foundation pixel. Be that as it may, enlargement makes an item bigger by including pixels around its edges. Each pixel that is contacting an item pixel is changed into article pixel. Other morphological tasks are opening and shutting.

b. SEGMENTATION

Segmentation is needed since handwritten characters frequently interfere with one another. Common ways in which characters can interfere include: overlapping, touching, connected, and intersecting pairs etc. So as to isolate content from diagrams, pictures, line, content/designs division is required. The yield ought to be a picture comprising of content as it were. Character division will isolate each character from another. It is one of the principle steps particularly in cursive contents where characters are associated together. The detached characters acquired because of character division are standardized to explicit size for better precision. Highlights are extricated from the characters with a similar size so as to give information consistency. Christopher E. Dunn and P. S. P. Wang [5] utilized a progression of district discovering, gathering, and part calculations. Area finding will recognize all the disjoint districts. The pixels are initially marked On/Off where "on" means the information zones. Picture is analyzed pixel by pixel until "on" esteem is discovered. Once discovered it is named with new locale number and its neighbors are looked for extra "on" esteem. Search continues until no "on" esteem is found. The outcome is that every single disjoint area will be recognized and all pixels in any district will be marked with a one of a kind number. Gathering manages the characters which have separate parts or which are broken. A littles bouncing box is determined that totally encases another locale. In the event that for any two locales the jumping box of one area totally encases another district, at that point the encased locale is relabeled to the estimation of the encasing district. Along these lines, the subsequent locale is made out of two disjoint sub-districts. This is useful for associating areas that have been isolated because of commotion. Splitting [5] manages contacting characters. Anshul Mehta [2] utilized Heuristic division calculation which sweeps the manually written words to distinguish the substantial division focuses between characters. The division depends on finding the curves between letters, normal in written by hand cursive content. For this a histogram of vertical pixel thickness is inspected which may demonstrate the area of conceivable division focuses in the word. Other character division approaches [4] are Thinning based strategy, Contour Fitting strategy, Robust Statistical system, Hypothesis Verification, Shape Feature Vector technique and so on.

c. FEATURE EXTRACTION

Feature extraction is finding the set of parameters that define the shape of a character precisely and uniquely. Feature extraction [3] methods are classified into three major groups as:

- Statistical features.
- Global transformation and series expansion.
- Geometric and topological features.

Statistical features represent the image as statistical distribution of points. Various methods which use statistical features are Zoning, Crossings and Distances, Projections etc. In worldwide change and arrangement extension different methods are Fourier change, Gabor change, Fourier Descriptor, wavelets, minutes, Karhunen-Loeve development and so on. In Geometric and topological highlights, the basic highlights like circles, bends, lines, T-point, cross, opening to one side, opening to one side and so on are utilized. The different classifications are coding (freeman chain code), extricating and tallying topological structures, diagrams and trees. Geometric highlights are utilized alongside fluffy rationale to perceive characters [7]. Adnan Amin [6] and Puttipong Mahasukhon [7] utilized auxiliary data to concentrate highlights from a character like Breakpoints, Inflection Point, Cusp Point, Straight Line, Curve, Open or Close Loop and so on. Breakpoint isolates a way into sub ways. It has two potential conditions-Inflection Point (change in ebb and flow) and Cusp Point (sharp change in direction). Straight line has two points in grouping in a way. Open bend is as in letter "S". Shut bend is as present in "a". These portions are given as contribution to neural system classifier. Anshul Mehta [2] utilized Fourier descriptor for extricating one of a kind component from a character. At first limit is distinguished, at that point discrete Fourier coefficient $a[k]$ and $b[k]$ are determined for $0 < k < L-1$. Where L is the absolute number of limit focuses. Fourier descriptor [8] can be utilized with one new system known as Border Transition procedure (BTT). In it each character is divided into four equivalent quadrants. The examining and computation of dark to-white progress occur in both vertical and level bearings in every quadrant. The normal change of every course (flat and vertical) in every one of the four quadrants of the container encompassing the character will be determined. Rafael M. O [1] utilized nine changed component extraction systems on a solitary database. Basic attributes comprise in removing histograms and profiles and joining then into a solitary element vector. In changed edge map a $M \times N$ picture is diminished and scaled into a 25×25 lattice. The Sobel administrators are utilized to separate four unmistakable edge maps: flat, vertical and two diagonals. These four maps and the first picture are separated into 25 sub-pictures of 5×5 pixels each. The highlights are gotten ascertaining the level of dark pixels in each sub-picture (25 highlights for each picture). The highlights are consolidated to shape a solitary element vector containing 125 (25×5) highlights. Picture Projections comprises of extricating the spiral and slanting projections. To extricate the outspread projections, the picture should initially be separated into four quadrants: top, base, right and left. Outspread projections are gotten by gathering pixels by its spiral separation to the focal point of the picture in every quadrant independently. The slanting projection is registered basically by gathering pixels by the two askew lines. The estimations of every projection are standardized to a range [0-1] through the division by the most extreme worth. The standardized highlights are Concatenated in a solitary vector containing 128 highlights. In Multi Zoning a $M \times N$ character picture is separated into a few sub-pictures and the level of dark pixels in each Sub-picture is utilized as highlight. It is a factual methodology as highlights are determined

dependent on the quantity of pixels used to speak to a picture. Other component extraction calculations utilized are Concavities Measurement, MAT-based Gradient Directional highlights, Gradient Directional highlights, Median Gradient highlights, Camastra 34D features[1].

d. CLASSIFICATION AND POST PROCESSING

The classification is the process of identifying each character and assigning to it the correct character class. The classification techniques [9] can be categorized as:

- Classical techniques.
- Soft computing techniques.

The various classical techniques are Template matching, Statistical techniques, Structural techniques. Whereas the various soft computing techniques are Neural networks, Fuzzy logic, Evolutionary computing techniques. Adnan Amin and W. H. Wilson [6] used Neural network for classification of characters with three layers namely Input layer, Output layer and Hidden layer. The geometric highlights separated like speck, line, bend or circles are given as contribution to the info layer. Every part of the divided portrayal is delegated a speck, line, bend, or circle. For each situation, the qualities of the part are resolved: if a line, what are its direction and its size in respect to the character outline - short, medium or long. One info neuron is utilized to encode every one of these potential decisions (short/medium/long) and every one of four potential directions for a line. One information neuron is utilized to encode the qualities of every segment extricated by geometric element extraction method. Neuron has two methods of activities as preparing mode and testing mode. In the preparation mode, the neuron can be prepared to fire (or not), for specific info designs. In the testing mode, when an encouraged information example is distinguished at the info, its related yield turns into the present yield. In the event that the info example does not have a place in the shown rundown of information designs, the terminating principle is utilized to decide if to fire or not. Anshul Mehta, Manisha Srivastava [2] utilized three systems for the acknowledgment of 26 lower case and 26 capitalized letters as Multilayer Perception (MLP) [2,8], Radial Basis Function (RBF) and Support Vector Machine (SVM). Multilayer discernment is a feed forward neural system with at least one layers among information and yield layer. Outspread premise work (RBF) organizes normally have three layers: an information layer, a concealed layer with a non-direct RBF enactment work and a straight yield layer. Post-preparing for the most part comprises of two undertakings – yield string age and blunder recognition/adjustment. Yield string age will reassemble the strings which have been isolated during the time spent division while mistake identification/remedy will address blunders with the assistance of lexicon.

4. NEURAL NETWORK

In artificial Neural Network, a neuron is a logistic unit. We feed input via input wires, the logistic unit does the computation and the output wire sends the output. The logistic computation is the same Logistic regression hypothesis calculation.

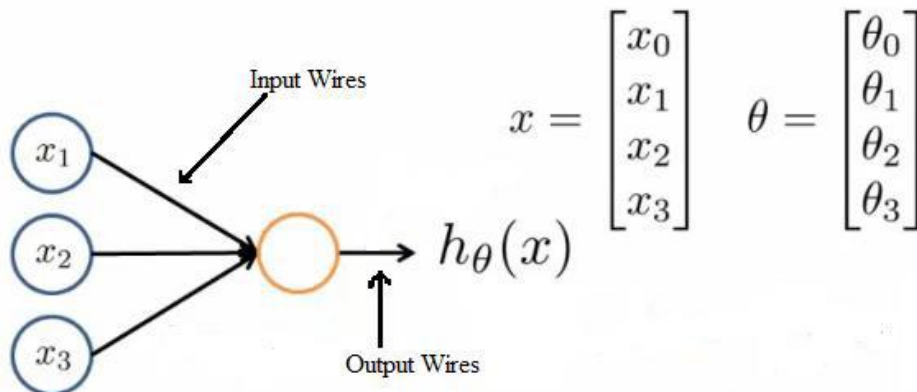


Fig 4: A single neuron

The above figure is an artificial neuron with a sigmoid (logistic) activation function. The Θ vector is also called the weights of the model.

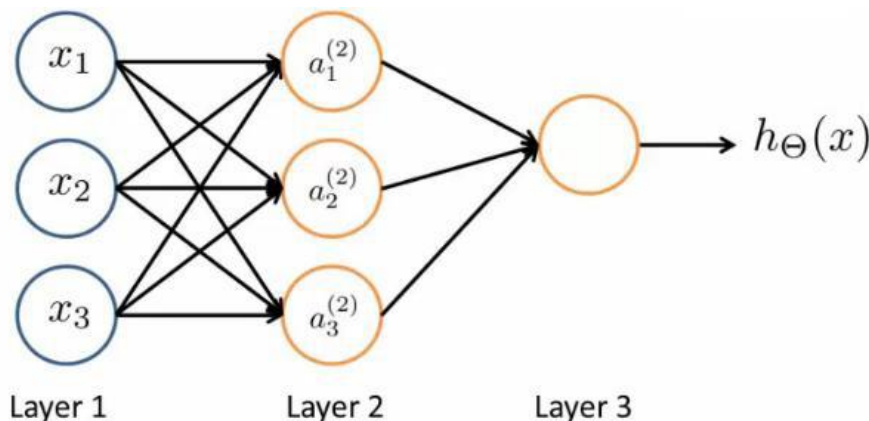


Fig 5: A neural network

In the above figure $x_1, x_2,$ and x_3 constitute the input layer, a_{12}, a_{22} and a_{32} constitute the hidden layer and $h_{\Theta}(x)$ which produces the output is called the output layer. We can have as many hidden layer as our requirement.

5. CONCLUSION

The major approaches used in the field of handwritten character recognition during the last decade have been reviewed in this paper. Distinctive pre-preparing, division, highlight extraction, order strategies are additionally talked about. However, different techniques for treating the issue of transcribed English letters have created in most recent two decades, still a great deal of research is required so a feasible programming arrangement can be made accessible. The current OCR for transcribed has extremely low precision. We need an effective answer for tackle this issue with the goal that general execution can be expanded.

6. FUTURE RESEARCH

From 1950's OCR is an active area of research. Many techniques for recognition of Offline English Handwritten Characters have been suggested. Yet at the same time a productive OCR for the acknowledgment of written by hand letters does not exist. Hardly any means have been taken for Hand composed and Hand printed (which is a compelled hand composing) English letter acknowledgment. Different difficulties are recognized which may give all the more enthusiastic enthusiasm to the scientists. These difficulties are: trouble to distinguish the assorted human composition styles, various edges of letters, various shapes and size of letter, unadulterated information quality, low exactness rate in acknowledgment and so forth. Thus, a ton of research work is to be done to tackle these issues.

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