LITERATURE SURVEY

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INTRODUCTION

Digit recognition is fundamental, but most challenging in the field of pattern recognition with a large number of useful applications. It has been an intense field of research since the early days of computer science due to it being a natural way of interacting between computers and humans. More precisely Character recognition is the process of detecting and recognizing characters from the input image and converting it into ASCII or other equivalent machine editable form.
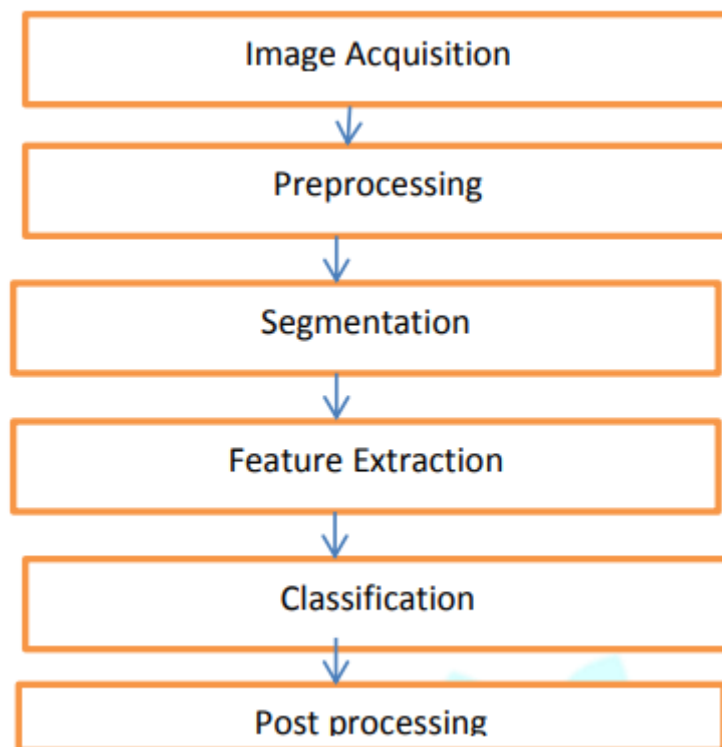
The technique by which a computer system can recognize characters and other symbols written by hand in natural handwriting is called the handwriting recognition system. Handwriting recognition is classified into offline handwriting recognition and online handwriting recognition. If handwriting is scanned and then understood by the computer, it is called offline handwriting recognition. In this case, the handwriting is recognized while writing through the touchpad using a stylus pen, it's called online handwriting recognition.

From the classifier perspective, character recognition systems are classified into two main categories i.e. segmentation free and segmentation based. The segmentation free also known as the holistic approach to recognize the character without segmenting it into subunits or characters. Each digit is represented as a set of global features, e.g. ascender, loops, cusp, etc. Whereas segmentation based approach each word/ligature is segmented into subunits either uniform or non-uniform and subunits are considered independently. Handwritten digit processing systems are domain and application specific, like it is not possible to design a generic system which can process all kinds of handwritten scripts and language.

The handwritten digits from 0 to 9 are trained and then tested using supervised machine learning model. Histogram of Oriented Gradient (HOG) based features are extracted from handwritten digits. Proximal Support Vector Machine classifier is used

. For classification of features of handwritten digits, classifiers like ANN, k-nearest neighbors (k-NN) and Support Vector Machine (SVM) are used. Out of these classifiers SVM is widely applicable. The main advantage of SVM classifier is high accuracy, but the classifier takes long training time.

WORKING PRINCIPLE

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│         Preprocessing           │
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│         Segmentation            │
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│       Feature Extraction        │
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│         Classification          │
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│         Post processing         │
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A. Image Acquisition : Digitized/Digital Image is initially taken as input. The most common of these devices is the electronic tablet or digitizer. These devices use a pen that is digital in nature. Input images for handwritten characters can also be taken by using other methods such as scanners, photographs or by directly writing in the computer by using a stylus.

B. Preprocessing : Pre-processing is the basic phase of character recognition and it's crucial for good recognition rate. The main objective of pre-processing steps is to normalize strokes and remove variations that would otherwise complicate recognition and reduce the recognition rate. The variations or distortions include the irregular size of the text, missing points during pen movement collections, jitter present in text, left or right bend in handwriting and uneven distances of points from neighboring

positions. Pre-processing includes five common steps, namely, size normalization and centering, interpolating missing points, smoothing, slant correction and resampling of points.

C. <u>Segmentation</u> : Segmentation is done by separation of the individual characters of an image. Generally document is processed in a hierarchical way. At first level lines are segmented using row histogram. From each row, words are extracted using column histogram and finally characters are extracted from words.

D. <u>Feature Extraction</u> : The main aim of feature extraction phase is to extract that pattern which is most pertinent for classification. Feature extraction techniques like Principle Component Analysis (PCA), Linear Discriminant Analysis (LDA), Chain Code (CC), Scale Invariant Feature Extraction (SIFT), zoning, Gradient based features, Histogram might be applied to extract the features of individual characters. These features are used to train the system .

E. <u>Classification</u> : When input image is presented to HCR system, its features are extracted and given as an input to the trained classifier like artificial neural network or support vector machine . Classifiers compare the input feature with stored pattern and find out the best matching class for input.

F. <u>Post Processing</u> : Post-processing refers to the procedure of correcting misclassified results by applying linguistic knowledge. Post processing is processing of the output from shape recognition. Language information can increase the accuracy obtained by pure shape recognition. For handwriting input, some shape recognizers yield a single string of characters, while others yield a number of alternatives for each character, often with a measure of confidence for each alternative.