

Abstract

Character recognition (CR) has been extensively studied in the last half century and progressed to a level, sufficient to produce technology driven applications. Now, the rapidly growing computational power enables the implementation of the present CR methodologies and also creates an increasing demand in many emerging application domains, which require more advanced methodologies. As a subset of CR, special attention is given to the offline handwriting recognition, since this area requires more research to reach the ultimate goal of machine simulation of human reading. As a result, this project aims to create an offline handwritten character recognition model. A standardized process of achieving offline handwriting recognition which broadly consists of five steps, namely pre-processing, segmentation, representation, training and recognition and post processing. Pre-processing can be segmented into subtasks which consist of noise removal, binarization i.e. converting the image to grayscale, thinning, edge detection, slant estimation and correction, skew detection and resizing. Segmentation and representation will consist of dividing the cleaned image for feature extraction and then arranging the divisions into a standard format. Training and recognition will consist of the deep learning neural network architectural model which will involve a combination of convolutional and recurrent neural network layers. Post processing will consist of stitching the context of the information together to obtain meaningful text. Finally, a simplistic human interface will act as a interactive program enabling user to employ the proposed offline handwriting recognition application to digitize document images.

Introduction

Machine simulation of human functions has been a very challenging research field since the advent of digital computers. In some areas, which require certain amounts of intelligence, such as number crunching or chess playing, tremendous improvements are achieved. On the other hand, humans still outperform even the most powerful computers in the relatively routine functions such as vision. Machine simulation of human reading is one of these areas, which has been the subject of intensive research for the last three decades, yet it is still far from the final frontier.

In general, handwriting recognition is classified into two types as offline and online handwriting recognition methods. In the offline recognition, the writing is usually captured optically by a scanner and the completed writing is available as an image. But, in the online system the two dimensional coordinates of successive points are represented as function of time and the order of strokes made by the writer are also available. The online methods have been shown to be superior to their offline counterparts in recognizing handwritten characters due to the temporal information available with the former. However, in the offline 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 offline handwriting recognition systems. As a result, the offline handwriting recognition continues to be an active area for research towards exploring the newer techniques that would improve recognition accuracy.

The first important step in any handwritten recognition system is pre-processing followed by segmentation and feature extraction. Pre-processing includes the steps that are required to shape the input image into a form suitable for segmentation. In segmentation, the input image

is segmented into individual characters and then, each character is resized into $m * n$ pixels towards the training network.

The selection of appropriate feature extraction method is probably the single most important factor in achieving high recognition performance. An artificial neural network as the backend is used for performing classification and recognition tasks. In the offline recognition system, neural networks have emerged as the fast and reliable tools for classification towards achieving high recognition accuracy.

Handwriting recognition is one of the many branches of computer vision, a vast field involving the mimicry of human capabilities of senses using massive technology advancements in the field of machine learning and artificial intelligence. It mainly comprises of achieving machine vision to automate human-like tasks. Handwriting recognition has been an age old part of computer vision and with the advent of the technological boom in deep learning techniques, systems for this purpose have been successfully developed with astounding accuracy. Despite this, the offline handwriting recognition problem belonging to a broad category of recognition still remains unexplored and poses high research scope.