



Automated Digitization of Student's Marks from the Answer-Book Images Using a Lightweight CNN Model

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Abstract

Preparing student's digital marksheet using images of student answer-books is a potential application in academic institutions. Segmenting assigned marks automatically from answer-book images is extremely challenging, and it also demands pre-processing before the recognition stage. In addition, recognizing handwritten digits is crucial due to different writing styles. Existing research admits the superior performance of deep learning-based models in handwritten digit recognition (HDR) applications for popular datasets. However, their implication on real-time data for an experimental setup needs much attention. This paper presents an experimental setup that uses student answer-book images to record students' marks digitally. We proposed a lightweight convolutional neural network (CNN) model for HDR. We also introduced a contour-based segmentation process for automatically extracting student details from answer-book images. The obtained results show the state-of-the-art performance of our proposed CNN model for real-time images. Further, introducing additional pre-processing before recognition significantly enhances the accuracy of the HDR experimental setup.

Keywords Convolutional neural network (CNN) · Handwritten digit recognition (HDR) · Handwritten digit segmentation · Image classification

Introduction

Handwritten digit recognition is vital for a variety of document analysis applications [1, 2], such as automated bank cheque processing [3], handwriting recognition for text-based input [4–8], and recognizing numbers for data entry. It is also used for security purposes, such as for biometric identification [9]. Handwriting recognition is also used to

help people with disabilities, such as those with dyslexia [10], to access written information better.

One of the significant HDR applications lies in the field of academic transcript analysis [11]. Handwritten digit recognition is necessary for digitizing marksheets, which makes the process of collecting, storing, and analyzing marksheets easier and more efficient. Additionally, handwritten character recognition can help reduce errors, eliminating the need for manual data entry. Classical HDR algorithms [12] include four stages: pre-processing, segmentation, feature extraction, and classification. Popular pre-processing techniques include image super-resolution [13, 14], thresholding [15], and denoising. Such processed images improve the segmentation of digit images. Meaningful features from the segmented digit images are extracted to identify the digit. Common feature extraction techniques include edge, contour, and line detection. These extracted features enable the classifier to assign the digit image to a class. K-nearest neighbors (kNN), deep neural networks (DNN), and support vector machines (SVM) are some of the popular classifier algorithms. A similar feature-based segmentation is implemented in [16].

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