International Journal on Document Analysis and Recognition (IJDAR) (2023) 26:89–107
https://doi.org/10.1007/s10032-022-00418-3

ORIGINAL PAPER

WriterINet: a multi-path deep CNN for offline text-independent writer identification

A. Chahi[1,2] · Y. El merabet[2] · Y. Ruichek[1] · R. Touahni[2]

Received: 17 May 2022 / Revised: 5 September 2022 / Accepted: 27 September 2022 / Published online: 14 October 2022

Abstract
Handwriting-based identification is a fundamental pattern recognition problem that has attracted considerable interest in recent years. Writer identification is a major challenge, considering how diverse the written content is and how much handwriting differs between writers. This paper presents $WriterINet$, a CNN-based approach to learning and characterizing each writer's writing style. The proposed $WriterINet$ approach takes handwritten documents as input, decomposing each of them into word images and connected component sub-images. Each segmented image is then fed into our feature learning step to generate discriminative and deep features. To this end, we developed a powerful deep CNN feature architecture consisting of two CNN streams derived from fine-tuning the ResNet-50 and DenseNet-201 models. Deep learned features are computed from all segmented images representing the writer's document and classified using a proposed 1D artificial neural network for predicting writer identification by averaging the similarity scores. Experimental results on IAM, ICDAR2013, CVL, IFN/ENIT, ICDAR2011, Firemaker and CERUG show that our $WriterINet$ approach achieves the highest or competitive performance over the state-of-the-art.

Keywords Handwriting · Deep learning · Text-independent · Convolutional neural network · Off-line writer identification · Feature learning · 1D artificial neural network

1 Introduction

Handwriting is one of the most reliable behavioral biometric data for characterizing the individuality of the writer. It has the same importance as fingerprint systems for biometric identification. Unlike machine texts, handwriting contains distinguishing characteristics of the person who wrote it. The handwriting of the same person is often influenced by many factors such as age, schooling, mood, time, and so on. This is called intraclass variance. The dissimilarity between samples from two different people is called interclass variance. A good biometric writing trace has a small intraclass variance and a large interclass variance. This means that a person will never produce the same writing style in exactly the same way twice. This makes handwriting analysis a challenging task and an interesting field of research for psychologists, graphologists, forensic scientists, and historians. It has been used for many centuries as a means of identity verification and pattern recognition.

Handwriting is an important aspect of document understanding and analysis with many scientific and technical locks. Existing approaches from the fields of pattern recognition and authentication have focused on developing new and reliable systems for handwriting analysis. These systems can be learned and applied to different writing styles with different application requirements. Handwriting analysis using artificial intelligence has many applications in modern life. It includes in full extension a number of applications such as classification of old documents [1], smart meeting rooms [2], online/offline verification of handwritten signatures [3],

✉ A. Chahi
abderrazak.chahi@utbm.fr

Y. El merabet
y.el-merabet@univ-ibntofail.ac.ma

Y. Ruichek
yassine.ruichek@utbm.fr

R. Touahni
touahni.raja@uit.ac.ma

1 CIAD UMR 7533, Univ. Bourgogne Franche- Comté, UTBM, F-25200 Montbéliard, France

2 Laboratoire LASTID, Département de Physique, Faculté des Sciences, Université Ibn Tofail, BP 133, 14000 Kenitra, Morocco