Universidade Federal de Pernambuco
Centro de Informática
Graduação em Engenharia da Computação

Data Augmentation for Offline Handwritten Signature Verification

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Área: Aprendizagem de máquina

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Resumo

A tecnologia de biometria é usada em uma ampla variedade de aplicações de segurança e principalmente para verificar a identidade de uma pessoa devido aos traços biométricos específicos associados a ela. O objetivo de tais sistemas é distinguir entre assinaturas reais e falsificações. Este trabalho é focado em sistemas de verificação de assinaturas off-line, que são baseados em imagens de assinaturas digitalizadas (estáticas), onde informações dinâmicas não são fornecidas. No entanto, para esses sistemas, geralmente, a quantidade de dados disponíveis para cada indivíduo é limitada a um pequeno conjunto de amostras, o que torna a classificação uma tarefa desafiadora. Este estudo tem como objetivo analisar o impacto nos resultados de classificadores dependentes e independentes de escritor com novas assinaturas geradas a partir de redes adversariais generadoras profundas, aumentando o número de amostras disponíveis para a tarefa de classificação.

Palavras-chave: sistema offline de verificação de assinaturas**,** DCGANs, aprendizagem profunda, classificador dependente de escritor, classificador independente de escritor

Abstract

Biometrics technology is used in a wide variety of security applications and mainly employed to verify a person's identity due to the specific biometric traits associated with it. The objective of such systems is to distinguish between genuine signatures and forgeries. This work is focused on offline signature verification systems, which are based on images of scanned signatures (static) where dynamic information is not provided. However, for these systems usually, the amount of data available for each individual is limited to a small set of samples, what makes classification a challenging task. This study aims to analyze the results of writer-dependent and writer-independent classifiers by adding new signatures generated with deep generative adversarial networks, increasing the number of samples available for the classification task.

keywords: offline signature verification system; DCGANs; Deep learning, Writer-independent classifier, Writer-dependent classifier

Contents

Introduction

Handwritten signature verification is a widely employed technique to identify people's identity in financial and administrative areas due to the non-invasive process of signature collection and the familiarity of users with this method.

In this field, systems are mainly classified into two categories: verification and identification. In the first case, a user of the system claims an identity and provides the biometric sample. The role of the verification system is to check if the user is indeed who he or she claims to be. In the identification case, a user provides a biometric sample, and the objective is to identify it among all users enrolled in the system [1].

Another common classification inside the verification systems category refers to online and offline systems. In online verification systems, signatures are captured in real-time, providing some dynamic information such as hand pressure, stroke order, pen inclination, etc. In the offline case, the signature is captured after the writing process in a digital form (scanned).

Afterward, a classifier verifies if the signature is indeed genuine or a forgery. Verification models used to classify signatures from any user are called writer-independent (WI) systems, while writer-dependent (WD) systems refer to models trained to specific users.

One of the biggest challenges in this field is the large variability between samples of the same user. Furthermore, forgeries which try to imitate user's signature, also named *skilled forgeries,* possess a low variability compared to the genuine ones.

Besides that, another challenge addresses the lack of information during the training process. In a real scenario, classifiers only obtain genuine signatures, nevertheless, this information is not enough to ensure high-accuracy discriminating genuine and forgery signatures.

Moreover, users usually do not have sufficient data samples, restricting the performance of real applications. For instance, financial and administrative contracts often demand few signatures for the same user.

During the last years, techniques based on hand-engineering feature extractors have been broadly employed, however raw data featuring representation are starting to become used with the increasing interest in deep learning approach.

Haffemann et al.[5]. Proposed a Writer-Independent feature learning method, where a Convolutional Neural Network (CNN) is used to learn feature representations, consequently, Writer-dependent classifiers are trained over this representation.

Zhang et al.[3] proposed using Generative Adversarial Networks(GAN) [4] for learning the features from a subset of users. In this case, two networks are trained: a generator, that learns to generates signatures and a discriminator. That learns, to discriminate if an image is from a real signature or one that was automatically generated [1].

Addressing the challenge of the low number of samples for training, several data augmentation techniques have been proposed, Huang and Yan [7] proposed some slight modifications to genuine signatures generate new samples, while others have proposed a signature synthesis approach [8] [9].

Finally, offline signature verification systems have improved drastically with several advances in Deep learning. Data augmentation and improving classification keep being a challenge for researchers and representations using convolutional neural networks are a trend for actual works.

Objective

This project aims to purpose and analyze a technique of data augmentation using deep convolutional generative adversarial networks in handwritten verification systems to generate new signature samples and provide them to writer-dependent and writer-independent classifiers in order to improve their classification results.

Methodology

Approach

In this work, I propose a data augmentation technique, which uses a modified Deep Convolutional Generative Adversarial Network (DCGAN) over a signature dataset to generate high-quality *skilled forgeries*. These signatures are later added to the original dataset where Writer-independent (WI) and Writer-dependent classifiers (WD) are employed to discriminate between genuine signatures and forgeries. All the code will be developed using the PyTorch deep learning framework [11].

Database

The proposed method is evaluated using a publicly available off-line signature dataset, named GPDS-300. The GPDS-300 corpus [10] was developed by the Grupo de Procesado Digital de Señales, it contains 300 writers divided by 24 genuine and 30 forged signatures. In this experiment, this dataset will be used to train and evaluate the performance of the technique.

Performance

Some of the well-known classifiers from the state-orf-the-art performance on the GPDS Dataset will be evaluated using the data augmentation proposed technique according to the reference metrics from the literature. False Rejection Rate (FRR) – the percentage of rejected genuine signatures, False Acceptance Rate (FAR) – the percentage of accepted skilled forgeries, Error Rate (AER) – the average error considering only FRR and FAR [1].

Schedule

	Semester															
Activity	August		September				October				November				December	
Literature Review																
Implementation																
Experiments																
Result Analysis																
Thesis writing																
Presentation																

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[10] GPDS dataset is available on: http://www.gpds.ulpgc.es/download/. Acessed September 9, 2018.

[11] PyTorch framework is available on: https://pytorch.org/. Acessed September 9, 2018.

Possible Examiners

- Leandro Almeida – Centro de Informática, UFPE
- George Darmiton – Centro de Informática, UFPE

Signatures

Recife, 10 de Setembro de 2018

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