

Loss Function Optimization for CNN-Based Fingerprint Anti-Spoofing

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Abstract : As biometric systems become widely deployed, the security of identification systems can be easily attacked by various spoof materials. This paper contributes to finding a reliable and practical anti-spoofing method using Convolutional Neural Networks (CNNs) based on the types of loss functions and optimizers. The types of CNNs used in this paper include AlexNet, VGGNet, and ResNet. By using various loss functions including Cross-Entropy, Center Loss, Cosine Proximity, and Hinge Loss, and various loss optimizers which include Adam, SGD, RMSProp, Adadelta, Adagrad, and Nadam, we obtained significant performance changes. We realize that choosing the correct loss function for each model is crucial since different loss functions lead to different errors on the same evaluation. By using a subset of the Livdet 2017 database, we validate our approach to compare the generalization power. It is important to note that we use a subset of LiveDet and the database is the same across all training and testing for each model. This way, we can compare the performance, in terms of generalization, for the unseen data across all different models. The best CNN (AlexNet) with the appropriate loss function and optimizers result in more than 3% of performance gain over the other CNN models with the default loss function and optimizer. In addition to the highest generalization performance, this paper also contains the models with high accuracy associated with parameters and mean average error rates to find the model that consumes the least memory and computation time for training and testing. Although AlexNet has less complexity over other CNN models, it is proven to be very efficient. For practical anti-spoofing systems, the deployed version should use a small amount of memory and should run very fast with high anti-spoofing performance. For our deployed version on smartphones, additional processing steps, such as quantization and pruning algorithms, have been applied in our final model.

Keywords : anti-spoofing, CNN, fingerprint recognition, loss function, optimizer

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