AI in Business/FinTech (Applied-Research Collaboration Project with Joint-Research Paper Publication)
Using Three-Layer Detector for Seal Recognition and Verification

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(https://dslab.saas.hku.hk/cgi-bin/application1.cgi/)

In order to recognise and verify the company seal, PwC collaborated with the HKU SAAS Data Science Lab to develop a novel three-layer detector using AI to locate the seal in the scanned document, to estimate the distortion of the seal, and to classify the seal of the company. The challenges of this project include how to detect the boundary box of the seal in the scanned document, use the color and intensity levels of the seal to estimate the distortion of the seal for real or fake seal verification, and to differentiate the seal of the company with the other seals with similar shape and pattern. The limitations of the existing statistical and AI methods are its low accuracy rate in noisy background filtering for seal detection, the lack of algorithm for ink deterioration and intensity measurement and classification of objects with similar shapes, and overfitting problem of the classification models.

The HKU SAAS Data Science Lab developed a novel three-layer detector with Pseudo-Siamese Network with LSTM model, Quadruplet Network with ResNet50 and a modified loss function for seal recognition and verification (see Figure 1). It used a novel clustered Efficientdet with EfficientNetb3 feature extractor for seal detection with 98.5% precision and 99.0% recall. Our model outperforms the existing methods as the best results in existing research are 92.7% (D-StaR), MAP (92.7%), and MAR (84.2%).

"It is delighted to collaborate with HKU SAAS Data Science Lab as a community of solvers coming together to deliver outcomes while building trust across the value chain. The three-layer detector is how ingenuity combines with new technology innovation and experiences. It can be deployed to other business applications such as identity verification, fraud document detection, etc," said Mr Leo Hsu, Digital Trust & Analytic Partner of PwC Mainland China & Hong Kong.

To determine the real or fake seal, we simulated a set of images with seal distortion (see Figure 2). We used the Pseudo-Siamese Network with LSTM model, that no research study uses this method before, for seal intensity measurement with accuracy rate 92.1% to estimate the distortion of the seal. We implemented a time-series model of the seal distortion as one of the features to determine the real or fake of the seal.

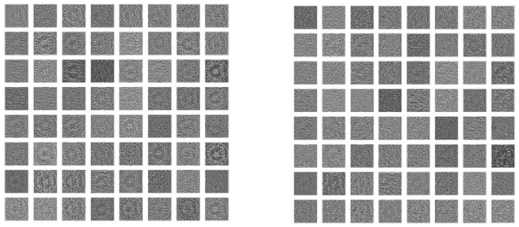

Figure 2 The first 64 filter results of original circular seal passed through the 20th convolution layer of ResNet (Left) and the first 64 filter results of simulated circular seal passed through the 20th convolution layer of ResNet (Right) using Pseudo-Siamese Network with LSTM.

Finally, we developed a novel Quadruplet Network with ResNet50 and a modified loss function for seal classification with 98.6% accuracy rate. Our model outperforms the current research work as the best results in tackling object detection in previous research is 95.46% (CSRS)..

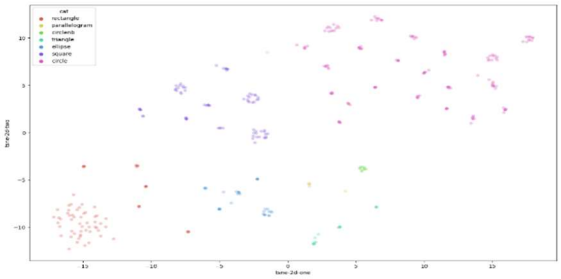

Figure 3 Quadruplet Network with ResNet50 and modified loss function and sampling ($m = 0.6$, $n = 0.3$, $a = 0.8$, $b = 0.4$, $g = 0.01$)

"It is excited for Data Science Lab to collaborate with PwC Mainland China and Hong Kong to apply our innovation to a real business problem. We engage to work with industrial partners on applied research collaboration," said Dr Adela Lau, Deputy Director of HKU SAAS Data Science Lab.

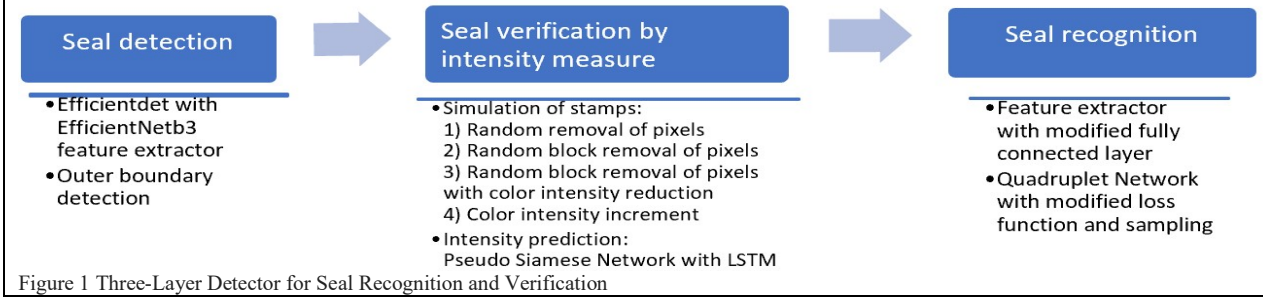

Figure 1 Three-Layer Detector for Seal Recognition and Verification