**背景**

生理特征技术是根据用户提供生理或行为特征进行识别或验证用户身份的技术，其中HSV是该技术的一种具体应用。HSV分为online和offline，offline只需要根据签名图像进行用户身份验证，而online是在offline的基础上增加数字化设备收集的笔尖压力、倾斜度等几何特征，根据图像特征和几何特征共同验证用户身份。这种技术通常用于身份验证和金融交易等安全领域。例如银行取钱时需要签名。

Biometrcis technology is a technology that identifies or verifies the identity of a user based on the physiological or behavioral characteristics provided by the user, of which HSV is a specific application of this technology. HSV is divided into online and offline. Offline authentication only requires the user to authenticate the identity based on the signature image, while online authentication adds geometric features such as pen tip pressure and tilt collected by digital devices to the offline method, and verifies the user's identity based on both image features and geometric features. This technology is usually used in security fields such as identity authentication and financial transactions. For example, a signature is required when withdrawing money from a bank.

While collecting signature images through digital devices, geometric features such as pen tip pressure and tilt are collected

通过数字化设备收集签名图像的同时，采集笔尖压力、倾斜度等几何特征

**重要性和意义**

离线签名验证实际上是图像二分类任务的衍生，模型要求能够输入一对数据样本，根据提取的特征进行对比判断query签名是否为伪造的。因此对离线签名验证的研究，一方面能够不断优化和改进模型性能，另一方面能够将优化和改进的思路传播给相关的验证方向。采取深度学习模型也是为了能够在实际的应用生产中保持高精准度和高泛化能力的性能，不用人工过多干涉进行各种前处理和后处理。

Offline signature verification is actually a derivative of the image binary classification task. The model requires the input of a pair of data samples and compares the extracted features to determine whether the query signature is forged. Therefore, the research on offline signature verification can continuously optimize and improve the model performance on the one hand, and spread the optimization and improvement ideas to related verification directions on the other hand. The deep learning model is also adopted to maintain high accuracy and high generalization performance in actual application production without excessive human intervention in various pre-processing and post-processing.

**相关工作**

人工特征工程 Manual feature engineering

欧几里得距离 Euclidean distance

注意力机制 Attention Mechanism

**Methodology**

孪生网络 Siamese Network

水平方向 Horizontal direction

垂直方向 Vertical direction

放大倍率 Magnification

自相关性Autocorrelation

缩放因子 Scaling Factor

双边界 Double Margin

真伪签名的差异往往存在于细微的局部区域，传统方法可能因注意力分布过于分散或自然稀疏性不足，而无法有效捕捉这些关键区域。

The difference between genuine and forged signatures often exists in subtle local areas, Traditional methods may fail to effectively capture these key regions due to their overly dispersed attention distribution or insufficient natural sparsity.

增强稀疏性 Enhanced sparsity

**Experiments**

在OSV中更关注伪造签名的识别情况，因此除了accuracy还使用了Biometrcis technology的相关评价指标：FRR、FAR、EER。FRR和FAR越低，说明模型分别对真实签名的拒绝率，对伪造签名的接受率更严格，EER和F1-score类似，综合评价模型对于签名伪造性的性能。

OSV focuses more on the recognition of forged signatures, so in addition to accuracy, we also use the relevant evaluation indicators of Biometrics technology: FRR, FAR, and EER. The lower the FRR and FAR, the stricter the model's rejection rate for real signatures and acceptance rate for forged signatures, respectively. EER is similar to F1-score, which comprehensively evaluates the model's performance in signature forgery.

Improved 提升

Reduced 降低

阶段性下降 Phase-wise decrease

训练收敛 Training convergence

**Conclusion**

多尺度特征对于跨数据集的OSV来说，能够更好的使模型理解不同尺度的签名图像，即具有更优秀的泛化能力。在相同的实验环境下，OSVTF的伪造签名判别准确率比TransOSV要高于17%，与HTCSigNet相比差了不少。

For OSV across datasets, multi-scale features can better enable the model to understand signature images of different scales, that is, it has better generalization ability. Under the same experimental environment, the accuracy of OSVTF in identifying forged signatures is 17% higher than that of TransOSV, but much lower than that of HTCSigNet.

**Further Work**

当前实验阶段下，并没能完全释放出OSVTF的性能，backbone方面采取的是最低级的ResNet-18。因此OSVTF的最小规格模型已经能够超越TransOSV，在后续的工作中应当在能够满足base规格的情况下进行实验。并且Transformer的注意力机制计算是在1D维度上的运算，后面工作应当优化成不需要flatten操作的2D注意力机制计算。在实验环节中，对伪造签名的细小敏感部位没能做到进一步的优化，在后续工作中应该加入对伪造签名部分敏感特征的加强操作，是的模型能够更注意一些细小的伪造文字部分。

In the current experimental stage, the performance of OSVTF has not been fully released, and the backbone adopts the lowest level ResNet-18. Therefore, the minimum specification model of OSVTF has been able to surpass TransOSV. In subsequent work, experiments should be conducted while meeting the base specifications. In addition, the attention mechanism calculation of Transformer is an operation on the 1D dimension. In subsequent work, it should be optimized to a 2D attention mechanism calculation that does not require a flatten operation. In the experimental stage, the small sensitive parts of the forged signature were not further optimized. In subsequent work, the enhanced operation of the sensitive features of the forged signature part should be added to enable the model to pay more attention to some small forged text parts.