Facial Marks: detection and fusion with FRS

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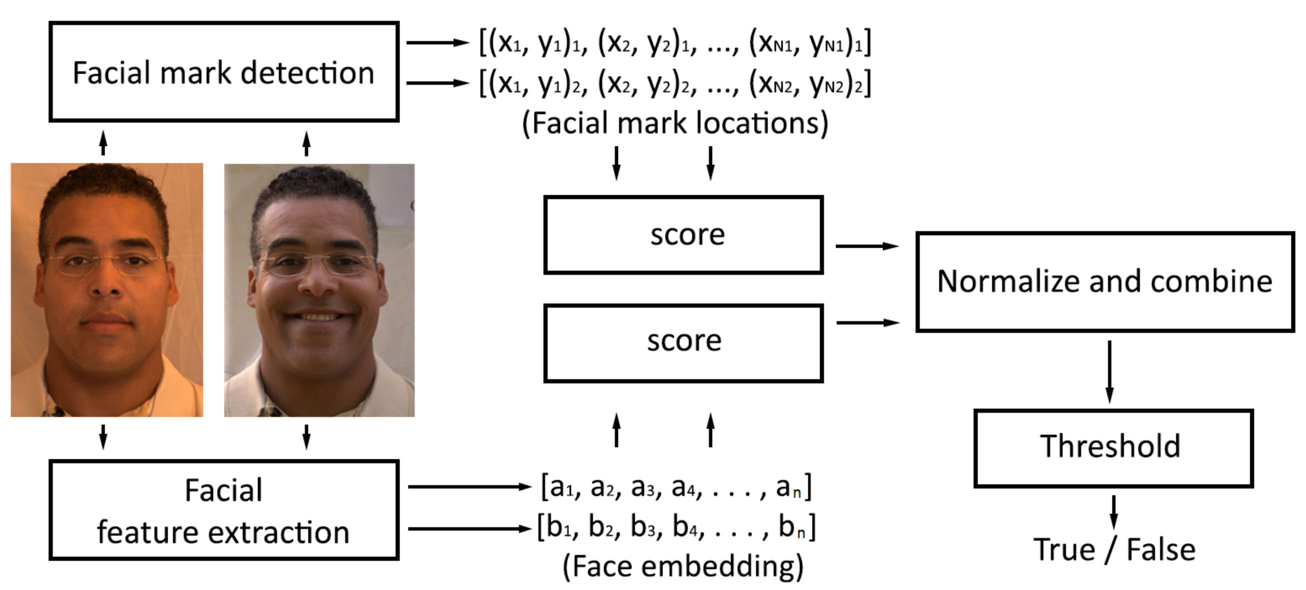
Introduction

- Facial marks include moles, scars and freckles and can potentially be highly discriminating [Sr12].
- This work studies recognition, detection and biometric performance of facial marks for recognition, standalone and combined with face recognition system (FRS).
- Facial mark recognition (FMR): whether a skin patch from a facial image contains a facial mark. Facial mark detection (FMD): localization facial marks within a face using FMR.



Research questions

- RQ1: FMR: influence factors on performance?
- RQ2: FMD: use sliding window or deep learning?
- RQ3: Face recognition performance using only facial marks?
- RQ4: Face recognition performance using fusion facial marks and FRS?

Experimental setup

- Datasets: FRGC non-twins (manually annotated facial mark location in [ZVS17] based on [FR]), set of twins [Ph11]: (non-mated comparisons within twins and between twins: Twins), and another set of twins (non-mated comparisons only between twins: Twins Diff).
- Two FMD methods: iterative sliding window and EfficientDet [TPL]. Trained on FRGC, evaluation on all datasets.

Experimental setup

- Two (overlap (p is number of overlapping points, $N = N_1 + N_2$ total number of facial marks) and point cloud ($\mathbf{p}_{i,j} \in P_j$) averaged negative distance between point clouds)) score functions.

$$s_o(P_1, P_2) = \begin{cases} 1 \text{ for } N = 0 \\ \frac{2p}{N} \text{ for } N > 0 \end{cases}, \quad (1)$$

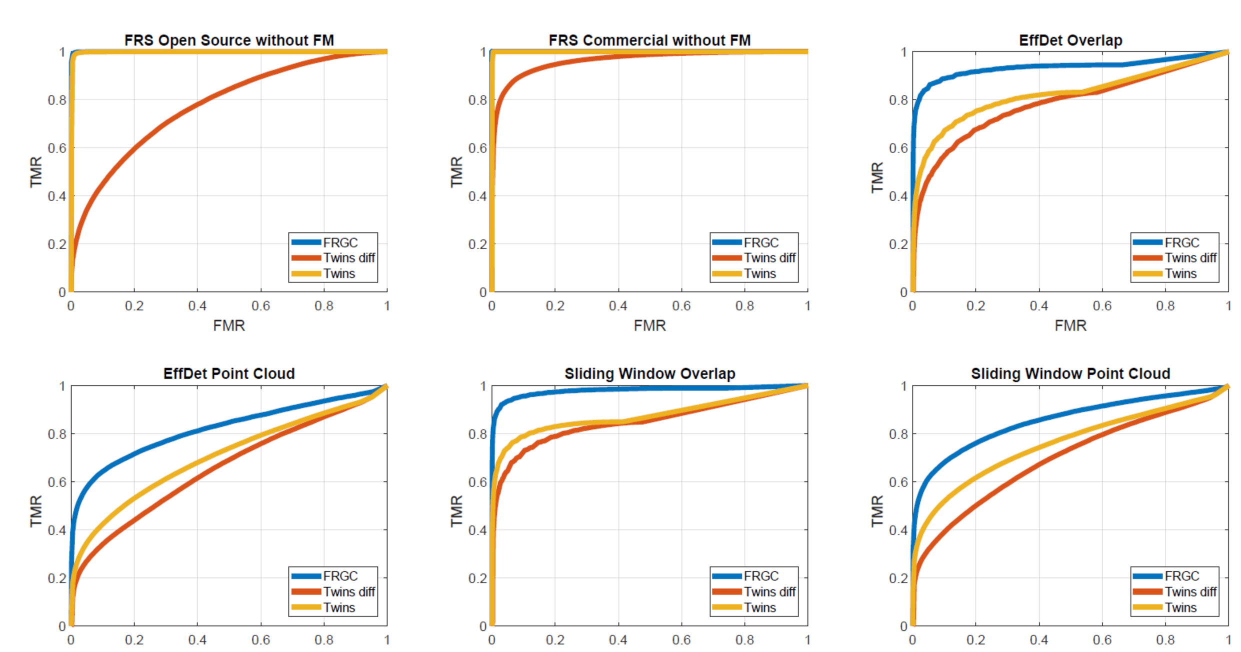
$$s_{pc}(P_1, P_2) = -\frac{1}{N_1}\sum_{i=1}^{N_1} d(\mathbf{p}_{i,1}, P_2) - \frac{1}{N_2}\sum_{i=1}^{N_2} d(\mathbf{p}_{i,2}, P_1). \quad (2)$$

- Adaptive z-score normalization and fusion:

$$Z = \frac{S - \hat{\mu}}{\hat{\sigma}}, \; S_{c,\alpha} = Z_{FMD} \pm \alpha \cdot Z_{FRS} \quad (3)$$

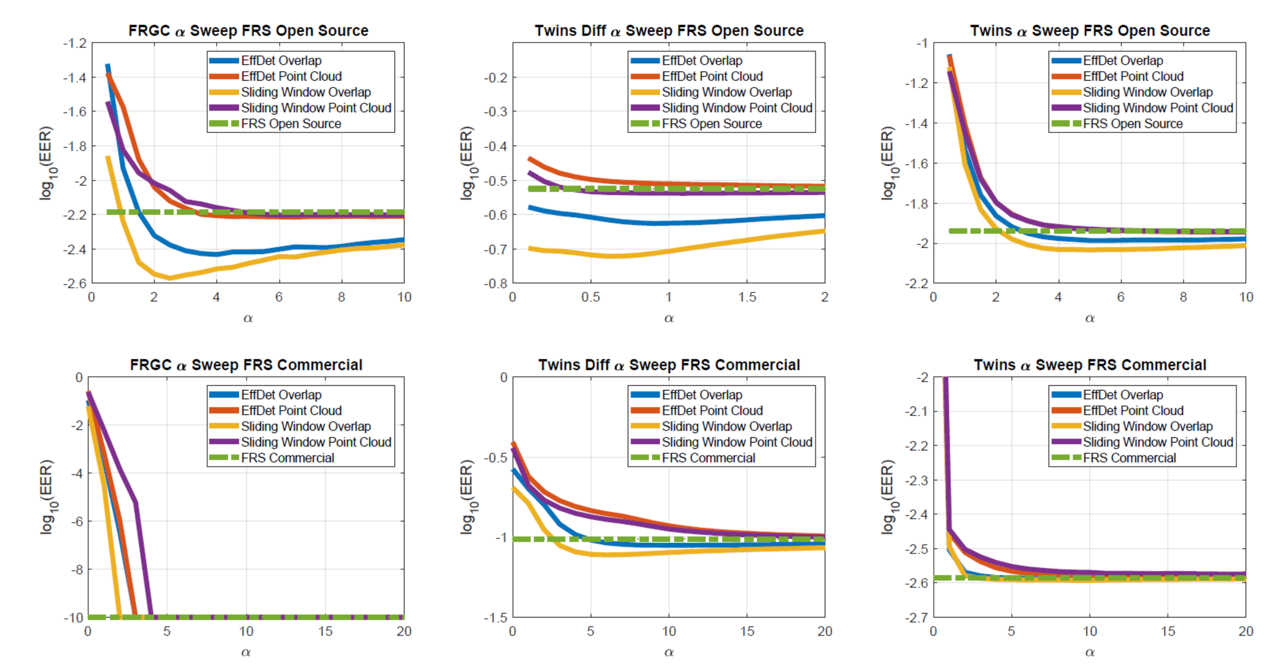
Results

- RQ1: FMR using modern CNN architectures attains state-of-the-art accuracy, larger patch size and transfer learning can have positive effect, using off-center facial mark patches has a negative effect.
- RQ2: Comparable results, timing $0.51 \pm 0.25\mu s$ (Sliding window) versus $0.046 \pm 0.072\mu s$ (EfficientDet).
- RQ3: Hierarchical sliding window technique outperforms every corresponding EfficientDet implementation, s_o is significantly better than s_{pc}, clear difference between open source and commercial FRS, in Twin Diff case two facial mark location based systems perform better than open source FRS.



Results

- RQ4: Open source FRS benefits from up to 59% EER reduction, commercial FRS achieves 20% reduction of the EER.



Conclusion

- FMR: deep learning detection models outperform custom models, patch size positive, off-center negative, transfer learning positive influence on EER.
- FMD works well visually, differences in db's and methods.
- Sliding window/overlap score best combination for FM based FRS.
- Fusion FRS: open source FRS (up to 59%)/commercial FRS (up to 20%) EER reduction, increases explainability of the fused results.

References

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