
Bachelor/Master theses Advisor: Univ.-Prof. Dr. Andreas Uhl***(1) Effects of using synthetic PAI data in fingerprint presentation attack detection***

Presentation attack detection (PAD), in which a fingerprint biometric system is trained to detect attempts to fool the sensor with an artefact generated particularly for this purpose (e.g. gummi fingers, silicone fingers, etc.), require a large number of such presentation attack instrument (PAI) samples to train corresponding PAD classifiers. The production of these PAI samples is hard (manual) work, so it is natural that the production of synthetic PAI samples is an attractive option. While this seems to be an excellent idea at first sight, it has been shown for vascular biometric datasets, that the usage of such training data can lead to disastrous results. Here, this effect (and eventual countermeasures) is/are evaluated for fingerprint data.

Additional Information: Some synthetic fingerprint PAI sample datasets are available. Also real datasets containing PAI sample data taken by different sensors are available, so additional synthetic data can and should be generated.

Recent publications on related topics done by the group:

* Andreas Vorderleitner, Jutta Hämmerle-Uhl, Andreas Uhl. Hand Vein Spoof GANs: Pitfalls in the Assessment of Synthetic Presentation Attack Artefacts. In Proceedings of the 2023 ACM Workshop on Information Hiding and Multimedia Security, pp. 133–138, New York, NY, USA, IH&MMSec '23, Association for Computing Machinery, 2023.
Open Access: <https://dl.acm.org/doi/10.1145/3577163.3595107>

* Michael Hafner, Aleksandar Radovic, Moritz Langer, Stefan Findenig, Andreas Vorderleitner and Andreas Uhl. Difficulties in using Synthetic Data for Presentation Attack Detection in Fingervein Recognition: The Role of Model Fingerprints. International IEEE/IAPR Joint Conference on Biometrics (IJCB 2024), Buffalo, NY, USA, September 2024.

(2) Analysis of vascular data captured during twin meetings

Biometric (non-) similarity of twins is an interesting issue and besides security, results touch important questions in physiology, i.e. what driving forces are behind the development of certain features used in biometric recognition, with emphasis on genetic pre-disposition or environmental influences. There is some work on various biometric technologies applied to twins, but only a single (low-quality and somewhat unclear) paper on vascular data collected from twins. We have collected finger- and hand-vein data from more than 40 twin pairs, which should be analysed with respect to differences to the “normal” population, using vascular biometric technology.

Additional Information: We will provide corresponding datasets including meta-data and a Matlab Toolbox containing model-based recognition schemes. As in-house sensors are used for capturing, RoI detection techniques applied to earlier dataset should be applicable and can be used. Learning-based recognition techniques should be developed according to the state-of-the-art.

Recent publications on related topics done by the group:

* Luca Debiasi, Christof Kauba, Bernhard Prommegger, Andreas Uhl. Near-Infrared Illumination Add-On for Mobile Hand-Vein Acquisition. In *2018 IEEE 9th International Conference on Biometrics Theory, Applications and Systems (BTAS)*, pp. 1-9, Los Angeles, California, USA, October 22 - October 25, 2018.

* Christof Kauba, Bernhard Prommegger, Andreas Uhl. Focussing the Beam - A New Laser Illumination Based Data Set Providing Insights to Finger-Vein Recognition. In *2018 IEEE 9th International Conference on Biometrics Theory, Applications and Systems (BTAS)*, pp. 1-9, Los Angeles, California, USA, October 22 - October 25, 2018.

(3) Biometric recognition using contact-less, wide-band imagery of the palmar side of the hand

Hand-based biometric recognition comes in various flavours, uses distinct parts of the hand. On the palmar side, we have fingerprint, finger-knuckle, and palmprint recognition if we resort to classical visible range imaging. We have acquired a small dataset of hand imagery, captured with high resolution visible range + near infrared (NIR) imaging, under NIR and natural light illumination. The aim is to develop a recognition system, that uses the different biometric traits of the hand according to their biometric quality observed in the actual capture, e.g. fingerprints of middle and ring finger, finger knuckle of middle finger, and palm. A further challenge is the differing imaging domain as compared to available public data sets as well as to enrollment data, which complicates training on public data as well as authentication.

Additional Information: Datasets with metadata for targeted analysis will be provided; fingerprint recognition software is available; recognition schemes for finger knuckles and palmprints need to be developed / taken from literature. Also, quality metric need to be developed.

Recent publications on related topics done by the group:

* Multi-Sample Compression of Fingerprints: Can it be Done? Kevin Schörgenhofer, Andreas Unterweger, Andreas Uhl. In *Proceedings of the 14th International Workshop on Biometrics and Forensics (IWBF'26)*, pp. 1-6, Côte d'Azur, France, 2026.

* Extension and further Evaluation of the PLUS Multi-Sensor and Longitudinal Fingerprint Dataset. Christof Kauba, Simon Kirchgasser, Andreas Uhl. In *Proceedings of the 12th International Workshop on Biometrics and Forensics (IWBF'24)*, pp. 1-6, Enschede, Netherlands, April 11 - April 12, 2024

(4) Ear recognition on the Move

Ear recognition is a niche biometric modality. However, it has proven to be useful in certain settings, of course in particular if a lateral view of subjects is being recorded. The aim of this thesis is two-fold: First, to investigate on publicly available datasets which percentage of people can be subject to ear recognition (and under which circumstances), and second, to identify and apply techniques suited to authenticate people passing by a static sensor which is approximately mounted orthogonal to the walking direction.

Additional Information: there is no previous work done locally, also no datasets are available. An important part of the thesis is to retrieve corresponding datasets, eventually capture custom datasets locally, and establish a state-of-the art collection of software for ear detection and recognition.

(5) Understanding Imaging in Vascular Biometrics

The classical way to image human blood vessels for vascular recognition is to apply near-infrared (NIR) illumination and to capture NIR sample data. Various commercial sensor producers have claimed (i) high relevance of NIR light polarisation and (ii) to be able to extract vascular information from white-light colour band differences, respectively. In this thesis, corresponding experiments and evaluations wrt. recognition accuracy have to be conducted in comparison to classical imaging techniques for this data.

Additional Information: We will provide NIR cameras and polarisation filters and will acquire additional optical hardware if required during the thesis.

Publications on related topics done by the group:

* Effect of polarization filters on hand vein sample image quality. Christof Kauba, Andreas Uhl. In *Proceedings of the Austrian Symposium on AI, Robotics, and Vision 3(1)*, pp. 112-116, Technical University of Vienna, 2026

* Christof Kauba, Bernhard Prommegger, Andreas Uhl. Focussing the Beam - A New Laser Illumination Based Data Set Providing Insights to Finger-Vein Recognition. In *2018 IEEE 9th International Conference on Biometrics Theory, Applications and Systems (BTAS)*, pp. 1-9, Los Angeles, California, USA, October 22 - October 25, 2018.

(6) Synthesis of NIR Iris / Vascular Biometric Samples from RGB Imagery

Iris and vascular biometrics rely on near-infrared (NIR) illumination and data acquisition. NIR cameras are often expensive or/and produce low quality imagery only. Therefore, it would be highly beneficial to be able to learn to generate / synthesize NIR data from RGB images, such that finally iris or vascular recognition can be done employing RGB data. The idea is to use pairs of NIR and RGB images (preferably in paired, i.e. aligned form) and train a system to generate a NIR image upon presentation of a RGB image. Techniques for paired data include the pix2pix network and more recent diffusion based schemes.

Additional Information: We will provide NIR and RGB cameras and software to test recognition on generated samples.

Publications on related topics done by the group:

* Georg Wimmer, Rudolf Schraml, Lukas Lammingner, Alexander Petutschnigg, Andreas Uhl. Cross-Modality Wood Log Tracing. In *Proceedings of the 23rd IEEE International Symposium on Multimedia (ISM 2021)*, pp. 191-195, 2021.

* Georg Wimmer, Michael Gadermayr, Andreas Vécsei, Andreas Uhl. Improving Endoscopic Decision Support Systems by Translating Between Imaging Modalities. In *Simulation and Synthesis in Medical Imaging (SASHIMI'20)*, pp. 131–141, Cham, Switzerland, LNCS, **12417**, Springer International Publishing, 2020.