GAN-based Finger Vein (FV) Image Augmentation for Biometric Authentication

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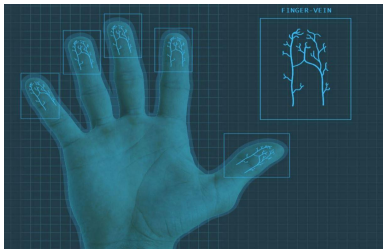
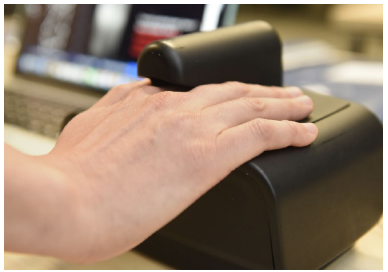
Presentation

- Global ID is a Swiss startup specialized in cyber-security through :
  - High level of security and confidentiality
  - Fighting against identity thief
  - Developing the technology : **Scanner for 3D Finger Vein (FV)**

- Advantages of FV biometrics [1]
  - ***Uniqueness*** of each person's FVs
  - ***Resistant*** to forgery and replication
    - FVs are inside the human body and invisible to human eyes
  - ***Untraceable*** in the future
    - Due to the absence of physical contact between customers and sensor devices.
  - ***End-to-end encryption (E2EE)***



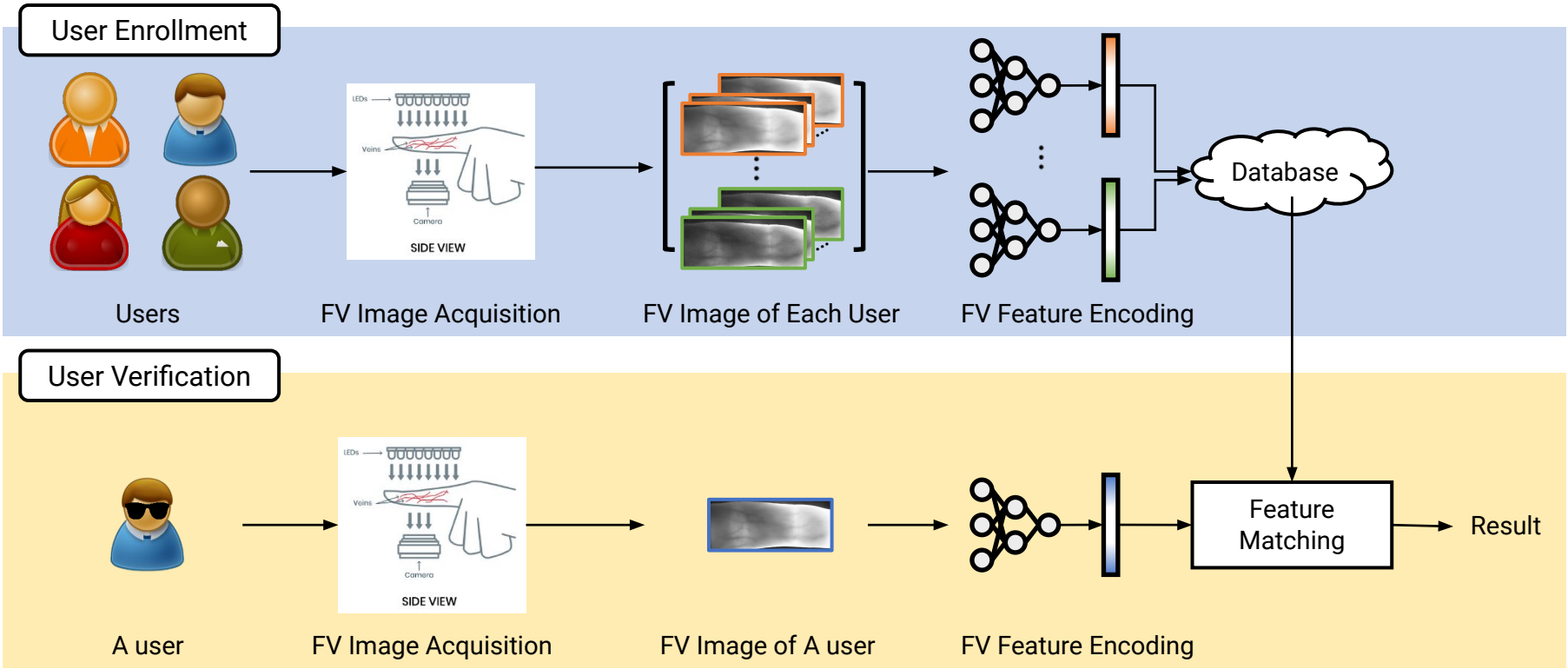
Finger vein (FV)
for biometric authentication system



3D FV scanner

[1] AH Mohsin et al., Finger vein biometrics: Taxonomy analysis, open challenges, future directions, and recommended solution for decentralised network architecture, IEEE Access 2020

FV-based Biometric Authentication System

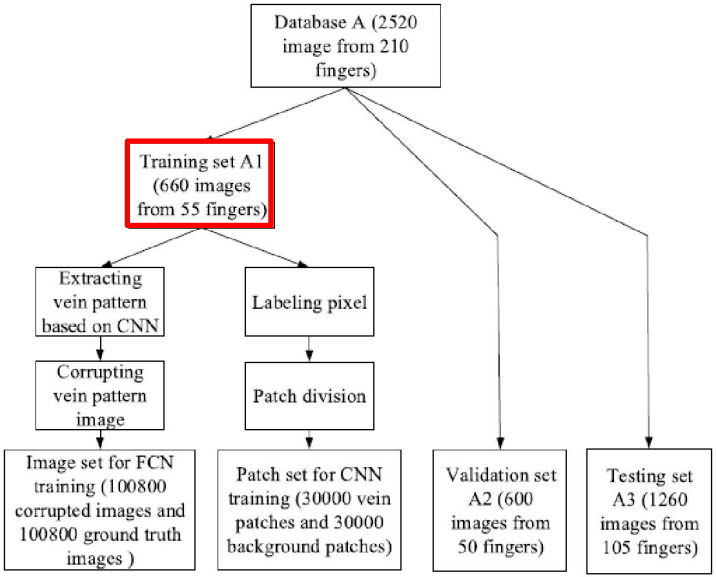


Problem & Motivation

- Importance of Diverse Training Dataset in DL for Biometric Authentication
  - Deep learning (DL) methods demonstrate state-of-the-art results for biometric authentication.
  - However, their performance and robustness ***depend upon the availability of a diverse training dataset to learn different users' attributes and capturing conditions*** such as shape and luminance characteristics.
- Difficulty of Large Scale Data Collection for Biometric Authentication
  - Large scale dataset collection for biometrics ***requires a variety of biometric patterns from each person in various conditions***, which is time consuming and labor intensive.
- The Necessity of Data Augmentation in FV Authentication
  - In the FV image acquisition, there are ***uncontrollable factors such as environmental illumination, light scattering, and different finger positions*** in imaging finger tissues, necessitating data augmentation.

Related Work

- DL-based FV authentication
  - There are several existing works for FV image feature representation based on DL [2, 3].
  - However, **their experiments were conducted with the limited number of FV images**.
- Data augmentation for FV authentication
  - A simple data augmentation such as pre-defined scale and translation was employed in [4, 5].
  - However, **there is no research on the data augmentation to improve FV authentication**.



Data petitioning and training data construction in [2]

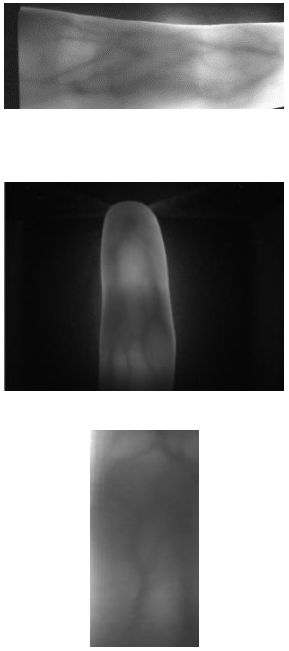
[2] H Qin and MA El-Yacoubi, Deep representation-based feature extraction and recovering for FV verification, IEEE TIFS 2017
[3] W Yang et al., FV-GAN: Finger vein representation using GANs, IEEE TIFS 2019
[4] KJ Noh et al., Finger-vein recognition based on densely connected CNN using score-level fusion with shape and texture images, IEEE Access 2020
[5] J Choi et al., Modified conditional GAN-based optical blur restoration for FV recognition, IEEE Access 2020

Contribution

- 1) Generation of a large number of finger veins images from a small starting dataset using Generative Adversarial Network (GAN)
- 2) Designing of a GAN-based FV image data augmentation considering the spatial variation and illumination variation in FV image acquisition
- 3) Integration of our algorithm in the startup pipeline in order to have consistent and effective information

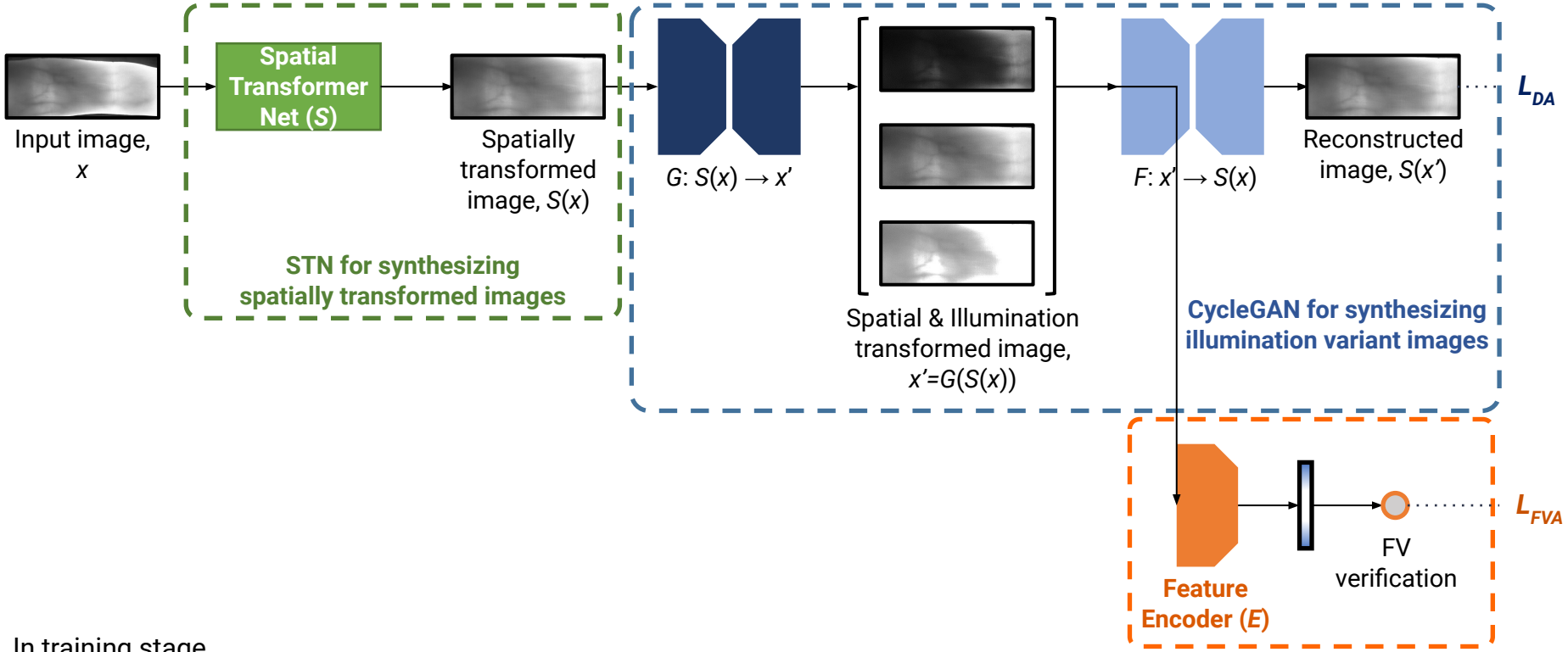
Public Databases Survey and Collection

- VERA Finger Vein Database for Finger Veins recognition
  - Produced by IDIAP Research Institute, used by the Global ID startup
  - Total of 440 images from 110 subjects (4 FV images for each subject)
- Finger Vein USM (FV-USM) Database
  - Produced by Universiti Sains Malaysia for FV recognition
  - 2 sessions, 123 subjects, 4 fingers and 6 pictures taken
  - Total of 5,904 images from 123 subjects (48 FV images for each subject)
- Tsinghua University Finger Vein and Finger Dorsal Texture Database (THU-FVFDT)
  - Produced by Tsinghua Univ. for FV representation and authentication
  - 3 database but only 1 of interest
  - Total of 1,220 images from 610 subjects (2 FV images for each subject)



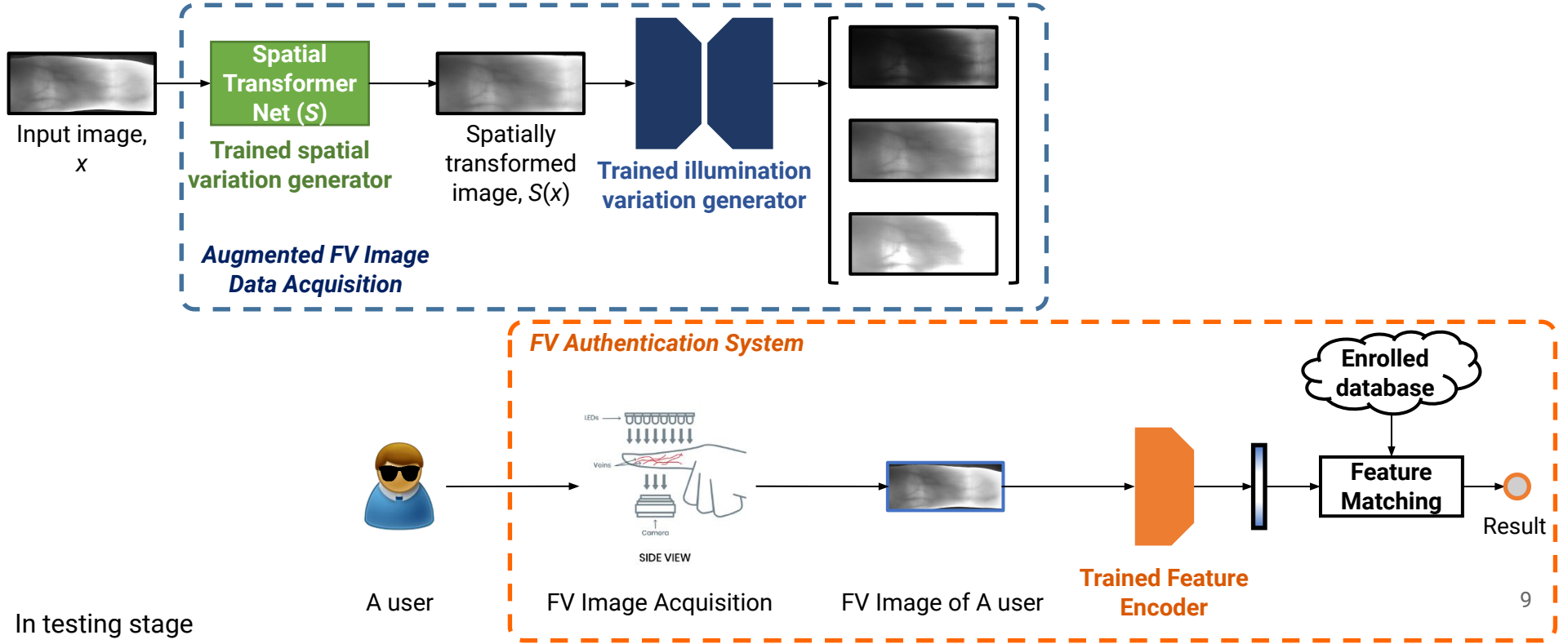
Examples of FV image in each database

Proposed FV Image Data Augmentation

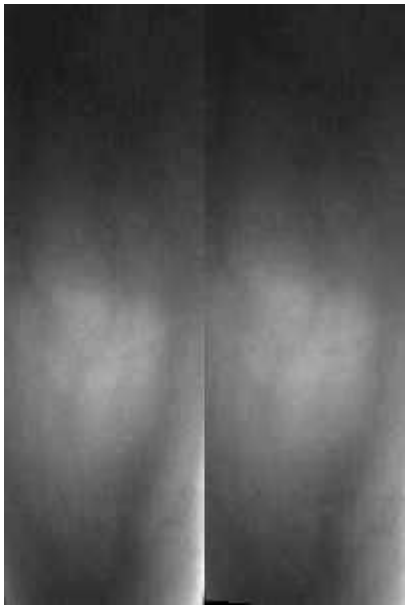


In training stage

Proposed FV Image Data Augmentation



Experiments: FV Images Augmented by STN

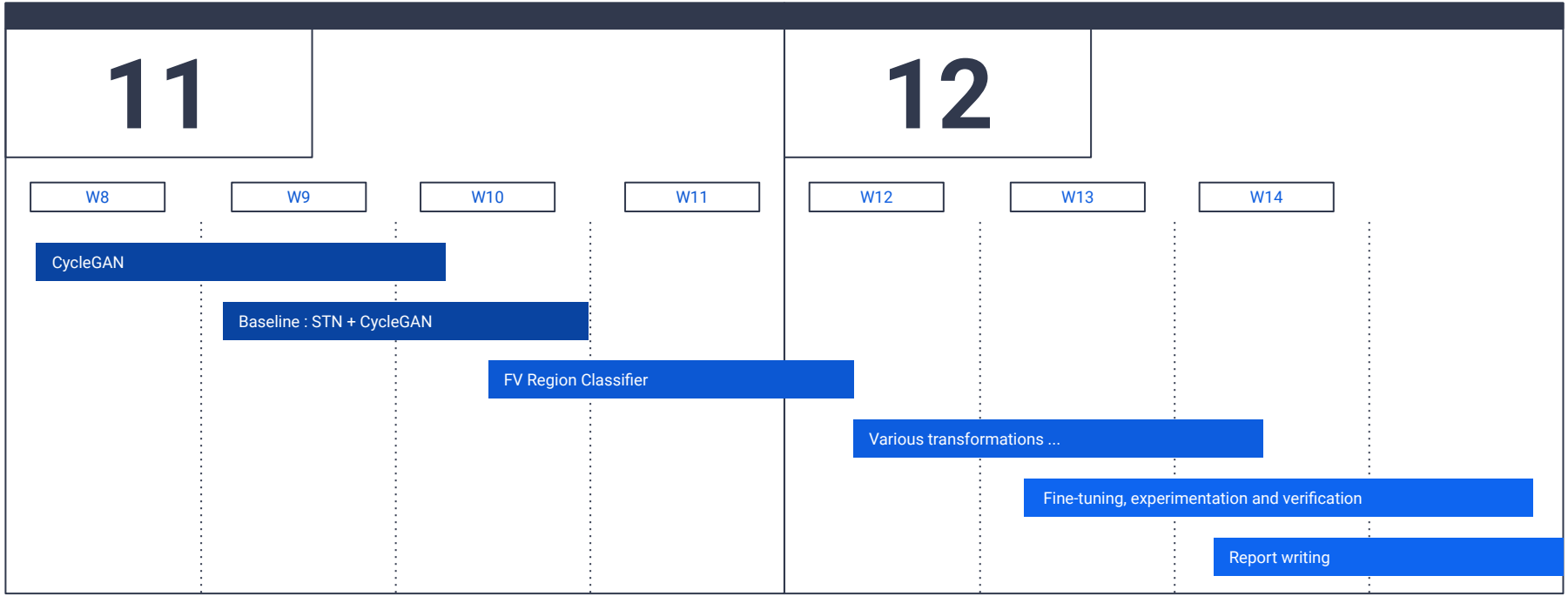


STN output on extracted FV image

STN output on raw data FV image

FV Classification when training network with :	
Only original images	Training acc : 1.0 Validation acc : 1.0 Testing acc : 0.788
Original images + STN output	Training acc : 1.0 Validation acc : 1.0 Testing acc : 0.867

Future Work


11
12
W8
W9
W10
W11
W12
W13
W14
CycleGAN
Baseline : STN + CycleGAN
FV Region Classifier
Various transformations ...
Fine-tuning, experimentation and verification
Report writing

Questions ?

Thank you !