Transverse Projects 2024-2025

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#1 LEADER IN IDENTITY TECHNOLOGIES

IDEMIA GROUP

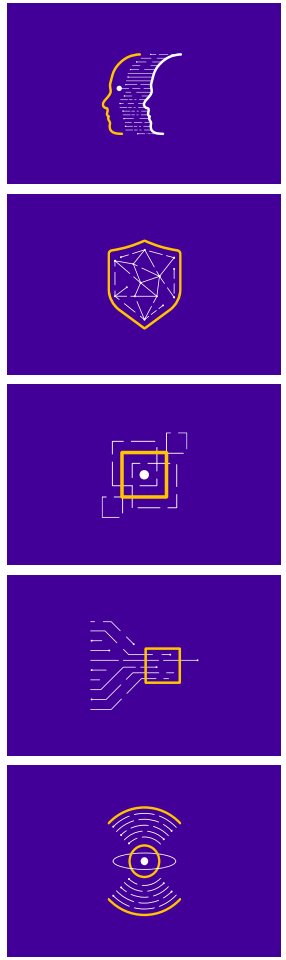
MARKETS

- PAYMENT
- CONNECTIVITY
- TRAVEL
- ACCESS CONTROL
- PUBLIC SECURITY
- IDENTITY

BUSINESS DIVISIONS

- IDEMIA SECURE TRANSACTIONS
- IDEMIA PUBLIC SECURITY
- IDEMIA SMART IDENTITY

TECHNOLOGIES



- BIOMETRICS
- CRYPTOGRAPHY
- SYSTEMS
- ANALYTICS
- SMART DEVICES

MAJOR PLAYER

1,500+
Active patent families in 84 countries

15,000
employees worldwide

€3b+
in revenue in 2023

CUSTOMERS

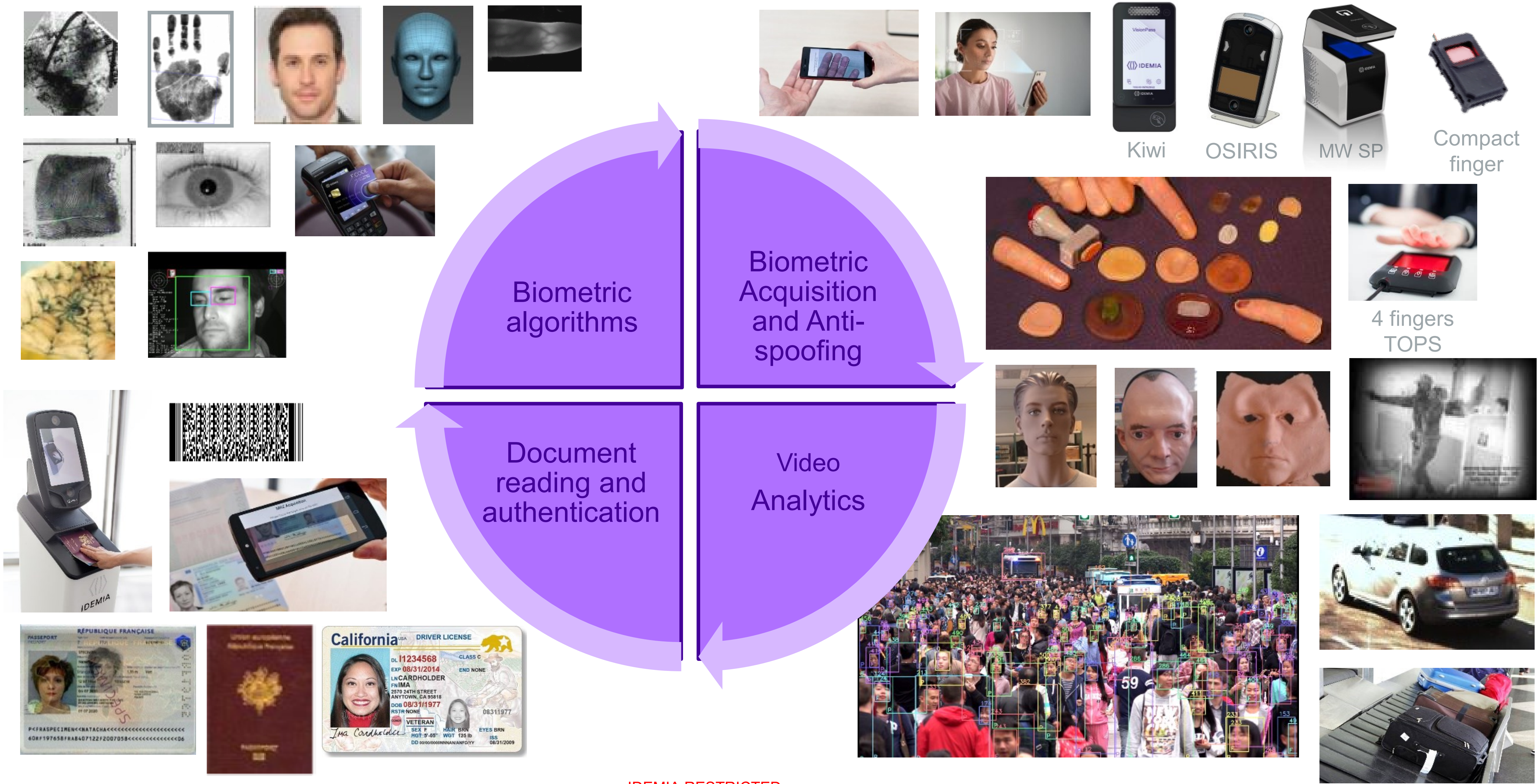
2,300+
companies

Microsoft · SOCIETE GENERALE · HSBC · vodafone · orange · CHANGI airport group

600+
governments, state & federal organizations

eu-LISA

Research & Technology / Data Science Units – Our challenges



Transverse Project 2024-2025

Project n°1
Diffusion models for fingerprint images

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FINGERPRINT IMAGE TRANSLATION

Different products to capture fingerprints

Standard contact sensor

Contactless sensor (Camera)

FINGERPRINT IMAGE TRANSLATION

Different products to capture fingerprints

Standard contact sensor

Contactless sensor (Camera)

Same recognition performances
Same biometric information

Faster to enroll
Lightweight device
More hygienic

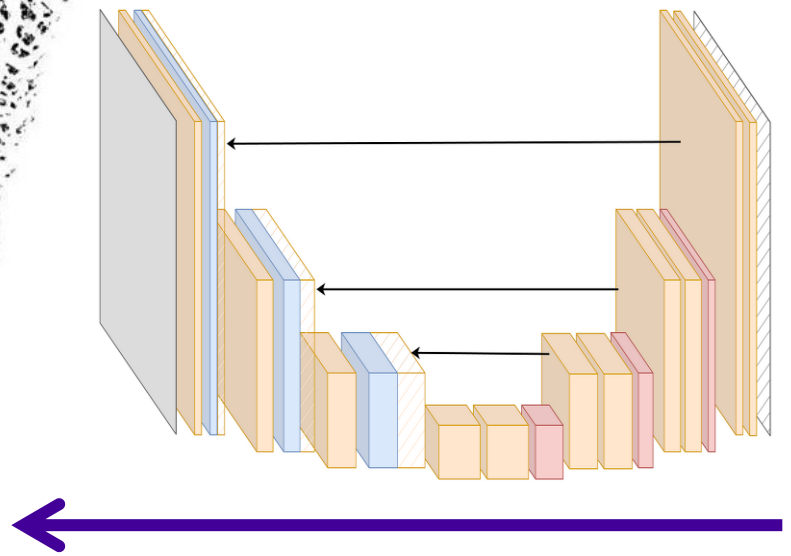
Visually better looking
from human perspective

FINGERPRINT IMAGE TRANSLATION

Project : Image Translation for the contactless sensor

Standard contact sensor

Image Translation
with CNN like UNet



Contactless sensor (Camera)

FINGERPRINT IMAGE TRANSLATION

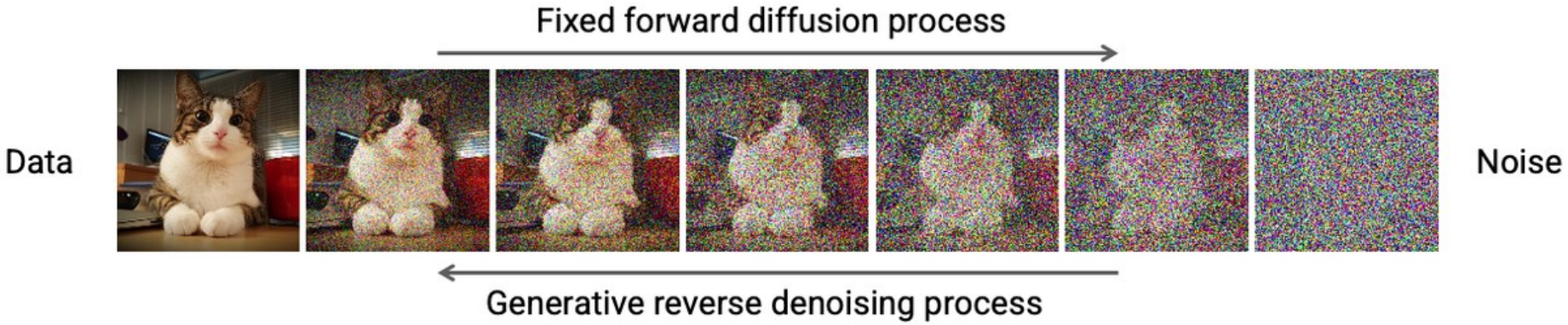
Goal :

CNN

With the **style** of

Approach : Diffusion Models

- State of the Art for image generation (Stable Diffusion, Dall-E, Midjourney…)
- Possible to condition the generative process (Conditional Denoiser) with contactless fingerprint



FINGERPRINT IMAGE TRANSLATION

Hypothesis : contact and contactless fingerprint are more similar in the Gaussian Noise space.

Train a Denoiser Network to reverse the noising process on contact fingerprints.

Infer the network on contactless noised fingerprint.

FINGERPRINT IMAGE TRANSLATION

Student will have the opportunity to design, implement and train a Diffusion Model for contactless fingerprint image translation towards the distribution of contact fingerprints.

This includes the following steps :

1) Review the litterature to understand Diffusion Models, in particular the Conditional ones
2) Get familiar with our experimental code (baseline for the project) and fingerprint dataset
3) Propose ideas : architecture, data augmentation, loss function, noising process…
4) Discuss the ideas with us and set the experiments roadmap

Concerns about Diffusion Models : don’t they need huge amount of data and GPU to train ?

This is the case for prompt based diffusion, but our problem is much simpler. Since we work with fingerprint data only, the model has to learn only one data distribution. Secondly, the denoiser is conditioned with a fingerprint image, which helps a lot in the denoising process. We did a Proof of Concept that worked after few hours of training on a single GPU.

Transverse Project 2024-2025

Project n°2
HR Morphed face images detection

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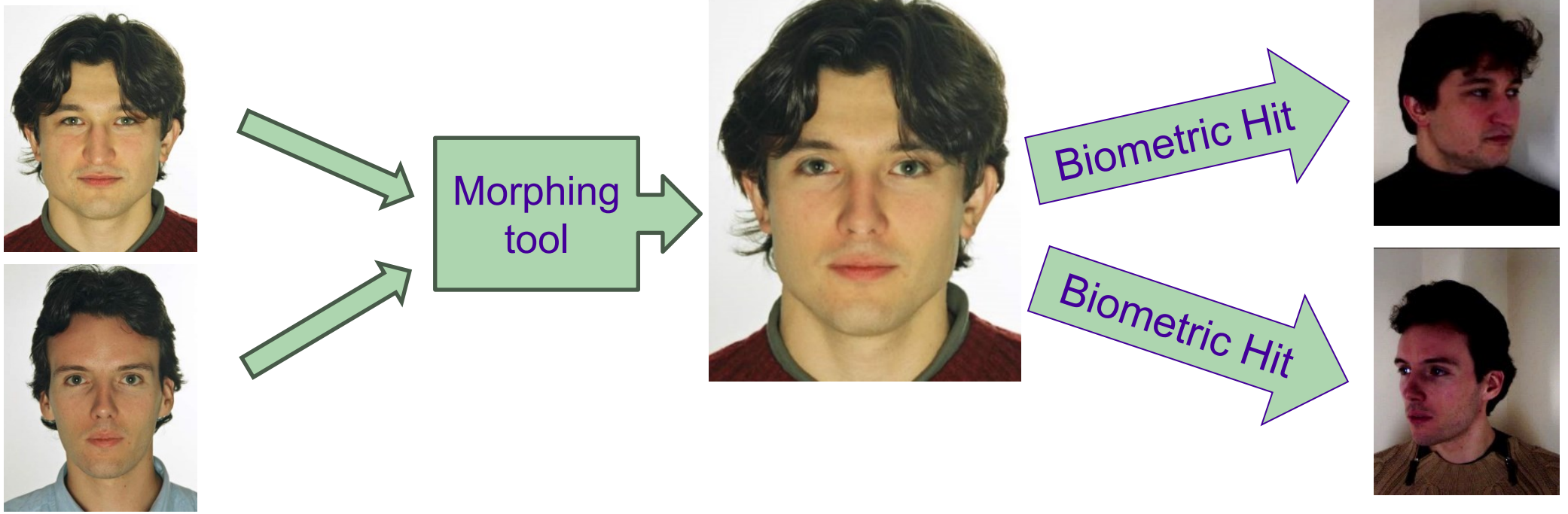
IDEMIA

AI brings new threats

Morphing : a synthetic merging of two real images and can be put in a biometric passport or ID-Document



Defense :

1/ Control Document Acquisition. Do not accept image from users.

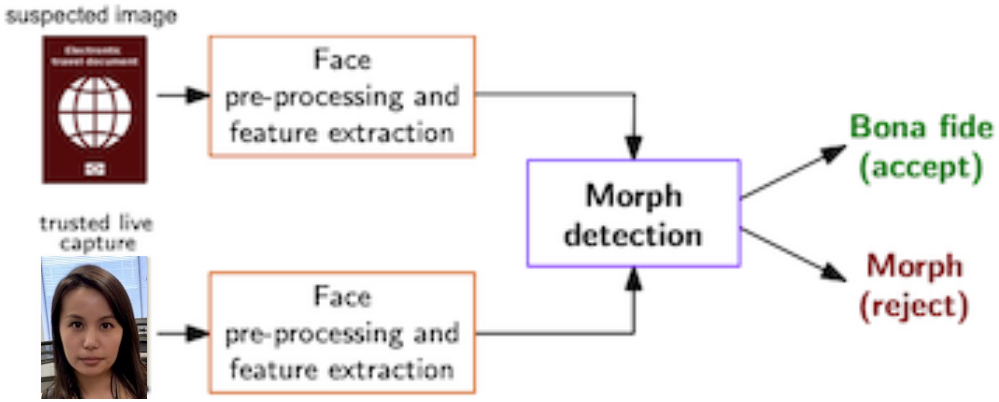
2/ Use a recent/accurate face recognition algorithm with a high threshold.

But the real solution is to have an accurate morphing detection algorithm.

S-MAD Vs. D-MAD

- Single image morphing attack detection (S-MAD)
  - One single *suspected* facial image is analysed (e.g. in the passport application)

- Differential morphing attack detection (D-MAD)
  - A pair of images is analysed - and one is a trusted Bona Fide image
  - Biometric verification (e.g. at the border)



NIST Morph-detection Benchmark

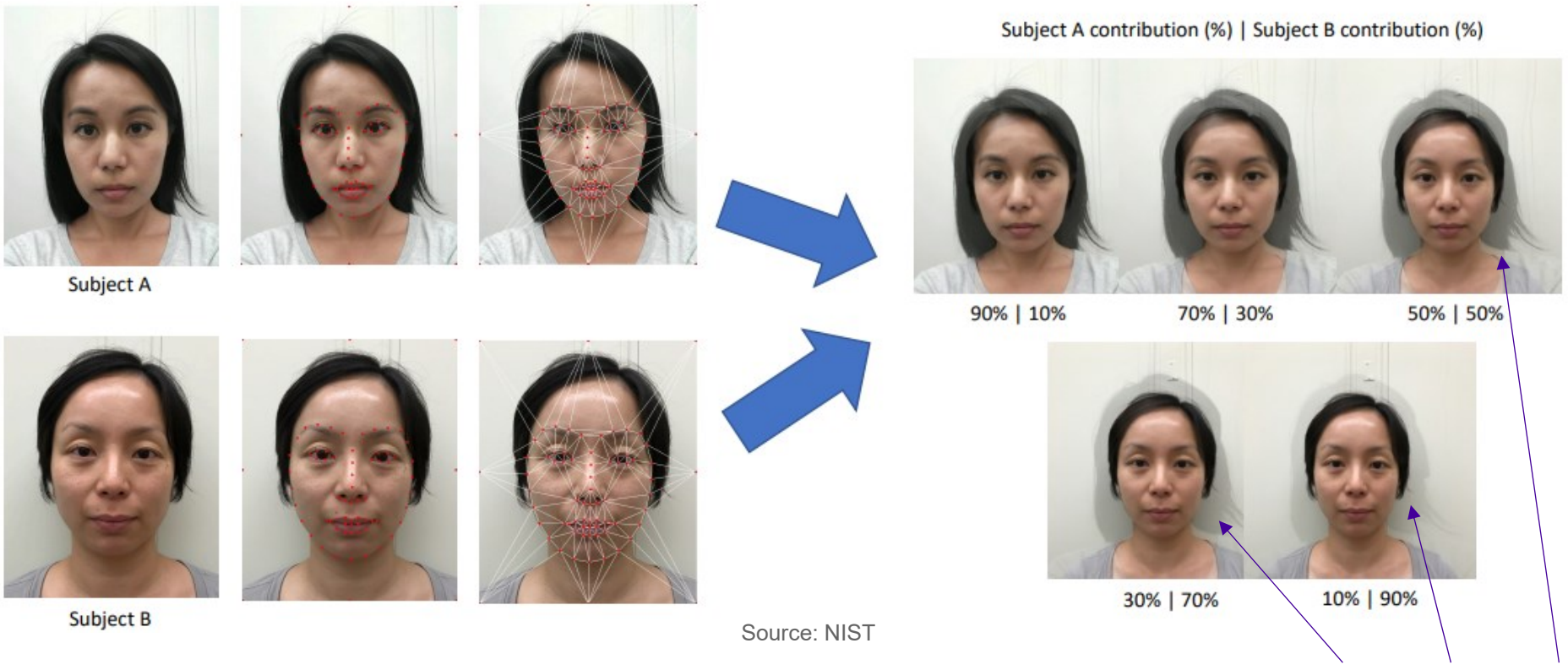
Background

2014 – “The Magic Passport” - Ferrara, Franco & Maltoni, IJCB (2014)
2018 – First real-world attacks noticed
2020 – NIST MORPH benchmark opens
2021 – Slovenian Police report having found at least 40 attacks

At IDEMIA:
2020 – Initial robustness analyses
2023 (March) – Initial detection experiments
2023 (Dec) – Start of work targeting NIST benchmark
2024 (Jan) – Submission of idemia-001 (D-MAD)
2024 (March) – Submission of idemia-002 (D-MAD)
2024 (May) – Submission of idemia-003 (D-MAD + S-MAD)

Morphed Image Generation

Global warping + texture-blending method



Source: NIST

Shown here is a “Global” morphing method which leaves behind obvious artefacts.

“Local” morphing methods merge the blended facial texture into one of the original images and so no problematic blending of hair or clothing is required. (Next slide)

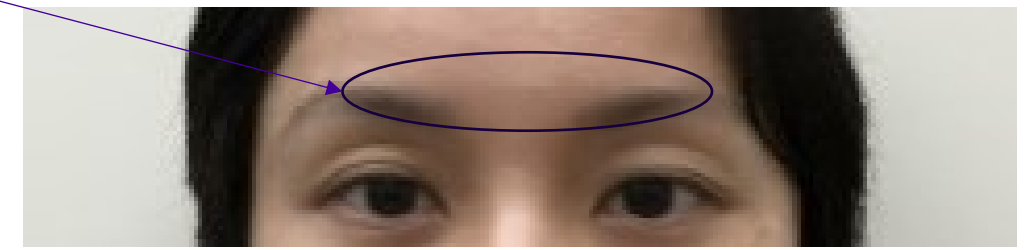
Morphed Image Generation

Some of NIST's "local" morph-generation methods

DST | Local Match | UNIBO v1 | UNIBO v2 | Twente

Merging and other editing / blending techniques visibly improve results.

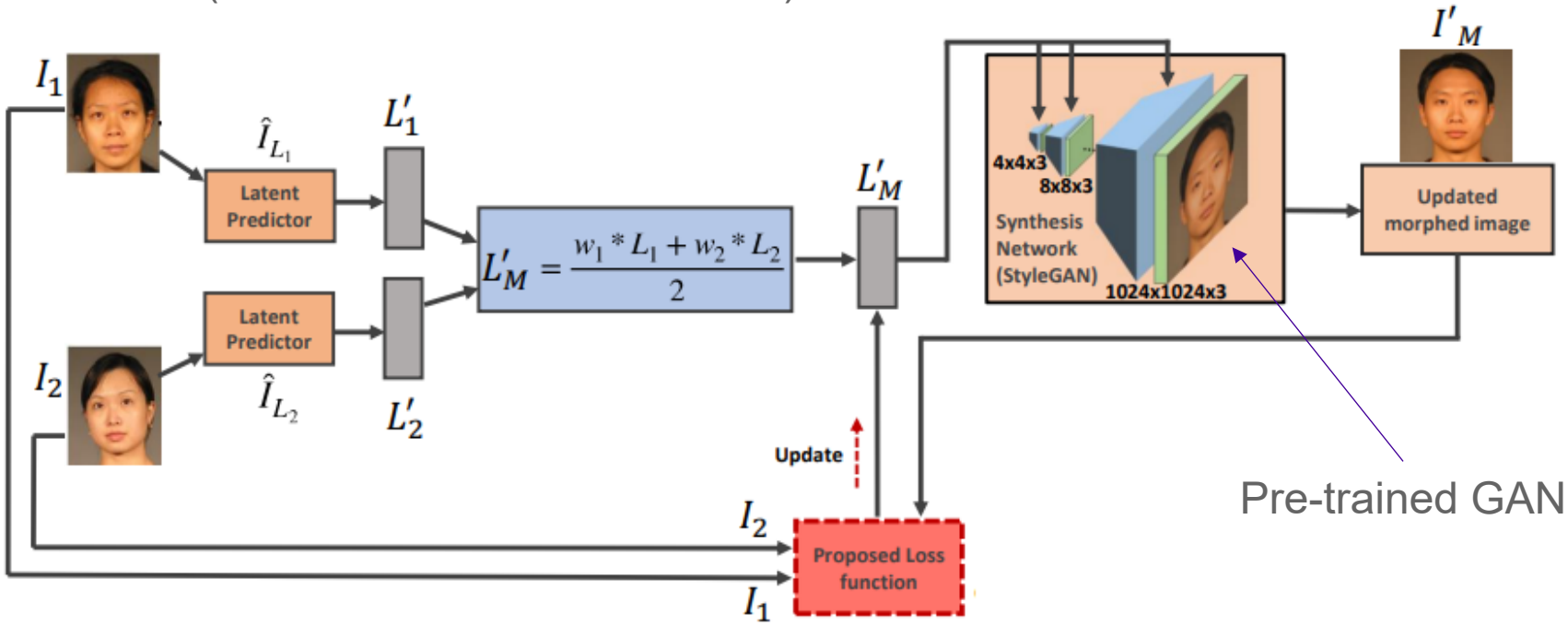
Note, however, that splicing introduces different kinds of detectible artefacts, e.g. sharp transitions between the inner and outer textures:



Morphed Image Generation

GAN-based morph-generation methods

MIPGAN (features in NIST's evaluation)



Since MIPGAN makes use of a pre-trained GAN, it generates high-quality morphed images with no splicing required.

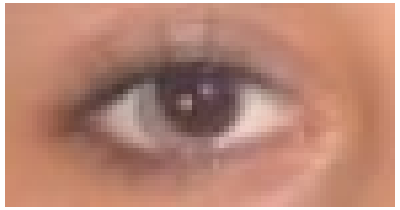
GAN-reconstructed / morphed images tend to lose biometric information of the two identities and so MIPGAN's method involves iterative optimisation of an identity loss.

GAN-based morphs can be visually pleasing. They suffer, however, from their own brands of artefact. For example, the type of noise present in the entirely synthetic image may be significantly different from that of a real image.

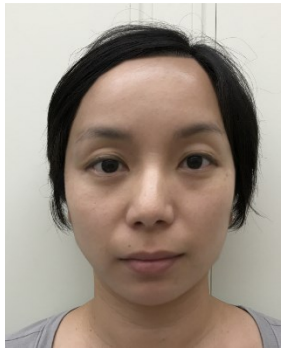
Morphed Image Generation

Manual labelling

Many of the easiest to detect artefacts occur due to imprecision in the estimation of keypoint locations, or even due to the lack of keypoints in important locations, for example surrounding the iris:



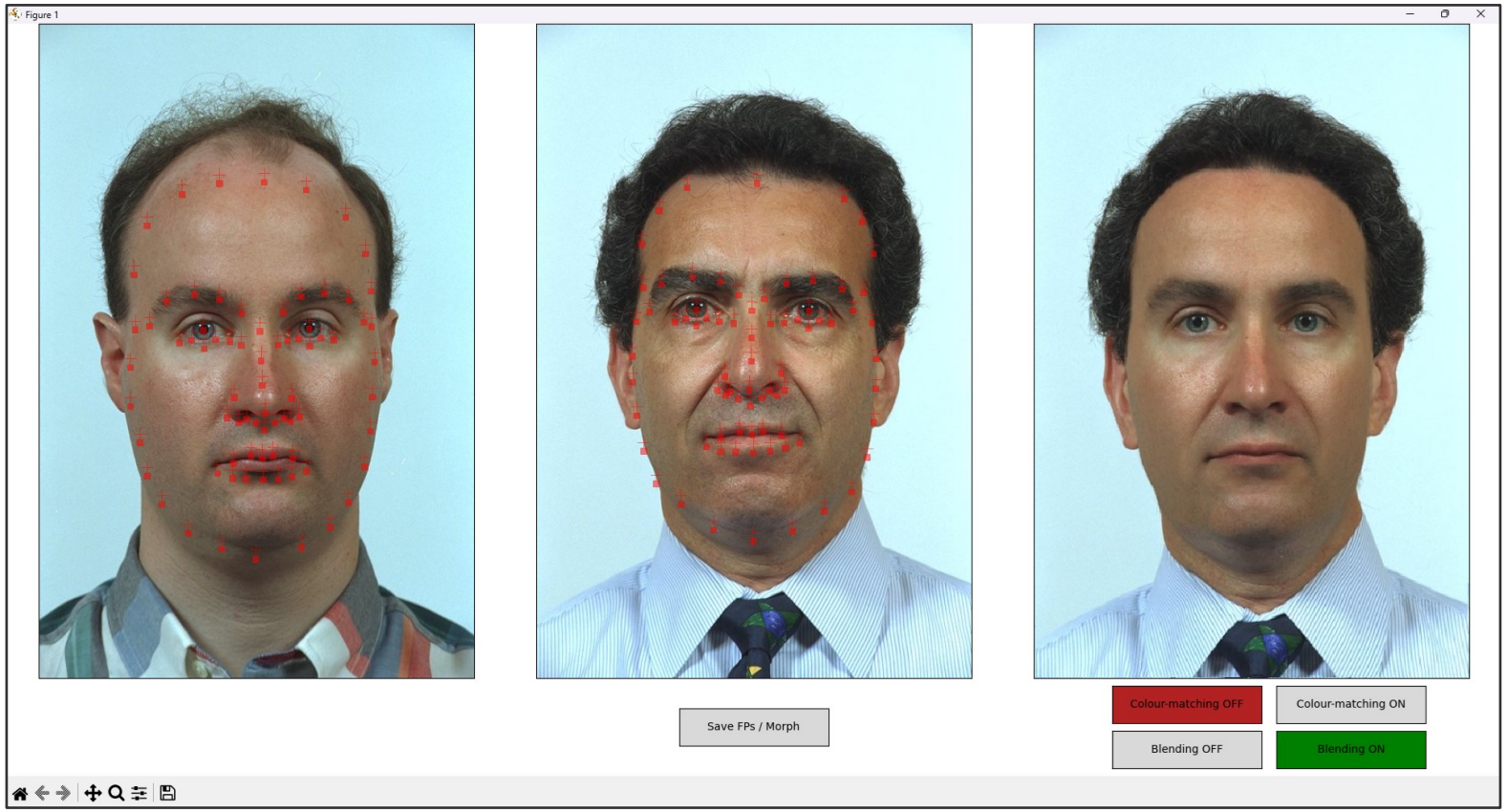
NIST's "Manual" and "Lincoln" morph-types are used to evaluate detection performance on high-quality morphed images where keypoints have been selected manually and artefacts have been removed by hand.



Manual

Lincoln

To assess generalisability of detection methods to high-quality morphs, IDEMIA has developed its own manual morphing tool and is producing a high-quality, manual evaluation dataset.



NIST Leaderboard

Page 1 of 4 of the NIST FATE MORPH leaderboard

IDEMIA

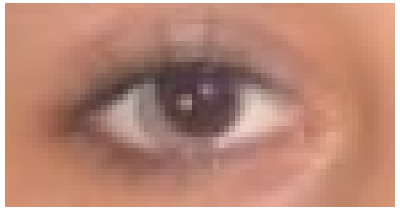
Algorithm (+reportcard)	Submission Date	Type	Manual [Tier 3 - High Quality]	Print+Scanned [Tier 3 - High Quality]	Local Morph Colorized Match [Tier 2 - Automated]	Visa-Border [Tier 2 - Automated]	Lincoln [Tier 3 - High Quality]	DST [Tier 3 - High Quality]
secunet 002	2022-11-08	differential	0.357	0.176	0.266	0.212	_	_
idemia 001	2024-01-25	differential	0.448	0.293	0.565	0.337	_	_
idemia 002	2024-03-20	differential	0.463	0.182	0.220	0.035	_	_
idemia 003	2024-05-18	single-image	0.659	0.163	0.060	0.030	0.926	0.842
idemia 003	2024-05-18	differential	0.699	0.125	0.135	0.040	_	_
visteam 003	2023-05-23	differential	0.872	0.926	0.735	0.682	_	_
visteam 004	2023-10-20	differential	0.911	0.915	0.437	0.624	_	_
visteam 003	2023-05-23	single-image	0.926	0.788	0.490	0.555	0.880	0.965
visteam 004	2023-10-20	single-image	0.932	0.814	0.466	0.507	0.889	0.959
visteam 002	2023-01-05	single-image	0.950	0.833	0.614	0.414	0.907	0.971
visteam 000	2021-10-12	single-image	0.954	0.812	0.447	0.686	0.944	0.982
visteam 002	2023-01-05	differential	0.954	0.917	0.816	0.815	_	_
neurotechnology 000	2023-10-13	single-image	0.966	0.765	0.624	0.353	0.806	0.977
ntnusub 000	2024-02-13	differential	0.967	0.991	0.990	0.939	_	_
visteam 001	2022-08-03	single-image	0.969	0.925	0.620	0.518	0.880	0.982

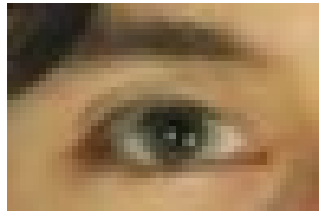
https://pages.nist.gov/frvt/html/frvt_morph.html

HR MORPHED FACE IMAGES DETECTION

Currently Idemia is working on full faces with IEDs ≈ 40 pixels.

The goal of this project is to look for high-resolution artefacts generated by the weak precision of textures alignments.





We will focus on a narrow area around one eye, because :

- it is enough to prove that higher resolution brings orthogonal information
- it allow us to share millions of images (GDPR compliant as images do not allow identification of subjects)
- Small images usage leads to smaller networks and then faster training process

This project includes: architecture selection (CNN, Transformers …), loss design, training, data augmentation, evaluations … and study of orthogonality with the current method

Transverse Project 2024-2025

Project n°3
3D luggage detection

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Vincent Despiegel vincent.despiegel@idemia.com

IDEMIA

THE ALIX PROJECT

Augmented Luggage Identification experience (ALIX™)

〉ALIX project.

- Retrieve Bags that lose their tags in the BHS (Baggage Handling System) of airports.
- We work with AirFrace, Paris-Charles-de-Gaulle Airport.

〉Acquisition system of bags

- There are « Archs » installed along the BHS of the airport.
- Each Arch represents 4 cameras that capture the bag from different angles: Front, Left, Rear, Right.
- Example ARCH001:

FRONT_CAMERA

LEFT_CAMERA

REAR_CAMERA

RIGHT_CAMERA

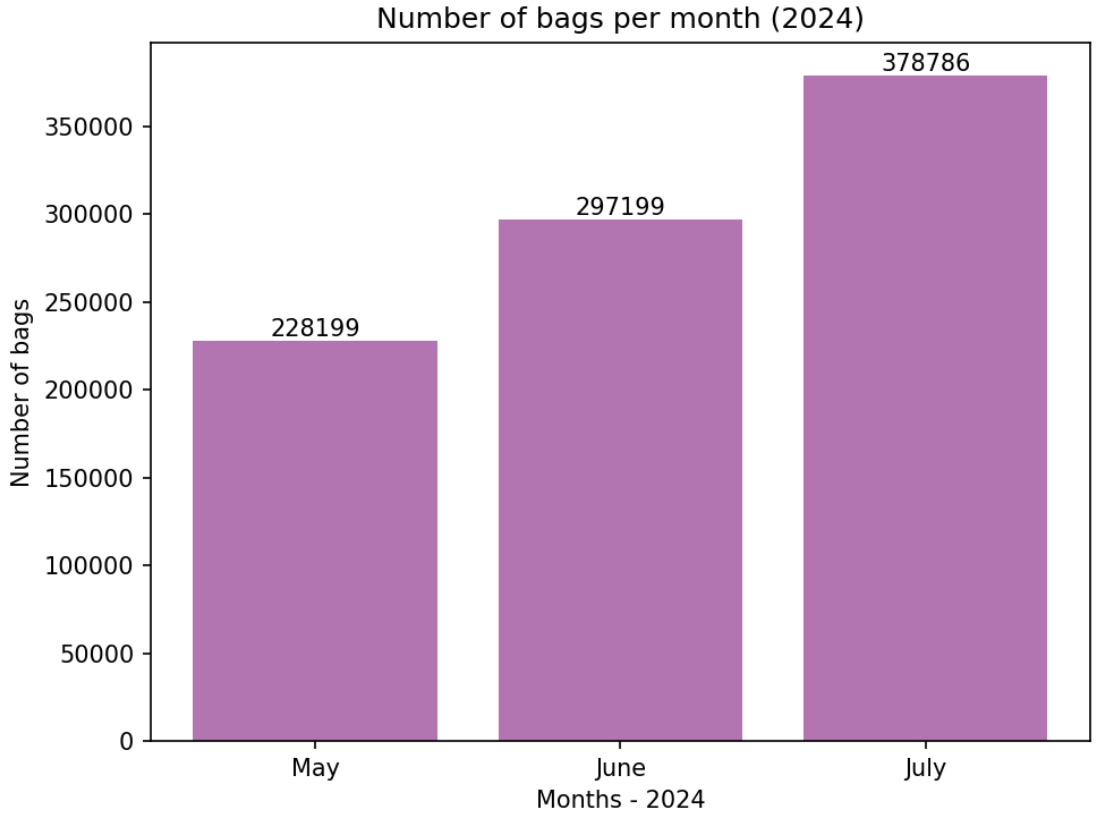
STATISTICS ON DOWNLOADED DATA

〉Statistics new data downloaded (for months: May, June, and July)

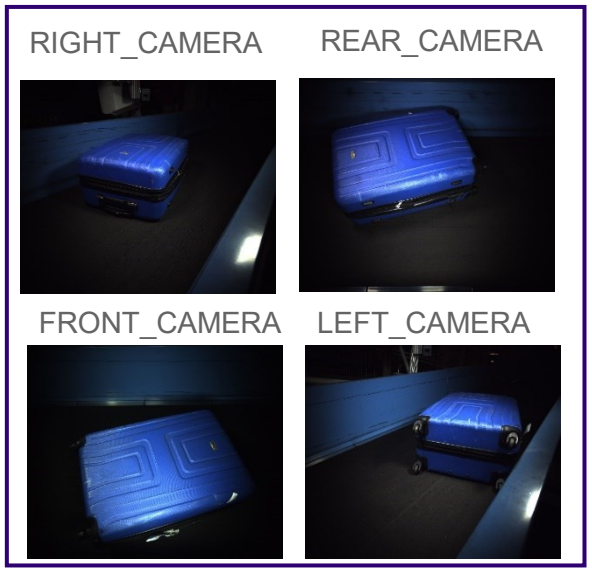
- Before 2024: 6 Archs installed
- In May 2024: 16 new Archs installed
- In July 2024: 5 other Archs installed

- Number of total bags in 3 months: 904,184

- Number of bags Ids in 3 months (May, June, July):



ALIX™ PROCESS



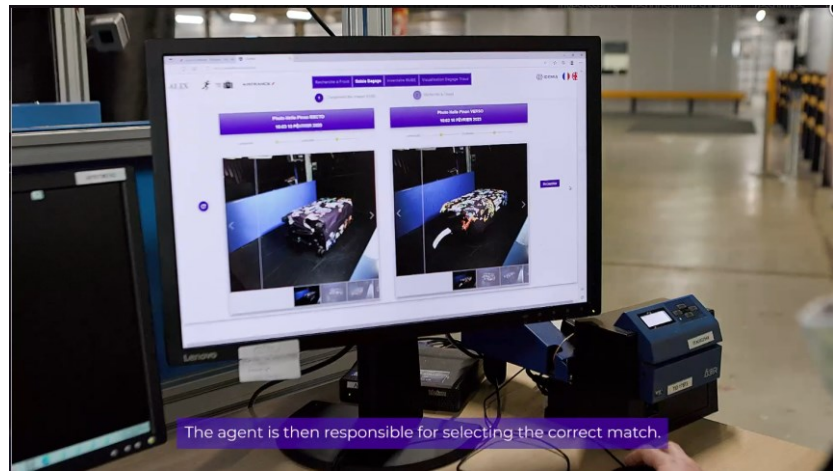
Before 2024: 6 arches installed
In May 2024: 16 new arches installed
In July 2024: 5 other arches installed

Bag is lost

Acquisition of the lost bag at CDG

Current coder is a ResNet trained with ArcFace

Matching with gallery



Bag is found

https://www.idemia.com/fr/video/alix-ai-powered-solution-unidentifiable-luggage-partnership-air-france

VISUALIZING LOW SCORES OF MATCHING

Low scores not only correspond to association errors but also other hard samples as shown below…

- **Association errors**

- **Double-sided bags**

VISUALIZING LOW SCORES OF MATCHING

Low scores not only correspond to association errors but also other hard samples as shown below…

- **Bags losing their cover**

- **Opened bags**

VISUALIZING LOW SCORES OF MATCHING

Low scores not only correspond to association errors but also other hard samples as shown below…

- **Illumination challenges**

VISUALIZING LOW SCORES OF MATCHING

Low scores not only correspond to association errors but also other hard samples as shown below…

- **Two bags captured together**

CURRENT SOLUTION

- Simple regression with a light model




- Coding is done with a simple ResNet trained on stretched 2D images with a contrastive loss.
- Recognition is a simple distance on embeddings (zero shot learning). It is done independently per 2D view. Global Score = max (4x4 scores)

3D luggage detection

Direction for improvement :

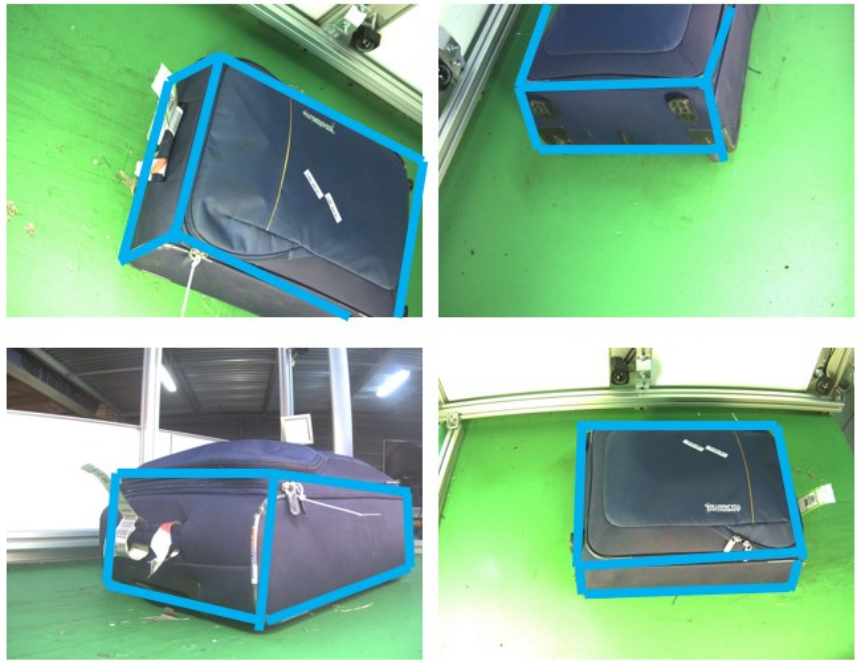
- Most of bags can be approximate by a 6 facets cuboid, with 5 facets visible per acquisition.
- Can we leverage 3D Information to build a better recognition algorithm ?
- Can we use to identify luggage from one uncalibrated view (smartphone) ?

The project objective : 1st step, understand the 3D shape.

- Leverage the calibration
- Leverage millions of 4 views acquisitions
- Leverage 2D box detection

Explore complementary of different approaches

- Dense stereo alignment with epipolar constraints
- Explore feasibility to learn a NERF (Neural Radiance Field)
- Predict directly a cuboid shape and position (6 parameters)
- Geometric constraints : 3D box projection fit into 2D boxes.



This project could be continued with an internship and a doctorate.

Questions ?

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