INTERNAL

NFIQ 2 and contactless acquisition

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Introduction

- **Fingerprint recognition ecosystem is mature and sustained by strong set of standards, tests and certifications (performance, compliance, interoperability, ...)**
  - Sensor standards & certification (eg IQS/PIV)
  - Algorithms: test methodologies, Feature extraction / matching tests & certification eg NIST, PIV)
  - Exchange format (eg ISO)
  - Quality metrics standards and SW (NFIQ2)
  - ...

- **Only a few evolutions in the last 30 years, driving few adaptations of standards and certifications**
  - Inked cards, optical livescans, single finger scanners, capacitive sensors, TFT sensors, ...

- **Today, contactless capture technologies are becoming available and the need for them is quickly accelerating**
  - Ergonomics of capture especially 4 fingers capture (border control, enrolment, access control, ...)
  - Portability/mobility: « any where, any time » with apps on smartphone
  - Increased need to avoid contact whenever possible due to COVID

=> What can be used as is / adapted or changed in this ecosystem to enable <u>quick</u> deployment of contactless ?

Several categories of contactless, with very different caracteristics and benefits

- **Controlled contactless capture devices (eg MorphoWave technologie)**
  - Dedicated stationnary devices specifically designed and optimised for fingerprint capture
  - Design to control geometric and optical caracteristics
    - Controlled resolution, 3D unwrapping of finger shape, hand positionning guide, device calibration, ...
  - Robustness to environment (ambient light, ...)
  - Proven interoperability with contact sensors (IQS PIV, interoperability tests)

  => Speed and ergonomics of use, full interoperability with legacy systems, performance close to contact-based acquisition

- **Uncontrolled contactless capture systems (eg Smartphone App)**
  - SW application on smartphone
  - No control on hardware (design of camera / optics, pre/post processing, ...)
  - Some control on acquisition workflow (image selection, quality check, focus area...) through phone OS camera API
  - Limited control on capture volume (only through UI guidance) and resolution
  - Low robustness to environment conditions (ambient light, motion, image background, ...)

  => Full mobility & portability, using existing devices, no HW cost

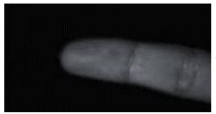
Controlled contacless capture device

Acquisition is **dynamic, high-speed** and **100% touchless**

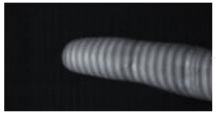
Fingerprints are **detected and tracked** from video stream *(ultra high frame rate)*

Fingerprint texture, shape and curvature are captured

The video stream is translated into **four 2D images**



Texture image



Pattern image

Texture image
@ 500 dpi sampling rate
(IQS - PIV certified)

Slap - contact

MorphoWave™

Rolled - contact

A richer image with about **30% more area** than conventional contact slap sensors **> higher accuracy**

⇒ Speed and ergonomics of use, full interoperability with legacy systems, performance close to contact
⇒ Acquisition is full frame (no stiching)

Uncontrolled contactless capture system (eg Smartphone App)

Acquisition requirements

Rear camera

Using the LED to get the **right illumination** and **limit motion blur**

Minimum requirements on the Camera resolution *(Full HD)*

Sufficiently good **auto-focus** solution

Challenges

Contrast of the fingerprint image

Managing the **focus** on all fingers

User Experience

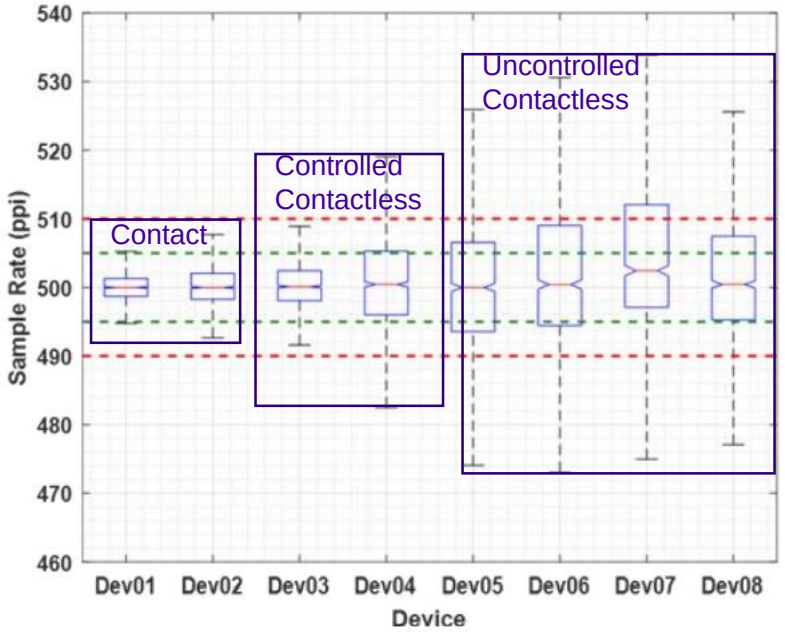
Variety of smartphones @ different level of **quality**

Scale or Sample rate might be difficult to manage

=> Full mobility & portability using existing smarpthone devices, available anywhere anytime, no additionnal HW cost

Interoperability: Controlled capture devices have geometric variation close to contact sensors

(charts from https://nvlpubs.nist.gov/nistpubs/ir/2020/NIST.IR.8307.pdf)



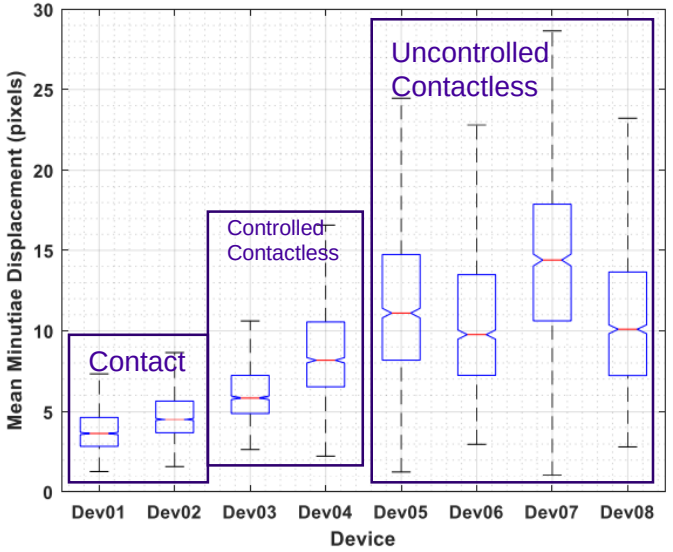


Figure 3 – Mean displacement of corresponding minutiae pairs

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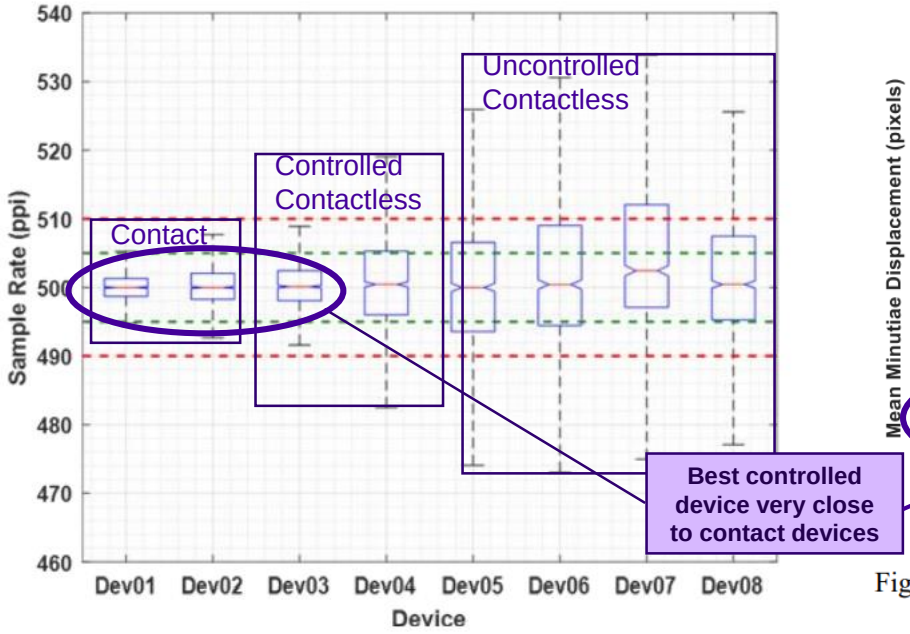

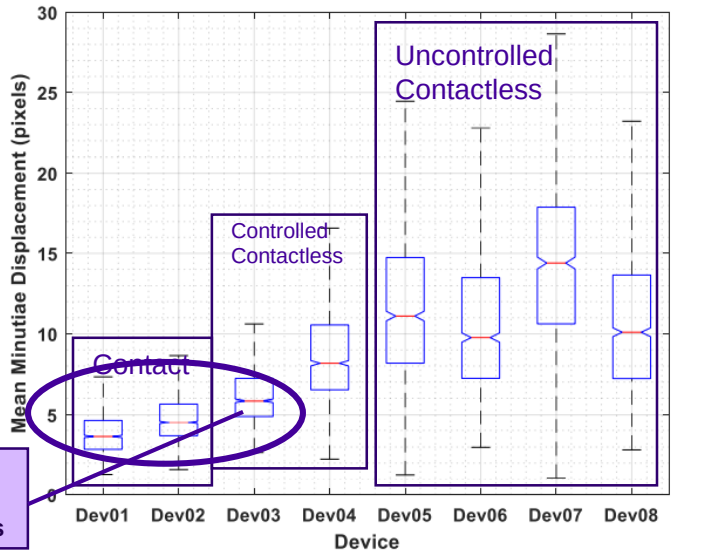

Figure 3 – Mean displacement of corresponding minutiae pairs

=> Controlled devices geometric variation can be within current matcher tolerance (PIV),
=>Uncontrolled capture has more variance that needs to be handled by the matching algorithm

Interoperability : Biometric performance is better with controlled than uncontrolled capture

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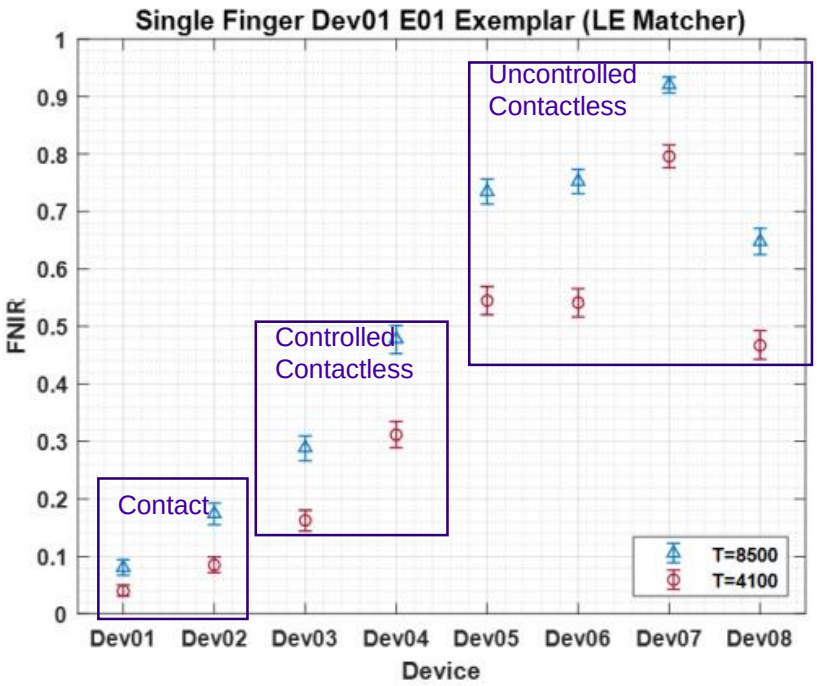
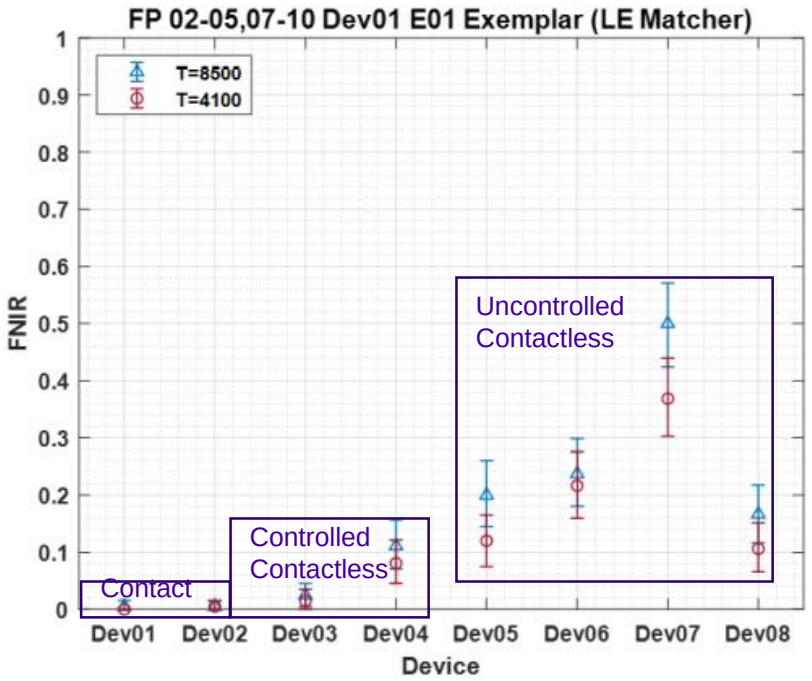
Single finger matching



8 fingers matching



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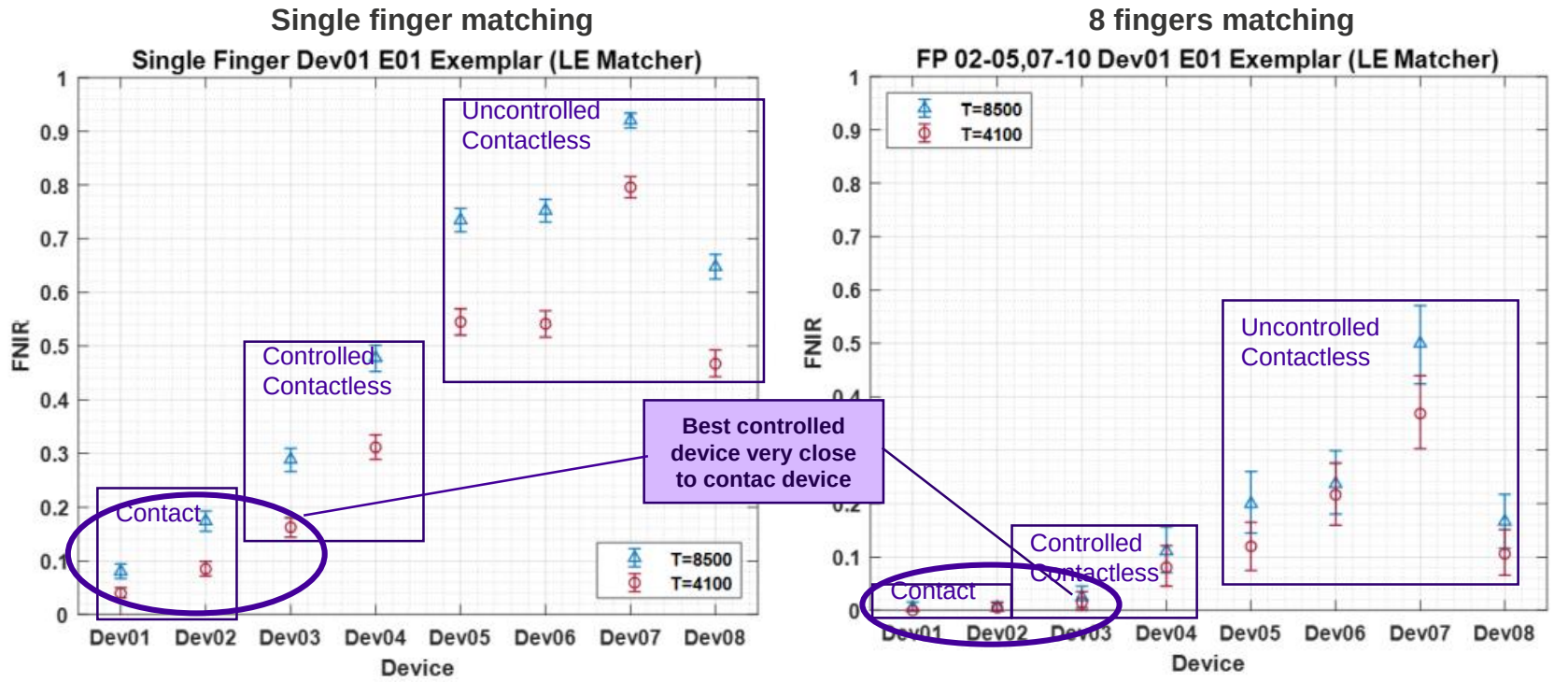
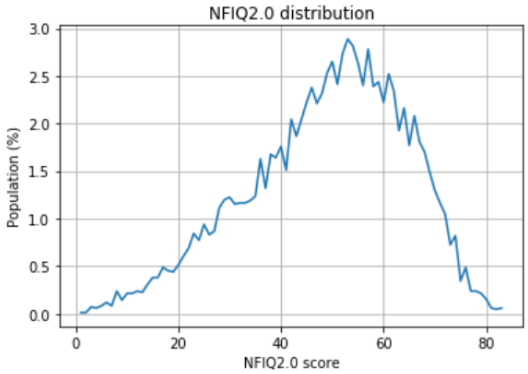
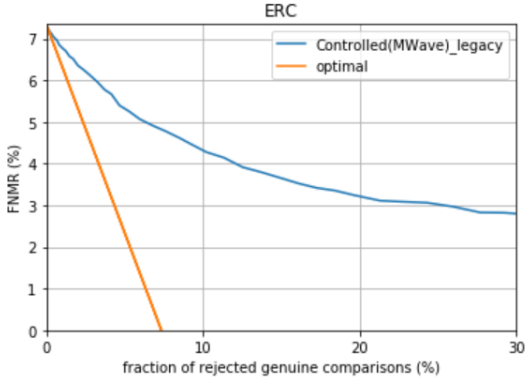


Controlled devices performance is closer contact devices especially with 8 fingers,
Uncontrolled capture has lower accuracy with legacy matchers

NFIQ2 as matcher predictor – Controlled contactless capture device

- 1,900 hand captures of 184 different individuals using MWC sensor and Idemia current matcher
- Error-versus-Reject Curves (ERC) at 0.1% FMR (contactless vs contact) is used to measure NFIQ2 efficiency
- Background noise contact database of 200,000 fingers is used to simulate large scale performance
- Single finger matching is used in this test to enhance impact of quality on accuracy for analysis (but 4 or 8 finger matching is typically used in real applications)





- ERC graph shows NFIQ2.0 ability to reject the poorest data (for Idemia matcher)

NFIQ2 as matcher predictor – Uncontrolled contactless capture

- 6,000 hand captures of 547 different individuals (Android and iOs phone apps) and Idemia current matcher
- Error-versus-Reject Curves (ERC) at 0.1% FMR (contactless vs contact) is used to measure NFIQ2 efficiency
- Background noise database of 200,000 fingers is used to simulate large scale performance
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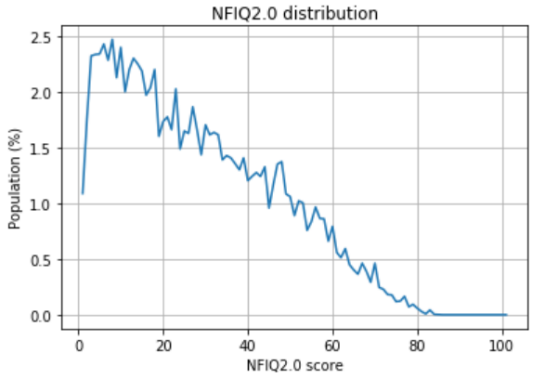

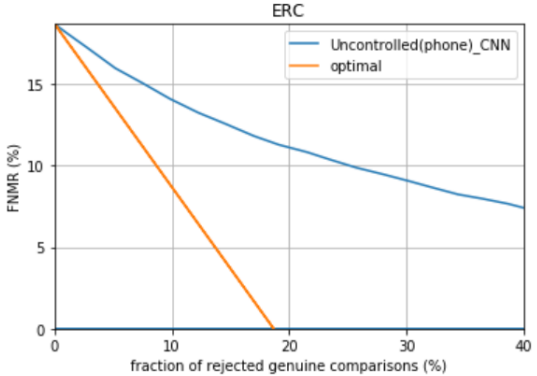

- ERC graph shows NFIQ2.0 ability to reject poorest data (for Idemia matcher)

Conclusion

- **Controlled and uncontrolled contacless capture devices have different maturity, performance and interoperability level but both can already bring today different but strong benefit to the user community**
  - Standards and tests are being conducted to ensure performance and interoperability (Sensor interoperability, Quality metrics, Matcher performance)
- **Even though NFIQ2 has not been trained on contacless images, NFIQ2.x score is able to reject many low quality data (with tested matcher)**
- **Controlled capture device are more mature and interoperable, and therefore can already benefit from existing standard framework, tests and tools**
  - They can demonstrate image level interoperability (IQS/PIV), reach good biometric performance (very close to contact) and NFIQ2.0 is efficient to detect lower quality prints (with tested matcher)
  - They will benefit from framework evolution but can already rely on the existing framework today (IQS/PIV, NFIQ2.x)
- **Uncontrolled capture systems (apps) are maturing quickly and do open new horizons (capture at home, any where, any time, they will likely require evolutions of the ecosystem (standards, framework, biometric matchers)**
  - By nature, they will not be able to bring the same level of interoperability (resolution, environment, ergonomics, ...) than controlled capture devices.
  - They can already be deployed today, with appropriate / dedicated system design (new generation of matching algorithm, acquisition workflow to control quality)
  - As they are not fully interoperable, dedicated quality algorithm is a more appropriate choice today
  - Even if NFIQ2 can reject many low quality data, evolution of NFIQ2 is to be considered to take such images into account