"THE MADRID STUDY", A COMPARATIVE TEST OF FINGERPRINT SENSORS AND ALGORITHMS

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OUTLINE

- Motivation
  - Sensors
  - Algorithms
- Collection procedure
- Database
- Performance Analysis: Full images
- Cropped images
  - Approach
  - Performance Analysis:
    - Cropped images vs Cropped Images
    - Full size images vs Cropped Images
- Conclusions
- Lessons learned

MOTIVATION

- 3 sensors:

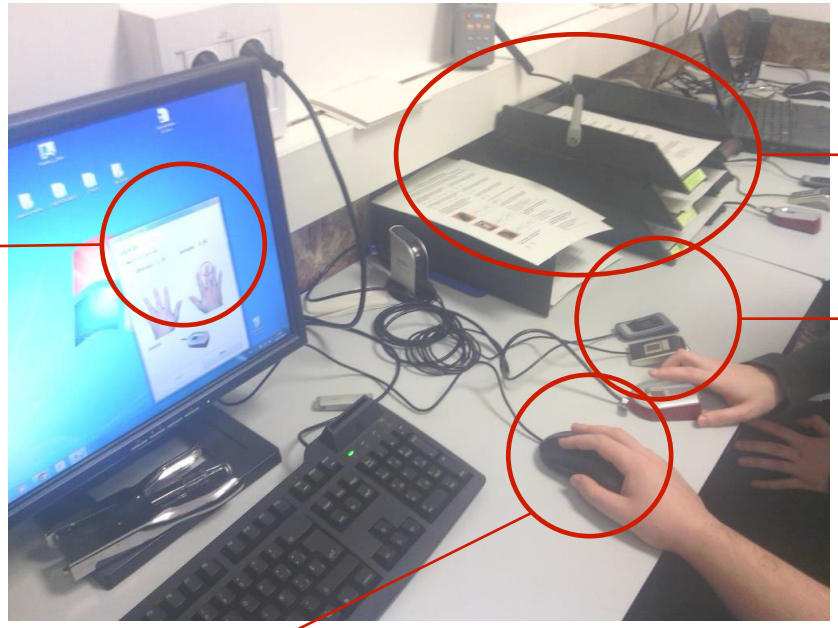
	Technology base	Resolution	Image capture area	Fingerprint Image size
NXT (NB-3010-U)		365 dpi	11,9 x 16,9 mm	180 x 256 pixels
FPC (FPC1011F3)	Capacitive	363 dpi	10,6 x 14 mm	152 x 200 pixels
UPK (UPEK EikonTouch 510)	Capacitive	508 dpi	12,8 x 18 mm	192 x 270 pixels

- 2 algorithms:
  - NBIS (public algorithm)
  - Neurotechnology (comercial algorithm)

MOTIVATION

COLLECTION PROCEDURE

ISO/IEC 19795



Dedicated application for capturing data

Data protection forms, delivery of receipts of incentives, usability surverys, etc

Sensors:
Random order
User:
6 fingers per user

Operator

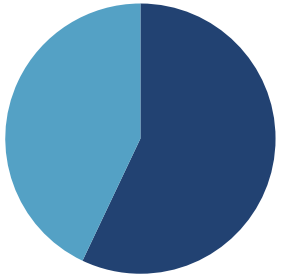
COLLECTION PROCEDURES

- 2 visits: Separated at least 15 days.
- 1st Visit: General instructions, acceptance forms, enrollment and 1st acquisition process
- 2nd visit: reminder of how to provide good fingerprint images, 2nd acquisition process
- Quality Assessment: NFIQ:
  - Enrollment: NFIQ <3
  - Acquisition: NFIQ ≤ 4
- N transactions:
  - Enrollment: 2
  - Acquisition: 1
- Ground Truth mechanism to reduce potential human errors

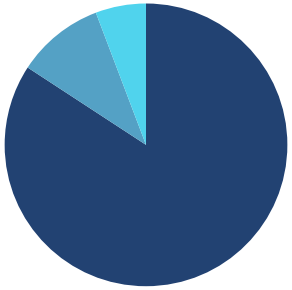
DATABASE

- 589 users:

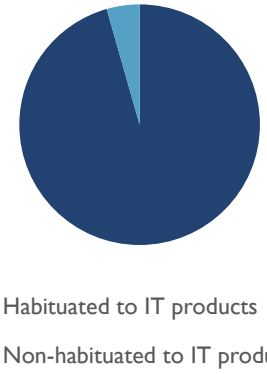
Gender Distribution



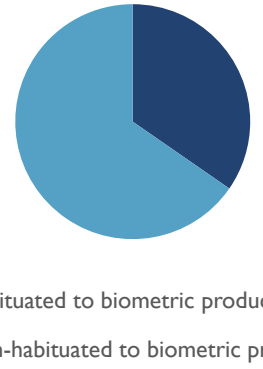
Age Distribution



Technical knowledge

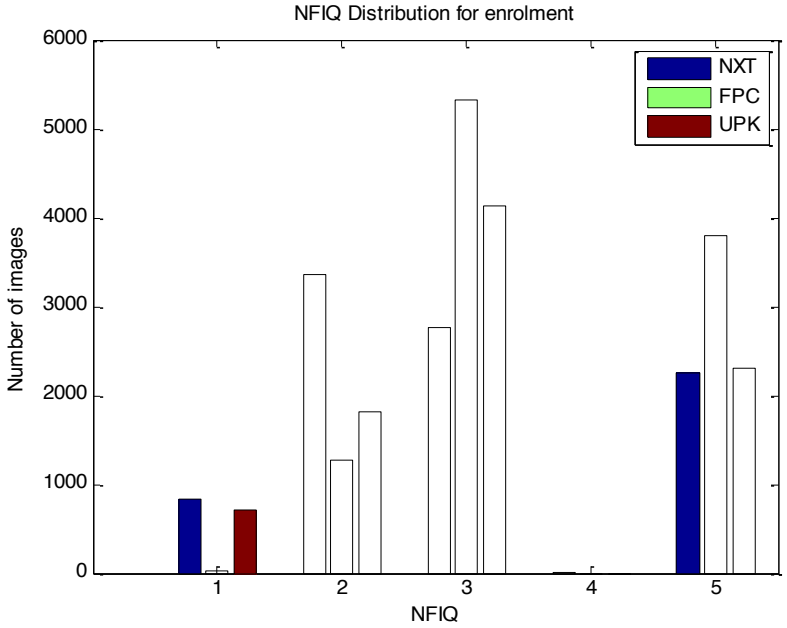


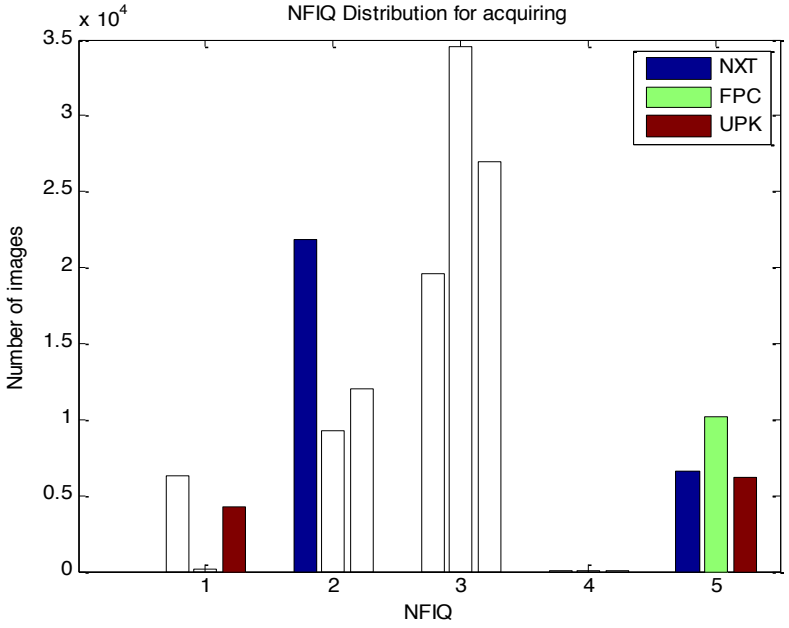
Biometric system habituation



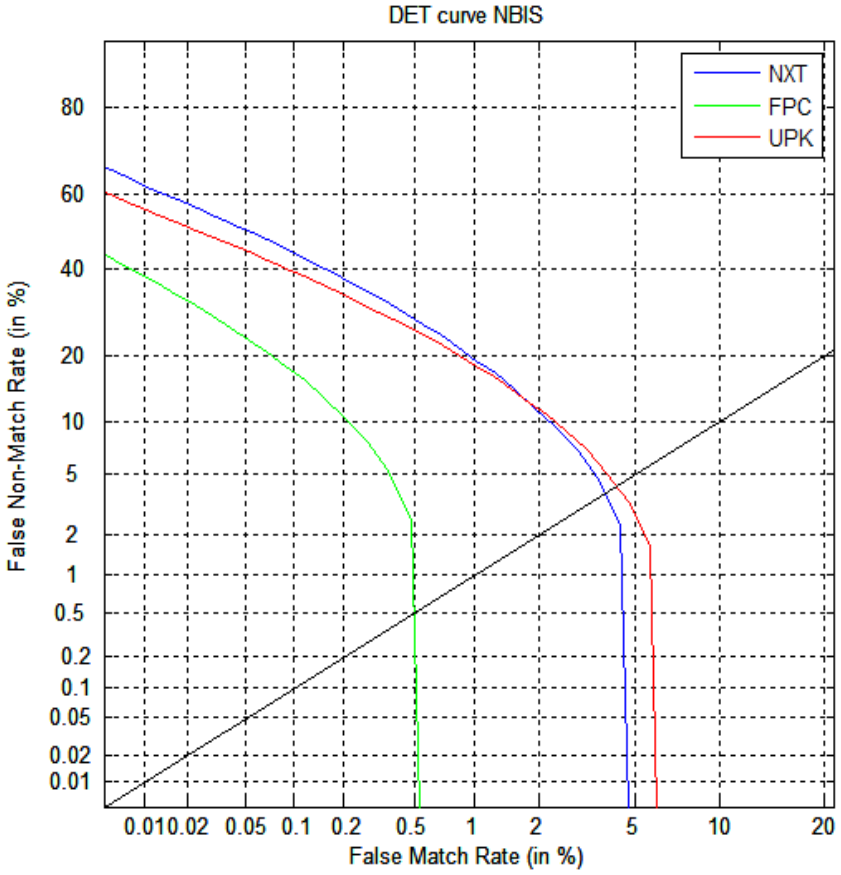
FULL IMAGE-PERFORMANCE

QUALITY ASSESMENT RESULTS



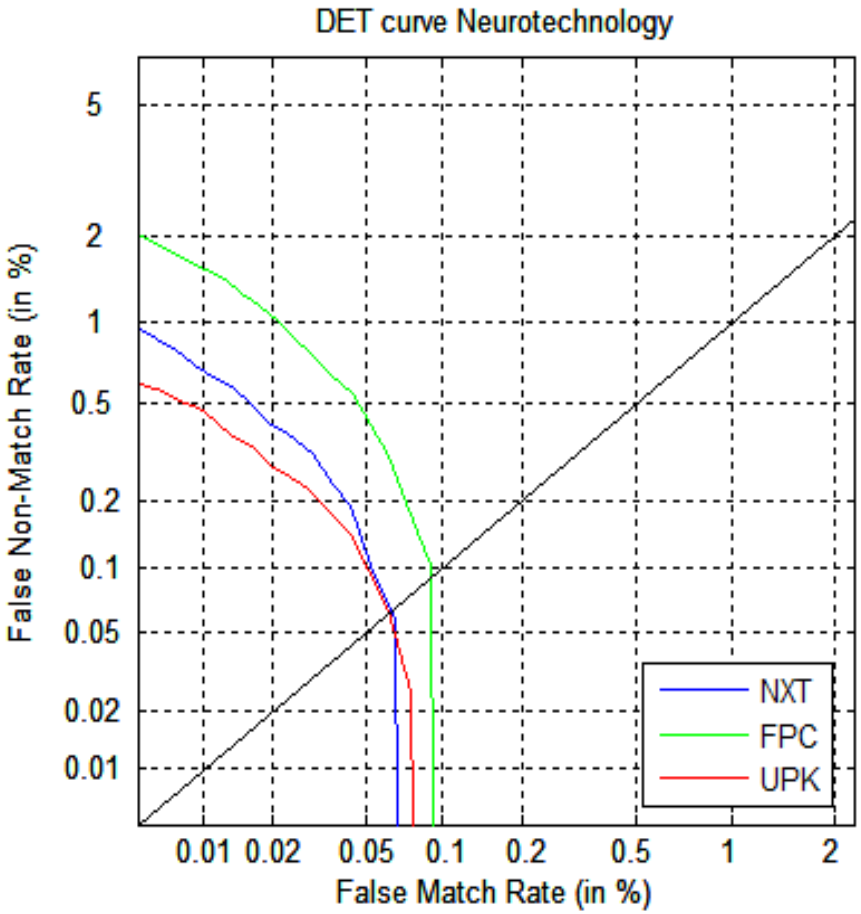


PERFORMANCE-NBIS



Error rate	NXT	FPC	UPK
FTE	8.97 %	20.03 %	11.82 %
FTA	34.17 %	46.24 %	27.66 %
EER	3.88 %	0.60 %	4.26 %

PERFORMANCE-NEUROTECHNOLOGY

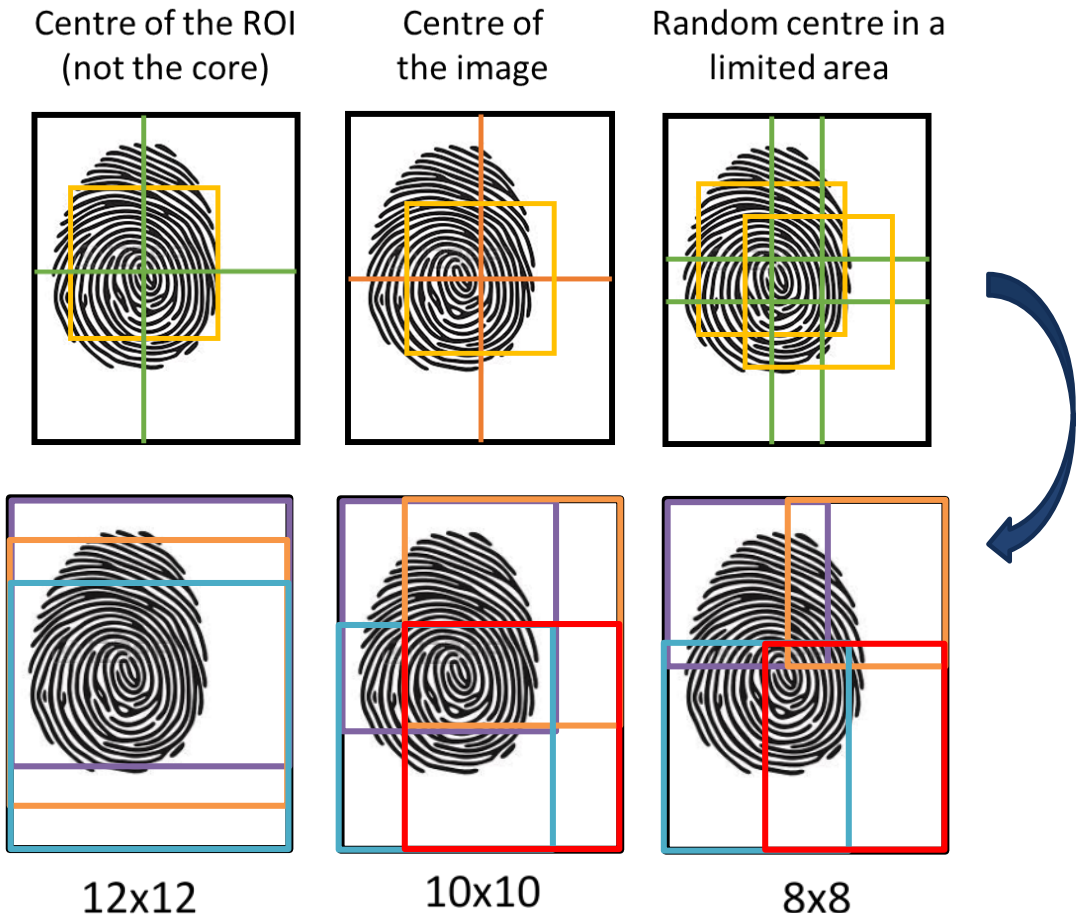


Error rate	NXT	FPC	UPK
FTE	8.60 %	17.85 %	11.40 %
FTA	17.76 %	25.83 %	20.93 %
EER	0.0639 %	0.0925 %	0.0616%

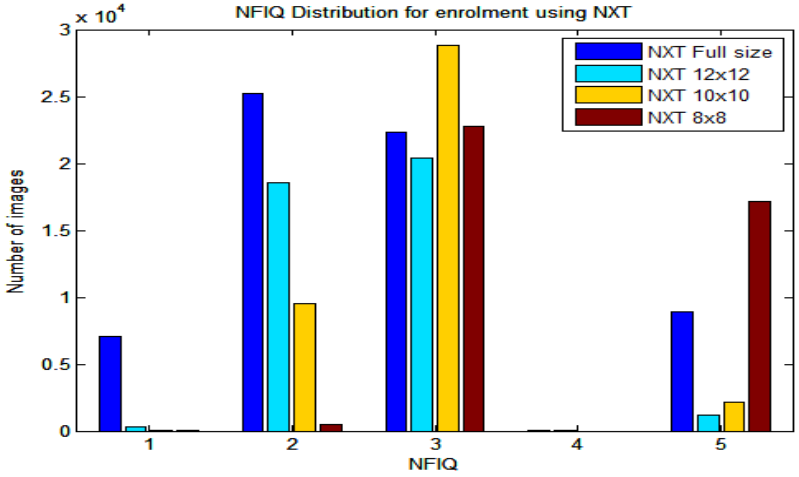
CROPPED DATABASES

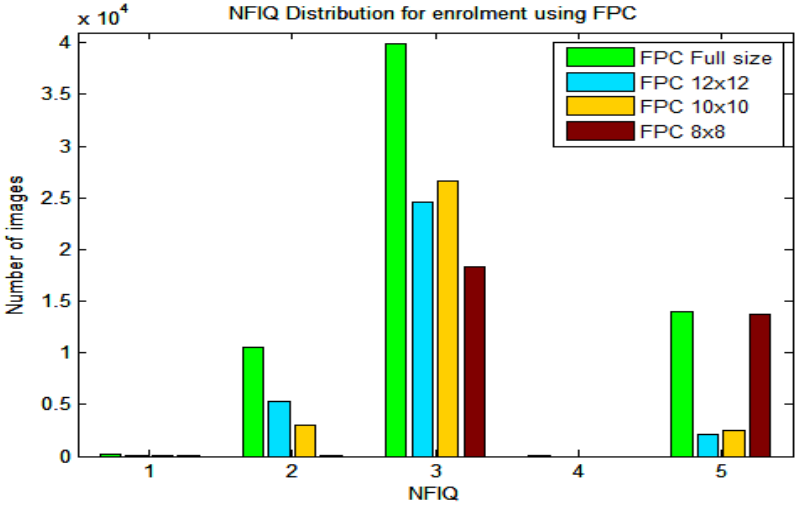
CROPPING APPROACH

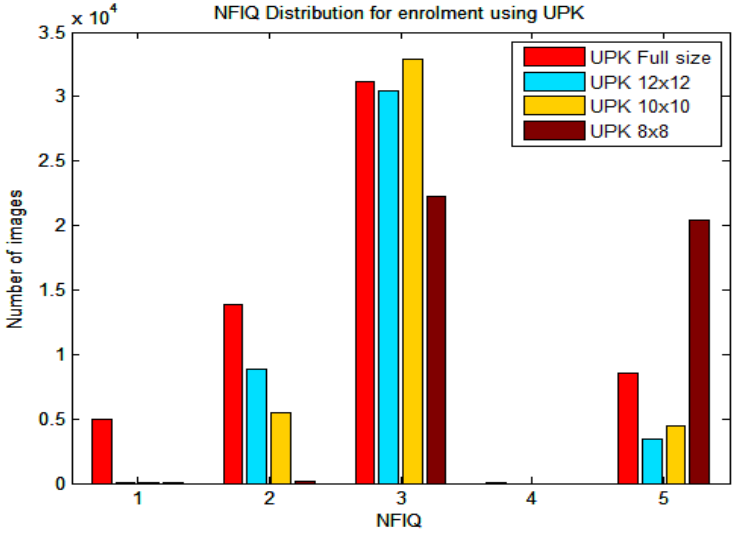
- Random center approach
- Three sizes:
  - 12 x 12 mm2
  - 10 x 10 mm2
  - 8 x 8 mm2
- Same enrollment and acquistion procedure



QUALITY ASSESSMENT RESULTS

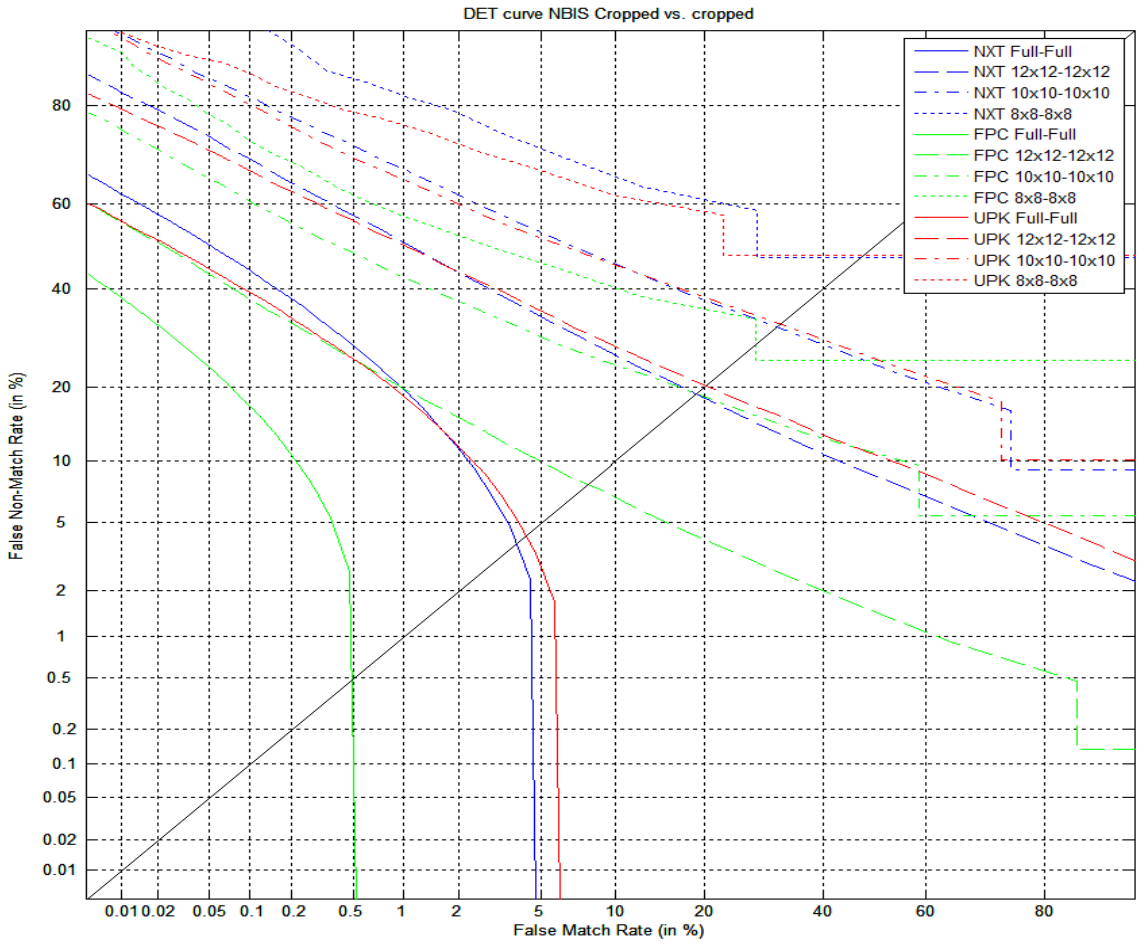






PERFORMANCE ANALYSIS: CROPPED vs CROPPED IMAGES

NBIS RESULTS



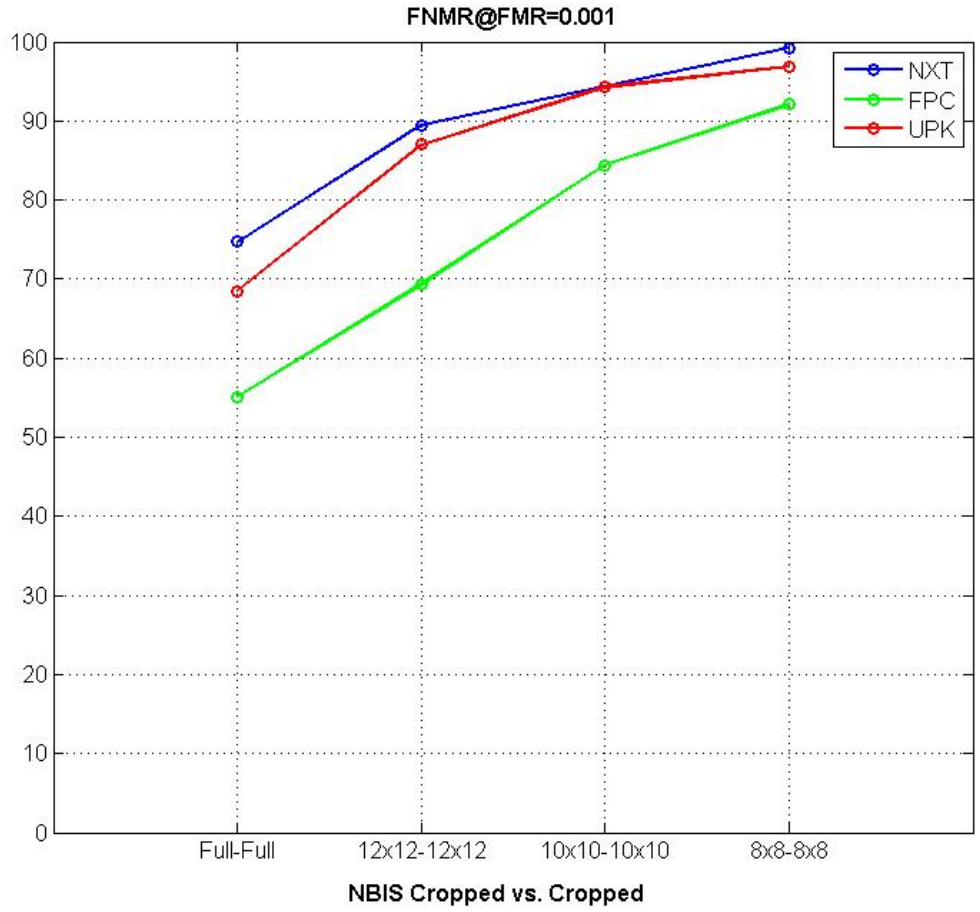
NBIS RESULTS

Sensor	Error rate	Full_Full	12x12_12x12	10x10_10x10	8x8_8x8
NXT	FTE	8.97 %	27.61 %	74.13 %	98.24 %
	FTP		0.00 %	0.01 %	1.94 %
	EER	3.88 %	18.89 %	31.62 %	47.17 %
FPC	FTE	20.03 %	68.33 %	66.64 %	94.59 %
	FTP		0.00 %	0.00 %	0.051 %
	EER	0.60 %	7.79 %	19.02 %	27.82 %
UPK	FTE	11.82 %	33.95 %	75.89 %	98.41 %
	FTP		0.00 %	0.02 %	4.67 %
	EER	4.26 %	20.23 %	32.16 %	47.94 %

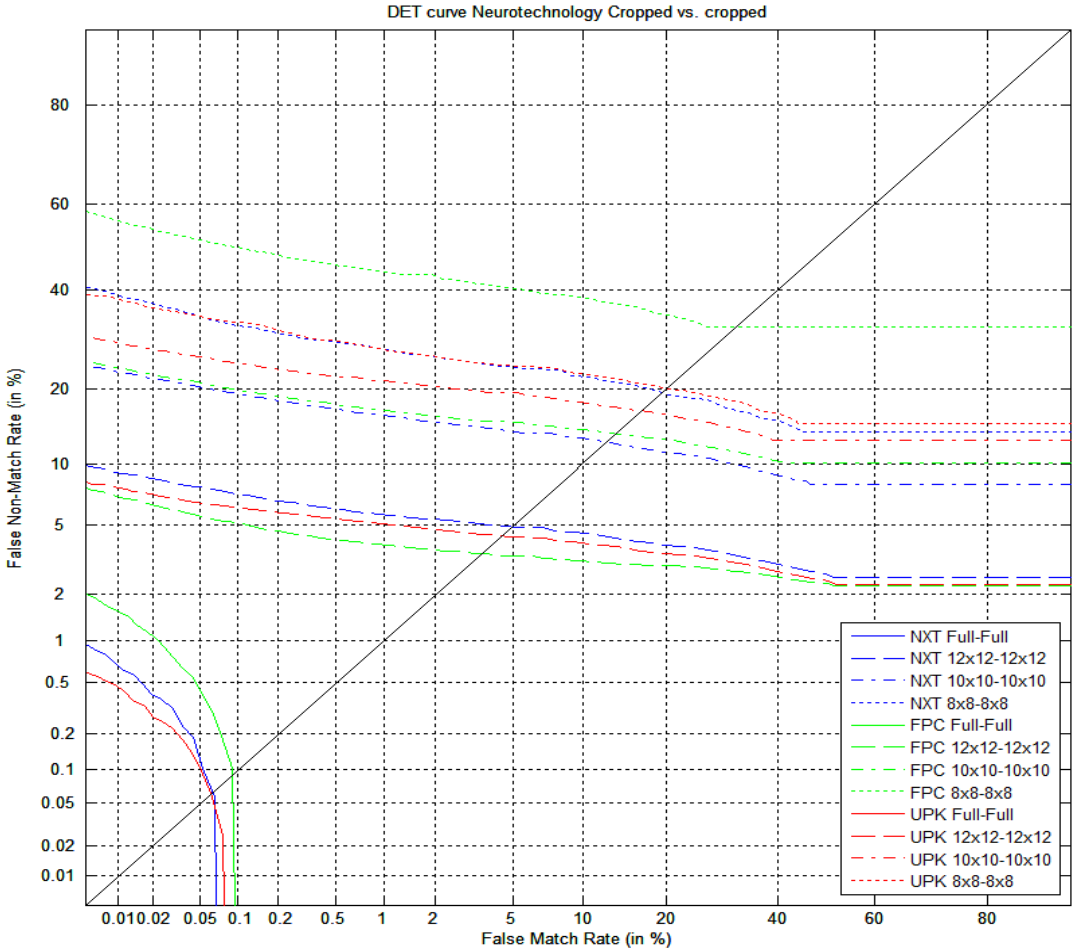
NBIS RESULTS

Sensor	Error rate	Full_Full	12x12_12x12	10x10_10x10	8x8_8x8
NXT	FTE	8.97 %	27.61 %	74.13 %	98.24 %
	FTP		0.00 %	0.01 %	1.94 %
	EER	3.88 %	18.89 %	31.62 %	47.17 %
FPC	FTE	20.03 %	68.33 %	66.64 %	94.59 %
	FTP		0.00 %	0.00 %	0.051 %
	EER	0.60 %	7.79 %	19.02 %	27.82 %
UPK	FTE	11.82 %	33.95 %	75.89 %	98.41 %
	FTP		0.00 %	0.02 %	4.67 %
	EER	4.26 %	20.23 %	32.16 %	47.94 %

NBIS RESULTS



NEUROTECHNOLOGY RESULTS



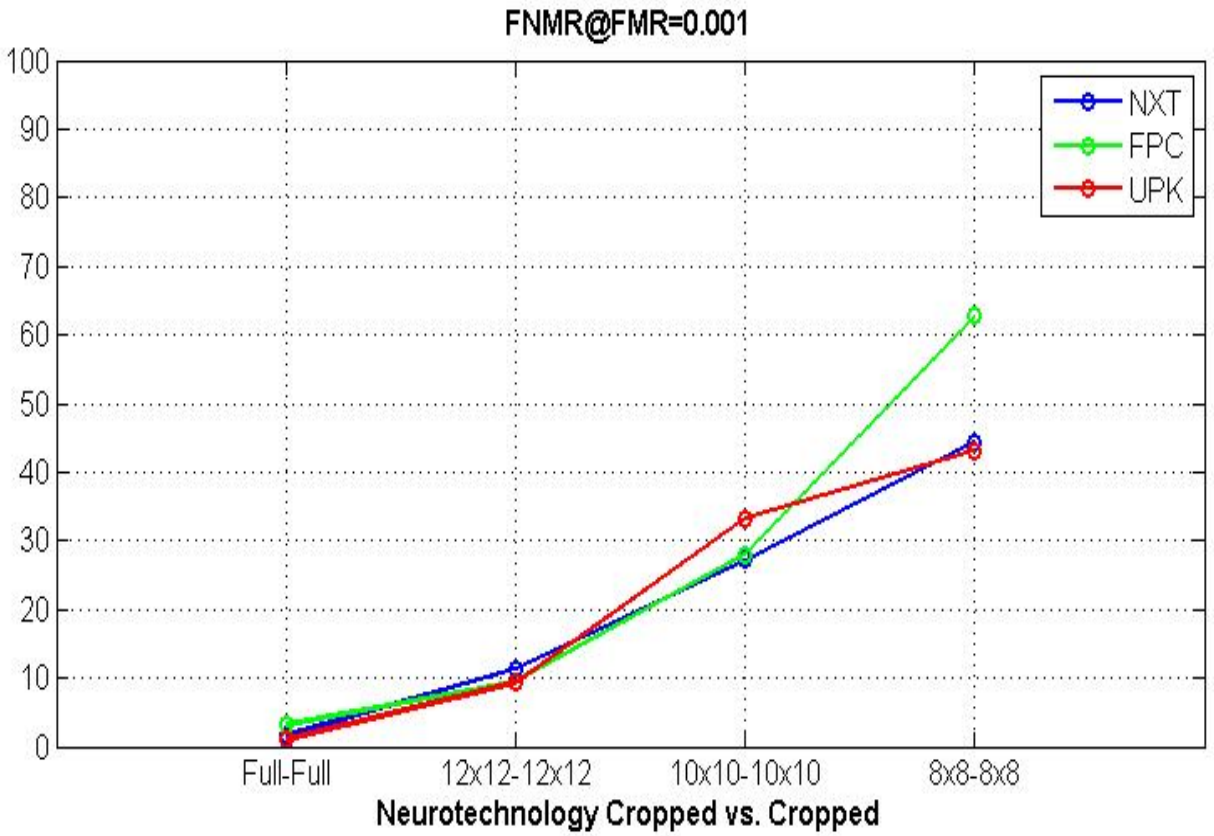
NEUROTECHNOLOGY RESULTS

Sensor	Error rate	Full_Full	12x12_12x12	10x10_10x10	8x8_8x8
NXT	FTE	8.60 %	17.77 %	46.46 %	87.97 %
	FTP		10.65 %	40.58 %	92.34 %
	EER	0.0639 %	4.89 %	12.43 %	19.42 %
FPC	FTE	17.85 %	17.63 %	22.61 %	30.81 %
	FTP		0.00 %	0.00 %	0.00 %
	EER	0.0925 %	3.49 %	13.48 %	31.96 %
UPK	FTE	11.40 %	20.91 %	26.62 %	88.96 %
	FTP		7.47 %	0.00 %	91.72 %
	EER	0.0616%	4.38 %	16.58 %	20.02 %

NEUROTECHNOLOGY RESULTS

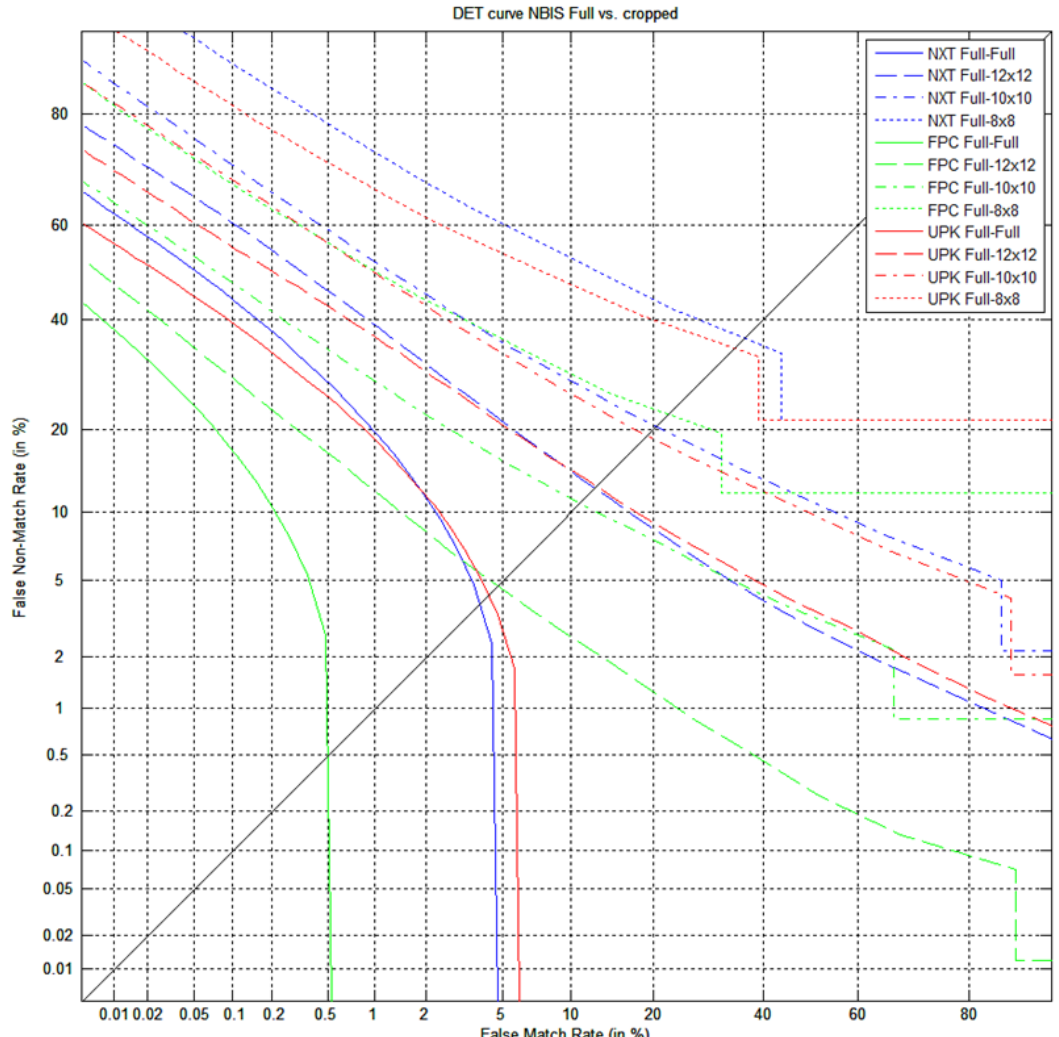
Sensor	Error rate	Full_Full	12x12_12x12	10x10_10x10	8x8_8x8
NXT	FTE	8.60 %	17.77 %	46.46 %	87.97 %
	FTP		10.65 %	40.58 %	92.34 %
	EER	0.0639 %	4.89 %	12.43 %	19.42 %
FPC	FTE	17.85 %	17.63 %	22.61 %	30.81 %
	FTP		0.00 %	0.00 %	0.00 %
	EER	0.0925 %	3.49 %	13.48 %	31.96 %
UPK	FTE	11.40 %	20.91 %	26.62 %	88.96 %
	FTP		7.47 %	0.00 %	91.72 %
	EER	0.0616%	4.38 %	16.58 %	20.02 %

NEUROTECHNOLOGY RESULTS



PERFORMANCE ANALYSIS: FULL SIZE vs CROPPED SIZE IMAGES

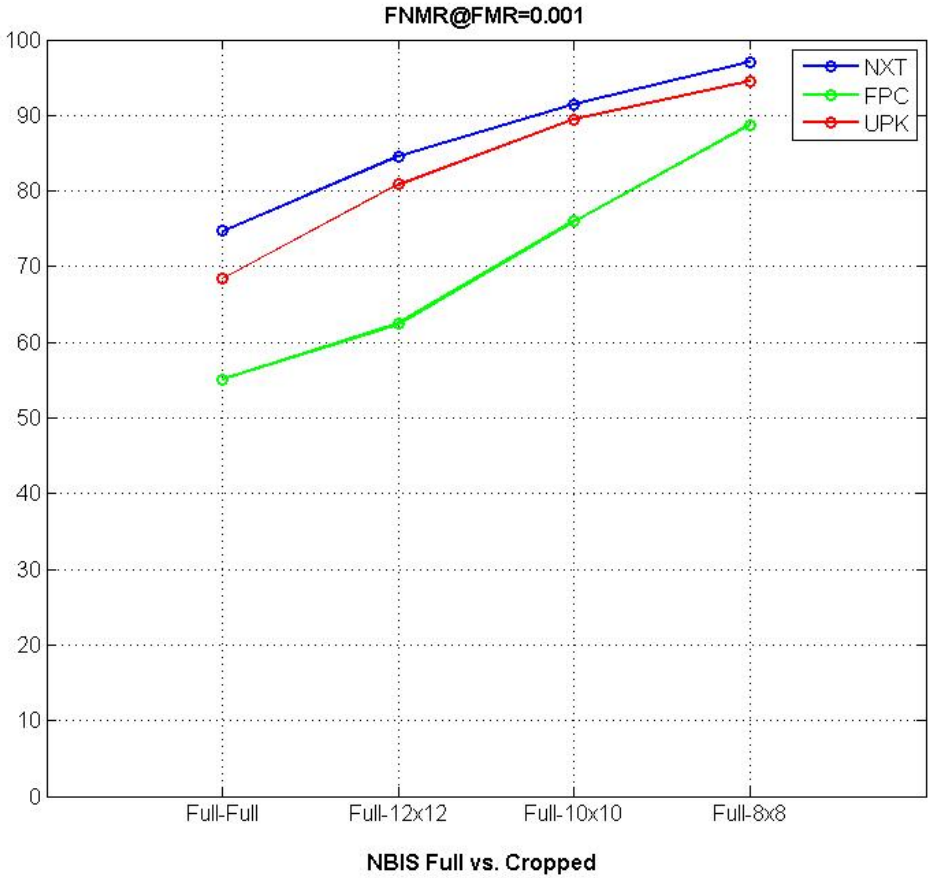
NBIS RESULTS



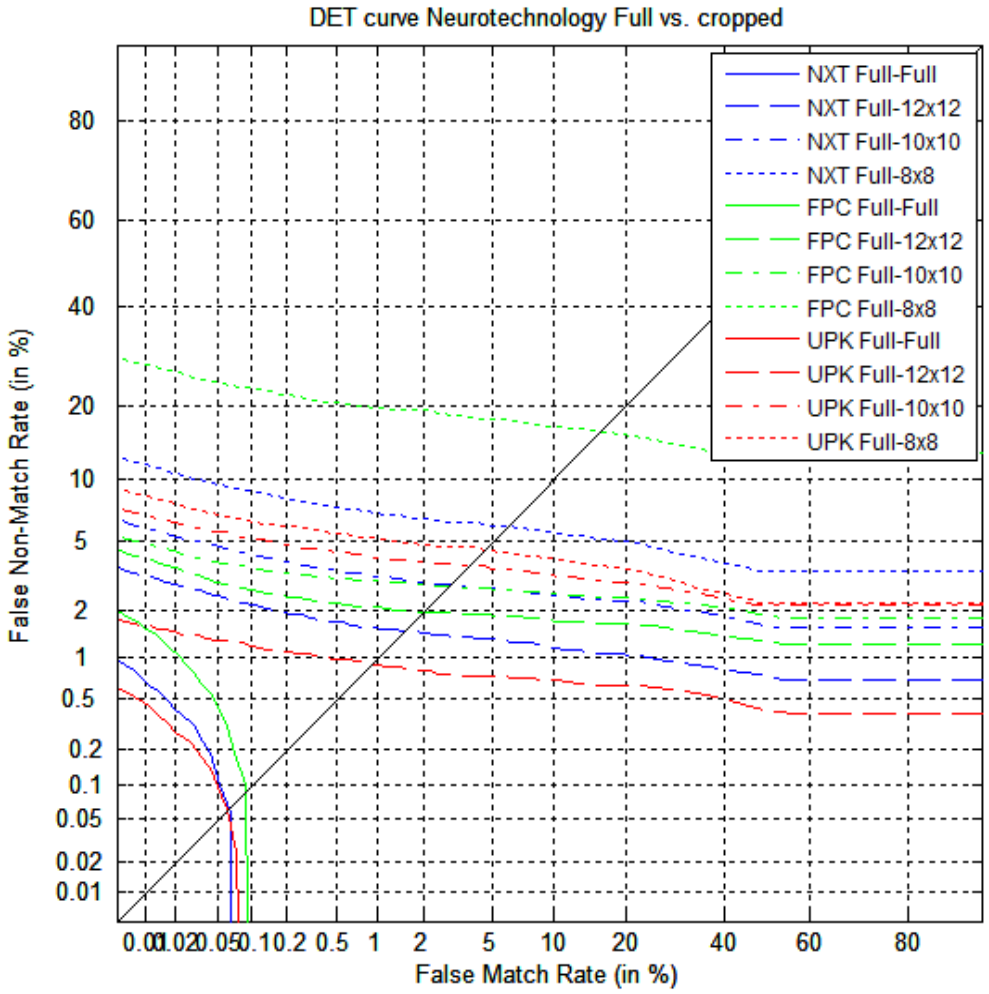
NBIS RESULTS

Sensor	Error rate	Full_Full	Full_12x12	Full_10x10	Full_8x8
NXT	FTP		0.00 %	0.0029 %	0.0038 %
	EER	3.88 %	12.43 %	20.49 %	36.47 %
FPC	FTP		0.00 %	0.00 %	0.0039 %
	EER	0.60 %	4.72 %	10.88 %	22.62 %
UPK	FTP		0.00 %	0.005 %	0.092 %
	EER	4.26 %	12.62 %	19.15 %	34.46 %

NBIS RESULTS



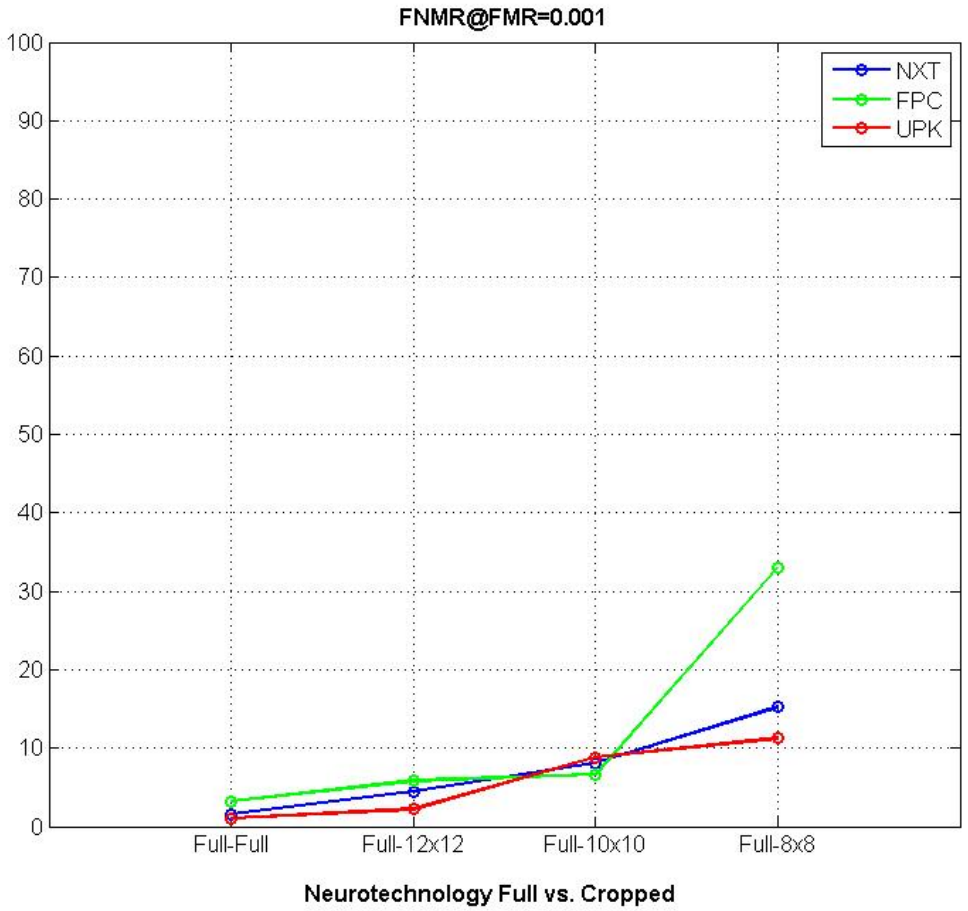
NEUROTECHNOLOGY RESULTS



NEUROTECHNOLOGY RESULTS

Sensor	Error rate	Full_Full	Full_12x12	Full_10x10	Full_8x8
NXT	FTP		9.86 %	31.06 %	73.29 %
	EER	0.0639 %	1.47 %	2.85 %	5.97 %
FPC	FTP		0 %	0 %	0 %
	EER	0.0925 %	1.96 %	2.80 %	16.04 %
UPK	FTP		6.49 %	0.00 %	68.14 %
	EER	0.0616%	0.90 %	3.70 %	4.48 %

NEUROTECHNOLOGY RESULTS



CONCLUSIONS

QUALITY:

- FPC presents more low quality samples.
- NXT sensor provides more high quality samples than UPK and FPC.
- FPC rejects more users because of quality ➔
  - a faster adaptation of the user to the NXT and UPK sensors, in the same level of easiness than with UPK.
  - Usability concerns with FPC
- Users felt more uncomfortable with the sensor having the smaller area

CONCLUSIONS

PERFORMANCE ALGORITHM-SENSOR PAIRS:

- NBIS and NEUROTECHNOLOGY:
  - FTE: NXT lower
  - FTA: FPC higher
  - EER: FPC best EER (1%) with NBIS, NXT and UPK best EER (0.006%) with NEUROTECHNOLOGY.
- BEST ALGORITHM RESULTS: NEUROTECHNOLOGY

CONCLUSIONS

IMPACT OF REDUCED AREA

- FTE rate increase enormously as the size of the image is reduced
- FTA: Neurotechnology: big effect of the "not many points"
- the smaller the image, the larger the rejection during acquisition, and the higher the error rates ➔ usability of a deployment concerns and the accuracy achieved

INTEROPERABILITY BETWEEN FULL SIZE AND REDUCED AREA

- Better results that with reduced images for both enrolment and acquisition.
- Using the Neurotechnology algorithm, the accuracy decreases in an order of magnitude with the size, but the error rates keep in a reasonable level (lower than 10% EER in most cases).

LESSONS LEARNED

- Using managed/interpreted languages for the evaluation process ➔ challenges in massive comparisons (memory management, garbage collection, core assignment, expected timing, etc).
- NFIQ does not provide consistent results ➔ An analysis of the results without using NFIQ is encouraged.
- The need of a mechanism to assure ground truth should be mandatory, even considering the impact to the mated distribution curve.

THANK YOU FOR YOUR ATTENTION!

"THE MADRID STUDY": A COMPARATIVE TEST OF FINGERPRINT SENSORS AND ALGORITHMS

More info at:

http://nextbiometrics.com/filarkiv/pdf/1_the_madrid_report_final_full_report.pdf