How Quality Influences Human-Computer Face Recognition

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Acknowledgements

- *In collaboration with*
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  - Nils Pénard
  - Janet Ayyad
  - Hervé Abdi
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Overview

- Rationale
- Background on the FRGC
- Testing humans
- Results
- Conclusions and implications

Problem

- Are face recognition algorithms *ready* for applications?
  - enormous improvements over last decade
  - accuracy of algorithms tested intensively
- *How accurate do they have to be to be useful?*
  - meet or exceed human performance

Why?

- *Humans are the competition!*
  - Human-machine comparisons *virtually* never done
- Putting algorithms in the field
  - Impact on security?
- Relative level of performance
  - “Easy” images
  - “Hard” images

Face Recognition Grand Challenge

Phillips, Flynn, Scruggs, Bowyer, Worek 2006

Independent Evaluation

FRVT 2002

July 2002

Technology Development

FRGC

May 2004 –

Mar 2006

Independent Evaluation

FRVT 2006

Jan 2006 –

Dec 2006

FRGC Objective

- The primary objective of the FRGC is to:

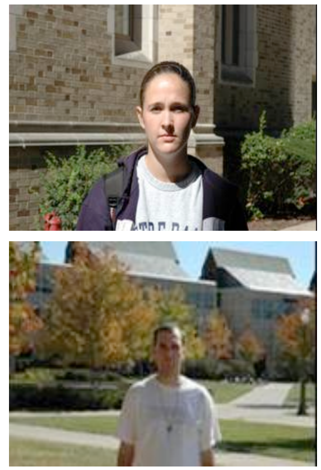
Develop still and 3D algorithms to improve performance an order of magnitude over FRVT 2002

Select Point to Measure

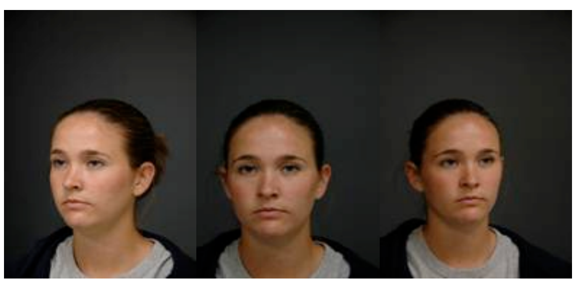
- **Verification rate at :**
  - False accept rate = 0.1%
- **Current:**
  - 20% error rate (80% verification rate)
- **Goal:**
  - 2% error rate (98% verification rate)

FRGC Modes Examined

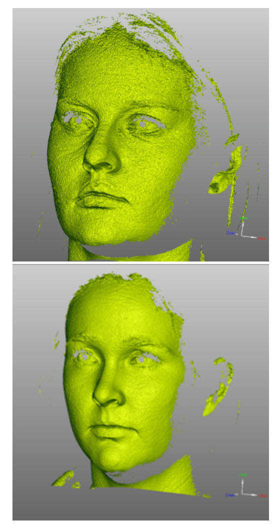
Single Still



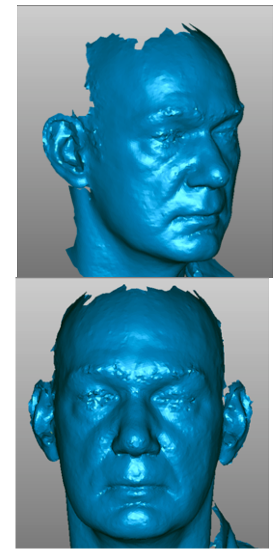
Outdoor/
Uncontrolled



Multiple Stills



3D Single view



3D Full Face

FRGC Experiments

Exp 1: Controlled indoor still versus indoor still

Exp 2: Multiple still versus multiple still

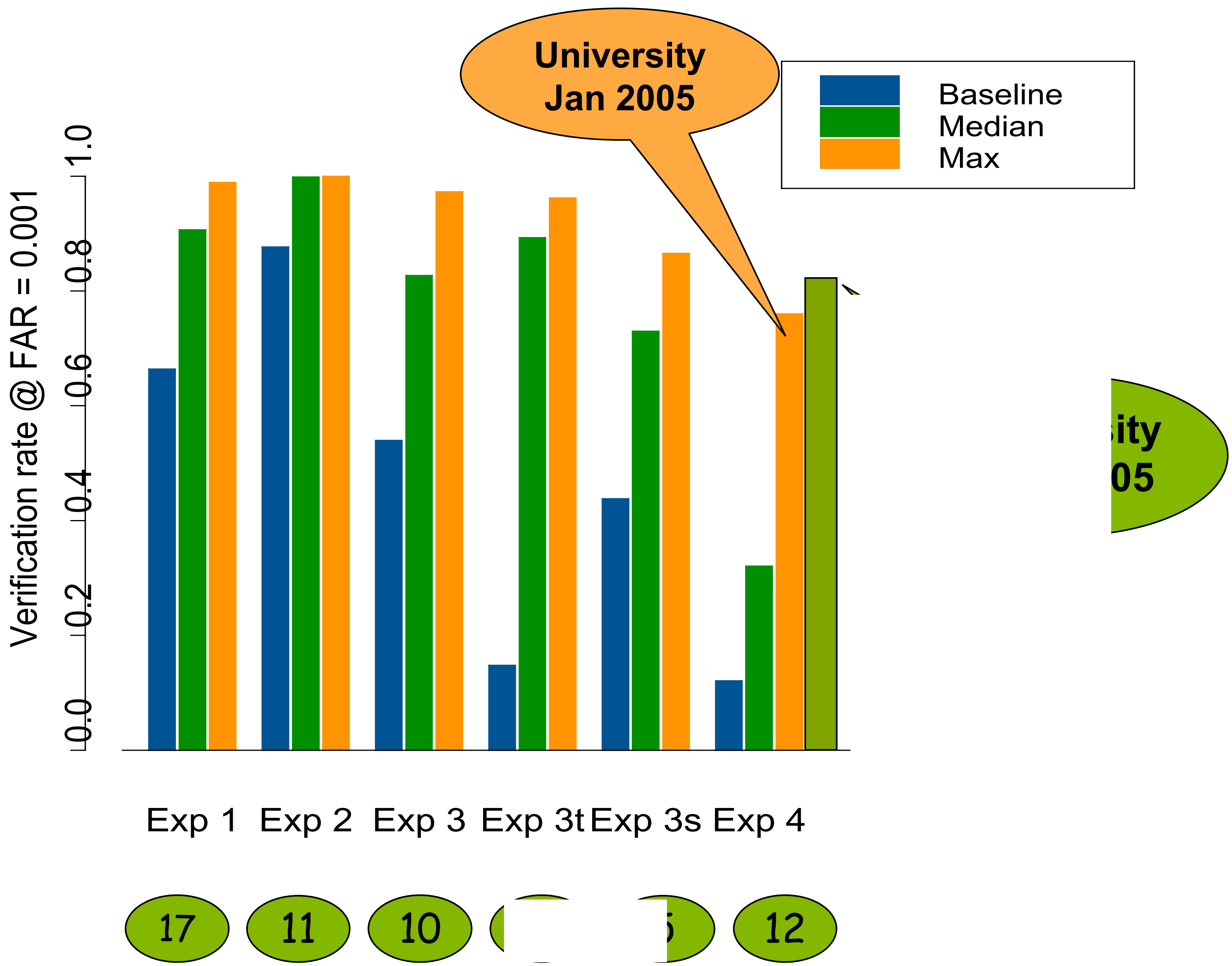
Exp 3: 3d versus 3D
3t - Texture only
3s - Shape only

Exp 4: Uncontrolled still versus indoor still

Size of Experiments

Exp.	Target set size	Query set size	No. Sim Scores (million)
1	16,028	16,028	257
2	4,007	4,007	16
3	4,007	4,007	16
4	16,028	8,014	128

FRGC Progress



Human-Computer Comparison

O’Toole, Phillips, Jiang, Penard, Ayyad, Abdi 2005

Human-Machine Comparisons

- Same image pairs from Exp. 4
- Seven state-of-the-art algorithms
  - 4 from industry
  - 3 from academic institutions
- Comparisons
  - 120 difficult face pairs
  - 120 easy face pairs

Sampling

- homogeneous
  - caucasian males/females 20-30 yrs
  - comparisons made on identity not
    - age, race, sex

Comparing Humans and Algorithms

- problem
  - 128 million face pairs?

- sample face pairs
  - most difficult
  - easiest

Easy and Difficult

- PCA Baseline Algorithm
  - scaled and aligned images (SAIC)
  - available and widely used since the 90's
  - but not state-of-the-art

Selecting Easy/Difficult Pairs

- *"easy" match pairs*
  - 2 "similar" images of same person
    - similarity scores > 2 sd ***above*** mean similarity of match pairs
- *"difficult" match pairs*
  - 2 "dissimilar" images of same person
    - similarity scores < 2 sd ***below*** mean similarity of match pairs
- *"easy" no-match pairs*
  - 2 "dissimilar" images of different people
    - similarity scores < 2 sd ***below*** mean similarity of no-match pairs
- *"difficult" no-match pairs*
  - 2 "similar" images of different person
    - similarity scores < 2 sd ***above*** mean similarity of no-match pairs

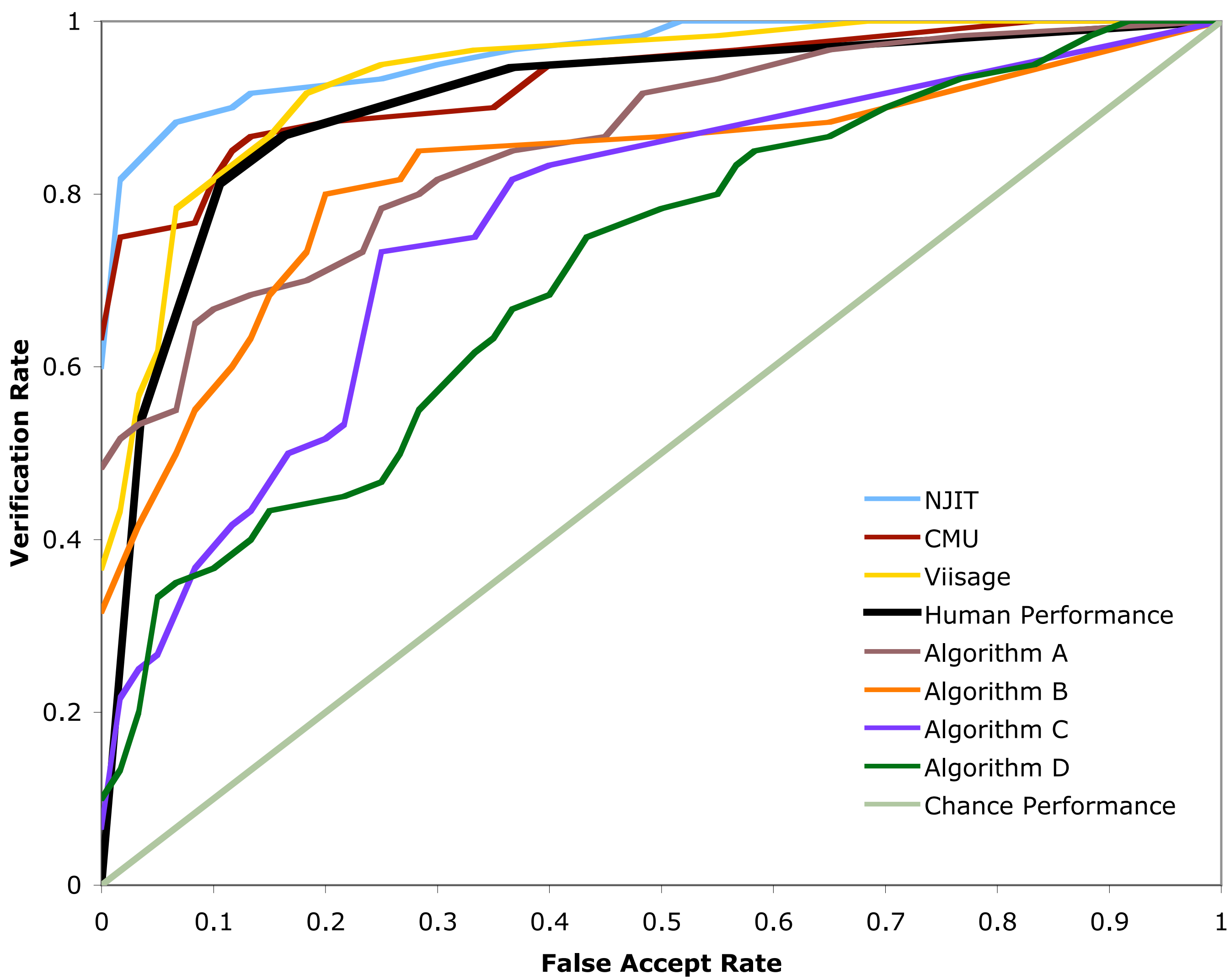
Methods

- Stimuli
  - 240 pairs of faces
    - 120 male pairs
      - 60 easy
      - 60 difficult
    - 120 female pairs
      - 60 easy
      - 60 difficult

Procedure

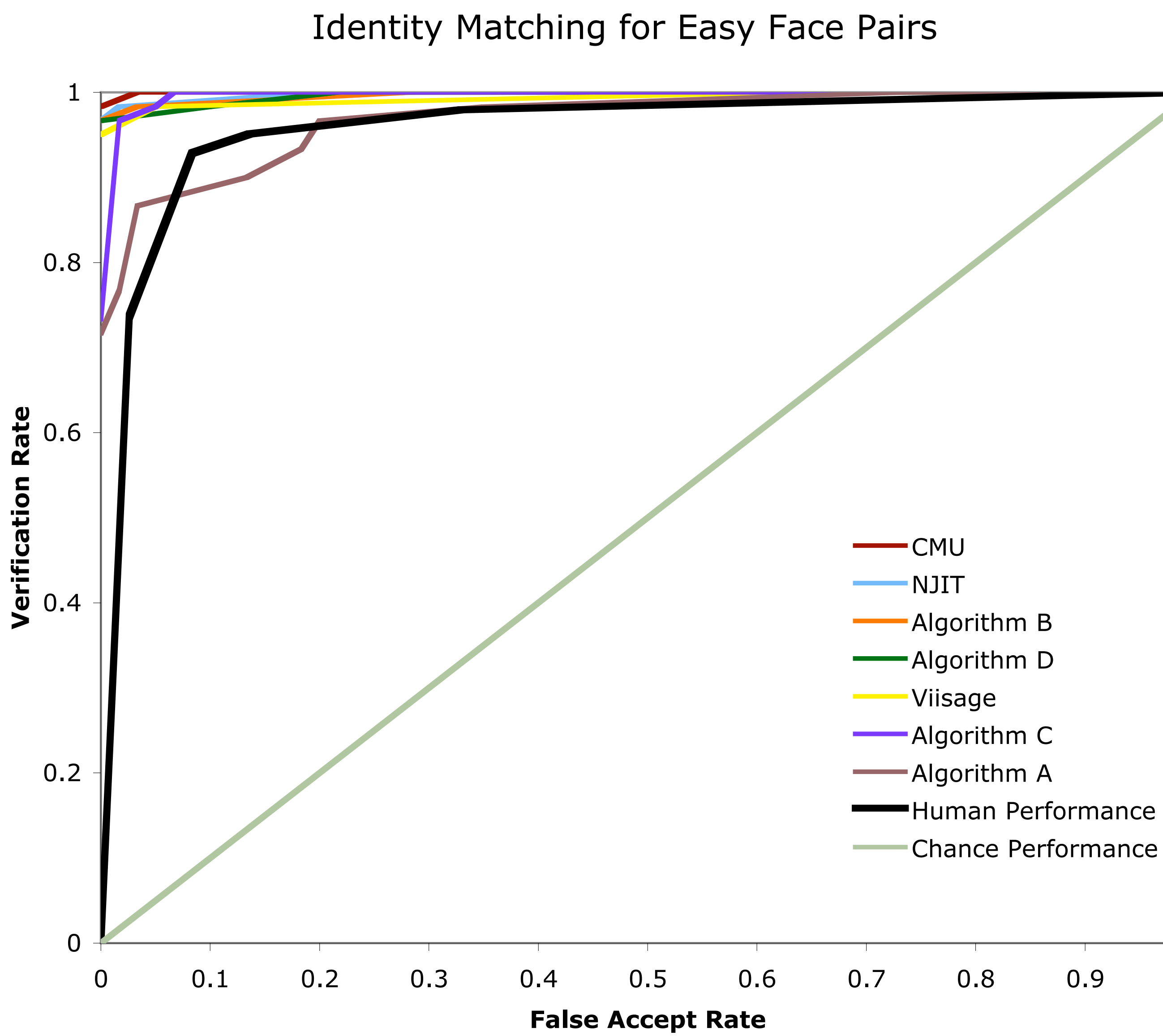
- Human subject raters respond…
  - 1. sure they are the same person
  - 2. think they are the same person
  - 3. not sure
  - 4. think they are not the same person
  - 5. sure they are not the same person

Identity Matching for Difficult Face Pairs



Results Summary

- 3 algorithms surpass humans!
  - NJIT (Liu, *IEEE: PAMI, in press*)
  - CMU (Xie et al., 2005) (In three talks)
  - Viisage (Husken et al., 2005)
- 4 less accurate than humans


Identity Matching for Easy Face Pairs
Verification Rate
False Accept Rate
0
0.2
0.4
0.6
0.8
1
0.1
0.3
0.5
0.7
0.9
CMU
NJIT
Algorithm B
Algorithm D
Viisage
Algorithm C
Algorithm A
Human Performance
Chance Performance

Conclusions

- Algorithms compete favorably with humans on the difficult task of matching faces across changes in illumination
  - some algorithms are *better* than humans on “difficult” face pairs
  - nearly all are *better* than humans on “easy” face pairs

We Have Quality

FRVT
2006

ICE
IRIS CHALLENGE EVALUATION