

Comparison and Combination of Visible and IR Image Face Recognition

Xin Chen, Patrick J. Flynn, Kevin W. Bowyer
Department of Computer Science & Engineering
University of Notre Dame

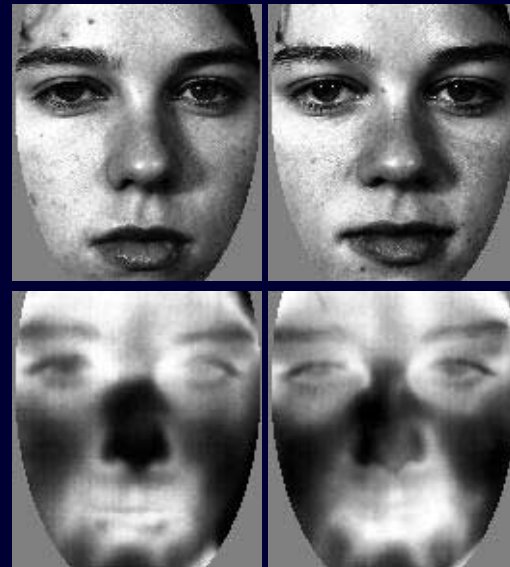
Introduction

- Motivation

- Uncontrolled illumination
- Twin identification
- Cosmetic

- Previous work

- Socolinsky *et al.*
- Wilder *et al.*



Acknowledgments

This work is supported by DARPA through Office of Naval Research N000140210410, and CIA and NSF through National Science Foundation EIA 01-30839.

Outline

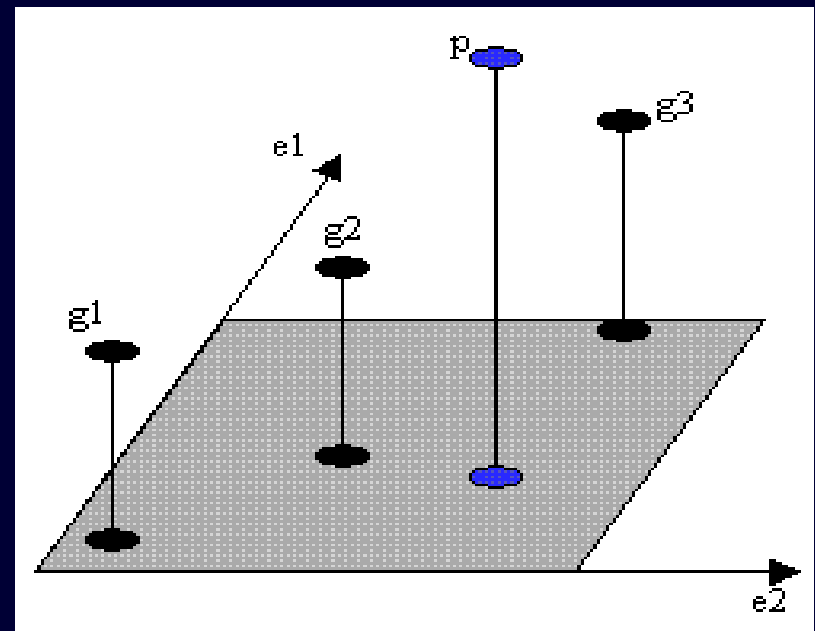
- **Introduction**
- **Experimental design**
- **Recognition in different scenarios**
 “same session” / “time lapse”
- **Combination of visible and IR**
- **Conclusion**

Experimental design

- Recognition method (PCA)
 - Training set: form a face space
 - Gallery set: “enrolled” images
 - Probe set: images to be recognized

- Software

- CSU Face Identification Evaluation System, 5.0



Data acquisition

■ Sensor

- Merlin uncooled microbolometer camera, Indigo Systems Corp.
- 12 bit, 320 x 240 resolution

■ Illuminations

- FERET light (LF), Mug shot light (LM)

■ Facial expressions

- Neutral (FA) and Smiling (FB)

Data acquisition cont.



FA|LM



FB|LM



FA|LF



FB|LF

Preprocessing

- Truth-writing
 - Locate eye centers manually
- Normalization



1200x1600



150x130



320x240



150x130

Same-session Recognition

	FA LF	FA LM	FB LF	FB LM
FA LF		0.98 0.98	0.99 0.98	0.99 0.94
FA LM	0.99 0.95		0.94 1.00	0.95 1.00
FB LF	0.96 0.95	0.95 1.00		1.00 1.00
FB LM	0.98 0.89	0.96 0.98	1.00 0.98	

— IR
— Visible

Training:
240

Gallery:
83

Probe:
83

Time-lapse Recognition

	FA LM	FA LF	FB LM	FB LF
FA LM	0.83 0.91	0.84 0.93	0.77 0.73	0.75 0.71
FA LF	0.81 0.92	0.82 0.92	0.74 0.75	0.73 0.73
FB LM	0.77 0.77	0.80 0.81	0.79 0.86	0.78 0.85
FB LF	0.73 0.75	0.76 0.79	0.77 0.90	0.76 0.90

— IR
— Visible

Training:

240

Gallery:

64

Probe:

431

Time-lapse Recognition cont.



Time-lapse Recognition cont.

Week
7



Week
9



Week
8

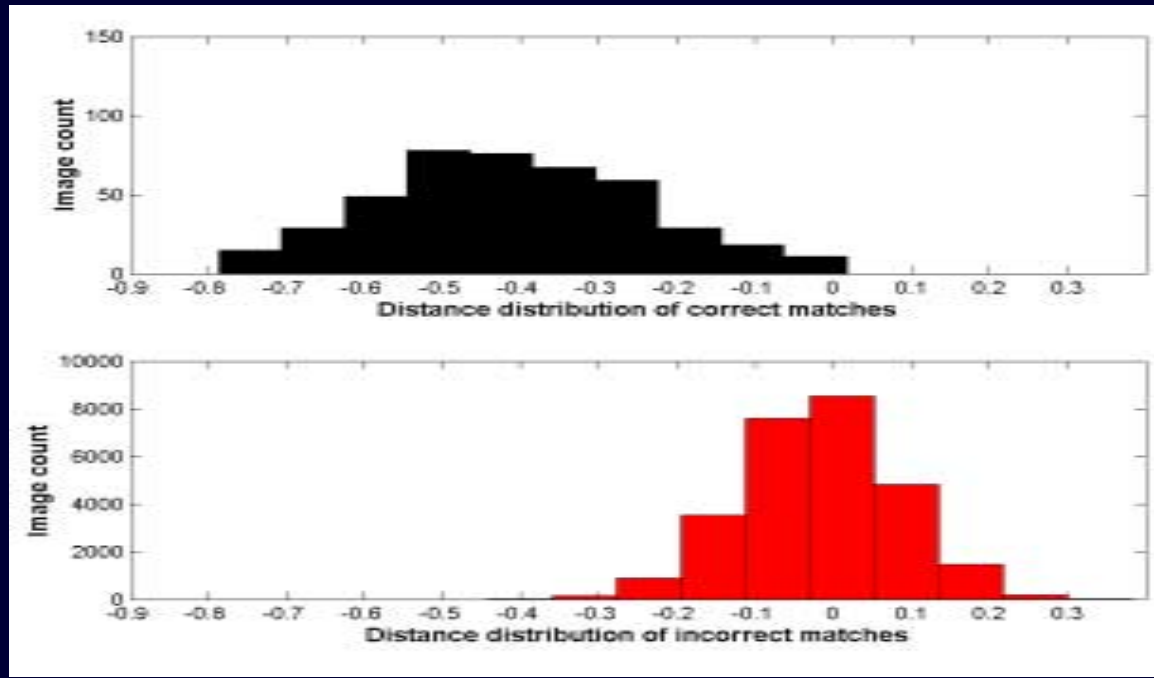


Week
10

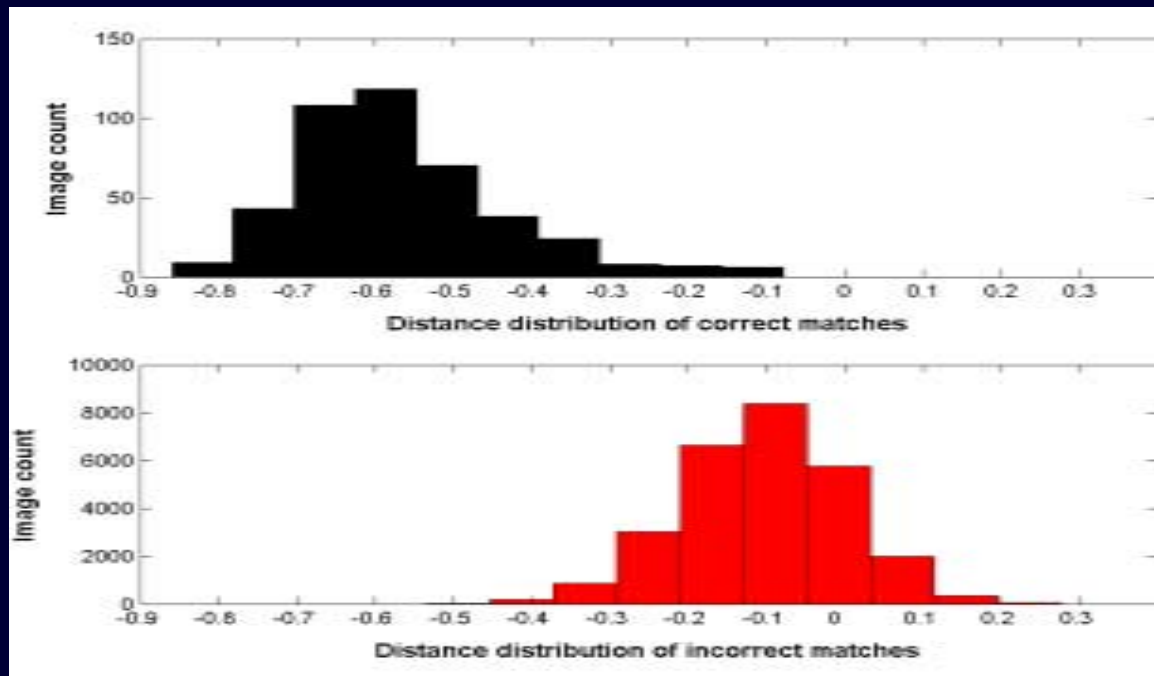


Note relative values on forehead and cheek in different weeks.

Match and Non-match Score Distrib.



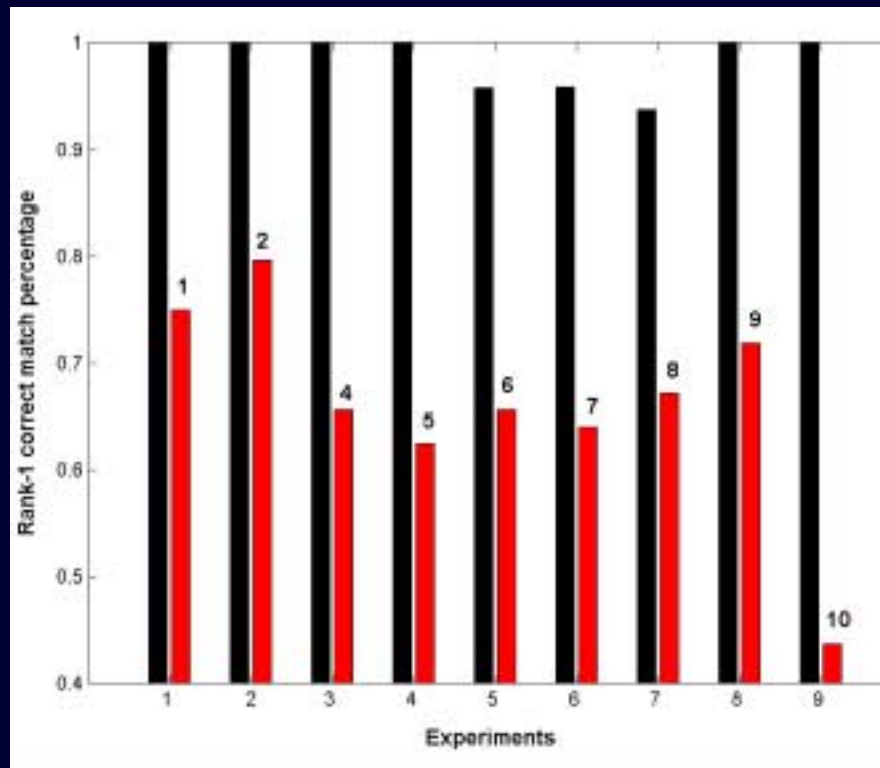
IR



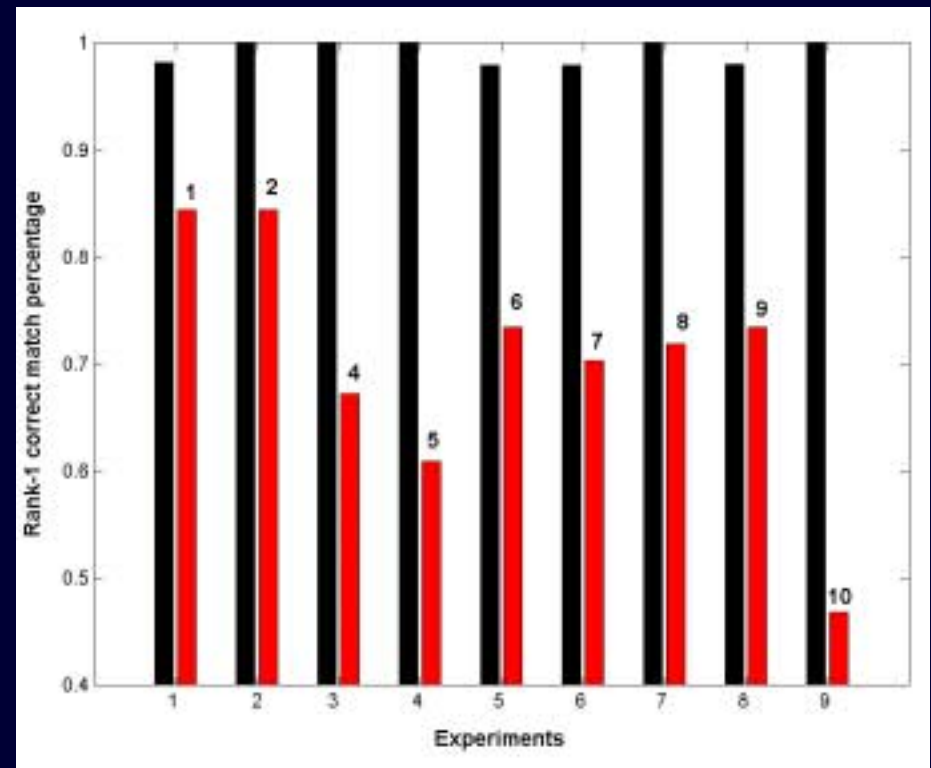
Visible

Same-session vs Time-lapse

— Same-session
— Time-lapse



IR

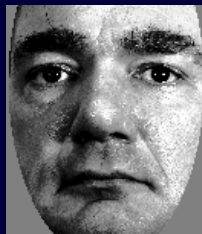


Visible

Combination of Visible and IR

- Decision level fusion
 - Score transformation
 - Sum of distances

Example:
Time-lapse
recognition
Gallery:
FA|LF
Probe:
FB|LM



IR

→ 74%

Visible

→ 75%

IR + Visible

→ 91%

Combination cont.

	FA LM	FA LF	FB LM	FB LF
FA LM	0.83 0.91 0.95	0.84 0.93 0.97	0.77 0.73 0.90	0.75 0.71 0.90
FA LF	0.81 0.92 0.95	0.82 0.92 0.97	0.74 0.75 0.91	0.73 0.73 0.90
FB LM	0.77 0.77 0.91	0.80 0.81 0.94	0.79 0.86 0.92	0.78 0.85 0.92
FB LF	0.73 0.75 0.87	0.76 0.79 0.91	0.77 0.90 0.93	0.76 0.90 0.95

Top:
IR

Middle:
Visible

Bottom:
IR+Visible

Conclusions

- **Neither modality is clearly significantly better than another in same-session recognition.**
- **Performance degrades noticeably in time-lapse scenario relative to same-session.**

Conclusions cont.

- **Visible imagery outperforms IR in time-lapse scenario.**
- **Combination of visible and IR outperforms either alone.**

Contact Information

xchen2@cse.nd.edu

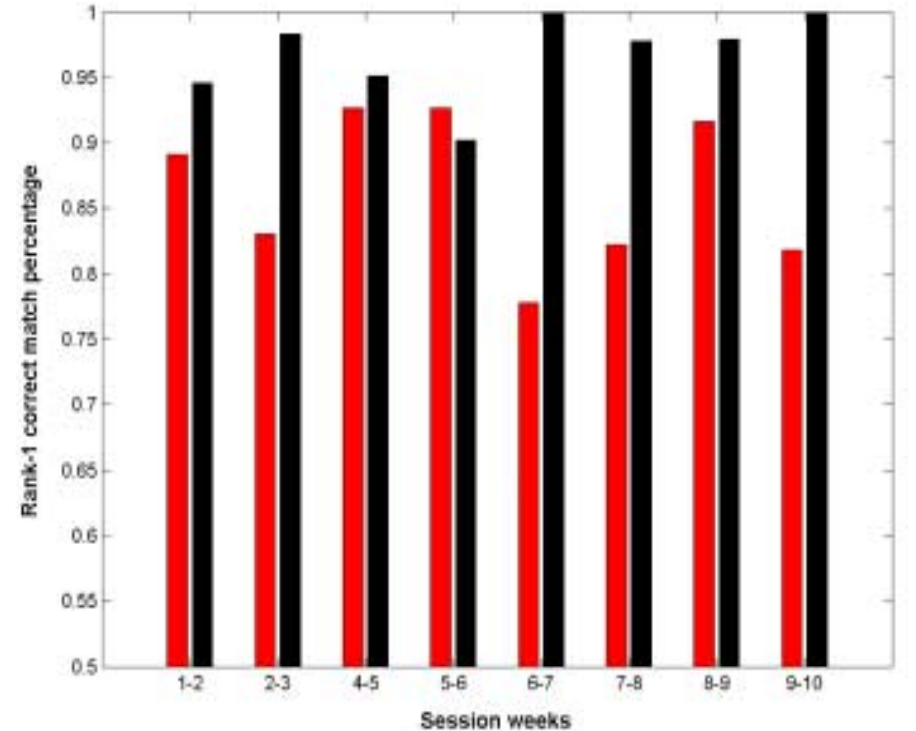
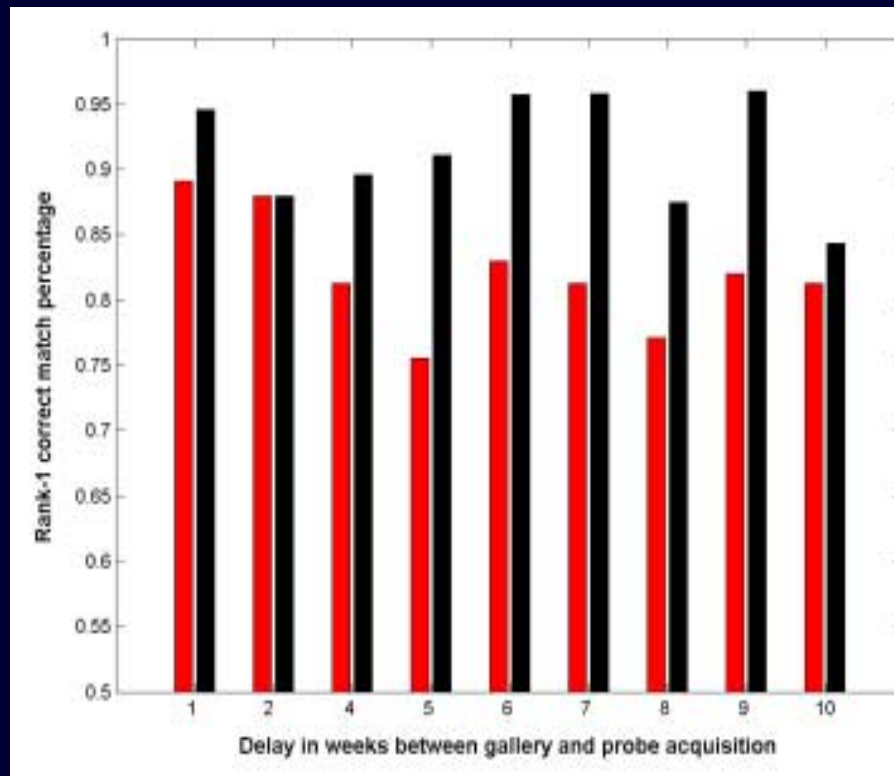
flynn@cse.nd.edu

kwb@cse.nd.edu

<http://www.nd.edu/~cvrl/>

Assessment of Time Dependency

— Visible
— IR



Different elapsed time

Constant elapsed time