



# Fingerprint recognition performance in rugged outdoors and cold weather conditions

Ron F Stewart<sup>1</sup>, Matt Estevao<sup>2</sup>,  
Andy Adler<sup>2</sup>

<sup>1</sup>Orica Canada Inc

<sup>2</sup>Carleton University, Ottawa, Canada

# Background:

- Security required in hazardous chemicals and explosives industries:
  - Access control: buildings/magazines
  - Authorization of use of explosives equipment
  - Electronic blasting
- Biometrics technologies show key promise
- Requirement: need good performance in rugged outdoors and extreme weather
  - Hot weather performance has good recent experience, so we were interested in cold.

# Research Approach / Questions

- We identified fingerprint biometrics as the most promising for the application:
  - Match to required workflow (using positive action)
  - Well understood operationally / multiple providers
- Biometrics *scenario evaluation* to determine:
  - Hardware/sensor performance issues:
  - Fingerprint physiology performance issues:
  - Usability factors



Blaster unit with added Biometric lock

# Research Approach / Questions

Hardware/sensor performance issues:

- Technology reliability
- Failure modes
- Effects of dirt / weather on sensors.

Fingerprint physiology performance issues:

- Fingerprint performance vs. temperature/humidity.
- Cold makes stiffer skin with less blood perfusion.  
We expect lower performance due to
  - Low compliance of friction ridges (optical scanner)
  - Increased impedance of dry skin (semiconductor)

Usability factors

- ... which can be addressed in training or interface.

# Experimental Configuration

Door access configuration at Orica regional explosives center near Ottawa (large temp range  $-35\text{ C} - +35\text{C}$  ).

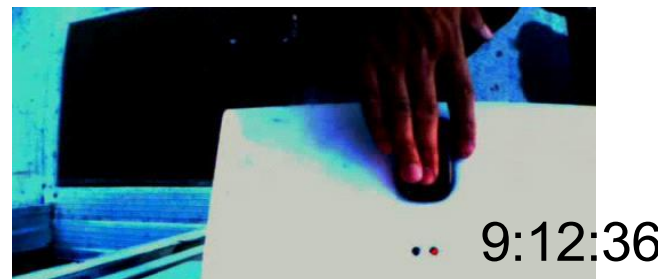
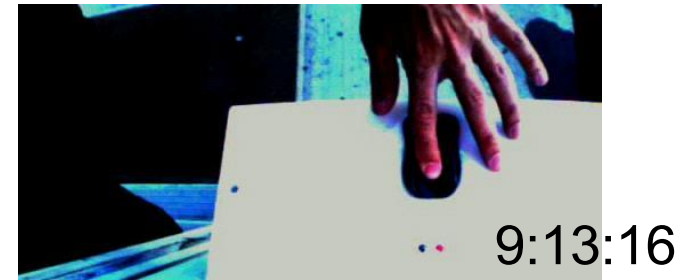
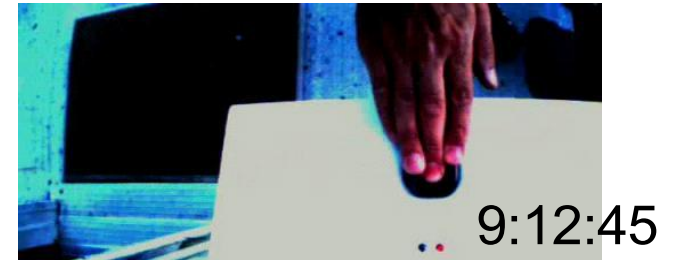
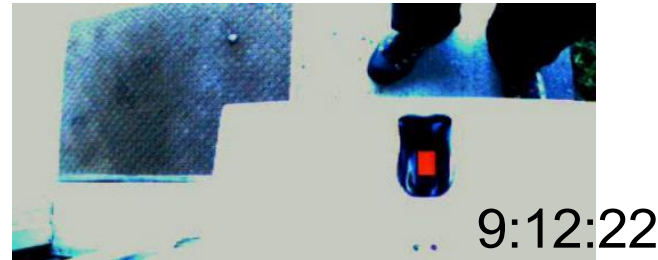
- Video of users
- Chip based scanner for 1 year (UPEK TCS1)
- Optical scanner for 1 year (Futronic FS88)
- Heated / weather sealed box



# Data Analysis: Unusual Usages

**Rapid  
alternating of  
fingers**

*Cause:*  
Feedback on  
indicator lights  
was too slow  
(1.0 sec. capture  
+  
1.0 sec. process)



# Data Analysis: Unusual Usages



- Cupping of hands around scanner.  
*Cause:* Indicator lights were not sufficiently bright in bright sunlight
- Chip sensor too hot to touch in direct sun

# Survey: overall, this population likes biometric technology, when it works

How would you describe your understanding of biometrics technology before this study?

- None (75%). Pretty good familiarity (25%)

Did you have any concerns about this project and usage of fingerprints?

- None.

Overall, what did you like about fingerprint access technology?

- In order of frequency: 1) Ease of use, 2) Not needing keys, 3) Convenient, 4) "Knowing system recognizes me"

Overall, what did you dislike about fingerprint access technology?

- In order of frequency: 1) It doesn't work sometimes, 2) Takes a long time to analyze print and make decision, 3) Too hot to use in sunshine in summertime

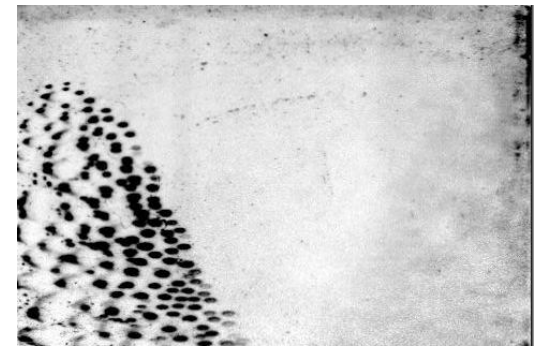


# Capacitive Sensors: Reliability and Faults

- Two capacitive sensors failed (on cold winter days,  $\approx -25^{\circ}\text{C}$ ).
  - On one unit condensation caused short.
  - No visible failure on other sensor
- In direct sun the capacitive sensor surface became unbearably hot to use

# Optical Sensors: Reliability and Faults

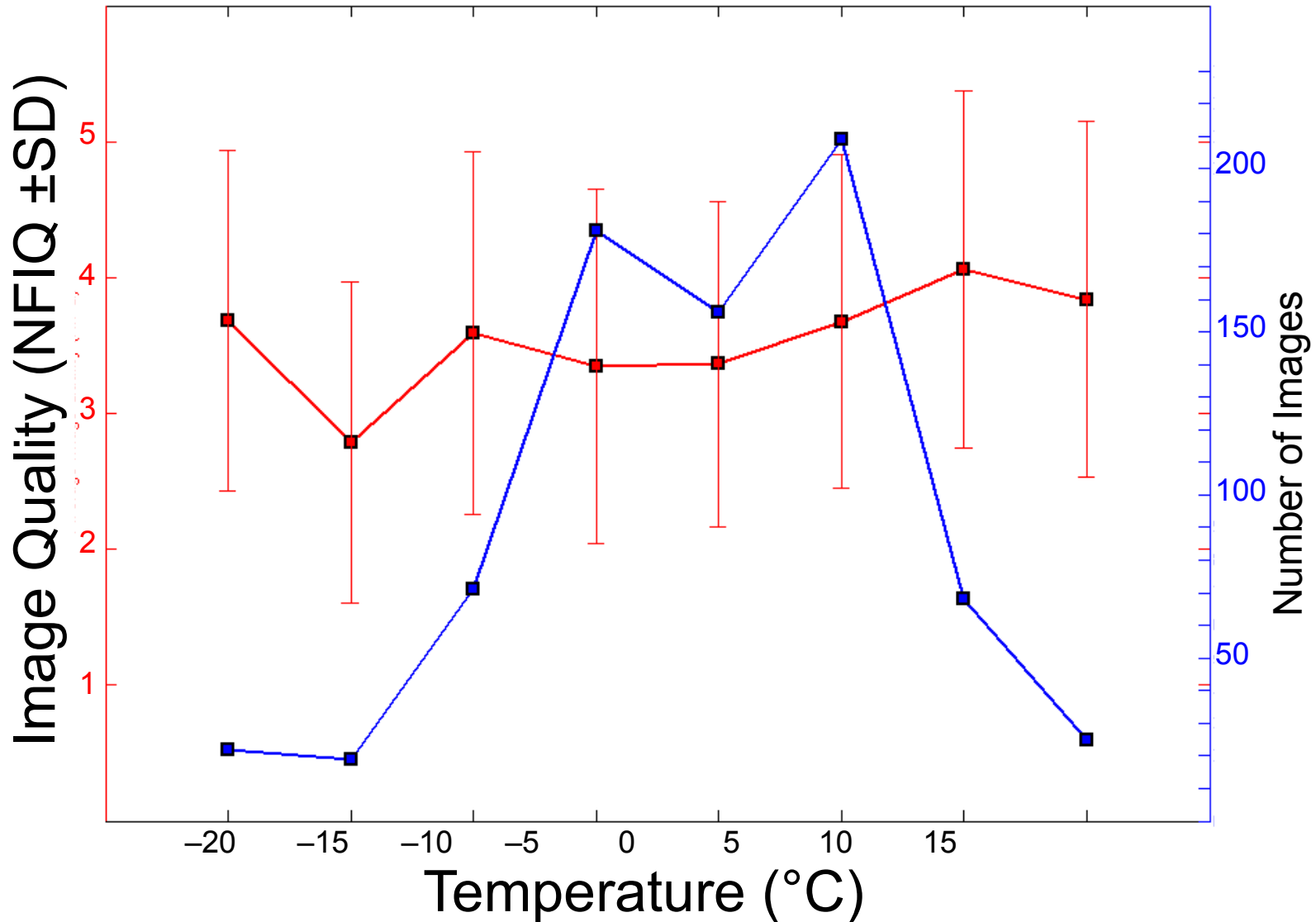
- condensation collected under the lexan optical window (on wet snow winter day)
- Liveness didn't work well
  - Especially in winter
- "Ghost" images
  - From sun on rain droplets (causing a reject)
  - From sun shining through latent prints of previous users (sometimes being accepted)



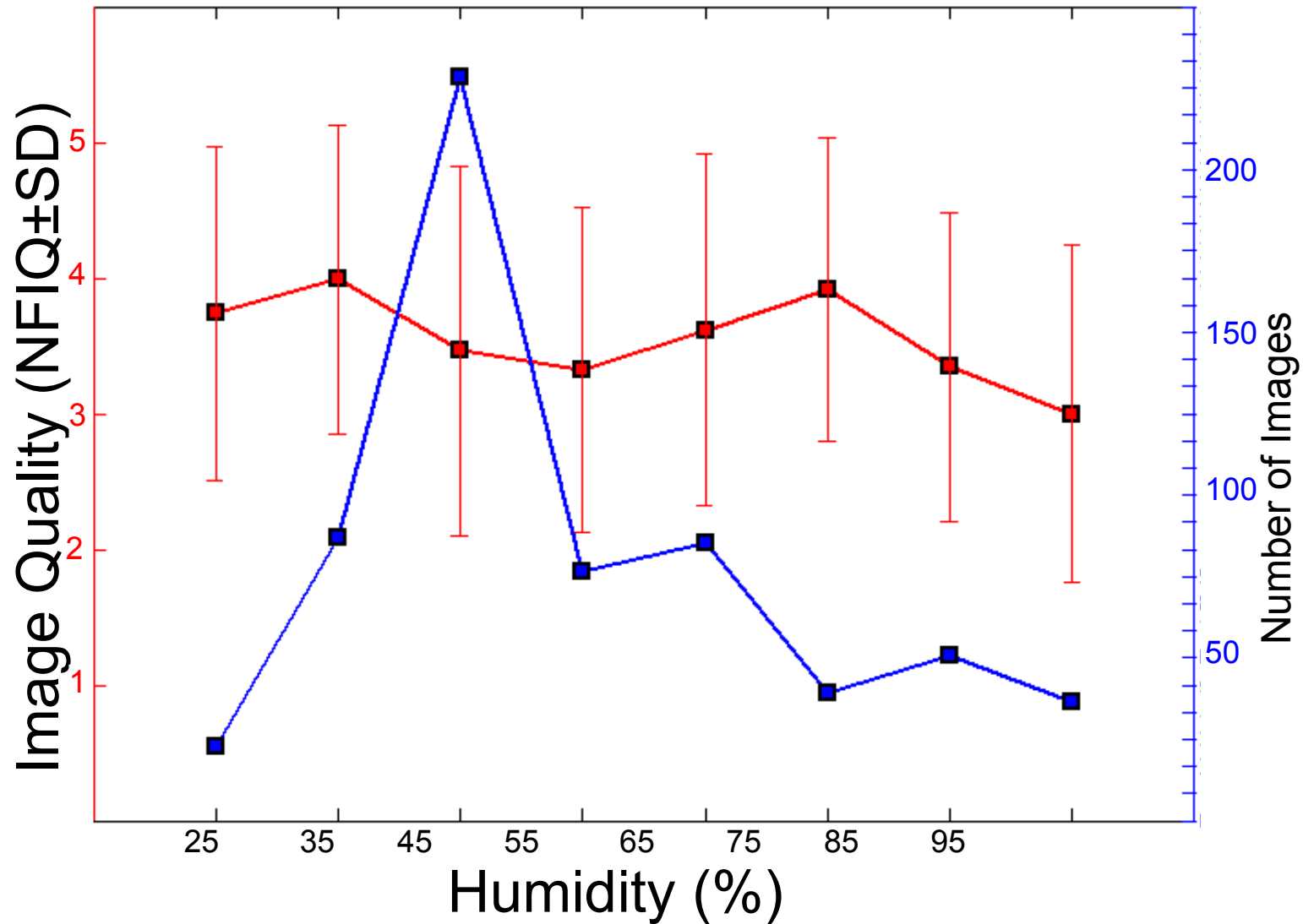
# Cold / Humidity Effects

- Methods:
  - Reject Rate vs. Temp / Humidity
  - Fingerprint Quality (NFIQ) vs. Temp / Humidity
- Overall, no significant correlation found.
  - Thus, our data show fingerprints work equally well in cold weather
  - This result surprised us, since anecdotal evidence has suggested a difference.

# Quality vs. Temperature



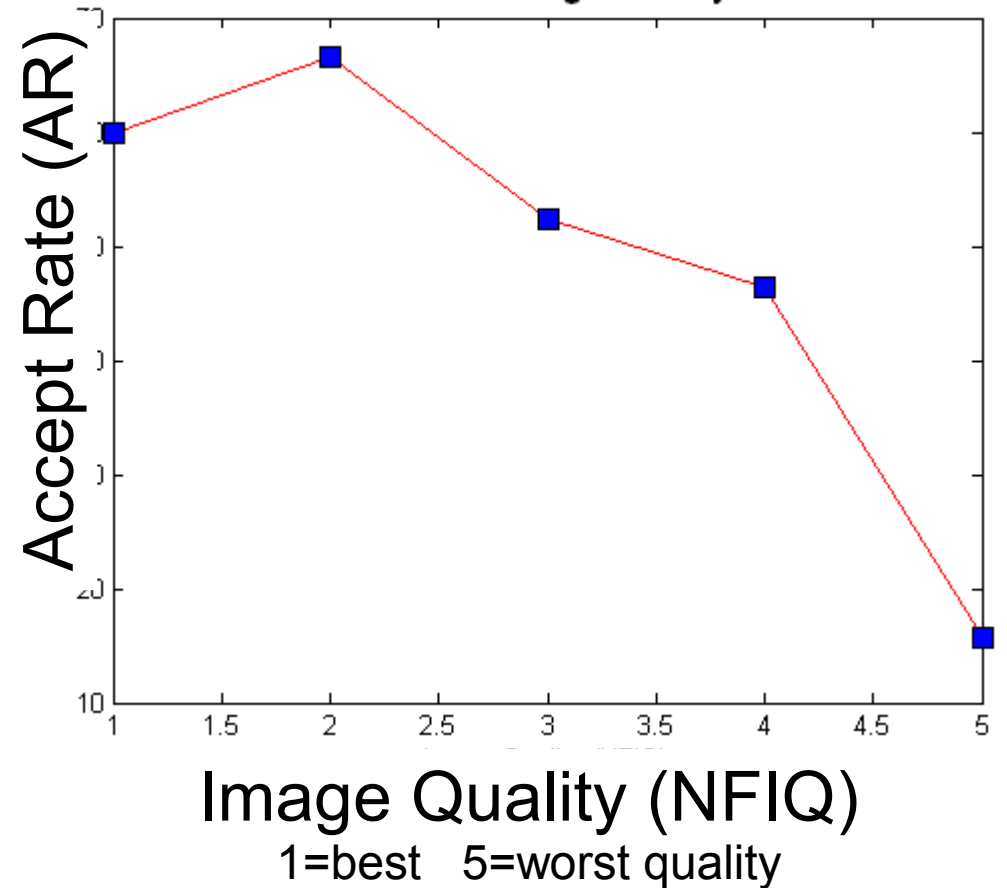
# Quality vs. Humidity



# Quality vs Accept Rate

Validation of measure:

- Even though Quality (NFIQ) does not correlate to environmental variables, it does correlate to the AR for the study



# Discussion

Results suggest:

- biometric performance has no significant dependence on temperature and humidity:  
–30°C – +20°C
- both chip based and optical fingerprint scanners have some issues in rugged and cold weather applications
  - Issues can be addressed by system design
- fingerprint biometric technology has a good level of usability in this application.
  - Users are broadly satisfied with use of this technology.