



**Biometric Standards, Performance,
and Assurance Laboratory**



DEPARTMENT
OF
INDUSTRIAL TECHNOLOGY
PURDUE UNIVERSITY

Securing a Restricted Site

Biometric Authentication at Entry Point

Eric Kukula & Stephen Elliott, Ph.D.

epkukula@tech.purdue.edu & sjelliott@tech.purdue.edu

Biometric Standards, Performance, and Assurance Laboratory

www.biotown.purdue.edu

*Department of Industrial Technology, School of Technology,
Purdue University, West Lafayette, IN 47906*



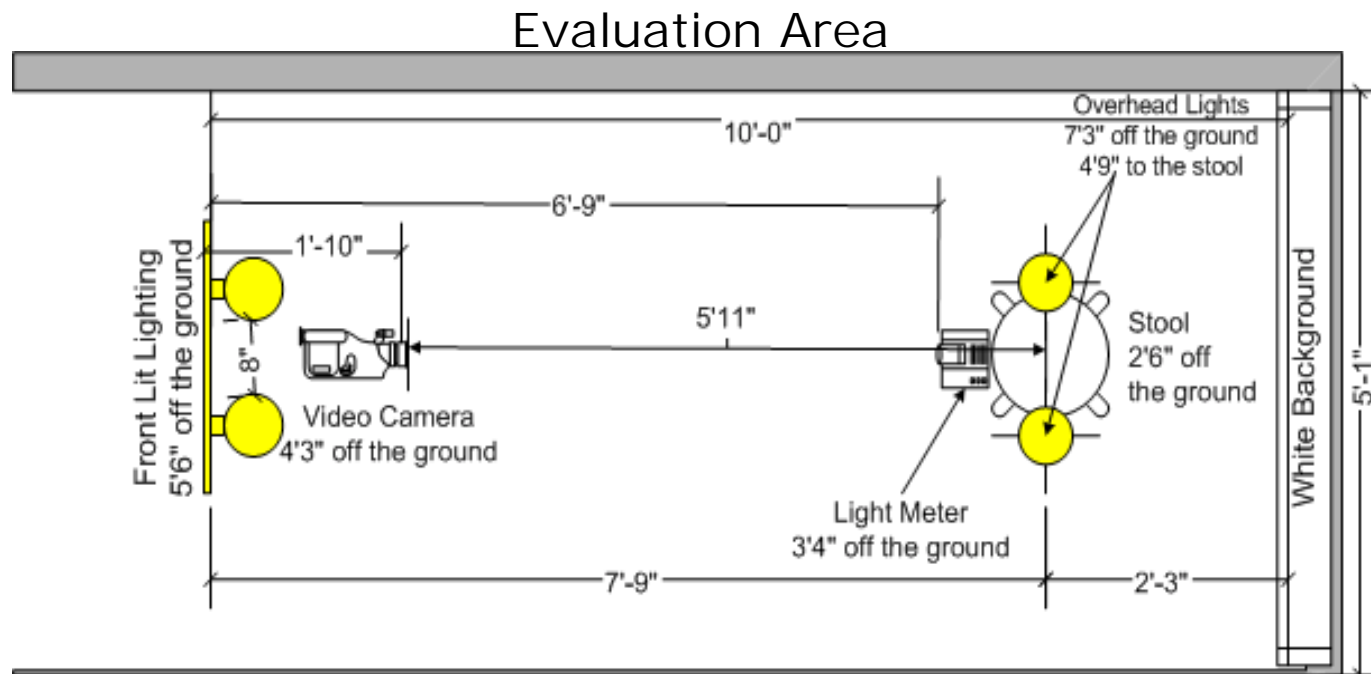
Introduction

- This evaluation examined the influence of variations in illumination on the performance of a face recognition algorithm, specifically with respect to factors of:
 - Age
 - Gender
 - Ethnicity
 - Facial characteristics
 - Facial obstructions



Experimental Setup

- This evaluation took place in Biometric Standards, Performance and Assurance Laboratory in the School of Technology at Purdue University.





Illumination Levels

1. The first light level, 7 -12 illuminance (lux) referred to as low illuminance, was determined by logging 60 minutes of data from a local campus restaurant.
2. The second light level, 800 – 815 illuminance (lux) referred to as high illuminance, was determined by logging 60 minutes of data from the Industrial Technology office.
3. The third light level, 407 – 415 illuminance (lux), referred to as medium illuminance, was determined by taking the mean of the other two light levels.



Sample Images from the Data Set



Low Illuminance
8 Lux

Medium
Illuminance
423 Lux

High Illuminance
800 Lux



Volunteer Crew

Gender	Male	73%
	Female	27%
Age	20 - 29	73%
	30 - 39	10%
	40 - 49	10%
	50 & older	7%
Ethnicity	African American	0%
	Asian/Pacific Islander	13%
	Caucasian	73%
	Hispanic	13%
	Native American	0%
Features	Facial Hair	30%
	Glasses	24%
	Hair over Face	0%
	Hats	6%
	Scars	3%
	None	36%



Testing Protocol

- Each enrollment collected a 100 images of the participants face from different directions to form a template
 - Subjects enrolled three times
 1. Low Illuminance (7 – 12 lux)
 2. Medium Illuminance (407 -412 lux)
 3. High Illuminance (800 – 815 lux)
- Each participant made three verification attempts in each of the three scenarios over a period of three visits for a total of 27 verification attempts per visit.

Evaluation Matrix

	Enrollment Conditions		
	7 - 12 lux	407 - 412 lux	800 - 815 lux
Verification Attempts	3 Low	3 Low	3 Low
	3 Medium	3 Medium	3 Medium
	3 High	3 High	3 High



Results

Failure to Enroll Rates & Failure to Acquire Rates

	FTE*	FTA
Low Illuminance (7 - 12 lux)	6.25%	0.92%
Medium Illuminance (407 - 412 lux)	3.22%	0.65%
High Light (800 - 815 lux)	1.09%	0.00%

* FTE included subjects that wore hats. The testing protocol placed no restrictions on participants' style of dress. After 3 attempts failed, the subject was asked to remove the hat. When removed, the subject was able to enroll.

Verification Rates

	Low Enrollment 7 - 12 lux	Medium Enrollment 407 - 412 lux	High Enrollment 800 - 815 lux
Verification Attempts 7-12 lux	89.62%	73.88%	80.55%
Verification Attempts 407 - 412 lux	57.40%	91.48%	89.44%
Verification Attempts 800 - 815 lux	58.70%	95.37%	94.25%



Conclusions

- The results of this study show that there are still significant challenges with regard to illumination levels and face recognition especially at lower illumination levels
- Further research will be conducted at Purdue University's Biometric Standards, Performance and Assurance Laboratory dealing with lighting effects and background changes
- This report may be downloaded at <http://www.tech.purdue.edu/it/resources/biometrics/bc2003.htm>