

Door Knob Hand Recognition System

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2 Door Knob Hand Recognition System

- Door Knob Imaging (DKI) Structure
- Feature Extraction and Classification

3 Performance



Outline

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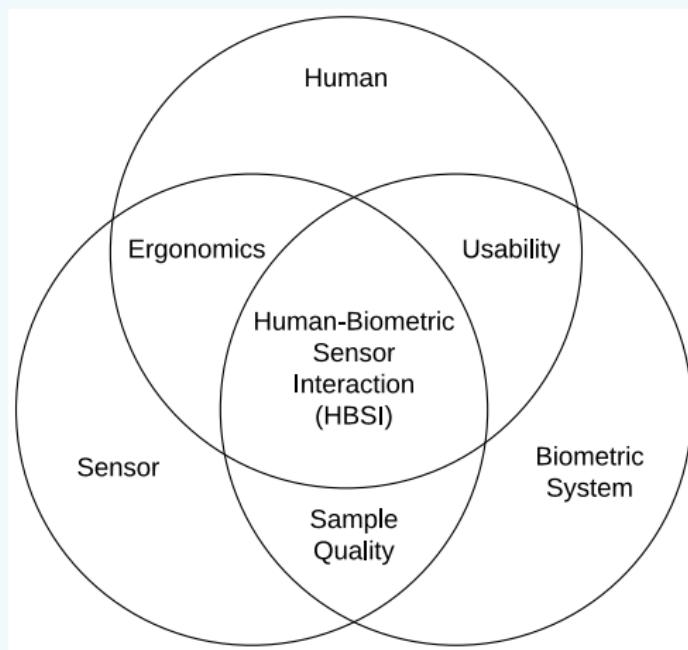
Background

- Biometrics has been utilized worldwide.
- A great amount of users have been educated of the convenience and security of biometric systems.
- There is an expanding need of biometric systems in everyday life.
- However, the majority of the biometric systems tend to consider ergonomics a secondary element in system developing.
- Thus, we proposed an ergonomic hand biometric system.



Human-Biometric Sensor Interaction Model

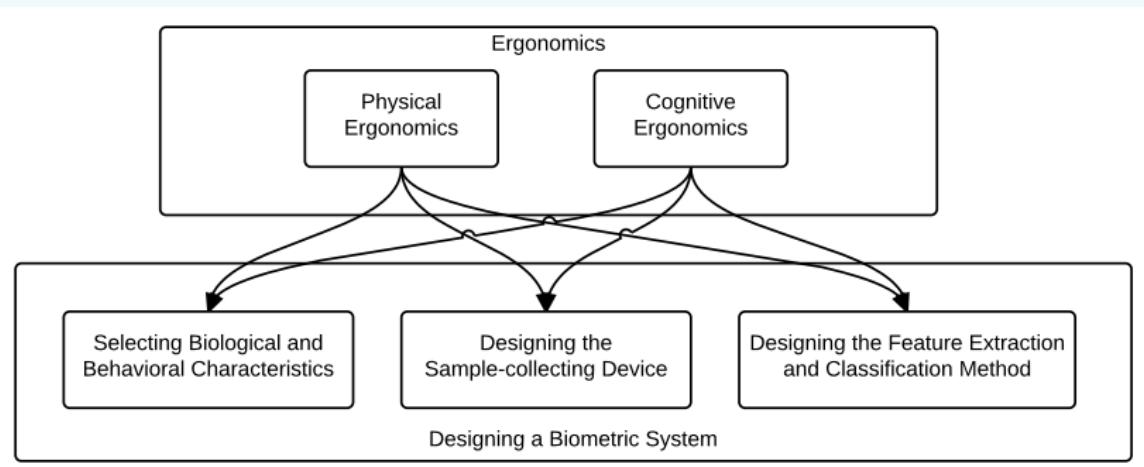
- Human Biometric Sensor Interaction Model analyzed and evaluated the behaviors between the sensor, system and user.



Ergonomic Biometrics Design (EBD) Model



- Considering both physical and cognitive ergonomics in the first stage/in all developing stages/in collaborating with recognition performance.





Door Knob

- Basic idea: the most conventional and widely used Access Control device (for over 100 years since 1893) and a perfect physical design which has been evolved for so many years.
- “Open the door just like it is not locked”.





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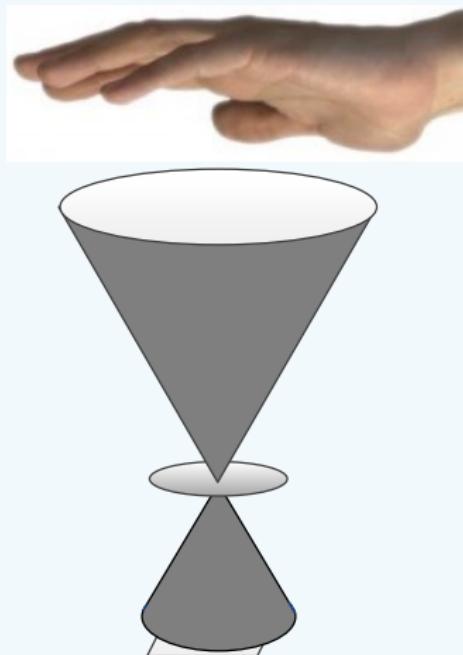
Two Challenges

- Imaging: Design a small, compact, and ergonomic hand image collecting device.
- Feature Extraction: Employ an effective and efficient hand feature extraction method.



Conventional Imaging

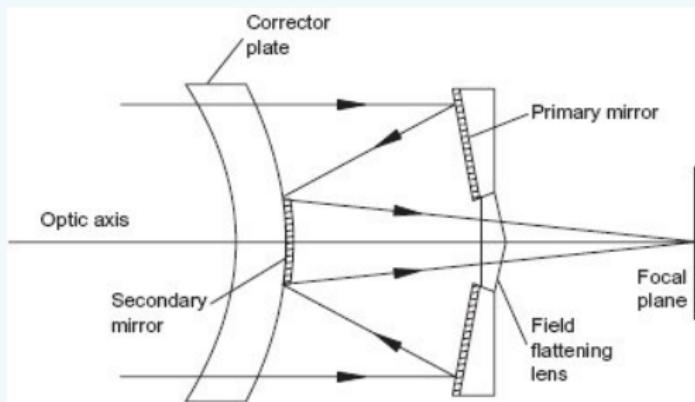
- Popular and widely used in biometric systems
- Requiring a large space
- Capturing objects in front of the lens
- The light path is sensitive to environment light





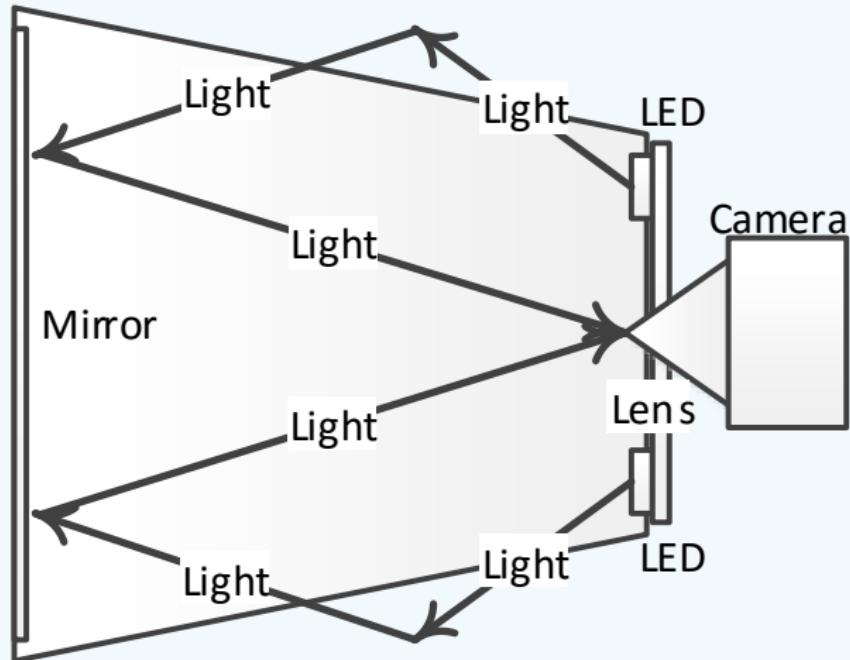
Catadioptric Scheme

Catadioptric scheme is an imaging structure, in which the ray is reflected once, or several times to increase the distance and to enlarge the field of view [1, 2]. It is widely used in omnidirectional cameras.



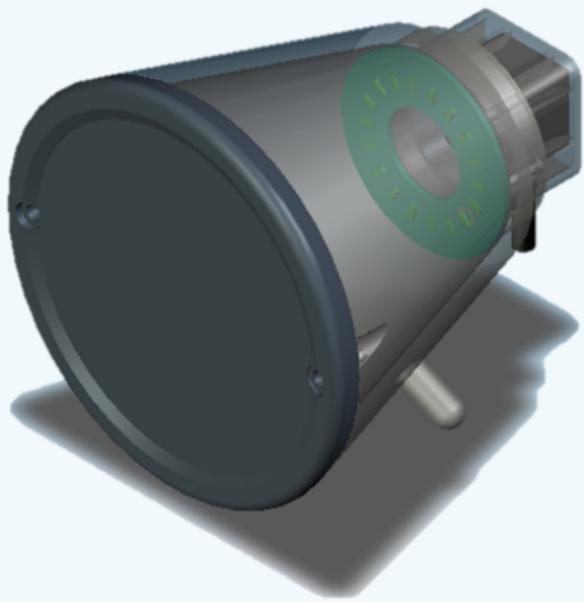


Door Knob Imaging



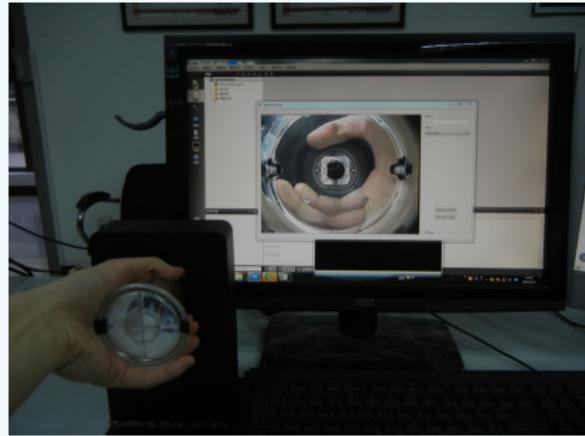


Demo System I



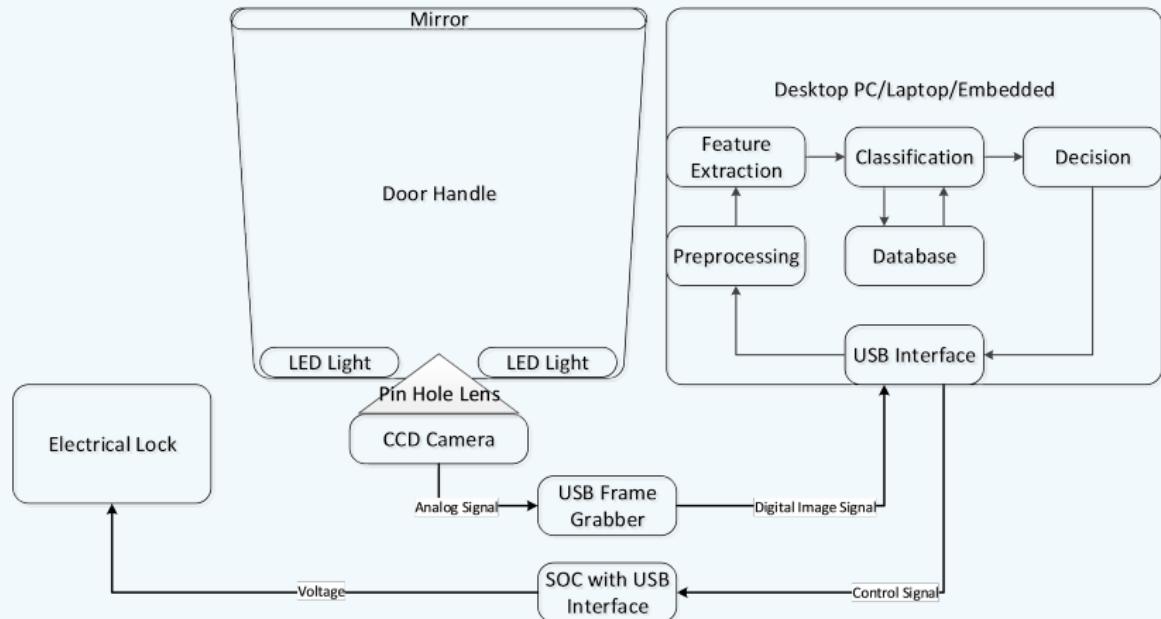


Demo System II





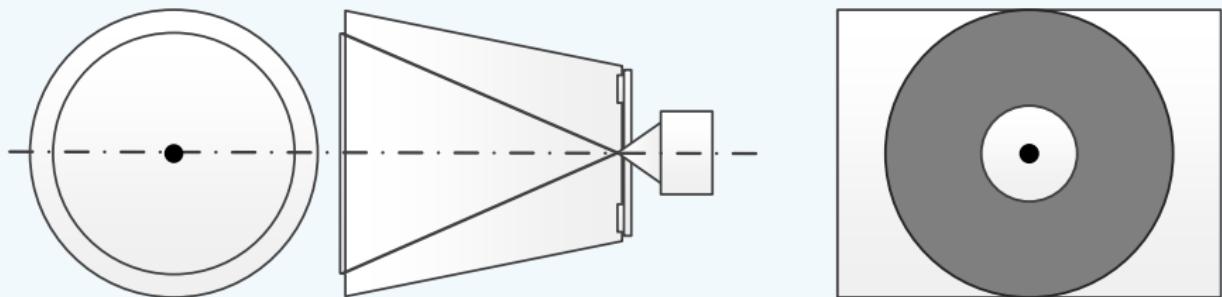
Application System Structure





Preprocessing

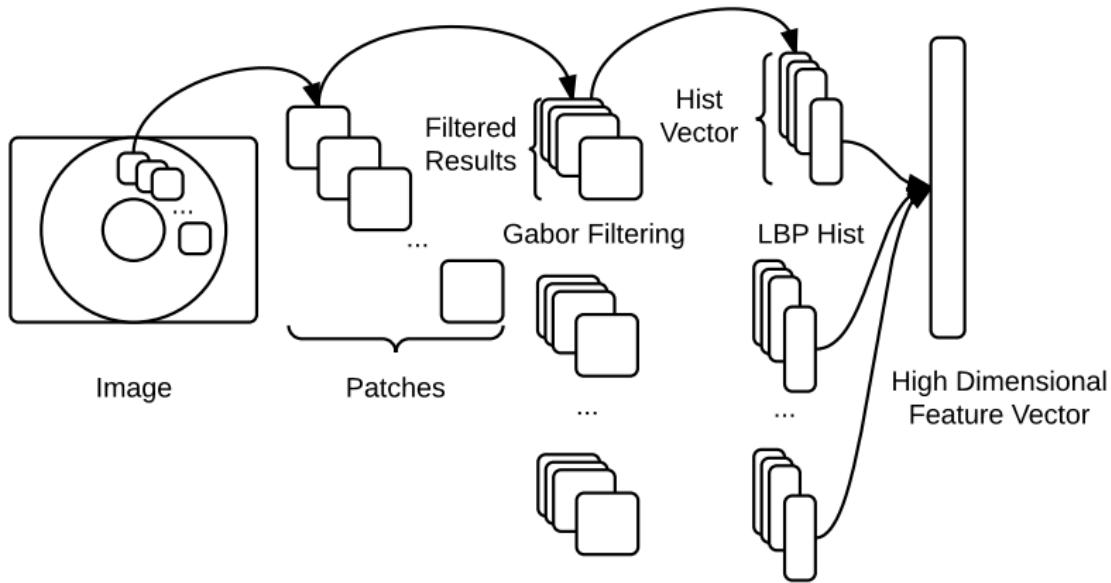
DKHRS is calibrated before the extraction of the region of interest (ROI), which is a wide ring area. The optical axis of the LED light, the knob, the lens, the sensor and the center of the round mirror are calibrated to the same point. The ROI region of a DKHRS image is a ring area cropped by two circles with the same center, which is stable after the calibration.





Feature Extraction

- Local Gabor Binary Pattern Histogram Sequence(LGBPHS) method





Projective Dictionary Pair Learning

Learning Function

$$P^*, D^* = \arg \min_{P,D} \|X - DPX\|_F^2 + \Psi(D, P, X, Y)$$

- Both a synthesis dictionary and an analysis dictionary are learned.
- Reconstruction error is used to classification.
- Fast; and High performance

Classification

$$\text{dissimilarity}(y) = \|y - D_i P_i y\|_2$$



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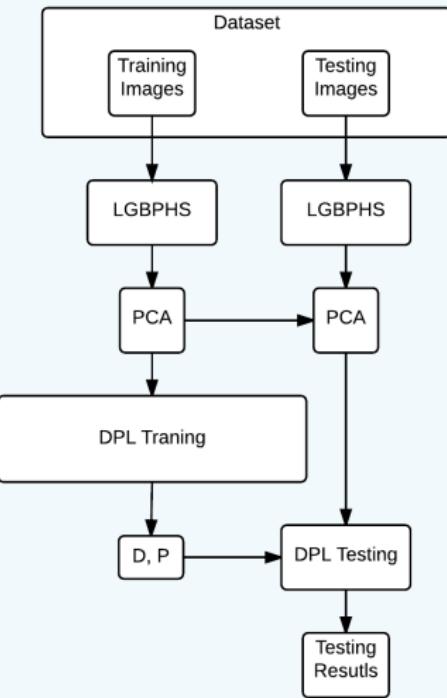
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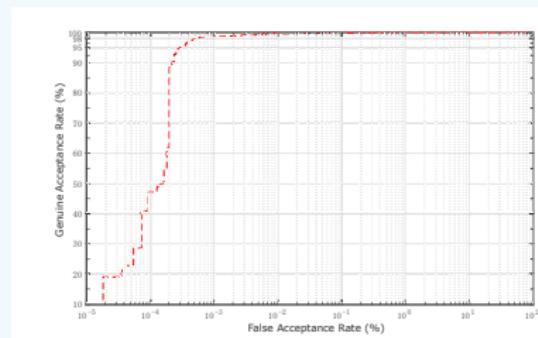
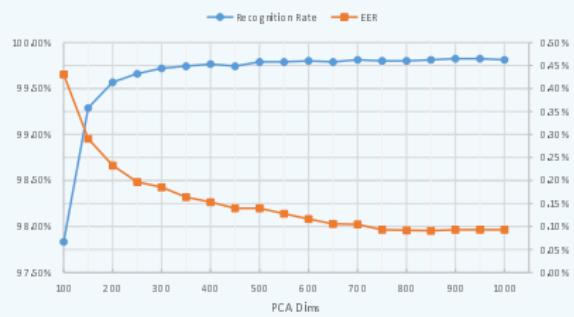
Experiments

- People: 200
- Hands: 400
- Effective Images Collected: 12000
- Train: half 6000 images
- Test: half 6000 images





Results





Discussion

- The best EER is 0.091%.
- The recognition rate of DKHRS is over 99%, and its EER can be lower than 0.1%.
- Generally speaking, the recognition performance of DKHSR is much better than hand back skin texture[3], gait[4] and face recognition[5, 6];
- it is even surpass fingerprint recognition (about 1% EER on STFV-STD-1.0 dataset[7]) and 3D fingerprint (3.4% EER[8]);
- but it is still not as good as iris recognition (<0.003% EER[9]), and palmprint recognition (EER from 0.062% to 0.012%[10, 11, 12, 13, 14, 15, 16, 17]).

Acknowledgments



Thank You!



Websites

- <http://www.doorknob.ml>
- [http://github.com/quxiaofeng/
ProjectiveDictionaryPairLearning.jl](https://github.com/quxiaofeng/ProjectiveDictionaryPairLearning.jl)

<http://www.doorknob.ml>



<https://github.com/quxiaofeng/ProjectiveDictionaryPairLearning.jl>





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