Cancelable Biometrics for Iris Detection with parameterized wavelets and wavelet packets

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Iris Detection

- Image acquisition
- Iris texture localization
- Feature extraction
- Matching
Acquisition

- Chinese Academy of Science: CASIA Iris database
- near infrared pictures
- “V3 Interval” set, consisting of 2653 images in 396 classes
Iris pattern extraction

- Canny edge detection
- Hough transform
- Remapping to rectangular texture
Iris pattern extraction
“rubber sheet”

Map area between pupil and iris circles to polar coordinates
- Split iris texture into set of 1-D signals
- Apply 1D wavelet transforms
- Use position of maxima/minima as features
- Convert to bit-code (512x20 Bits in our case)
Feature Extraction - Ma/Tan/Wang/Zhang

A graph showing a signal transformed with quadratic spline wavelet extrema.
Feature Extraction - Zhu/Tan/Wang

- 2D wavelet transformation
- Features: mean value and standard deviation of subbands
Matching

Ma et al.
- Hamming-Distance as score (count 1 bits after XOR)
- Mask out cut-off parts/lids/eye lashes/other noise
- for rotation invariance, shift the bit-code slightly, and use best match

Zhu et al.
- Euclidean distance
- Weighted with per-class training values
match distribution Ma algorithm
match distribution Zhu algorithm
Implementation performance

FNMR (%)
FMR (%)
Ma
Log-Gabor
Zou
EER (Ma): 1.07
EER (Log-Gabor): 1.12
EER (Zou): 6.34
Iris Recognition

- Enrollment: create template
- Verification/identification: match against stored template
Cancelable Biometrics

- If stored template directly relates to the biometric information:
- Biometric data cannot be revoked (unlike a password)
- If compromised: only 10 fingers, 2 irises, 1 face...
- And they are not very secret (fingerprints, hidden camera, ...)
- Same key for everything (e.g. bank account and workplace access)
- Allows cross matching, can reveal health information
Cancelable Biometrics

- Idea: Do not directly store biometric template
-Cancelable Biometrics: repeatable, non-invertible distortion applied to biometric data
- key-dependent
- Advantage: Representation of data not changed
- Transformation C:
  - $x_1 \sim x_2 \iff C(x_1) \sim C(x_2)$
  - $C(x) \sim x$, $C_1(x) \sim C_2(x)$
  - $C^{-1}(C(x)) \sim x$
- Each user has an additional key which is used for transformation.
- Untransformed data or features are not stored.
Texture Transformation

texture

randomly re-mapped blocks

randomly “warped”
Schneid parameterization of orthogonal wavelets:
Wavelet Packets

Pyramidal 2D-subdivision:

Random subdivision:
EER with different wavelet parameterizations
Matching one key against other keys.
Performance when each eye is enrolled 1, 20 or 100 times, with a random key for each class.
Performance when each eye is enrolled 1 or 100 times, with a random key for each class.
Conclusion

- implemented wavelet-using iris detection algorithms
- realized cancelable biometrics
- results look good
- exact security hard to measure