1. Introduction

Problem: Face recognition with occlusion
- Intra-class variations vs inter-class variations
- Causes imprecise registration of faces
  → Poor recognition performance!

Challenges: Why is it so difficult?
- No prior knowledge of occlusion
- Location, size, shape, texture -- unpredictable!

Our method:
- No occlusion detection
- No data-dependent training
- Works well with limited gallery images per person
- Efficient and appropriate for real applications

2. Method

Inspired by the time series analysis technique

Example: two similar time sequences
A = (3, 1, 10, 5, 6)
B = (3, 2, 1, 10, 5)
Bit-wise matching: distance = \(\sum |a_i - b_i| + 51 + 25 + 1 = 1039\)
Warping: 
- Distance is largely reduced
- However, cross-matching is not allowed:
  A = (3, 1, 10, 5, 6)
  B = (3, 2, 1, 10, 5)

1) Face representation

An image → a patch sequence
- Contains the order information of facial features
- Considers the inherent structure of the face

A face consists of forehead, eyes, nose, mouth and chin in a natural order
- does not change despite occlusion or imprecise registration

2) Matching

Image-to-image warping → image-to-class warping
Compute the Image-to-Class distance
- From a probe sequence to all gallery sequences of an enrolled class
- Each probe patch can be matched with patches from different gallery sequences

Why does it work?
- Tries every possible warping path and select the one with minimal overall distance
  → the large distance causes by occluded patches won’t be considered
- Exploits the information from different gallery images
  → image-to-class distance

Why use the difference patches?
- To enhance the detailed textured regions
- To enhance the order information of patches

3. Results

Randomly located occlusions: FRGC
- 0% ~ 50% synthetic occlusion

- Robust to different patch size in an appropriate range
- Smaller size, higher computational & memory cost
- Sizes from 4 x 4 to 6 x 5 pixels are recommended

Real disguise: AR
- Gallery images per person: K = 1, 2, 4, 6, 8
- About 15 times faster than the reconstruction based methods

Realistic images
- When K = 8
- The best recognition rate reported

The face we make (www.thefacewemake.org)
- Frontal view faces of strangers on the streets, captured under totally uncontrolled conditions in real environment
- Face images are not well registered
- Includes hard occlusion which is difficult to be detected by skin colour based models

Conclusion
The proposed DICW:
- is robust to various types of occlusion
- performs consistently even when only single gallery image is available for each person
- can adopt other image descriptors such as LBP and Gabor

Face Recognition with Occlusion Using Dynamic Image-to-Class Warping (DICW)

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