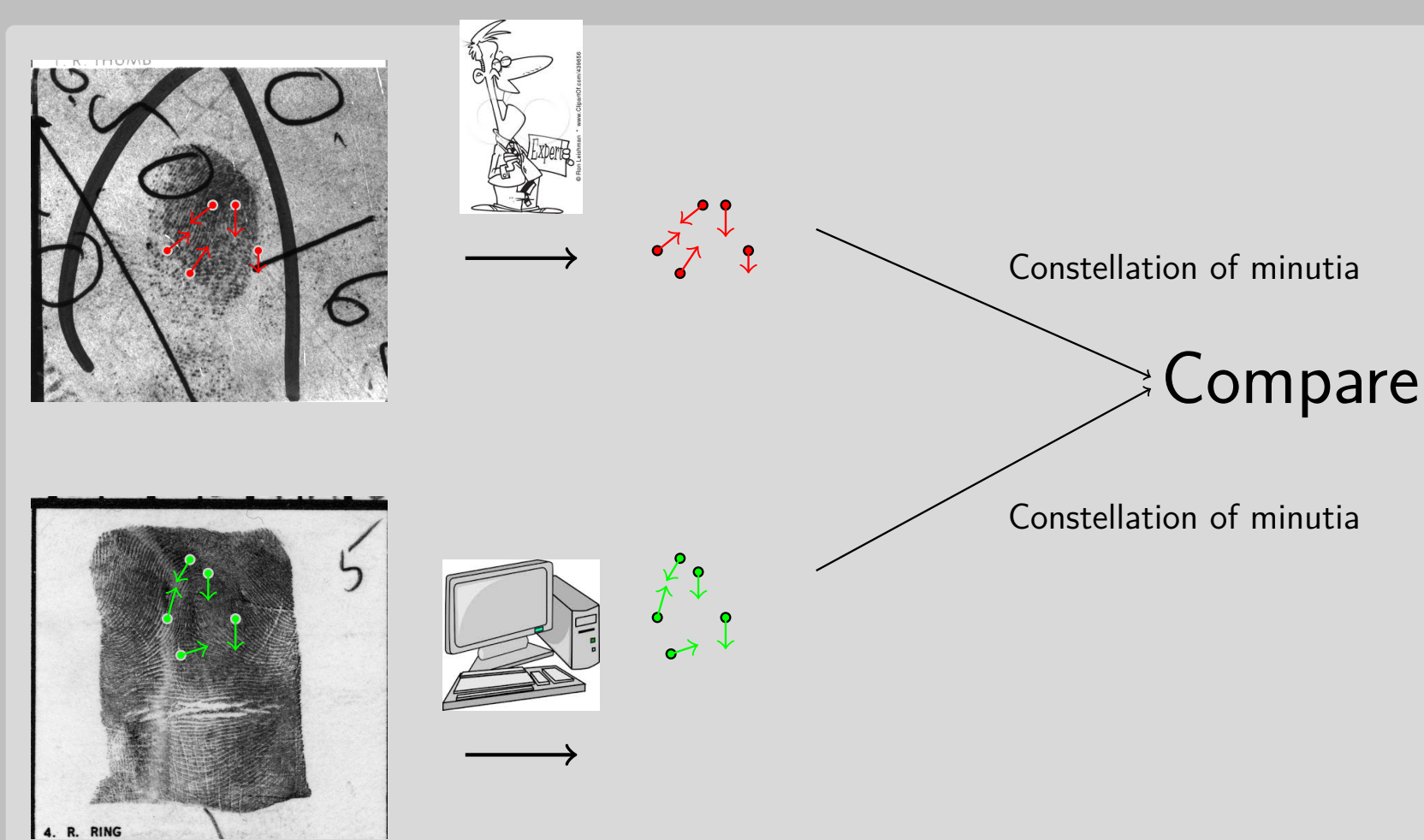


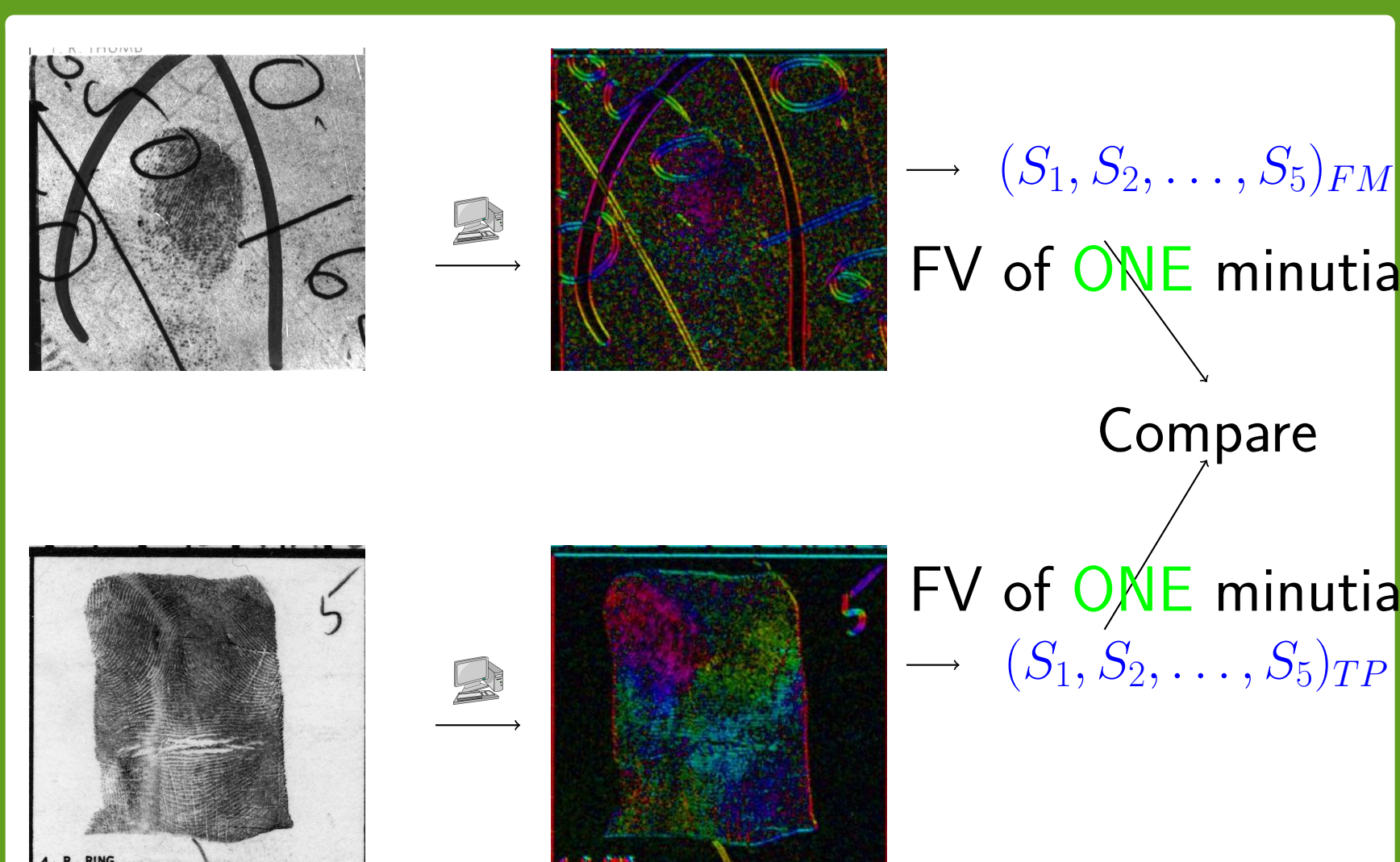
## Abstract

We investigate the uniqueness of a single minugia of a tenprint and, more important, fingermark. We propose new rotation invariant feature vector for a minugia. Currently, state-of-the-art matching fingerprint algorithms use only coordinate and angle of minugia leaving other image information unused. We suggest feature vector describing neighbourhood of a minugia at different radii. In this paper we study if we can identify or narrow down the search space substantially by using information from a single minugia.

## State-of-the-art matching process



## Proposed matching process



## References

Bigun J.: **Vision with Direction**, Springer(2006)  
Mikaelyan A, Bigun J.: **Ground truth and evaluation for latent fingerprint matching**, IEEE CVPR(2012)  
Jain A. and Feng J., **Latent fingerprint matching**, IEEE PAMI (2011)

## Conclusions. Orientation map

To Improve reliability of feature vector we

- use orientation map instead of image directly
- optimize orientation map locally

## Conclusions. Feature vector

- State-of-the-art approach  
{Minugia Constellation, Fingerprint} vs {Minugia Constellation, Latent}
- We propose  $(x_i, y_i, t_i) \leftrightarrow (x_j, y_j, t_j)$  - minugia-wise correspondence
- We used free distributed software to establish minugia-wise correspondence (they look into constellation of minugia) for SD27 database:
  - kplet (40% EER)
- There is a lot of space for improvement, which will probably come from using more image information

A. Jain and J. Feng, Latent fingerprint matching, 2011.

## Fingermark (Latent)=Left at crime scene



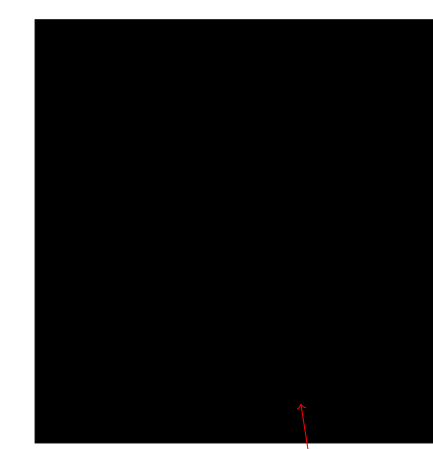
- bad quality
- left unintentionally
- small area of fingermark
- unknown orientation

SD27

Full minugia set

$(x_1, y_1, t_1)$   
 $(x_2, y_2, t_2)$   
...  
 $(x_n, y_n, t_n)$

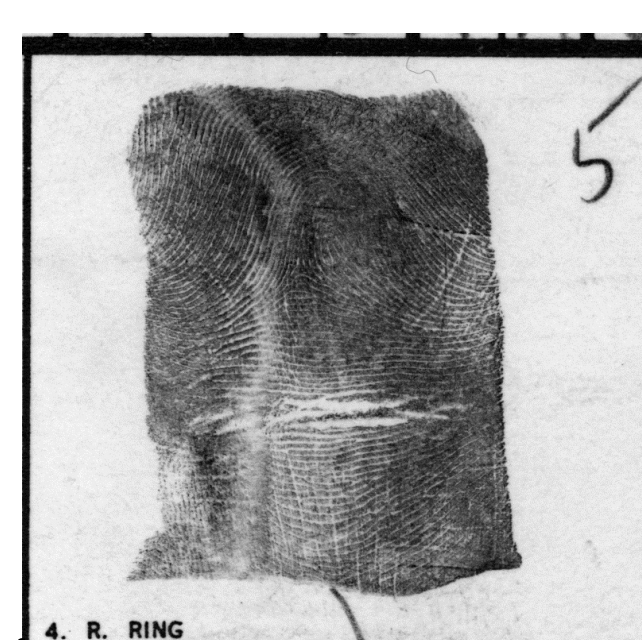
AFIS



Person 1  
Person 2  
...  
Person m

- extracted by an expert
- sent to an algorithm on a db
- get possibly matching fingerprints obtained in a supervised manner

## Tenprint=obtained from the controlled acquisition



- good quality
- supervised acquisition

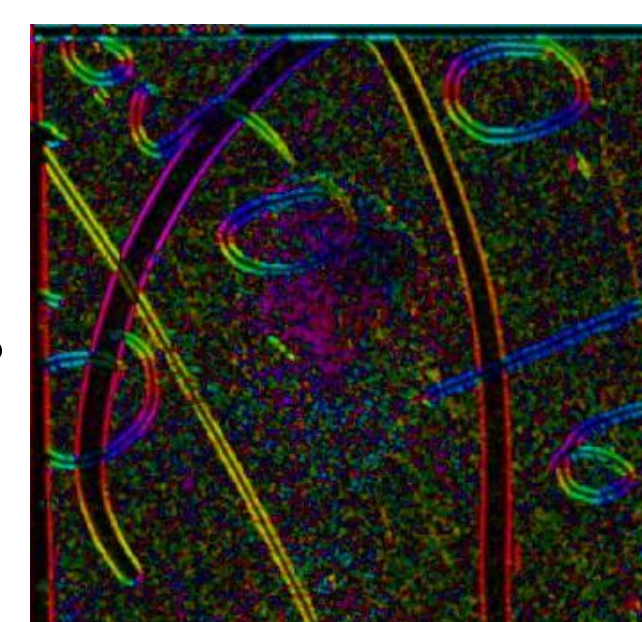
SD27

Full minugia set

$(x_1, y_1, t_1)$   
 $(x_2, y_2, t_2)$   
...  
 $(x_n, y_n, t_n)$

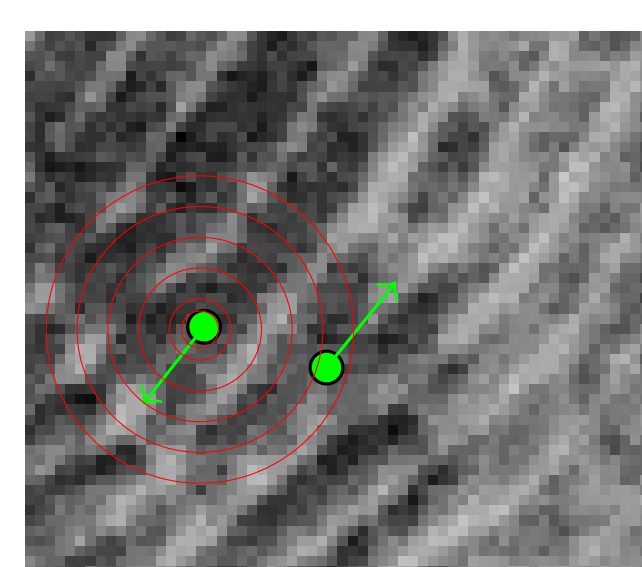
- obtained by the automatic algorithm for each suggested tenprint

## Fingermark identification



- Finding optimal parameters  $\sigma_i, \sigma_o$  of the orientation image
- Creating NEW feature vector for each minugia
- Identifying fingermark based on as few minugia as possible

## Features and quality estimation for fingermarks



$(S_1, S_2, S_3, \dots, S_5)$

- Our current feature vector describing orientation map is rotation-invariant
- We project orientation map on Spiral Space (which is rotation invariant)

## Data for performance evaluation

- Difficult to obtain fingerprint data that comes from crime scenes
- Currently few datasets are available and only SD27 database is public, (published by NIST and contributed by NIST and FBI)

## Technical specifications of SD27 database

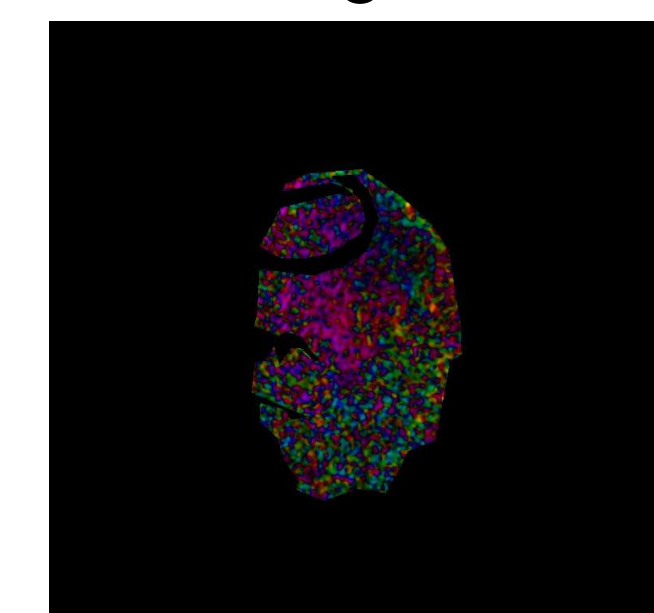
- contains 258 pairs of fingerprints
- at 500 dpi resolution
- each pair consists of two images of the same finger: one from crime scene and one from controlled acquisition
- fingerprints from crime scenes are classified into three quality categories (bad, good, ugly)
- the minugia are annotated by human experts
- for each fingerprint there are two annotated minugia sets: full minugia set (Ideal) and Matched

## I. Orientation Estimation

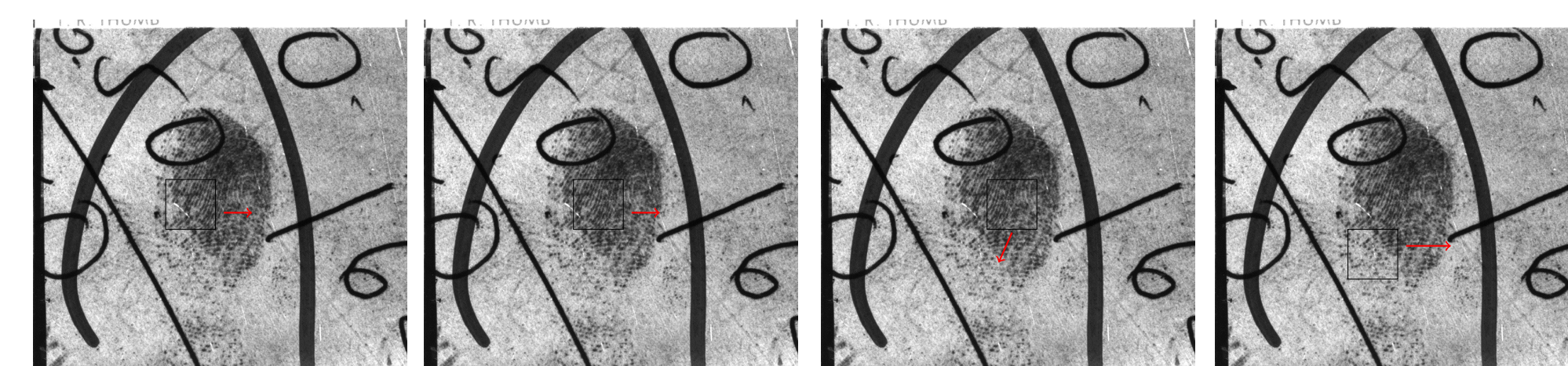
- $\sigma_i$  - fixates inner-scale, i.e. the frequency contents
- $\sigma_o = 1.57\sigma_i$  - fixates outer-scale, i.e. integration



meaningful orientation



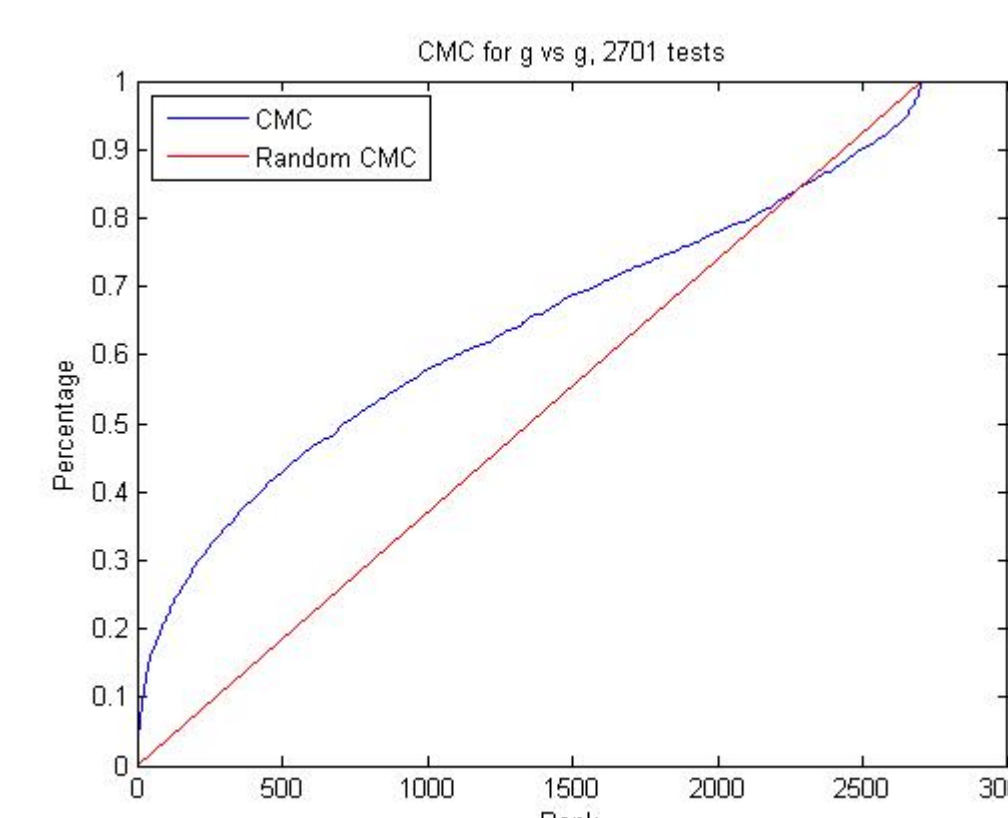
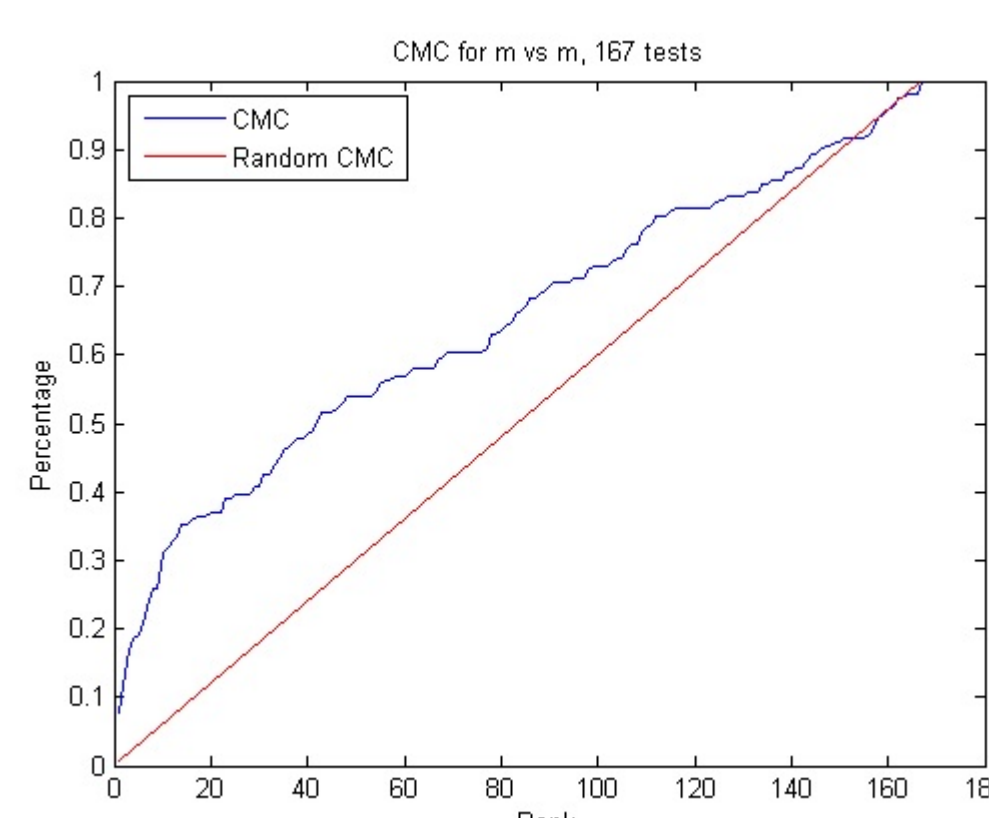
## Local Orientation Estimation



- In the opposite to existing practice of calculating orientation map (same parameters for whole image)
- NOW it is calculated for every neighbourhood separately
- AND turn out to depend on the ridge distance (which changes over the image)

## Results

For minugia sets  
With good orientation around



good: from 'good' images from SD27  
manual: manually selected minugia with good orientation