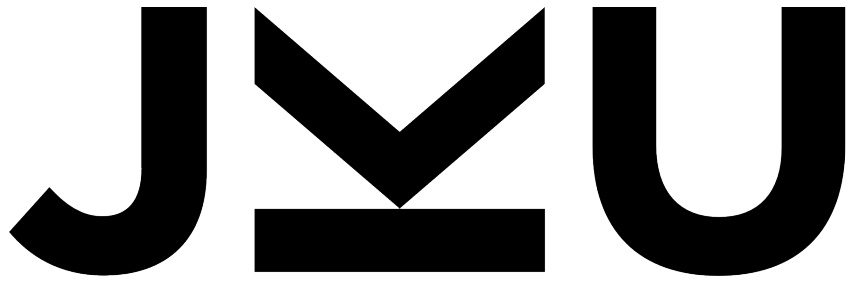

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BIOMETRY

Orientation Field Modeling of Low Skin Quality Biometric Fingerprints

Robert Pollak

June 2016

Dep. Knowledge-Based Math. Systems

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FUZZY.LOGIC.LAB.LINZ

INTRODUCTION

Biometric fingerprints

- What?
- Why?
- When?
- Who?
- Where?
- How?

[Fingerprint images have been masked for publication.]

Fingerprint features

global

local

“Very local”

Ridge flow classes

Image: OpenStax, CC BY. Download for free at http://cnx.org/contents/360ab6f3-31eb-4017-9b40-984ca27e7f43@3.

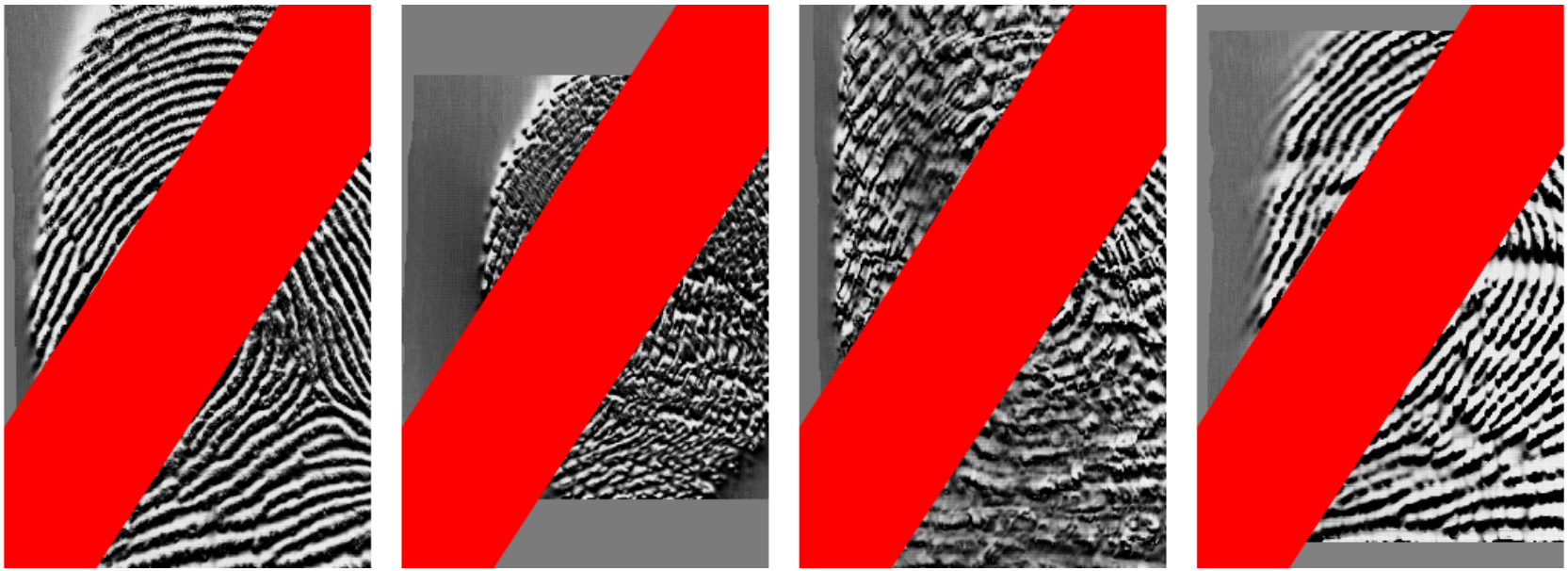
Industry partner

[Information removed for publication]

Test database

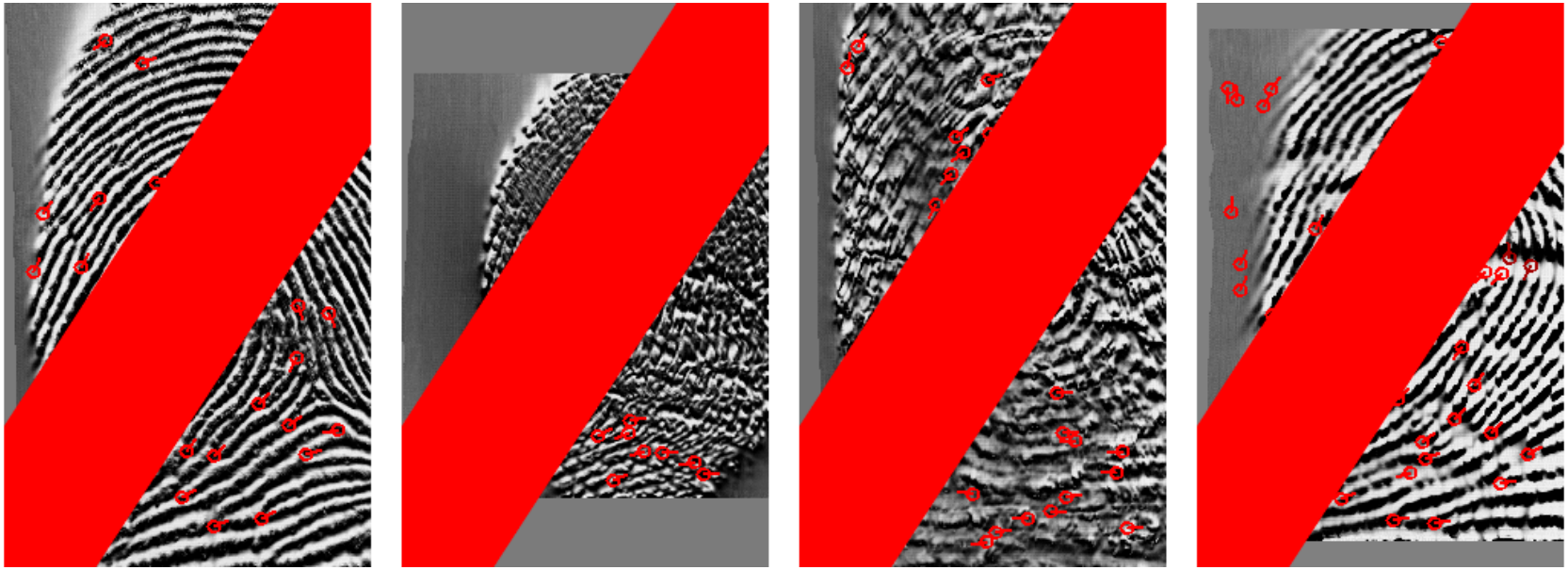
[Information removed for publication]

Varying surface quality

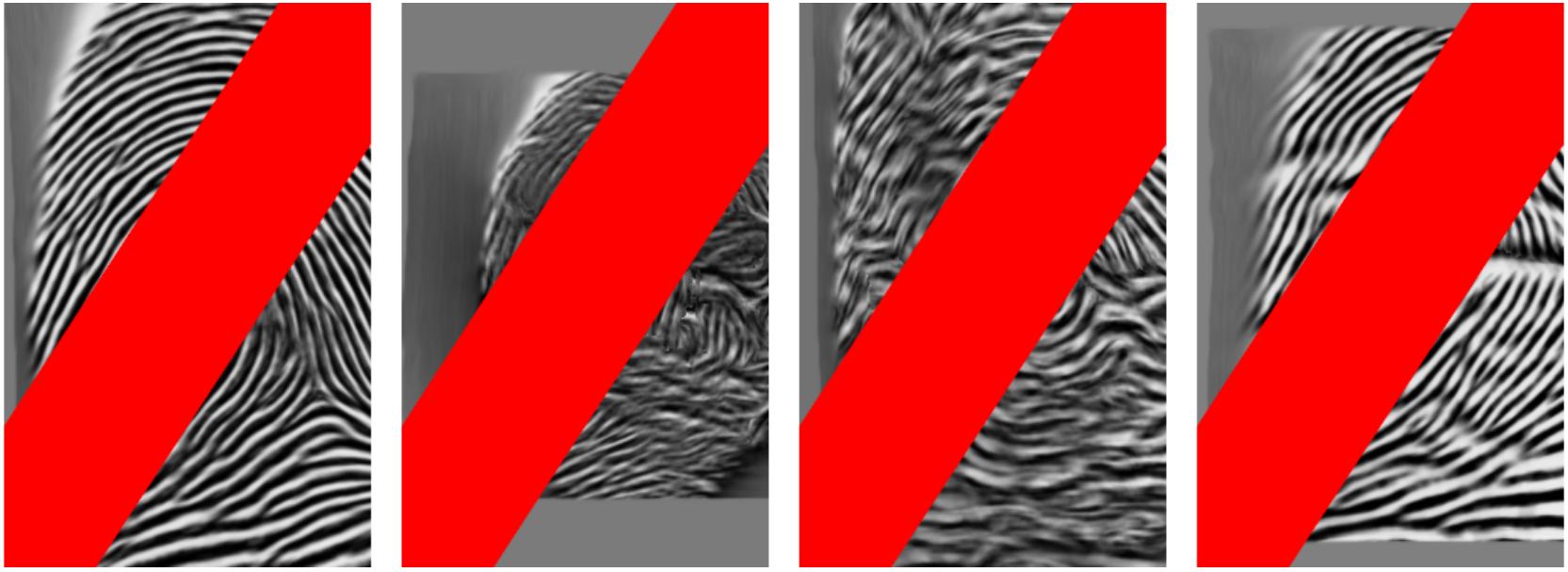


good rough young rough old creases

Minutiae: good, bad, missing

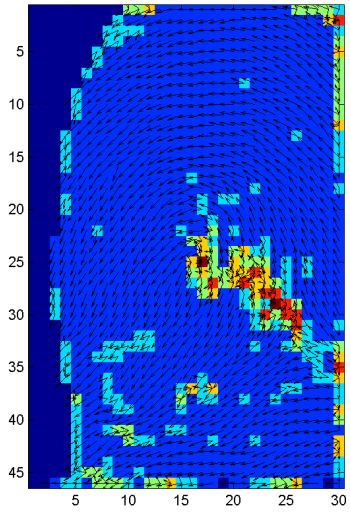


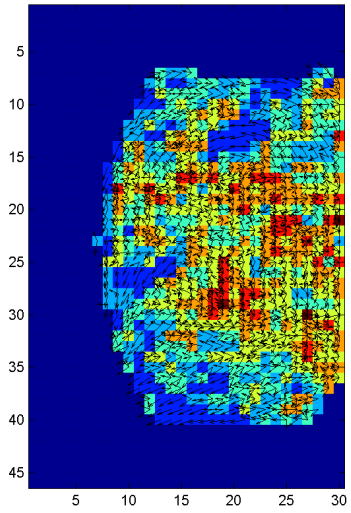
Local orientations

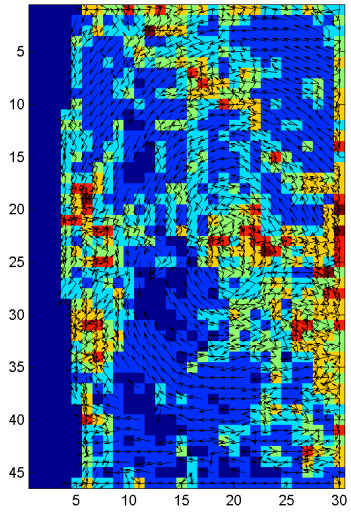


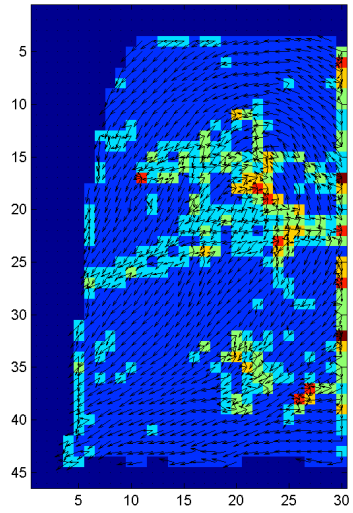
MODELING

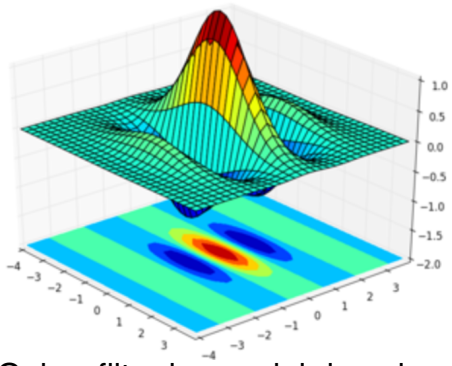
Gabor filter bank



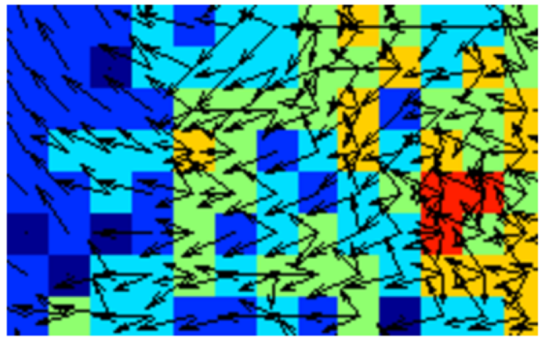




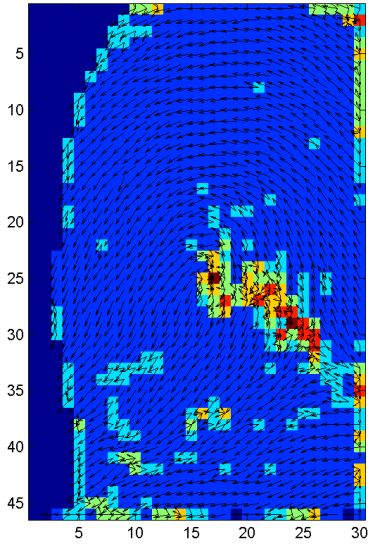


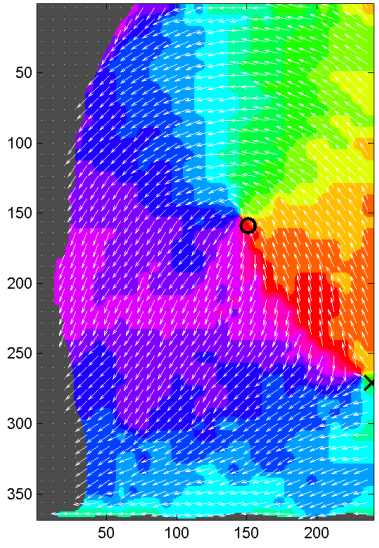


Gabor filter in spacial domain



Global polynomial model

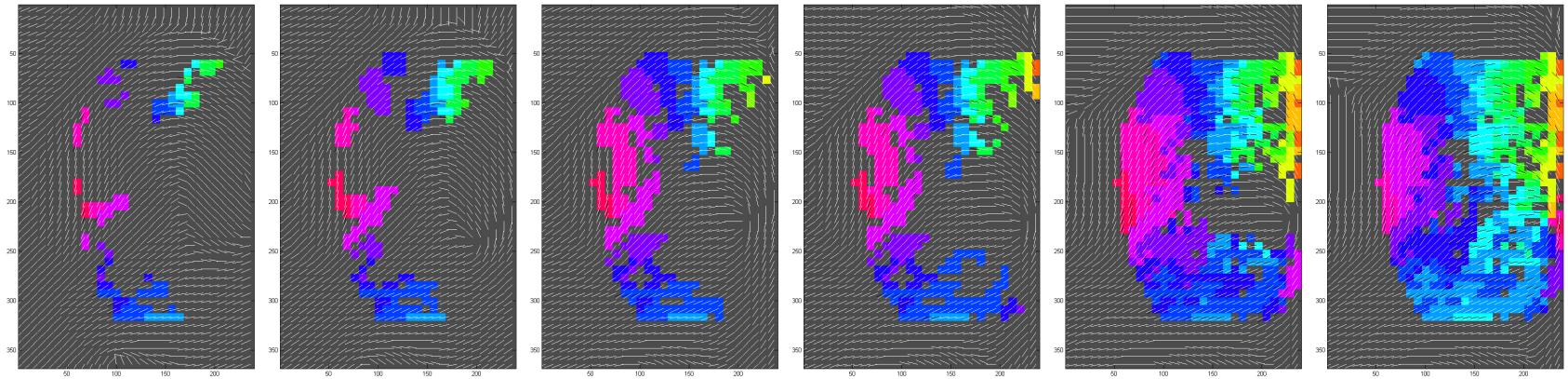




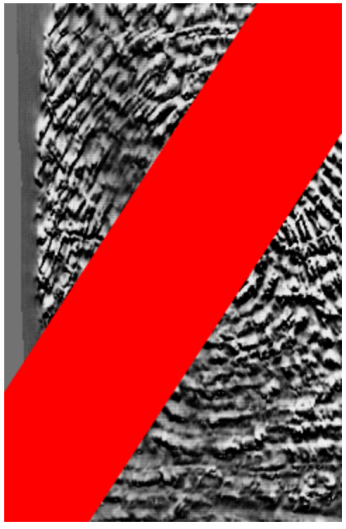
mono-component model:

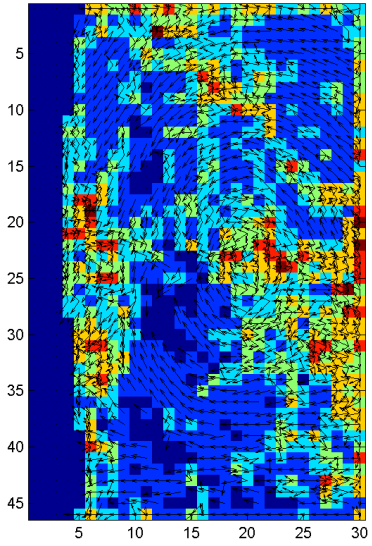
$$C(x,y) = \cos(2\theta) + i\sin(2\theta)$$

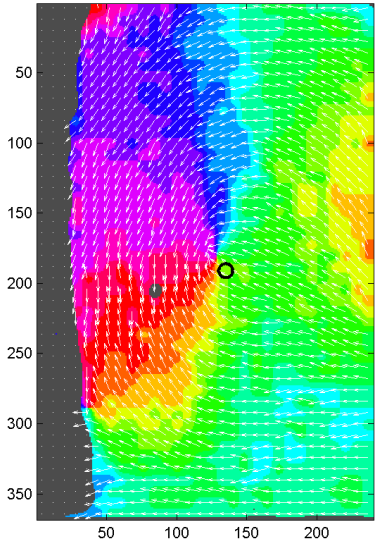
Stepwise orientation selection

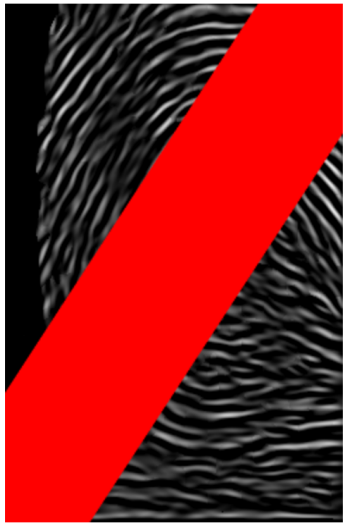


Global polynomial model: Problem example









Global rational model

Definition

The orientation field model

$$\phi(z) = \frac{1}{2} \arg \left[f(z) \frac{P(z)}{Q(z)} \right],$$

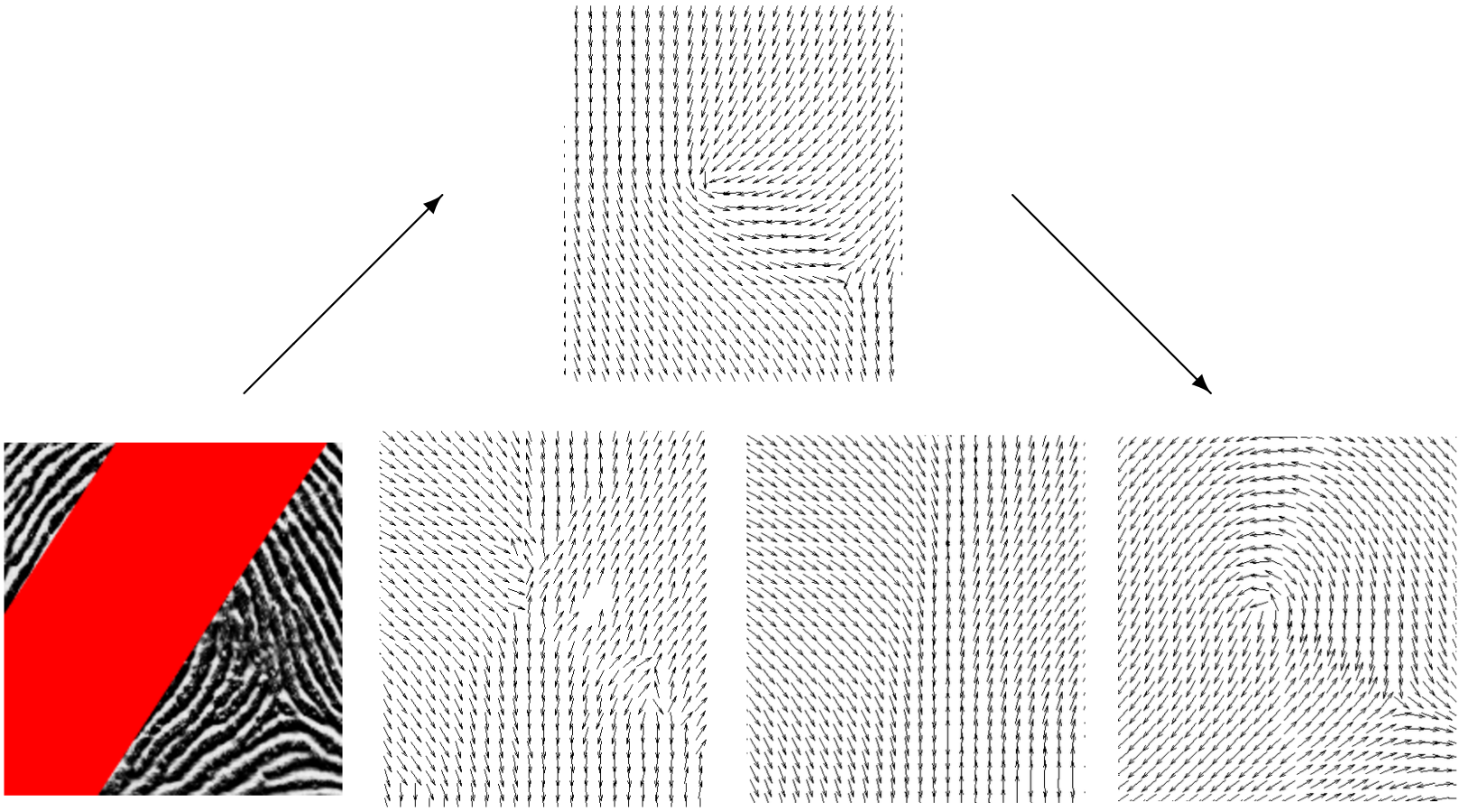
$$\text{where} \quad P(z) = \prod_{i=1}^{n_c} (z - z_c^i), \quad Q(z) = \prod_{j=1}^{n_d} (z - z_d^j),$$

and the roots of $f(z)$ outside the fingerprint,

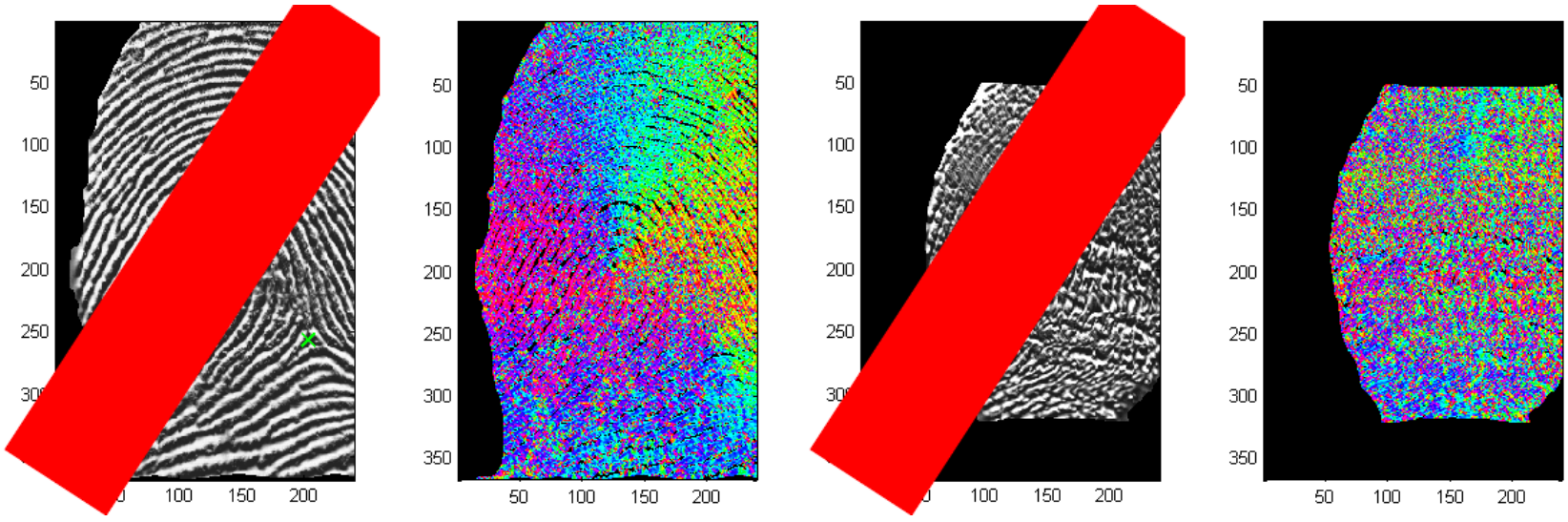
is called a rational complex model.

J. Zhou, J. Gu, “Modeling orientation fields of fingerprints with rational complex functions”, J. Pattern Recognition, vol. 37, 2004

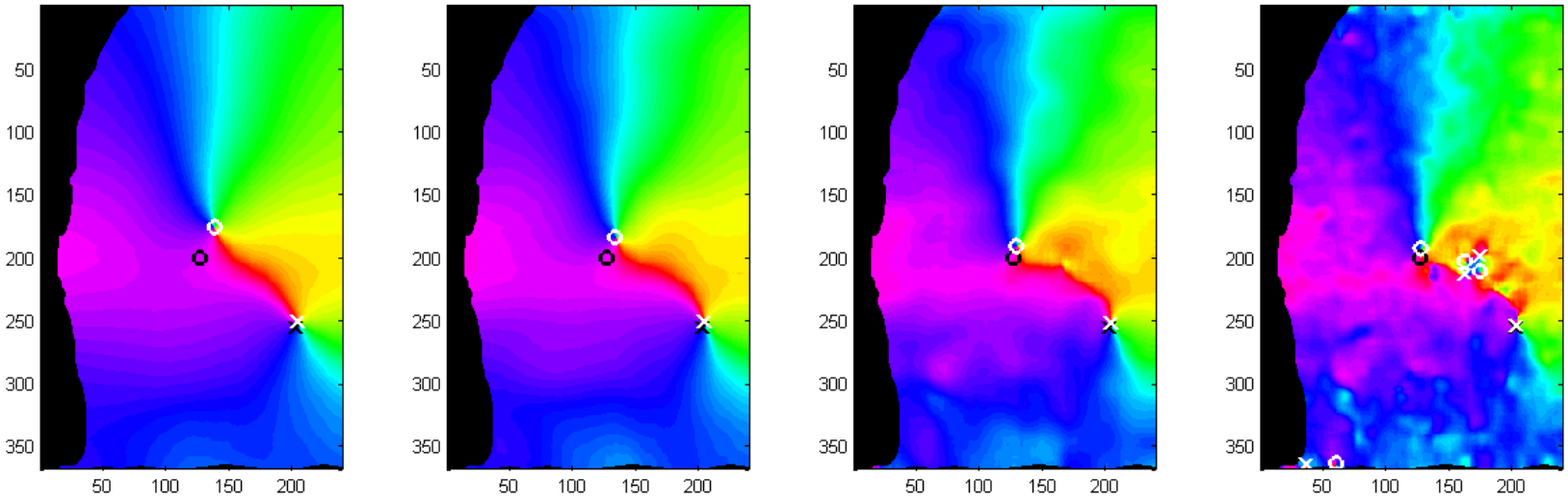
Global rational model: Steps



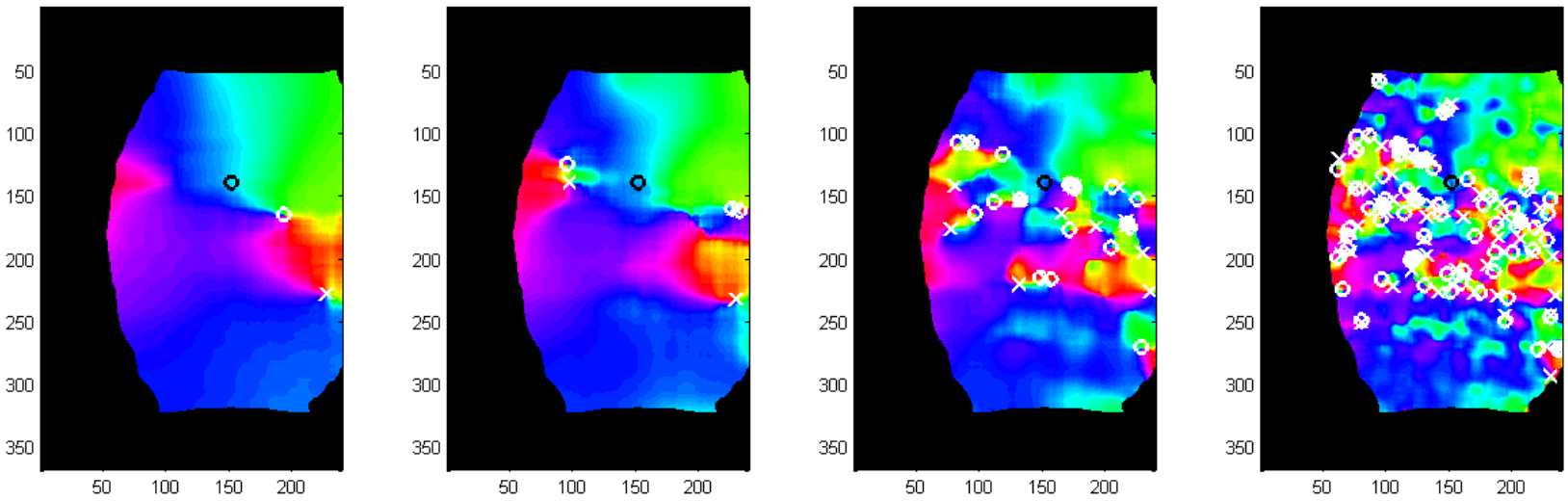
Singularities via Poincaré index: Gradient variance



Singularities via Poincaré index: Dependency on blur



Singularities via Poincaré index: Dependency on blur

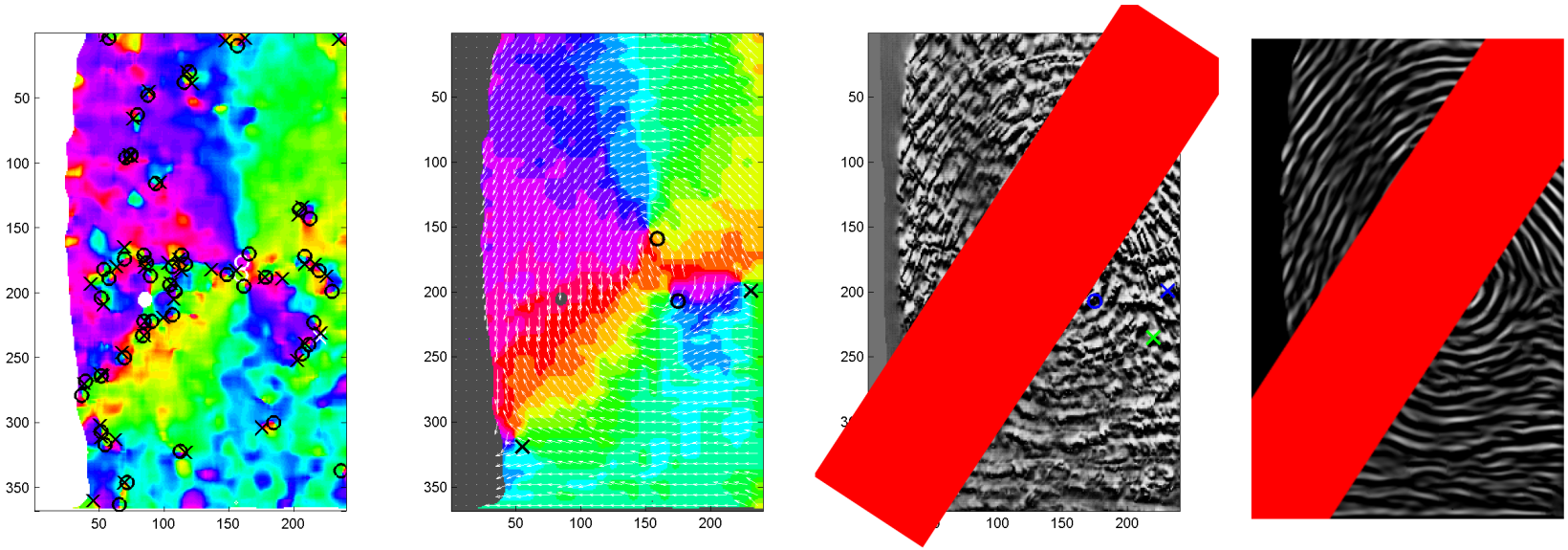


Selecting singularities

- Start with polynomial model
- Add a core
  - Loop over all core candidates
  - Create a rational model
  - Evaluate by comparing to the Gabor orientation bundles
  - Take the best candidate
- In the same way, add another core,
  then two deltas one after the other.

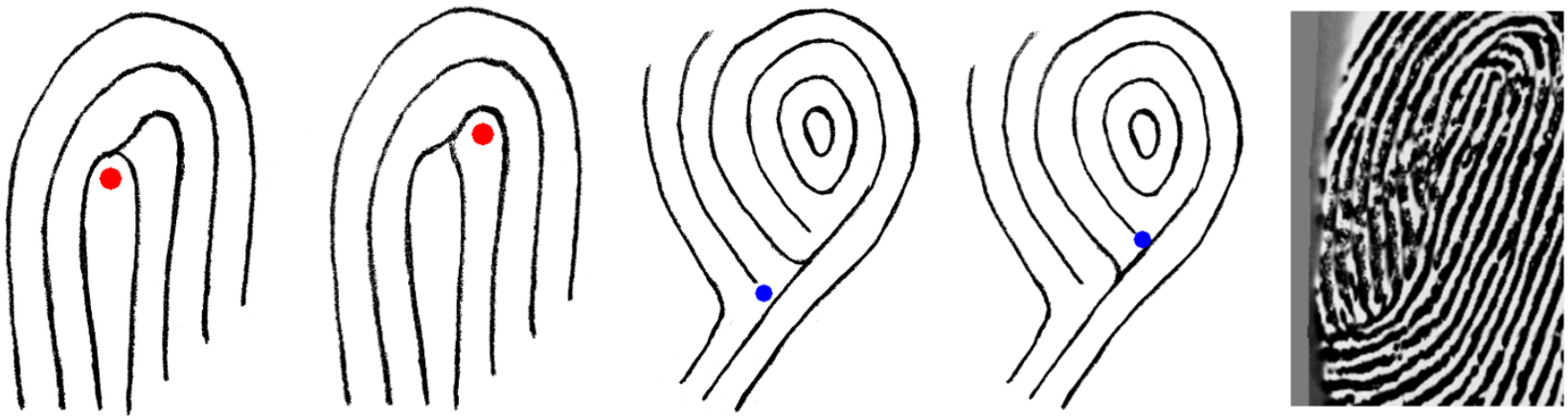
Based on J. Zhou, F. Chen, J. Gu, “A Novel Algorithm for Detecting Singular Points from Fingerprint Images”, IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 31, 2009

Selecting singularities: Example

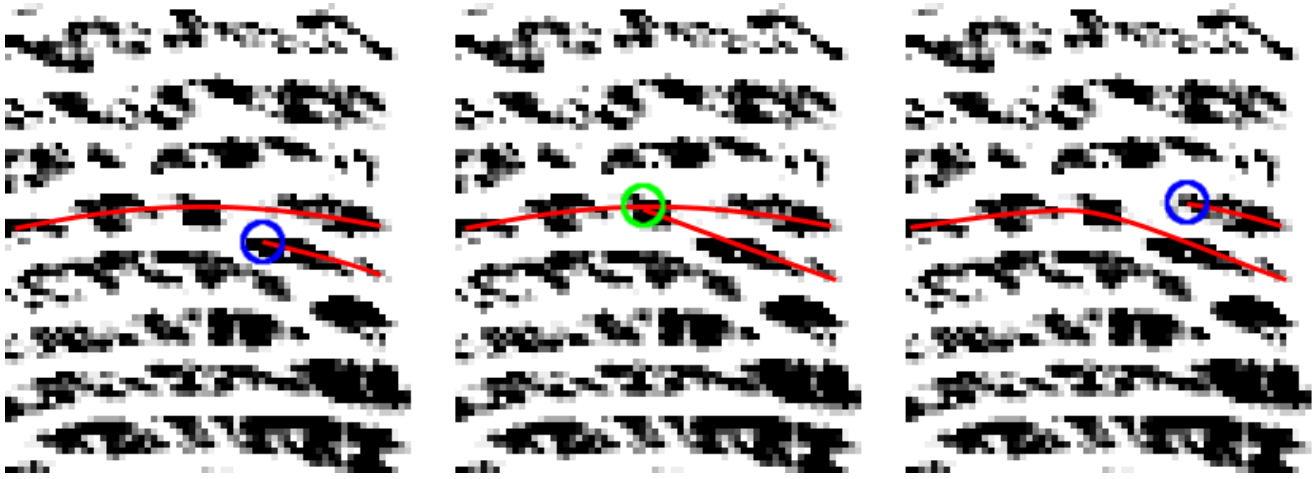


CURRENT LIMITATIONS AND OUTLOOK

Unstable singularities



Unstable minutiae



Outlook

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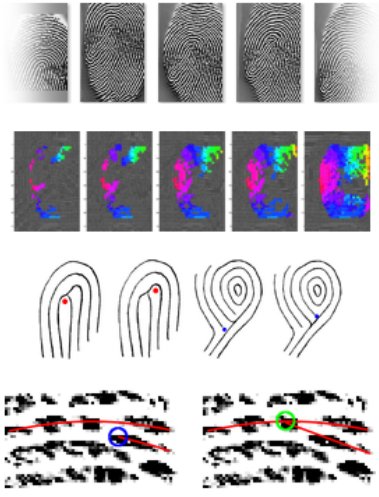

- Examine bigger, public databases
- Graph-theoretical model of “border iteration”
- Model unstable singularities and extended discontinuities
- Model unstable minutiae

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