Fingerprints in Forensic Verifications

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2021-FEB-09

- Collaboration with criminal police and security agencies

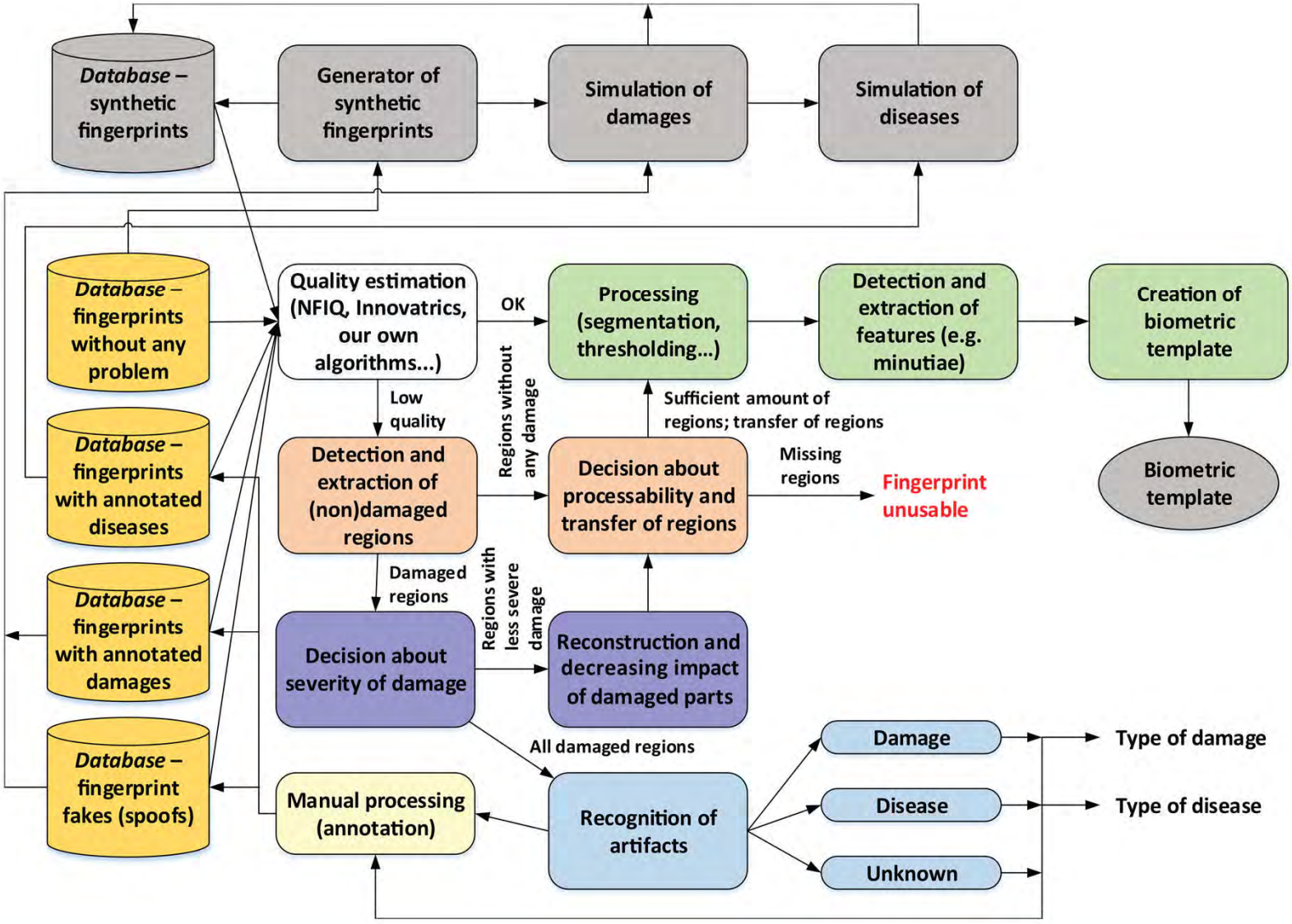
- Various damages in **real fingerprints** (including diseases)
- Generation and damage simulation of **synthetic fingerprints** (including diseases, fingerprint spoofs)
- **Fingerprint spoofs** – production process, use cases (scanners – with and without PAD, crime scene)
- **MoI** project (2021-2022) – **police**: Croatia, Germany, Israel, Netherlands, South Korea, Switzerland, UK, USA,

Our fingerprints are sometimes freely available – 1/2

http://lovelybella.com/

Our fingerprints are sometimes freely available – 2/2

Overview of our activities in the fingerprint area



Real fingerprints and their conditions

- What defines a perfect fingerprint?
  - A lot of minutiae points?
  - High contrast of valleys and ridges?
  - Clear flow of the ridges?
  - High resolution?
  - Sweat pores visibility?

- Damaged fingerprints
  - User effects (e.g. dirty/diseased finger)
  - Sensor effects (e.g. used technology, scratches)
  - Environmental conditions (e.g. vibrations, surrounding strong light)

Examples of genuine damaged fingerprints

- Diseases on fingertips (eczemas, warts, psoriasis, etc.)





- Detergents on finger

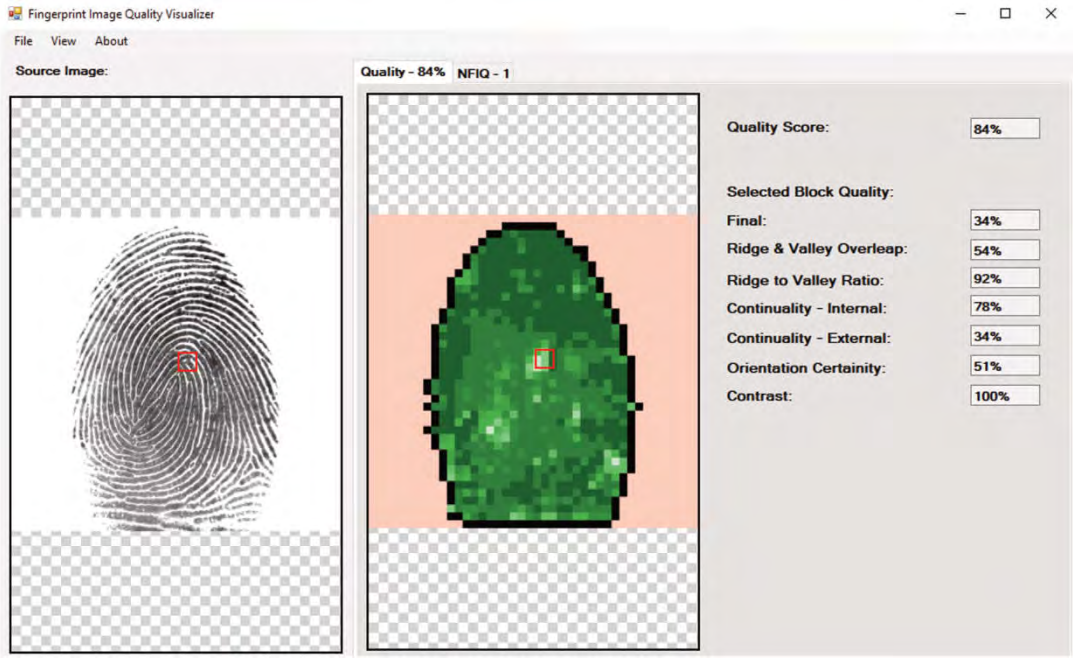




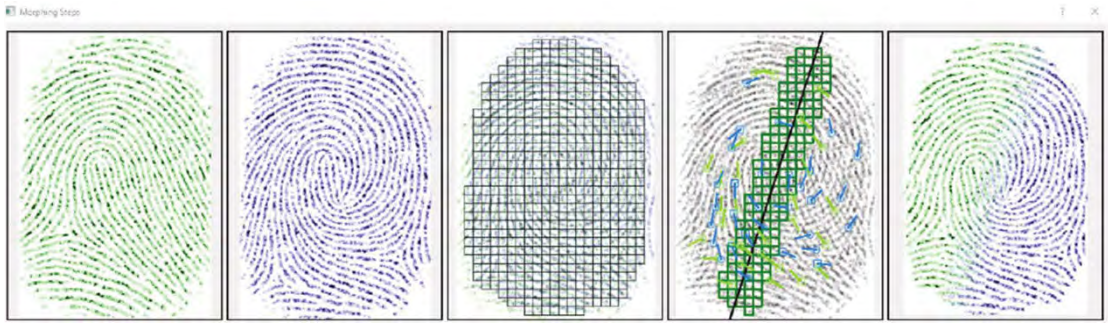

- Swipe sensor usage




- FiQiVI = Fingerprint Quality Visualizer
  - Available: https://www.fit.vut.cz/research/product/607/.en



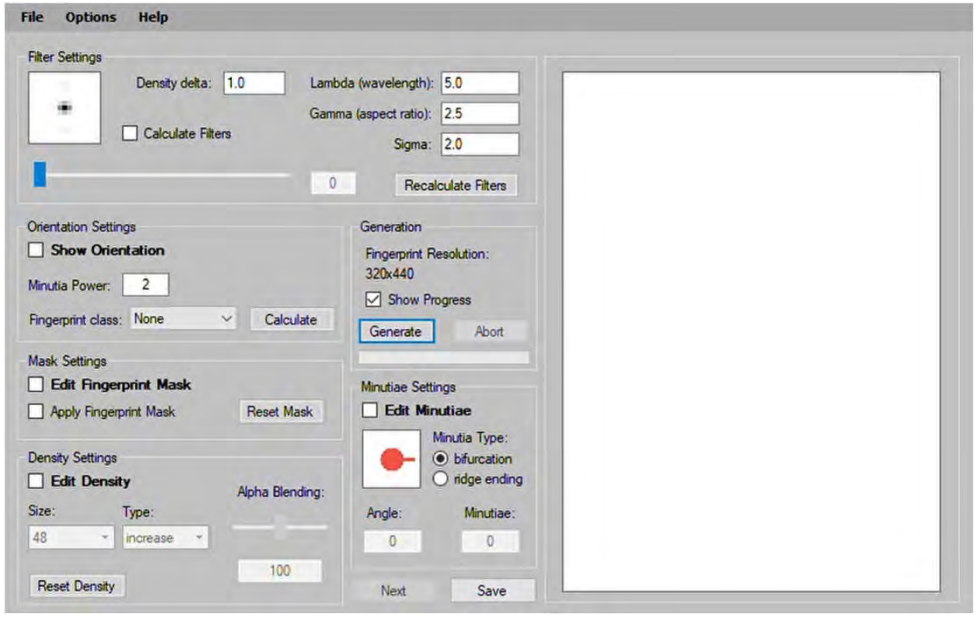
- FingMor = Fingerprint Morpher



Generation of synthetic fingerprints

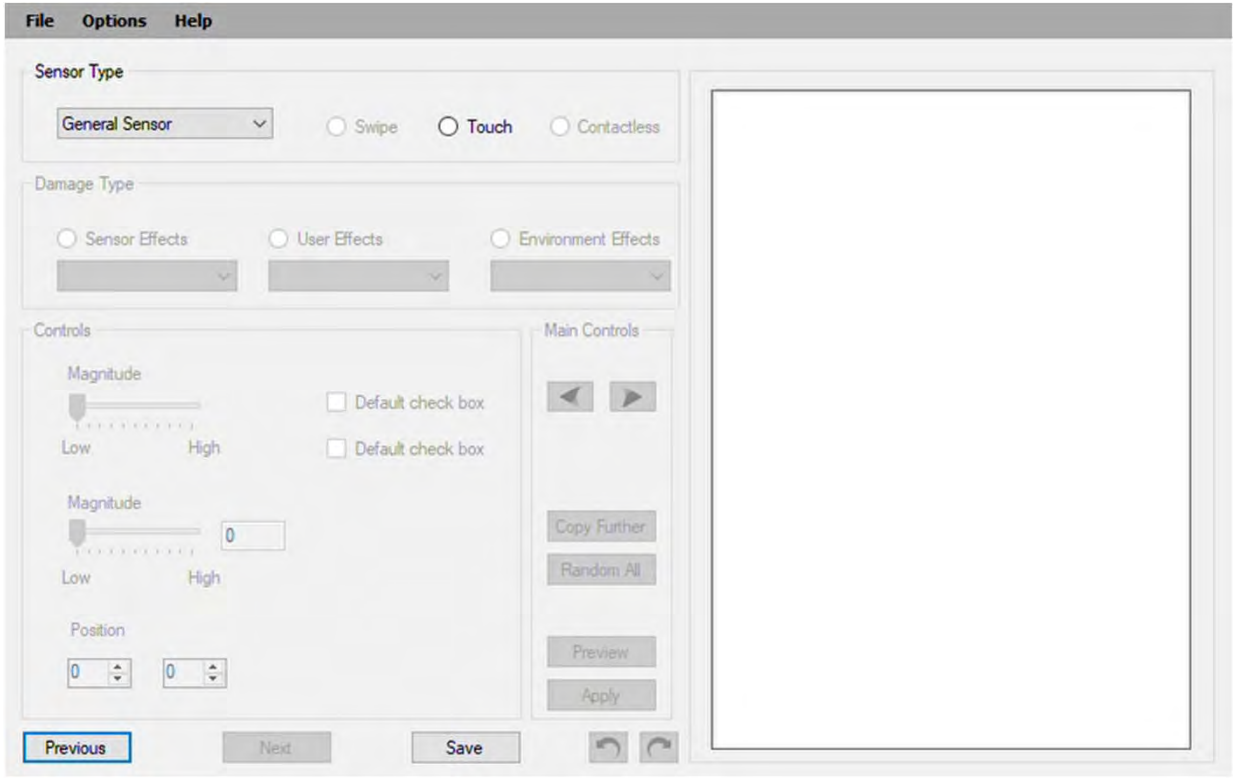
- Synthetic fingerprints – our approach
  - Master-print generation (perfect fingerprint)
  - Damage simulation (specifically damaged)

- **SyFDaS** – generation part https://www.fit.vut.cz/research/product/599/



- Other generators (SFinGe, Anguli, Finger-GAN)

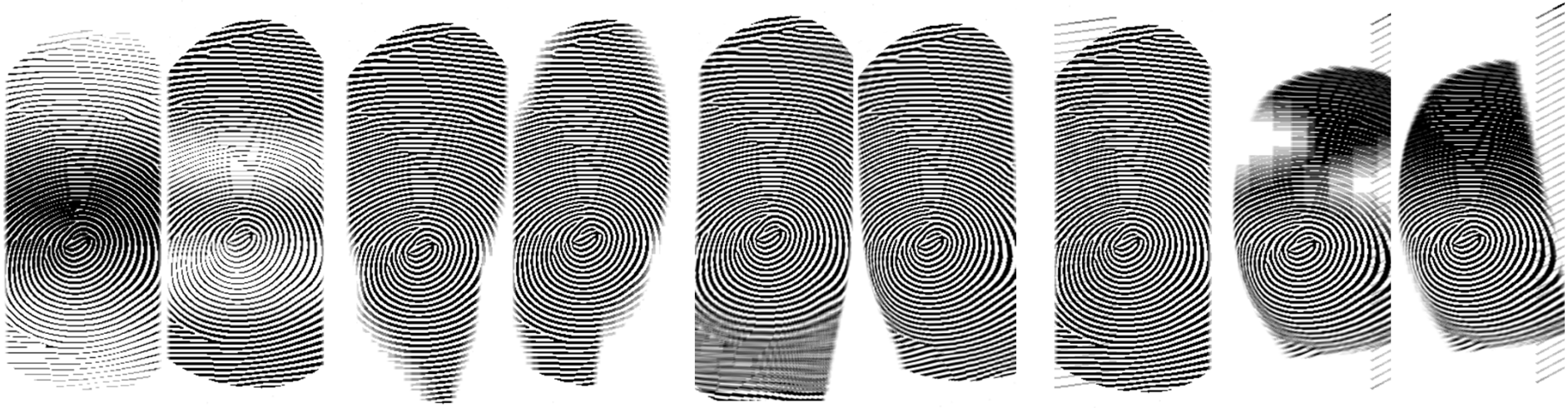
- SyFDaS – simulation part
  1. Choose desired damage(s)
  2. Try different settings
  3. Save suitable settings
  4. Set damage combinations
  5. Add master-prints
  6. Create required database



Examples of damaged synthetic fingerprints

- Touch-based damages (shape, distortion, pressure, etc.)

- Swipe-based damages (swipe mode and specific simulations)



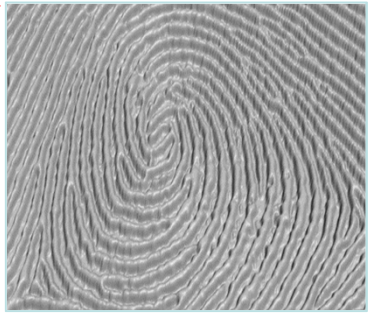
Examples of special damages to synthetic fingerprints

- Simulation of skin diseases (eczemas, warts, psoriasis, etc.)

- Simulation of spoofs artifacts (shape, air bubbles, etc.)

- Mold creation
  - Wax

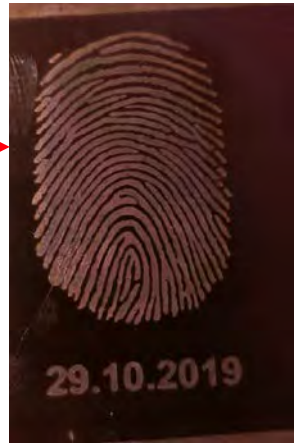
  - Print/3D print



  - PCB

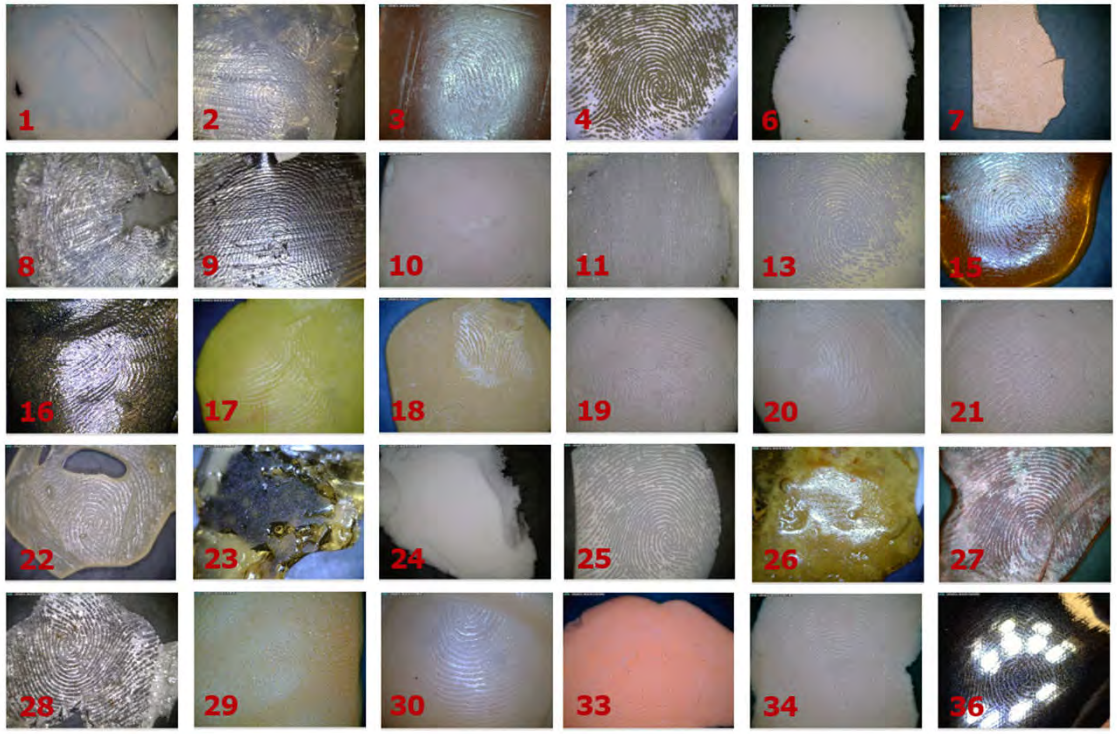
  - Engraving/Heating

  - Etching



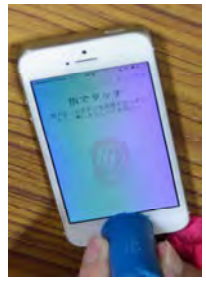
Production process for fingerprint spoofs – 2/2

- 40 various materials
  - Industrial (glue, putty, etc.)
  - Food (jelly, gummy bears, etc.)
  - Creative (wax, play-doh, etc.)
  - Special properties (graphite, etc.)



Opening a smart phone / mobile device

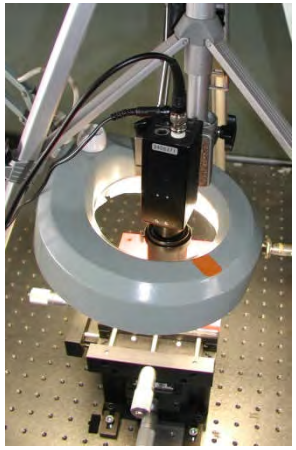
- 2 running projects
- Both projects generating confidential research reports in 2021
- Orientation on the biggest players on the market, but including important ones as well



- Understanding the general structure of biometric layers in the operating systems (especially Android and iOS)
- Checking the overall security, based (not only) on standards ISO/IEC 30107, FIDO…
- Cryptographic expert and professional evaluator of systems (especially banking and huge computer systems) involved

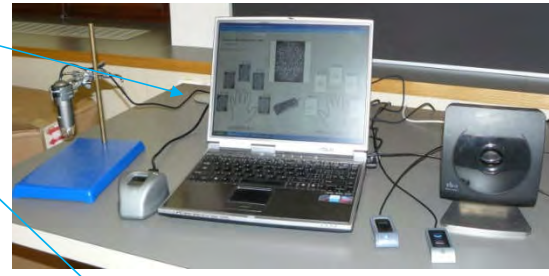
Fingerprint anti-spoofing

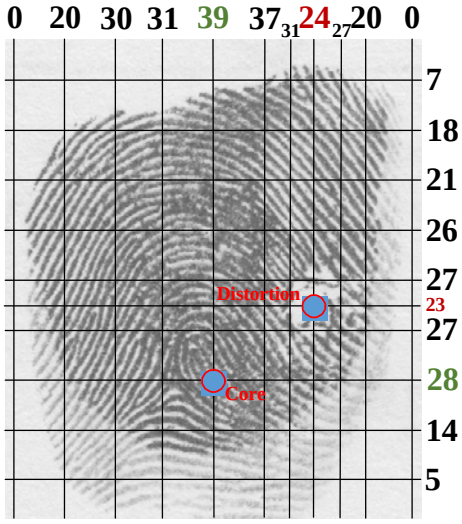
- We have (inter)national patents and utility models

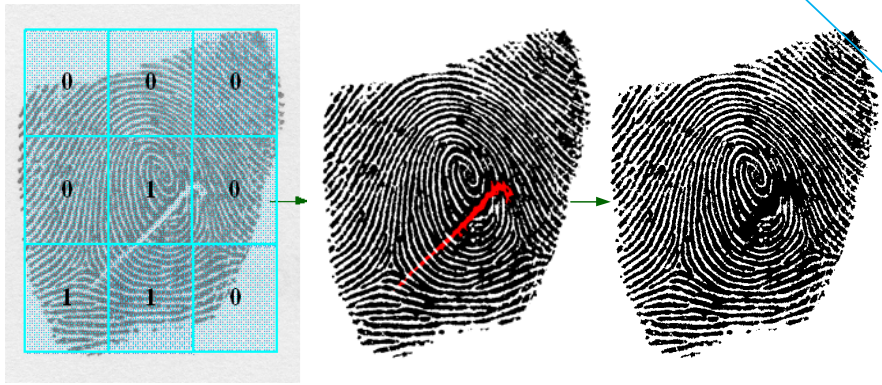


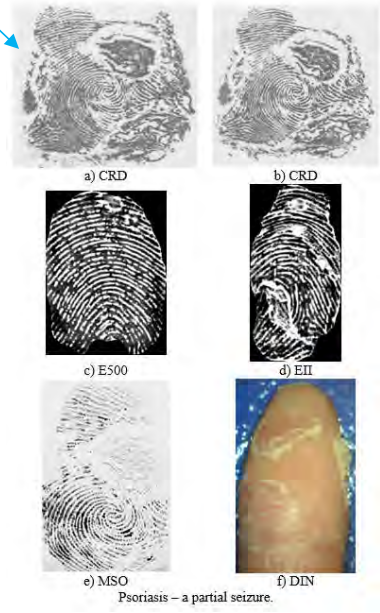
Influence of skin diseases on fingerprints – 1/2

- Histopathologic changes
- Change of skin color
- Histopathologic changes and color change
- We have an internationally unique DB
- Algorithms for detection and recovery

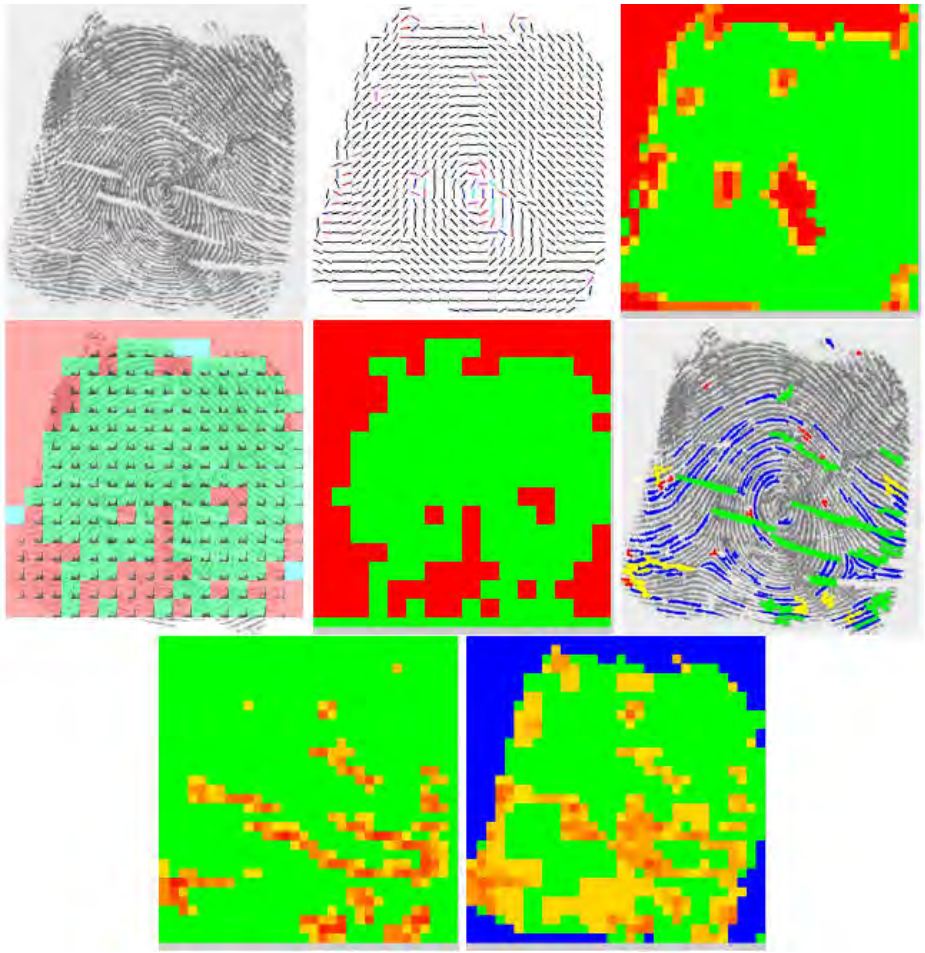




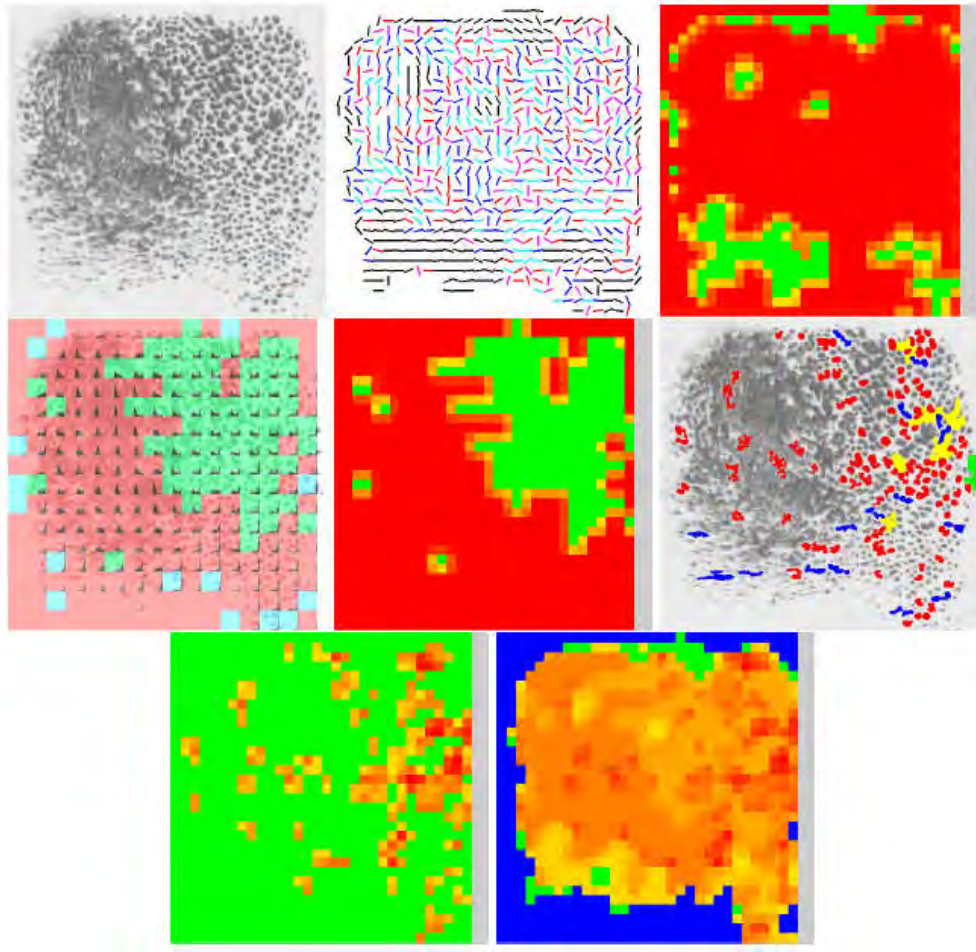




Influence of skin diseases to fingerprints – 2/2



Atopic eczema



Acrodermatitis

Use of fingerprint spoofs at a crime scene

- Materials: plain, sweat, blood (rat)
- Materials: paper, PE plastic (white, transparent), glass, buckskin, metal (zinc, copper), wood, sponge

- Acquisition of a new fingerprint database
  - At the Department of Dermatovenerology, University Hospital Brno and Faculty of Medicine, Masaryk University
  - Fingerprints (capacitive, optical, swipe, LFD, microscope)
  - Reaction of skin to various wavelengths (multispectral)
  - Level of melanin in skin (skin color)
  - Humidity, water evaporation, and elasticity of the skin
- Spoof traces under environmental conditions
  - Real fingerprints and spoof-prints
  - Plain, sweat and blood
  - Miscellaneous materials (wood, paper, plastic, metal, leather…)
  - Various environments with data logging of humidity and temperature

Thank you for your attention !