Fingerprints in Forensic Verifications

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Motivation and Outline

- 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
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 + FingMor

- FiQiVi = Fingerprint Quality Visualizer

- FingMor = Fingerprint Morpher
Generation of synthetic fingerprints

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


- 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.)
Production process for fingerprint spoofs – 1/2

- 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.)
• 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

Fingerprints in Forensic Verifications
Influence of skin diseases to fingerprints – 2/2

Atopic eczema

Acrodermatitis
• Materials: plain, sweat, blood (rat)

• Materials: paper, PE plastic (white, transparent), glass, buckskin, metal (zinc, copper), wood, sponge
Future Work

• 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!