Federal Office
for Information Security

Need and perspectives to realize liveness detection

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Federal Office for Information Security

Contents

1. “Fakes are not always a bad thing…”
2. BSI – strategy regarding spoofing
3. Challenges in Vulnerability Assessment
4. Open questions & To-Do-list

1. “Fakes are not always a bad thing…”

- In 2011 Bavarian police asked BSI for assistance in the investigation of a bombing attempt
- The suspect stored valuable information on his new mobile phone - equipped with newest biometric protection
- Provided with his fingerprints it was easy to break the biometric protection in the first attempt
- Unfortunately the police did not keep the phone charged
  ⇒ the booting process still required both pincodes!
  We had to resort to our standard methods.

Lessons learned:

- always keep confiscated phones charged !
- **raise awareness !**:

"Security is often cited as the biggest impediment to the broad adoption of mobile wallets, and we believe our jointly-developed NFC reference designs will give consumers greater confidence that mobile wallets are not only an easier way to pay but are much more secure than other means," *added AuthenTec CEO Larry Ciaccia*

3. BSI – strategy regarding spoofing

1. Threat Assessment

continuously collect &
develop attack methods,
„State of the Art“ -Tests

2. Countermeasures

development of fake
detection technologies, close
contact to manufacturers

3. Tests & Certification

development of test &
certification methodologies,
international standardization

2.1 BSI-strategy: 1. Threat Assessment

since 2007 (LF I & II):

- collecting & evaluating publicly known fakes
- development of new fake types
- → **BSI-Fake-Toolbox**

- Vulnerability analysis of:
  - relevant finger-scanner-technologies
  - relevant finger-scanners **with** fake-detection

- Knowledge exchange & cooperation with manufacturers, laboratories, universities, police departments and other governments
- Testing service for manufacturers

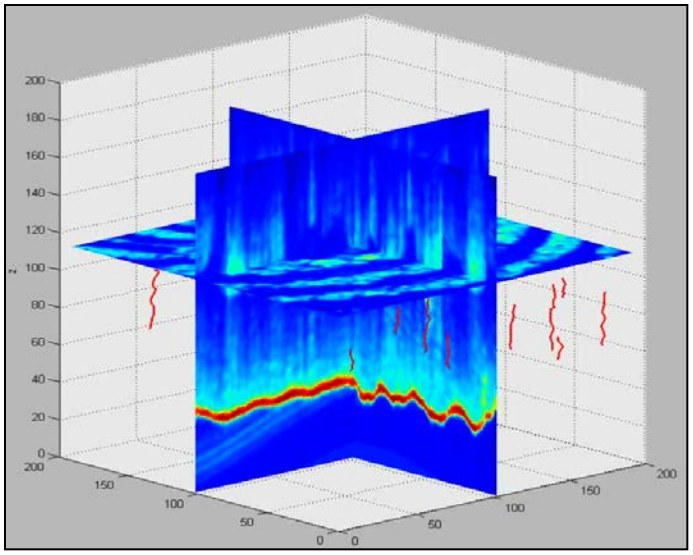
2.2 BSI-strategy: 2. HW-Countermeasures

New approaches for secure fingerprint scanners:

BOTTOM-UP: „Lifefinger III“

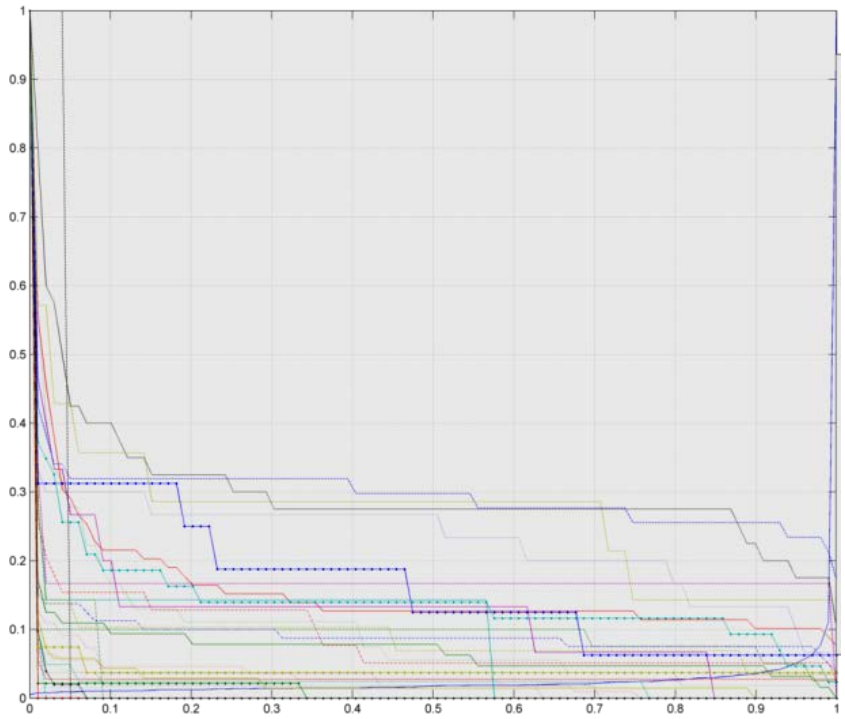
- Improvement of the “state of the art“ with additional sensors
- Basis: newest FP-scanner with high level SD
- Multimodal combination of liveness & selected skin properties detection

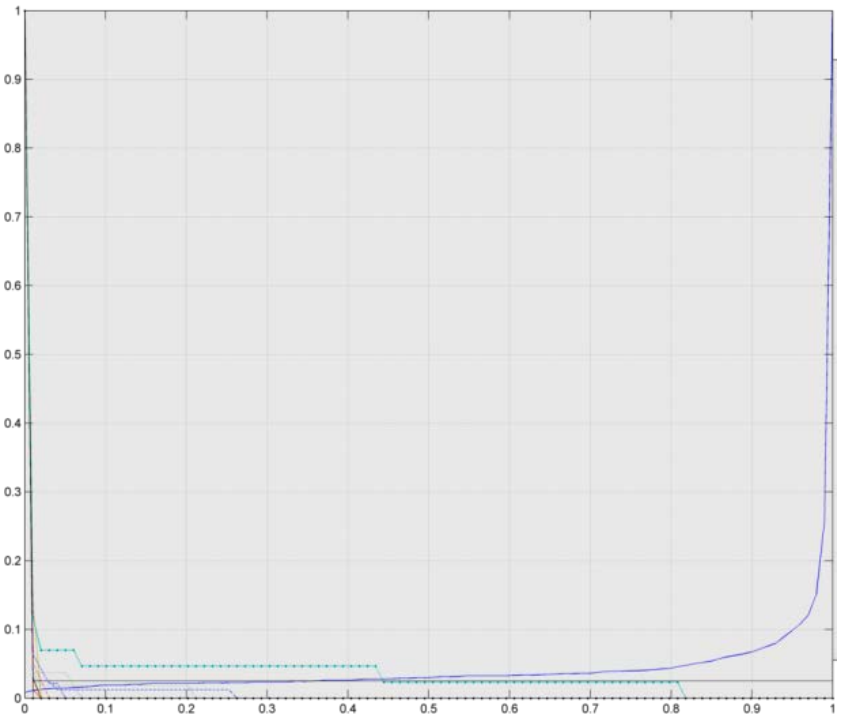
TOP DOWN: „3D-OCT-Finger“



- complete scan of the finger in 3D with up to 3000dpi w. 1,5mm depth
- detection of various anatomical skin features - all at once
- combinable with liveness detectors

2.2 BSI – strategy: *Lifefinger III – Results*





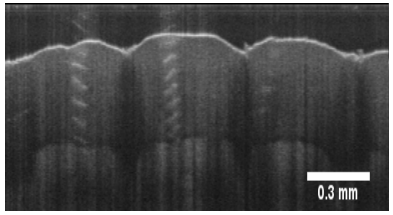
a) original FAR of LF1

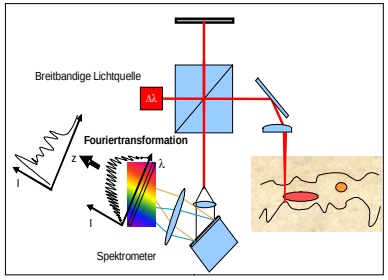
b) FAR of LF1 + new sensors

With alternative fusion: FAR = 0.0%, FRR = 1,41% ! ()

2.2 BSI - strategy: OCT-Finger

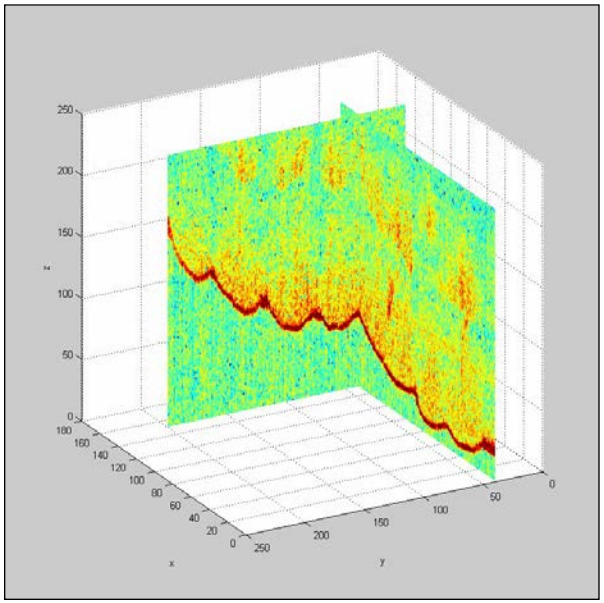
"Development of a new sensor type that detects many skin and FP properties at the same time"





- detailed 3D-measurement of the finger up to a depth of 1,5mm with "Optical Coherence Tomography" (OCT) [standard medical instrument for iris & retina]
- Resolution of up to 12µm in all 3 dimensions (small scanning area and low speed in 1st project)
- Detection of the fingerprint structure on the surface and in deeper layers (epidermis-dermis barrier). Comparison of both FP $\Rightarrow$ detection of thin & full finger fakes!
- detection of sweat producing spiraling tubes + many more

2.2 BSI - strategy: OCT-Finger results



- OCT shows a very high potential for SD
- However the results did not meet the expectations, due to:
  - a relatively high number of faulty measurements
  - filters and classificators could not be optimized
- Main issues were:
  - huge amount of data
  - very high complexity of filters/classificators (many different approaches at once)
  - The computational needs were too high for parameter optimization and practical use (5d for 1 evaluation of all ~5000 measurements!)
- OCT-CUDA: Massive parallel data analysis on GPUs – Speedup of ~40+ (<1 sec)

2.3. BSI-strategy: Certification of Spoof Detection


Deutsches IT-Sicherheitszertifikat

- international basis for the comparison of spoof detection solutions
- support for vendors of biometric devices to:
  - reward their existing efforts in spoof detection development
  - encourage further development in that area
- setting a starting point for international standardization & cooperation (& competition) in that area to make biometrics continuously more secure & trustworthy
- a CC-certificate is one possibility to define & to demand a certain standard of reliability

2.3. BSI-strategy: Common Criteria-first results


Deutsches IT-Sicherheitszertifikat

- two dedicated Protection Profiles (PPs) have been developed to address the specific characteristic of spoof detection devices
- The first PP (FSDPP_OSP) is based on Organizational Security Policies and focuses on a pure functional test of the biometric spoof detection
- The second PP (FSDPP) defines a dedicated level for vulnerability assessment (based on EAL 2) in order to describe an entry level into the classical assurance packages
- Both PPs are published on CC- & BSI- websites
- An evaluation methodology has also been developed but not yet published (FSDEG_V2.1 by TÜV-IT)

3. Challenges in Vulnerability Assessment

SD in biometrics is something completely different in the field of CC

- testing with fakes means „dirty“ handy work
- automated tests are barely possible
- Knowledge of possible attacks is always incomplete and constantly growing
- In the information-/Youtube- age one easy golden fake is enough to undermine the security of a device in general

- Functionality Tests = Vulnerability Tests
- no known complete statistical model/foundation for tests
- successful fakes today are cheap and can be made / used without much expertise (low effort)

3. Challenges in Vulnerability Assessment

Doing the numbers game:

- Standard security level for VTs in CC: 99,99..%!!!

→ Huge number of tests are necessary for a clean statistical analysis:

e.g.:

40 fake-materials *

5 additives *

mixture recepies with other materials [2c](10) *

mixture ratio variants (10) *

physical parameter variants [thickness] (10) *

fake type variants (30) * [rule of 30, CI of 95%]

= 200,000 fake types …. 6,000,000 tests!

we need a different approach!

3 Challenges in VT: BSI approach

BSI focused on certification of solely the SD component

- can be used as an additive in the certification of a biometric system
- can be transferred to other biometrics easier

worst case assumption:

- always use the best kinds of fakes
- all fake types are tested separately – no over all mean value
- if one fake type is “reproducibly” successful – the system fails!

The **Fake-Tool-Box** is the starting basis for functional tests
(has to be updated regularly! - leading to new certificates)

complete statistical analysis will not be practicable

- a reduced test setup must be fixed for comparability
- details of those tests are not known to the manufacturer

4. Open questions:

How can we reduce the necessary numbers?:

- Reducing tests by simulating parameter variants:
  - develop a feasable model of material influence out of view test samples (example: thickness)
  - automated tests may partially be possible to determine critical parameter values

How can we increase comparability?

Are there better ways to include VA in biometry in CC?

4. To-Do-List

- EU-Project B.E.A.T (FP7-SEC-2011) “Biometrics Evaluation and Testing” Standardization of SD evaluation in biometrics in general

- CCDB – Supporting document on

  „Characterizing Attacks to Fingerprint Authentication Mechanisms“

  National Cryptologic Centre (CCN, Centro Criptológico Nacional, Spain) + *ATVS University of Madrid (UAM).*

- CC-Certification of FP-scanners.
- Proposal for a VA-methodology Project in ISO SC27 to support and complement the current work in SC37
- Practical cooperation within the BVAEG-group

4.3 Future Projects

Upcoming BSI-Projects 2012 - 2014:

- ***"Face Trust"***
  - Vulnerability evaluation of face biometry systems against spoof attacks
  - Development of new technical countermeasures for SD
  - Preparation of a vulnerability assessment methodology for CC

- ***"OCT-Finger II"***

  New & optimized BSI-OCT-hardware in combination with new classifiers (with CUDA-acceleration), 10x scanning speed, higher resolution, better signal-noise ratio, bigger scanning area, etc – last development step prior to industrial prototype
  – parallel use for ***Iris*** (and ***Retina)*** biometry

… thank you for your attention!

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