



Biometrics - Blessing or Curse?

Online, 23.6.2020





SVA System Vertrieb Alexander GMBH



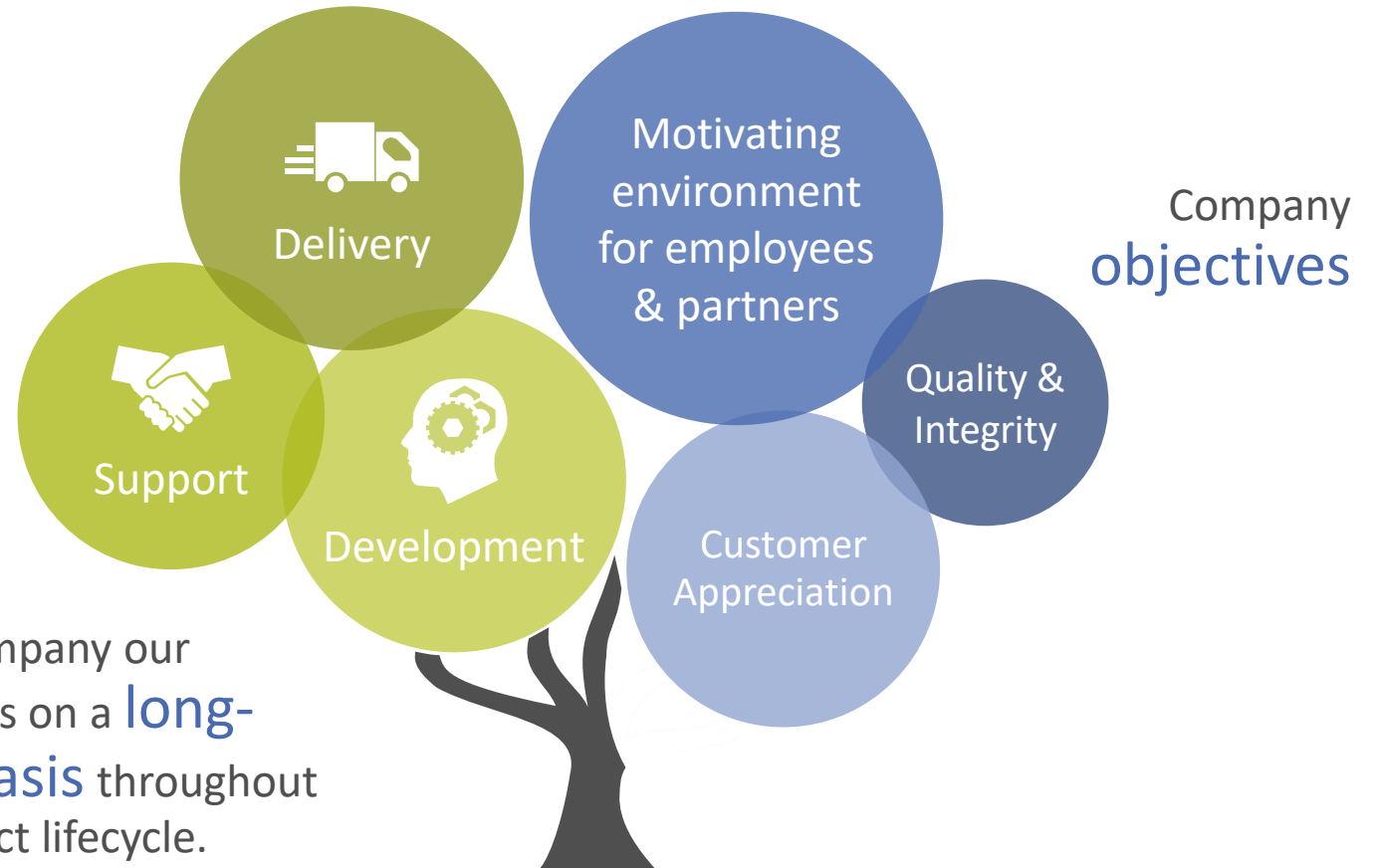
A short company introduction

/ Profile and corporate objective

Biggest **owner-operated system integrator** in Germany

Steady growth with more than **1.400 employees** in Germany

We accompany our customers on a **long-term basis** throughout the project lifecycle.

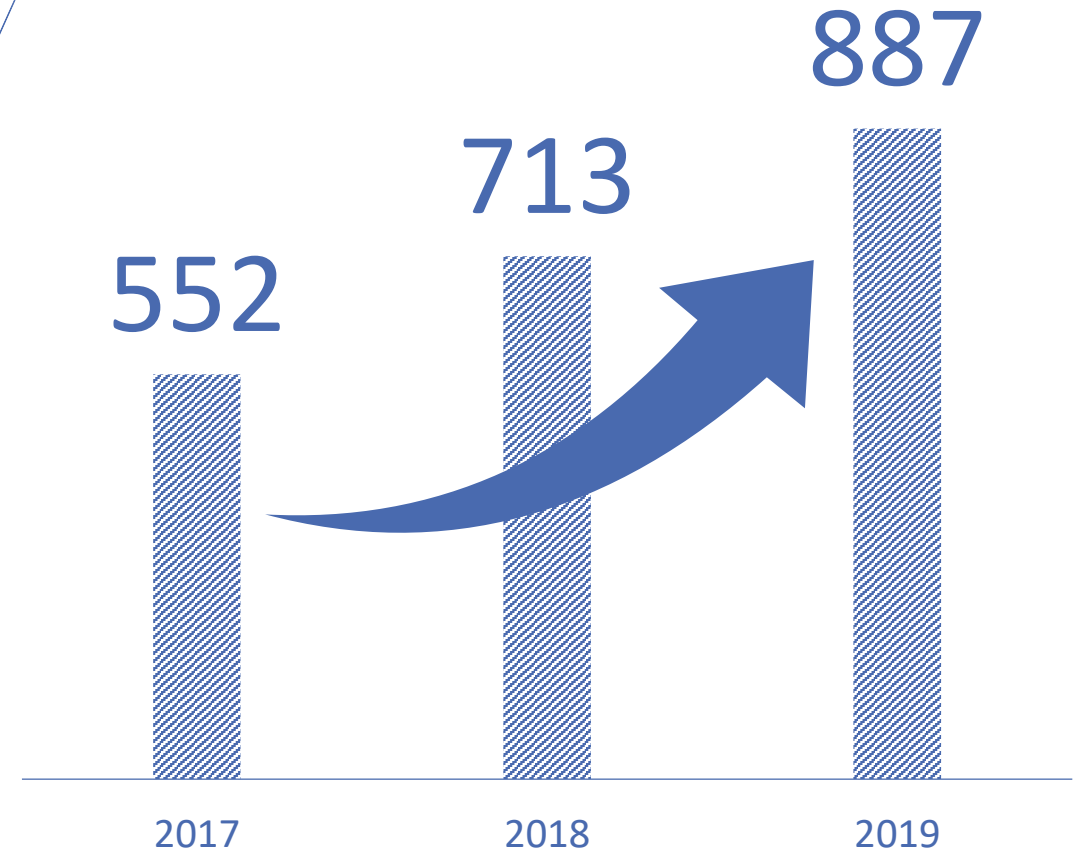


About us
/ Company

Employees

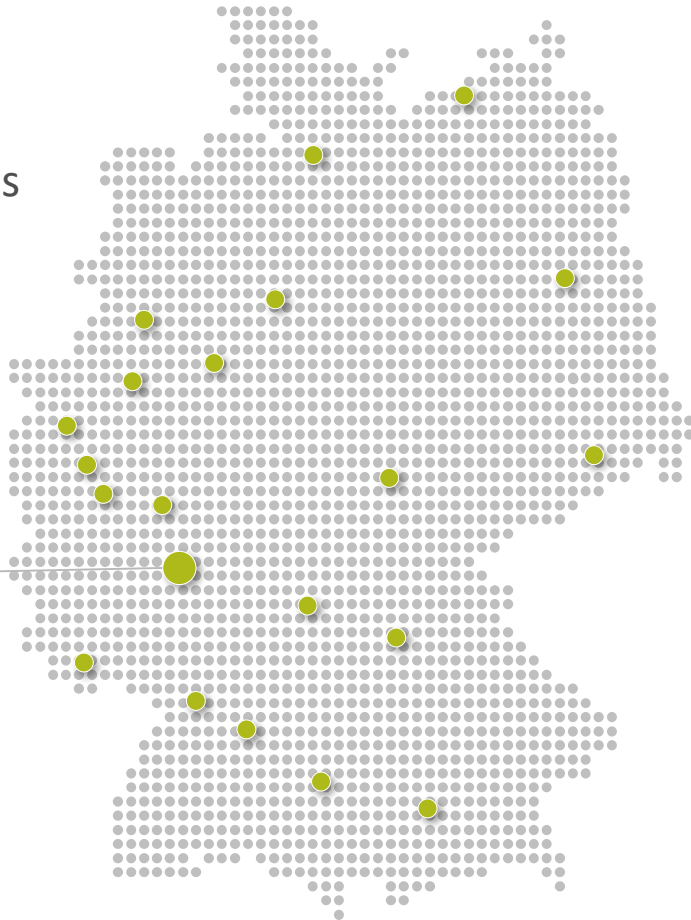


Sales volume in Mio €



21

Branch offices



Wiesbaden

6 TOP

Industries



Automotive



Retail



Public



Machine &
Plant
Construction



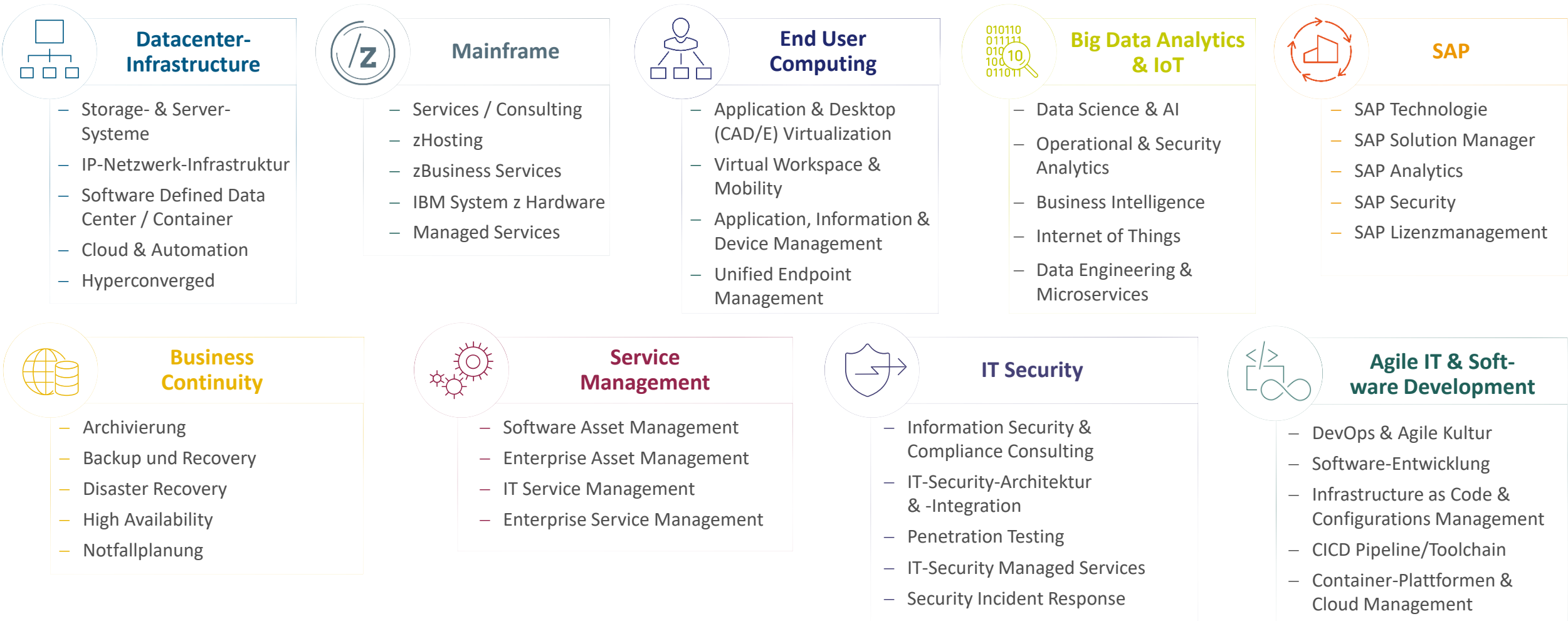
Finance &
Insurance



Telecommu-
nication

Products

/ Product portfolio at a glance



What makes us unique?

/ SVA ...



SVA
System Vertrieb
Alexander GmbH



› Owner-operated

› High employee satisfaction and loyalty

› Long-term technical support for solutions delivered by us

› Customer satisfaction and recommendation above average

*WirtschaftsWoche Award valid and free for use from 06.01.2018 until 05.02.2019, must not be changed.



Jürgen Kühn

Senior IT Security Consultant

Dipl.-Ing. Nachrichtentechnik UNI Duisburg

Identity and Access Management

Single Sign-On

Smartcards

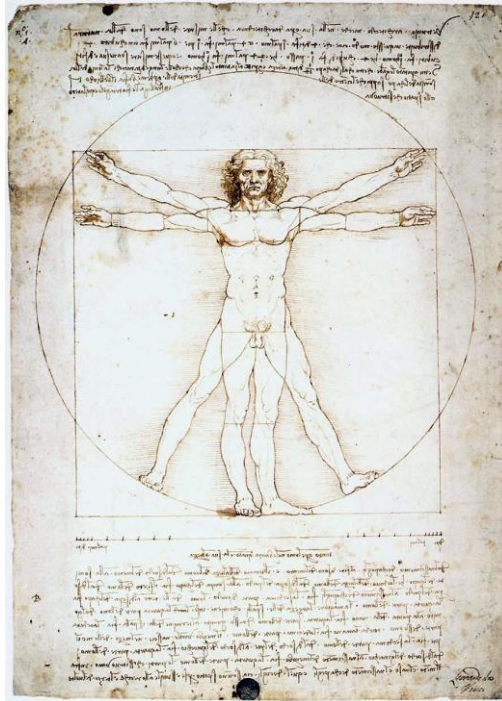
Biometrics

PKI

IT Security

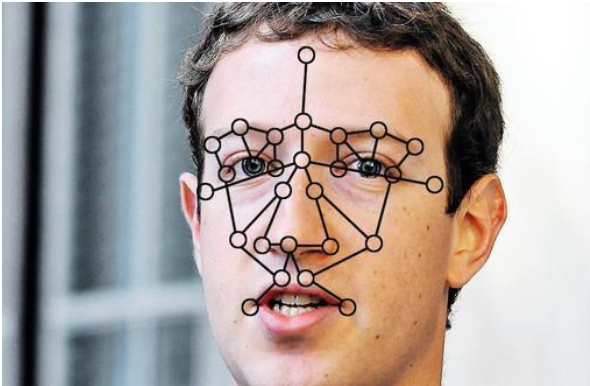
Database Security

/ Agenda



- Basics
- Fingerprint
- Iris scan
- Face recognition
- Hazards
- Discussion

/ Biometrics in everyday life



/ What is Biometrics

- "Science of counting and [body] measurements on living organisms «
- From Greek
 - Bios = Life
 - Métron = Measure
- Biometrics is a technique for identification and authentication of persons based on specific physiological or behavioral characteristics



/ Features of biometric characteristics



Universality



Uniqueness

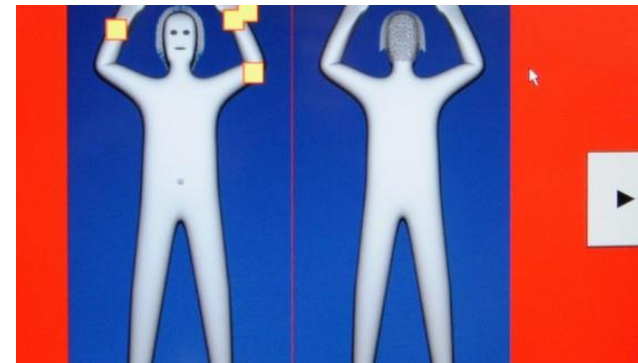


Permanence



Detectability

/ Features of biometric characteristics



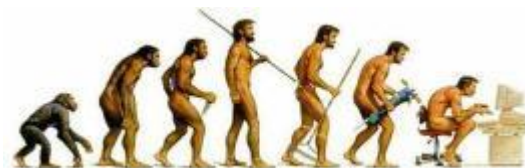
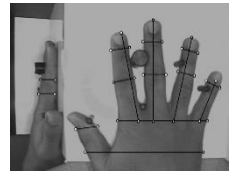
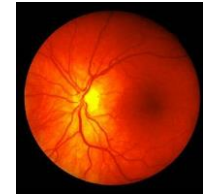
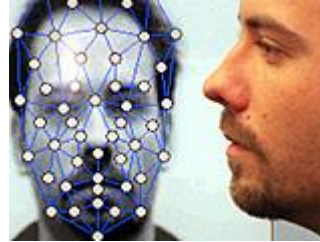
/ Characteristics for biometric identification

- Physiological features

- Fingerprint
- Face
- Iris
- Retina
- Hand geometry
- Vein pattern
- Ear geometry
- DNA

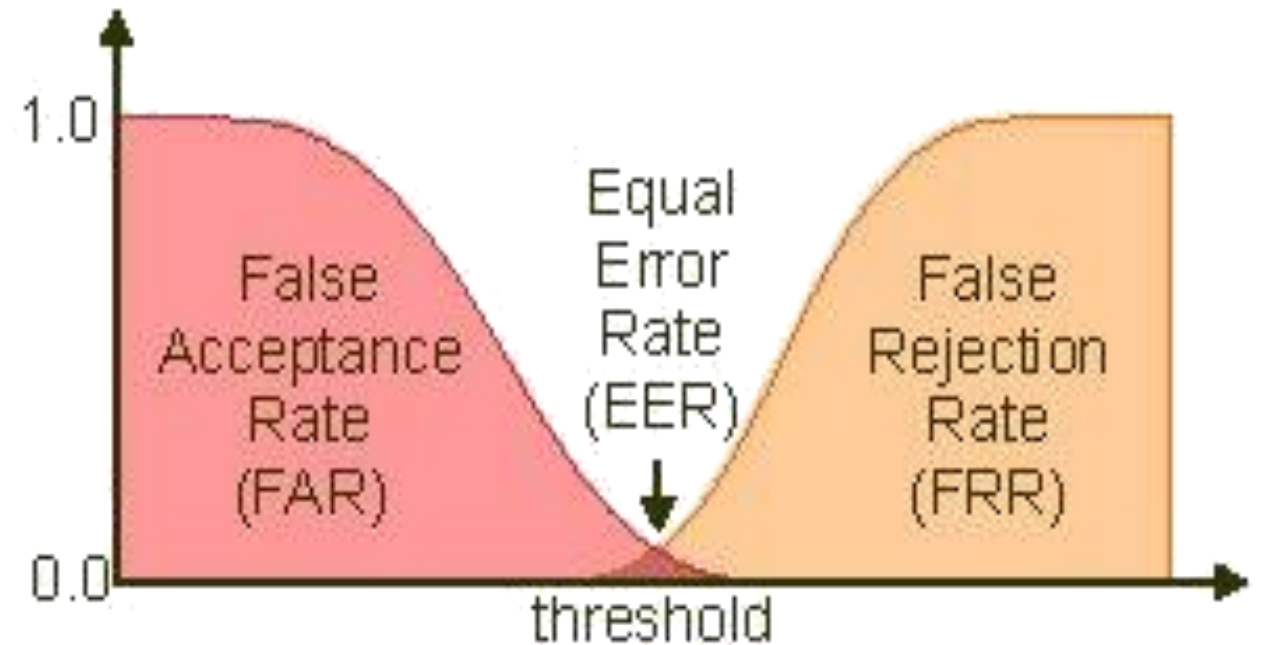
- Behavior-based features

- Signature (dynamic / static)
- Gestures / facial expressions while speaking
- Walk
- Lip movement
- Voice / speech behavior
- Keystroke at the keyboard



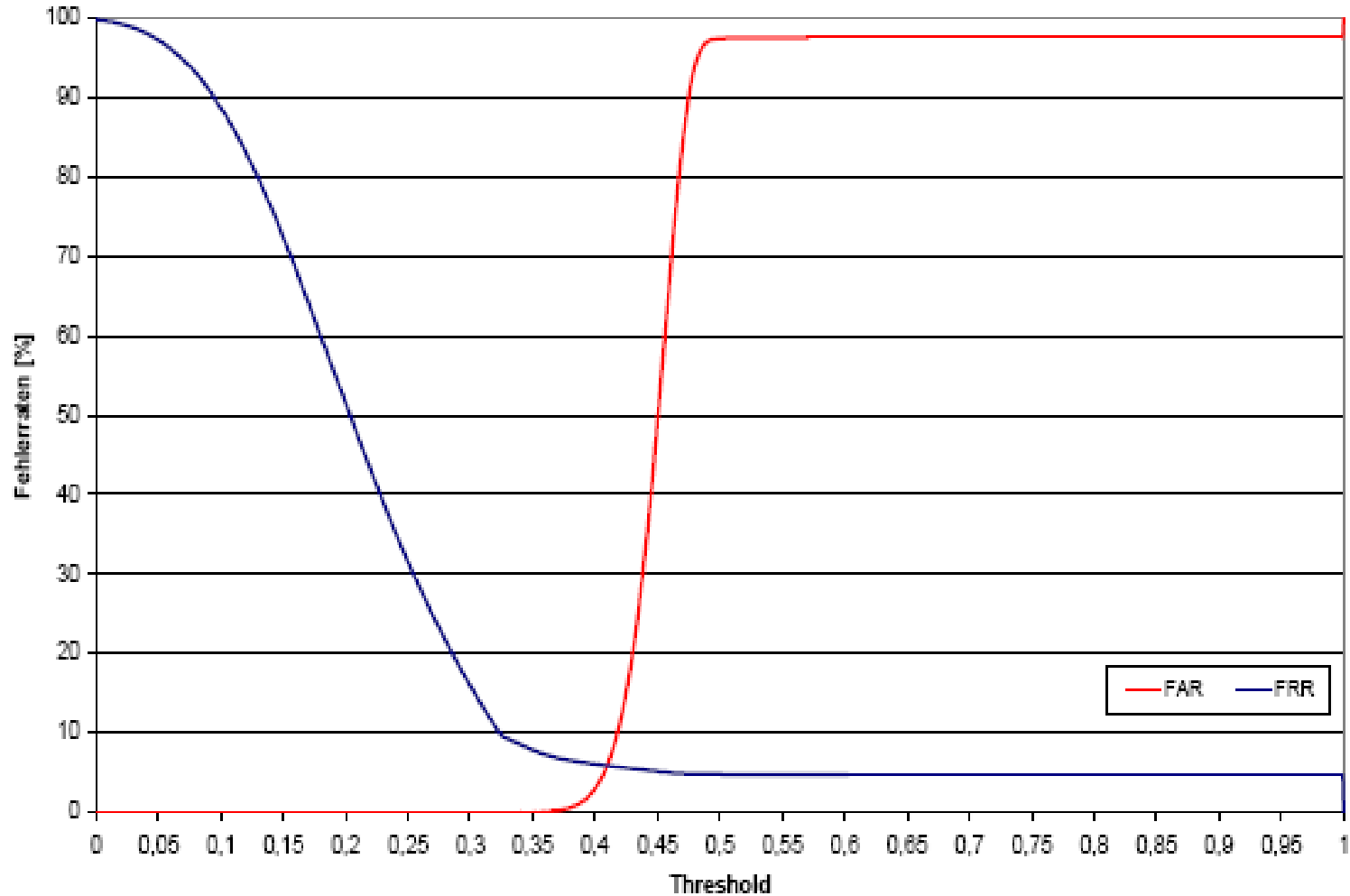
/ FAR und FRR (1)

- Only a probability of correspondence
- False Acceptance Rate FAR
 - Rate of unjustified accepted persons
- False Rejection Rate FRR
 - Rate of unjustified rejected persons
- Equal Error Rate ERR
 - FAR = FRR
- Threshold determines whether the system is "secure" or "comfortable"



/ FAR und FRR (2)

Reality



/ Verification and Identification

- Verification
 - Check against only one reference
- Identification
 - Check against any number of references
 - Probability of false detection increases exponentially with the number of references
- Several attempts against one reference
 - 2 attempts and FAR = p
 - $P(2) = p + (1-p)*p$
 - n attempts and FAR = p
 - $P(n) = p + (1-p)*p + (1-p)*(1-p)*p + \dots = 1 - (1-p)^n$



$$\begin{aligned} \text{FAR} &= 0,002 \\ N = 200, P(N) &= 32\% \\ N = 2000, P(N) &= 98\% \\ N = 10000, P(N) &= 99.999\% \end{aligned}$$

/ Agenda



- Basics
- **Fingerprint**
- Iris scan
- Face recognition
- Hazards
- Discussion

/ Fingerprint: Operation (1)

- Sensor types

- Optical
- Capacitive
- Thermal
- Ultrasonic
- Pressure

- Process

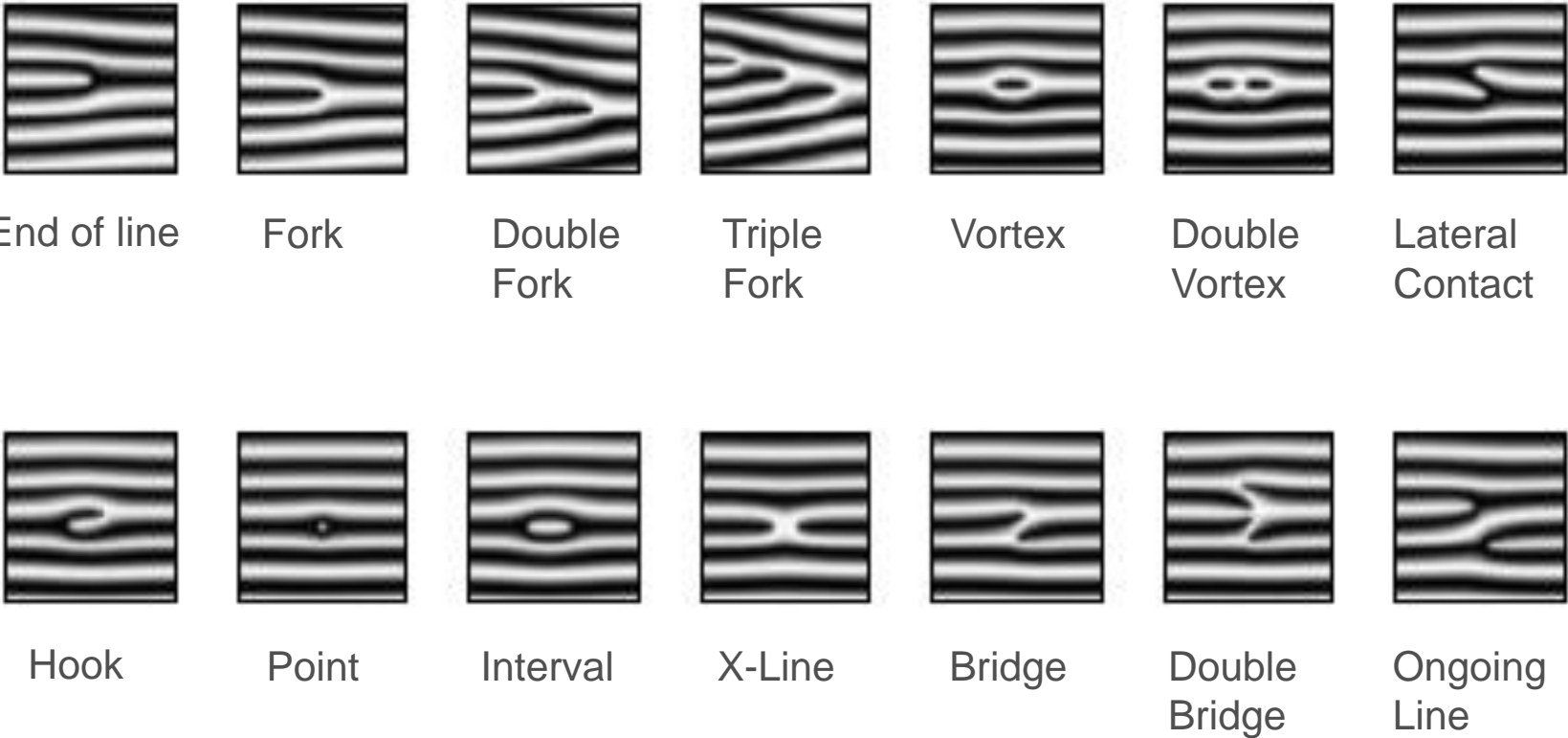
- Minutiae
- Pattern matching over the whole image
- Follow the papilla segments
- Position of sweat pores

- 20-30 Characteristics



/ Fingerprint: Operation (2)

Minutiae



Source: BSI, „Evaluierung biometrischer Systeme Fingerabdrucktechnologien – BioFinger“, öffentlicher Abschlussbericht

/ Fingerprint: Liveness Detection

- Measurement of the blood oxygen content by determination of the hemoglobin concentration ratios on the basis of the different absorption of different wavelengths of infrared light
- Pulse
- Electrical resistance of the skin
- Temperature
- Reflection properties in the ultrasonic range
- Blood flow

/ Fingerprint: Sensors



Entrance door



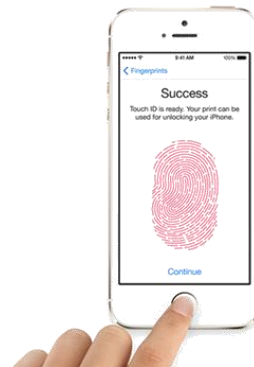
Ultrasonic



Live Detection



Capacitive



Qualcomm
Snapdragon



Optical

/ Fingerprint: Vulnerabilities (1)

- Latent image reactivation
 - Breathe on
 - Graphite powder
 - Color powder
- Use of latent images
 - Graphite powder and Tesa
- Build a fingerprint hardcopy
 - Gelatin
 - Wood glue
- Incorrect driver software
 - Access to passwords stored in the Windows registry
 - Preinstalled by leading notebook manufacturers



/ Fingerprint: Vulnerabilities (2)

Authentication to computer

(Video removed)

Source: Kopfball

/ Fingerprint: Advantages and Disadvantages

- Very well researched methods
 - High degree of uniqueness
 - Cheap sensors
 - Suitable for identification
-
- Good Life recognition is cost intensive
 - Hygienic concerns
 - 5% of people have no really usable fingerprints
 - Not tamper-proof



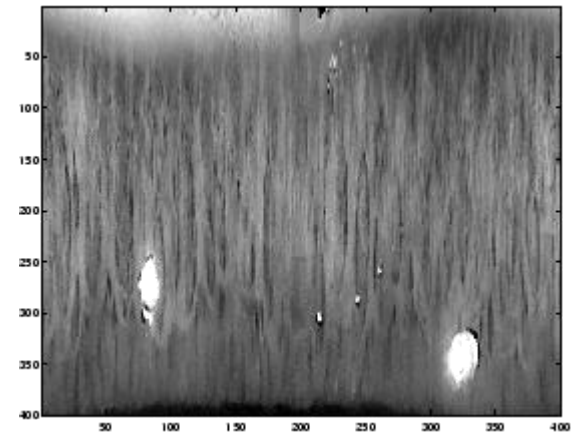
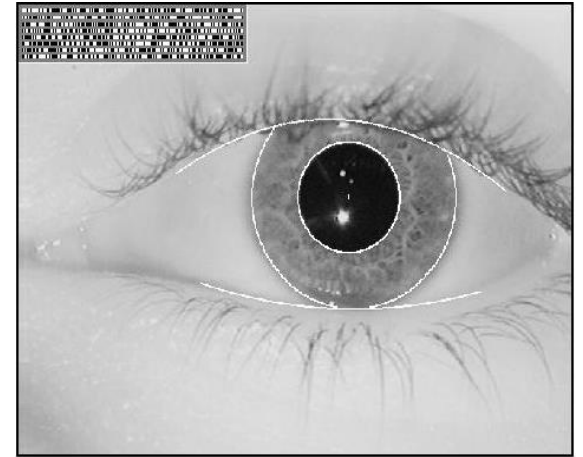
/ Agenda



- Basics
- Fingerprint
- **Iris scan**
- Face recognition
- Hazards
- Discussion

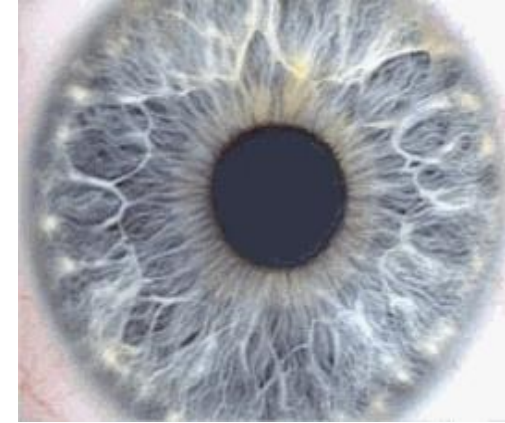
/ Iris Scanner: Operation (1)

- Illuminating with infrared light
- Macro shot of the eye in the near infrared wavelength (680-850 nm)
- Photographic extraction of iris
- Dividing the iris in 8 circular cutouts
- Detection of remarkable patterns (Cornea, crypts, fibers, stains, scars, radial furrows, stripes)
- Generation of iris code
 - Gabor Wavelet transformation
 - 244 measures
 - 512 bytes



/ Iris Scanner: Operation (2)

- One globally used algorithm
 - John Daugman, University of Cambridge
- Fast recognition
- Very good FAR and FRR
- Liveness detection
 - Irradiation and reflection
 - Pupillary reflex
- No detection of disease or drug use possible
- Iris indistinguishable after 25 years
 - According to Kevin Bowyer, the error rate changes after 2 years



/ Iris Scanner: Reader



Kiosk system



Mobile phone



Computer access



Building access



eGate

/ Iris Scanner: Vulnerabilities

- Outwitting with photo or inkjet print
- Presentation of a video sequence
- Contact lens with printed or hand-painted iris
- Contact lens with iris hologram
- Hard to outwit if liveness detection is active



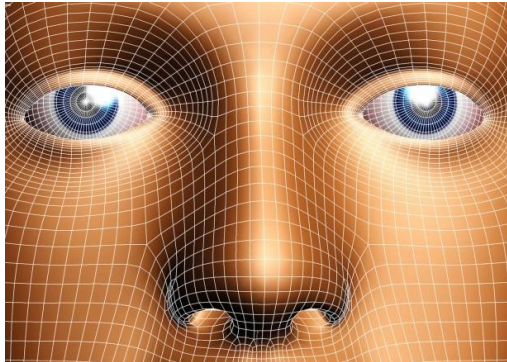
/ Iris Scanner: Advantages and Disadvantages

- High degree of uniqueness
- High temporal constancy
- Simple liveness detection by pupillary reflex
- Suitable for identification

- Change of characteristics due to illness
- Lighting, glasses, contact lenses
- Costs
- User acceptance
- User behaviour in front of active systems



/ Agenda



- Basics
- Fingerprint
- Iris scan
- **Face recognition**
- Hazards
- Discussion

/ Face recognition: Operation

- Based on characteristics
 - Extraction of individual characteristics
 - Classification based on these characteristics
 - Elastic Bunch Graph Matching
 - Detection using geometric characteristics
- Holistic approach
 - Observation of the entire face
 - Template Matching
 - Fourier transformation
 - Eigenface method
- Combination of the above methods



Source: Automatische Gesichtserkennung: Methoden und Anwendungen, Dominikus Baur, Universität München

/ Face recognition: Vulnerabilities

- Disguise
 - Makeup artist
 - Sunglasses
 - Glasses
- Photo
- Video sequence
- Artificial head
- Poor lightning
- „Grimaces“



/ Face recognition: Advantages and disadvantages

- High usability
- High user acceptance
- Face is always (at least partially) visible
- Can be generated and reviewed without notice

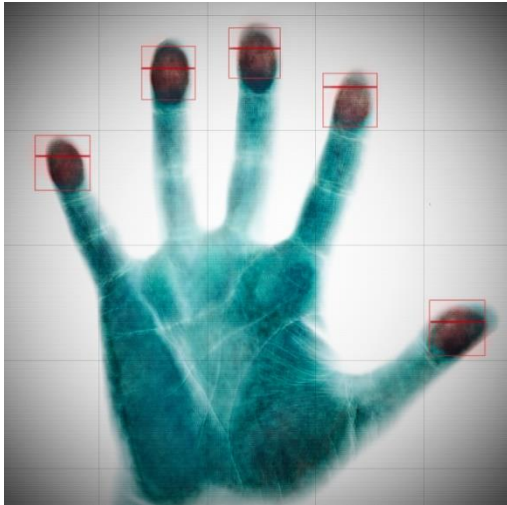
- Low relative constancy
- Low uniqueness
- No cooperation necessary
- Can be generated and reviewed without notice



/ Comparison of Technologies

Item	Fingerprint	Iris Scan	Face Recognition
Uniqueness	?	10e-78	?
FAR	0,002 - 0,2 % 1:50.000 - 1:500	0,0001 % 1:1.000.000	0,01 - 1 % 1:10.000 - 1:100
FRR	0,1 - 5 %	1 %	1 - 20 % (1993: 79%)
Characteristics	25	244	22
Acceptance	-	- -	+ +

/ Agenda



- Basics
- Fingerprint
- Iris scan
- Face recognition
- **Hazards**
- Discussion

/ Fiction?

(Video removed)

/ Hazards (1)

- Loss of a biometric characteristic
- Fingerprint
 - Security
 - Unique
 - Not tamper-proof
 - Burden of proof
 - Forensic consequences
 - Legal consequences
- Faith in technology
 - Fingerprint of Wolfgang Schäuble
 - Murders deposit foreign DNA at the crime scene (study)

Ein Tatrichter, der seine Überzeugung von der Täterschaft des Beschuldigten auf das Beweisanzeichen der an den Tatorten festgestellten und nach den wissenschaftlichen Grundsätzen der sogenannten Daktyloskopie sorgfältig ausgewerteten Fingerabdrücke des Täters stützt, begeht damit keinen Verstoß gegen Rechtsnormen des Strafrechtes oder gegen allgemeine Erfahrungssätze der Wissenschaft



/ Hazards (2)

Shopping with fingerprint

(Video removed)

„Economics of Crime“



$$\begin{aligned} \text{FAR} &= 0,002 \\ N = 200, P(N) &= 32\% \\ N = 2000, P(N) &= 98\% \\ N = 10000, P(N) &= 99.999\% \end{aligned}$$

Source: Planetopia 25.1.2009

/ Apple iPhone

Touch ID

- Apple states that the chance of a random finger unlocking an iPhone is 1 in 50.000
- 1 in 100 results in FAR 1% or 0,01
- 5 fingerprints can be enrolled
- 1 in 10000 results in FAR 0,0001
- Five unsuccessful fingerprint match attempts are allowed before a password must be entered

$$\begin{aligned} \text{FAR} &= 0,0001 \\ N = 200, P(N) &= 2\% \\ N = 2000, P(N) &= 18\% \\ N = 10000, P(N) &= 63\% \end{aligned}$$

$$\begin{aligned} \text{FAR} &= 0,000001 \\ N = 10000, P(N) &= 1\% \\ N = 100000, P(N) &= 9,5\% \end{aligned}$$

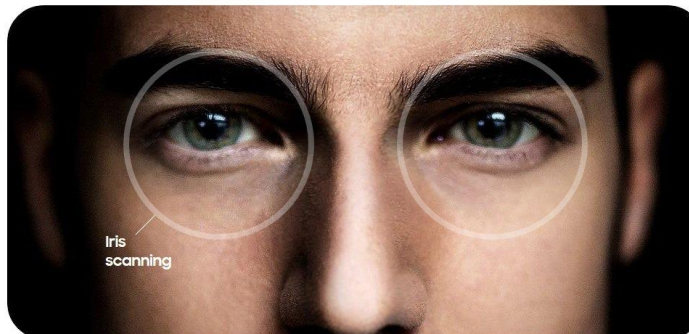
Face ID

- Projects over 30.000 invisible dots on the face
- Camera reads the dot pattern
- Camera captures an infrared photo
- Collected data are merged
- Apple states that Face ID can not be fooled by
 - High end masks
 - Printed photos
 - Videos
- Due to Apple the chance of a random face unlocking an iPhone is 1 in 1.000.000
- 1 in 1.000.000 results in FAR 0,000001
- Live recognition circumvented by glasses with glue tape

/ Samsung Galaxy S8

Iris Scan

- Works like a charm
 - Enrolled without glasses
 - Works with or without glasses
- Hacked by Chaos Computer Club
 - Photo of the iris in night mode
 - Print photo on laser printer
 - Place contact lens on photo



/ Fiction?

(Video removed)

/ ePass (1)

- Stored in optically machine readable zone
 - Given names and surname
 - Issuing state
 - Pass number
 - Gender
 - Date of birth
 - Expiration date
- Stored in the contactless chip of the passport
 - Photo
 - Two fingerprints as compressed images
- Storage at registry offices
 - Photos are stored at registry offices
 - Fingerprints are not stored at registry offices
 - In contrast to the proposal of the former German Interior Minister Otto Schily

Source: Paßgesetz (PaßG) §21 Paßregister



/ ePass (2)

- The exact usage and storage of the data read out at boundaries is not clear
- Unencrypted wireless transfer of data
- Wireless chips allow unnoticed monitoring and tracking of individuals
- Increase in counterfeit security could be realized even without storage of personal data
- A Study of the BSI showed the immaturity of the technology in biometrics in everyday life
 - Rejection rate of 3 to 23 percent
 - Separate examination of rejected people
 - Unsustainable staffing overhead

/ ePass (3)

- Left Party criticized biometrics strategy of the Federal Government

According to the Left Party in the Bundestag, the Federal Government has acknowledged that biometric methods can be at best used as secondary early detection of suspected terrorists (13.01.2009)

- EU Parliament agrees on a compromise proposal for biometric passports

The European Court of Human Rights has set a limit on the national governments with his decision against the British government (Marper vs. UK) recently. Therein, the ECJ declared the storage of DNA data and fingerprints are disproportionate and incompatible with Article 8 of the European Convention on Human Rights. Any national laws to biometric databases would find here their EU legal limit (15.1.2009)

Source: www.heise.de

Biometrics - Blessing or Curse?

/ Strange (1)

- Cat Stevens
 - If a file ends up times ...
- Phantom of Heilbronn
 - 40 Crime scenes with identical DNA traces
 - “Different DNA results of "unknown female person" (UWP) in relation to facts that were not plausible from a criminological perspective“
 - Contamination of cotton swabs used for receiving samples of DNA by an employee
- Biometric face recognition for laptops hacked
 - The system has been tricked with a photo of a registered user
 - With fake facial images by generating a large number of images
 - Security experts required the laptop manufacturers to remove biometric authentication from the devices and to warn all users before using the function



Source: www.heise.de

Biometrics - Blessing or Curse?

/ Strange (2)

Wir entdecken unseren Körper

Wieso?
Weshalb?
Warum?

Knochen sind das Gerüst unseres Körpers

... und von dir.

Nur Zwillinge sehen sich zum Verwechseln ähnlich. Oft haben sie sogar die gleiche Art zu sprechen und sich zu bewegen.

ANNA TIBO HELEN

Kein Mensch auf der Welt hat genau die gleichen Fingerabdrücke wie du. Wie sieht dein Daumenabdruck aus?

Ferse

/ Wish List

Wikileaks 30.11.2010

- US Secretary of State Hillary Clinton is said to have given their ambassadors in July 2009 secret directives ... to collect biometric data of important UN officials.
- On Clinton's wish list were amongst others passwords and encryption keys used by high-level UN staff for official communication, as well as credit card and frequent flyer numbers.
- Moreover, US diplomats in the DRC, Uganda, Rwanda and Burundi should even collect fingerprints, DNA samples and iris scans of specific target persons from UN circles.

Source: www.heise.de

Biometrics - Blessing or Curse?

/ FBI Biometric Database (1)

FBI takes largest biometrics database piecemeal in operation (25.3.2011)

- The "Next Generation Identification" system have reached the first phase of "operational usability".
- Replaces the Integrated Automated Fingerprint Identification System (AFIS) of the US Police.
- The system is initially fed with fingerprints.
- Later to be captured are iris scans, voice samples, pictures of handprints, tattoos, scars and facial shapes.

/ FBI Biometric Database (2)

FBI provides biometric database completed (16.9.2014)

- With Rap Back, authorized sites may automatically receive updates about conflicts of staff with the law. This would include employees who are dependent in their work on trust, such as teachers.
- In addition, national prosecutors can now access the facial recognition system IPS (Interstate Photo System).
- The FBI said that the images of suspects are compared only with photos of convicted criminals.
- Internal information suggested that other photos may be used, such as shots of crowds or Facebook photos.
- The face recognition system has been criticized massively by civil rights activists.

Source: www.heise.de

/ FBI Biometric Database (3)

- In the FBI office in Clarksburg in the State of Virginia on average around 168,000 fingerprints are being daily analyzed and identified.
- In future, the system should enable 18,000 law enforcement agencies around the clock an automated search for fingerprints, a real-time matching and associated information exchange. Investigators on site will in future be equipped with handheld scanners.
- The Department of Homeland Security (DHS) has in parallel built a private system for fingerprinting and iris scans of travelers entering the United States at airports.
- For the US civil rights activist Barry Steinhardt of the data protection organization Privacy International, there is no question that biometric systems are an important component of future government surveillance projects. He warns that an "Always on" – surveillance society will be possible due to reconcile abilities. The Californian futurologist Paul Saffo warns in this context against that biometric features, unlike some credit card numbers, cling to an individual for it's life. Errors in government databases could therefore have serious consequences.

Source: www.heise.de

Biometrics - Blessing or Curse?

/ FBI Biometric Database (4)

- FBI massively extends their biometric database (22.9.2015)
- Storage of job applicant's fingerprints that employers must send to the FBI for a background check in many professions.
 - Engineers, doctors, brokers, stockbrokers, lawyers, or architects
- Employers and other authorities can additionally send facial images to the FBI.
- The EFF is concerned that these are then used to track the movement of people between different locations.
- According to EFF, confusion with the physical characteristics resulted in innocent persons migrating to jail.

/ EU-Project E-Border Control

EU-Project: Federal police testing e-border control with ten fingerprints (17.3.2015)

- Frankfurt airport runs a trial where up to ten fingerprints are taken from volunteers.
- The German MP Andrej Hunko called on "to avoid absolutely" the tests because they paved the way for a "huge border police data retention of travel profiles".
- The Left Party called the entire package of "smart borders" a "stimulus plan for the defense and biometrics industry."
- It was actually launched to control migrants who overdraw their visa.
- However, the Federal Government sees the high level of investment justified only if police authorities have access to the collected facial and fingerprint data and could monitor travelers in general more intensively.

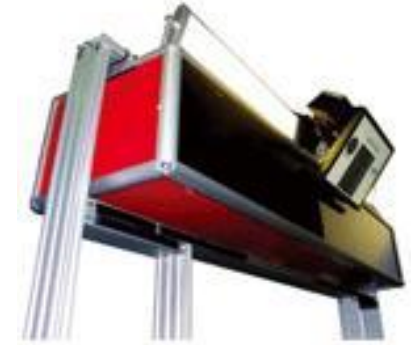
Source: www.heise.de

Biometrics - Blessing or Curse?

/ Voluntary

Léon de los Aldamas, Central Mexico (31.10.2010)

- Global Rainmakers Iris scanner "Hbox"
- Recognizes up to 50 moving persons per minute.
- Offenders are automatically recorded in an iris database.
- Innocent citizens can register voluntarily.
 - Global Rainmakers promises a number of benefits.
 - Pay by iris scan – the system just looks into a customer's eye, identifies him, and debits money from his bank account.
 - Passports or train tickets will become obsolete in the long term.
- „In the future, everything you want to open - one's own house, the car, the door to the office – will be accessible with a single key: the iris“ (Jeff Carter, COO of Global Rainmakers).
- „At a certain point, it is striking to refuse than to participate. Everyone will participate.“
- „In ten years every person, every place, and every object will be linked“.



Source: www.heise.de, Die Welt

Biometrics - Blessing or Curse?

/ Tourists pay by fingerprint

Japan (14.2.2016)

- Foreign tourists will be able to pay by fingerprint soon.
- Tourists need to register their fingerprint at the airport as well as store additional data, e.g. credit card accounts.
- Until the 2020 Olympic Games in Tokyo, the system is supposed to work nationwide.
- Data collected when using the system will be made anonymous and managed by a panel under administrative management.
- Because the data allow a deep insight into the spending habits of visitors, it is expected to be used for the domestic tourism industry too.

Source: www.heise.de

Biometrics - Blessing or Curse?

/ Face Recognition Champions League Finals

Cardiff (8.5.2018)

- Field test for identifying (criminal) persons
- **Bad recognition ratio**
 - 170.000 visitors
 - 2470 persons identified
 - 2297 persons wrongly identified
 - 92% false positives
 - Correct hit rate about 7%
- **Police states "No system is 100% secure"**
- **"No one was arrested because of a false positive"**

Source: www.heise.de

Biometrics - Blessing or Curse?

/ Face Recognition Train Station

Berlin (15.10.2018)

- Field test for identifying (criminal) persons walking nearby
- Bad recognition ratio
 - Best provider 69 %
 - Worst provider 19 %
- Bad FAR
 - Average of 0,67 %
 - 90.000 travelers per day
 - 600 persons per day are wrongly identified.

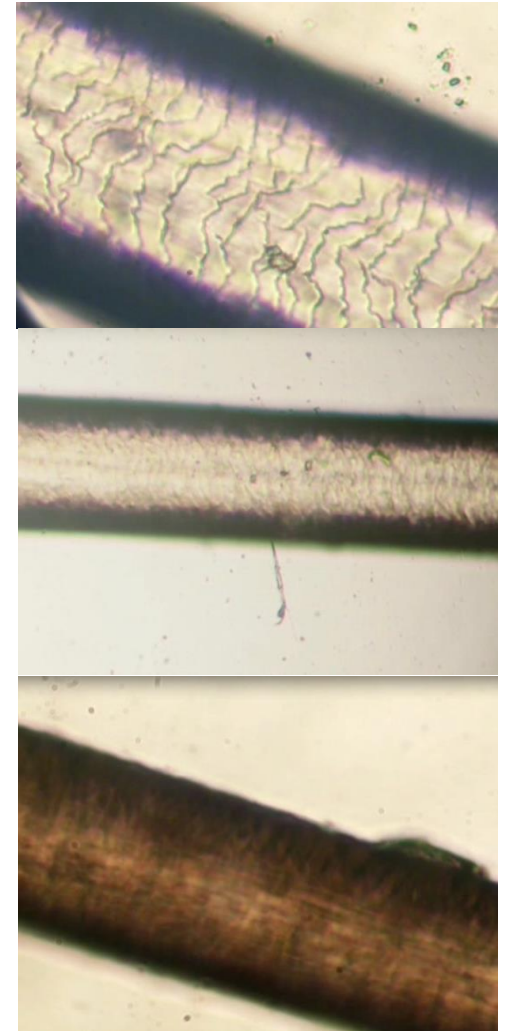
Source: www.heise.de, Chaos Computer Club

Biometrics - Blessing or Curse?

/ Wrong Analysis (1)

Deadly cover-up at FBI (19.4.2012)

- Since the 90s, the US government had knowledge of significant sources of error in the investigation laboratories of the FBI.
- Blatant errors in the microscopical analysis of hair samples and skin residues in murder and homicide cases (no DNA analysis).
- The results in 2004 were passed neither to wrongly imprisoned inmates which have been imprisoned for years not to their attorneys.
- Only the prosecutors involved were informed. They retained the partly exculpatory evidence largely for themselves.
- Hundreds of cases of miscarriages of justice and unjustified penalties
 - 268 judgements
 - 257 wrong judgements
 - 32 death penalties
- Wrongly convicted persons were not rehabilitated.
- The Justice Department is refusing to publish the names of those people.



Source: <http://www.derwesten.de/panorama/hunderte-justizirrtuemer-toedliche-vertuschung-beim-fbi-id6569273.html>

/ Wrong Analysis (2)

- The 17-year Santae Tribble was convicted of capital murder, although several witnesses testified under oath that Tribble was with them at the time of the crime.
- The core of the argument of the prosecutor were hair samples that were assigned to Tribble.
- As it turned out at the internal audits, the FBI evidence objects in truth have been dog's hair.
- A forensic scientist has apparently committed multiple fatal errors especially in hair analysis.
- "FBI experts repeatedly "came to unscientific conclusions" that were a great disadvantage for the accused."
 - Bombing of Oklahoma 1995
 - Murder trial against the former football star O.J. Simpson
 - First attacks to the World Trade Center in New York 1993



Source: <http://www.derwesten.de/panorama/hunderte-justizirrtuemer-toedliche-vertuschung-beim-fbi-id6569273.html>

/ EU Biometric Database

EU bodies agree on biometrics super database (6.2.2019)

EU Parliament decides on huge biometrics database (23.4.2019)

- EU databases are to be made "smarter" and specifically interlinked.
- Linked via a search portal
 - Schengen Information System (SIS) with about 80 million entries
 - Visa Register (VIS)
 - Eurodac file containing fingerprints of asylum seekers
 - Entry and exit system for biometric border control (Smart Borders)
 - European Travel Information and Authorisation System (ETIAS)
- Aim of the EU Commission: "Matching existing data with a single click"
- In addition, a "store for identity data" has been agreed
 - Date of birth, passport number, fingerprints and digital facial images



*China and Indien do
have that already!*

Source: <https://www.heise.de/newsticker/meldung/EU-Gremien-einigen-sich-auf-Biometrie-Superdatenbank-4298747.html>

/ Fingerprints in German ID cards

EU states should be allowed to use the biometric features freely (9.3.2019)

- Clause in the draft EU regulation
- Mandatory inclusion of two digital fingerprints in identity cards
- Member States should also be allowed to use the biometric information stored on an RFID chip for other, unspecified purposes beyond the "personalisation" of ID cards and pure identity verification.
- The Commission's original draft provided that
 - the fingerprints may only be stored on the chip itself,
 - reference data is stored in a highly secure manner with the registration authorities and
 - must be deleted at the latest 90 days after the documents have been issued.
- With the seemingly insignificant addition in Article 10, there would now be carte blanche for EU countries to use the sensitive data elsewhere or possibly even to store it in a central information system.



For security only!

Source: <https://www.heise.de/newsticker/meldung/EU-Gremien-einigen-sich-auf-Biometrie-Superdatenbank-4298747.html>

/ Last but not least

Quote of an online publication

„As biometric data can not be modified or passed on to other people, an extremely high security against forgery is given.“



/ Conclusion

- Biometric systems can increase security
- Prerequisite is an exemplary implementation
- Biometric systems can be bypassed
- Saved biometric data arouse desires
- Strength of evidence be challenged legally



„We are not only responsible for what we do but also for what we do not”

(Voltaire)



Many Thanks!



/ More Information

<http://www.biotrust.de/>

<http://www.biometrie-online.de/>

<http://www.bsi.bund.de/literat/studien/BioFinger/index.htm>

Behrens/Roth „ Biometrische Identifikation”

EU-Studie: „Usability of Biometrics in Relation to electronic signatures“

<https://berlin.ccc.de/index.php/Biometrie>

<http://www.google.de>

<http://www.wikipedia.de>