From Ground Truth to Semantic Conformance Testing

Demonstrated by the Example of Face Image Data

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Agenda

- Conformance Testing
- Ground Truth
- Practical Approach
- Conclusion
Conformance Testing
- Principles -

use case

features
functionalities

input data

TOE

output data
Conformance Testing
- Requirements -
Conformance Testing
- Specification Requirements -

Input Data

Property 1
- range of values
  (valid & invalid)
- reference point
  ("zero point")
- measure / scale

Property n
- range of values
  (valid & invalid)
- reference point
  ("zero point")
- measure / scale
Conformance Testing
- Test Data Requirements -

Test Data

Property 1

- validity (Yes / No)
- position relative to reference point ("value")
- measuring method

Property n

- validity (Yes / No)
- position relative to reference point ("value")
- measuring method

...
## Conformance Testing - Test Data Requirements -

### Test Data

<table>
<thead>
<tr>
<th>Property 1</th>
<th>Property n</th>
</tr>
</thead>
<tbody>
<tr>
<td>measuring method</td>
<td>measuring method</td>
</tr>
<tr>
<td>validity (Yes / No)</td>
<td>validity (Yes / No)</td>
</tr>
<tr>
<td>position relative to reference point (&quot;value&quot;)</td>
<td>position relative to reference point (&quot;value&quot;)</td>
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</tbody>
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Definition of Ground Truth in Biometrics

“Ground truth“ is reliable biometric data captured within a defined setup with known parameters and combined with additional metadata that describes the properties of the biometric data determined by defined and documented mechanisms and/or scientific experts.
Characteristics of Standardized Properties

**“Strict“ Properties**
- well known & accepted reference/zero point
- defined range

*measureable*

**“Soft“ Properties**
- no well defined reference/zero point
- undefined range

*not measureable*
Ground Truth
- Measurability Requirements -

- measure has to be close to reality
- measure has to be internationally reproducible
- measure has to be applicable
- reference points have to be clearly separated from each other
Practical Approach
- Project Idea -

ISO Standards, ICAO, BSI TR
(ISO/IEC 19794-5, ISO/IEC 29109-5, ICAIO TAG MRTD/NTWG, BSI TR-03104)

Experience with facial image data processing software

Requirements of developers and users of biometric systems

Quality assurance and improvement of facial image data processing systems
Practical Approach
- Realization -

Acquisition of valid and invalid images
(according to ISO/IEC 19794-5)

E. g. in respect to

- head gear, sun glasses, eye patches
- pose angles (pitch, yaw and roll), expressions
- lighting, shadows, under and over exposure, focus
**Practical Approach**
- **Color Measurement** -

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**Eye Colour**
- 5 colour classes
  (brown, grey-brown, multiple, gray-blue, blue)
- 3 colour depths
  (dark, medium, bright)
- synthetic eyes

**Hair Colour**
- 5 colour classes
  (black, brown, blond, grey, red)
- 3 colour depths
  (dark, medium, bright)
- synthetic hair

**Skin Colour**
- in evaluation
- spectrophotometer
Practical Approach - Eye Color Table -
Practical Approach
- Hair Color Ring -
Shape
- head shape
- eye shape
- line of mouth
- ...

Personal Data
- class of age
- gender

Miscellaneous
- glasses
- hairdo
- makeup
- ...

Practical Approach
- Miscellaneous Data -

shemes
checklist
checklist
Pose Variation – Looking for the Zero Point

- absolute zero point not defined
- aid: Frankfurt Plane
- problem: usually covered feature points
- extreme pose variation = killer for facial image processing
- standard has yet no answer
Practical Approach
- Handling “Soft“ Properties II -

15 x SLR cameras

- 1 central camera for full frontal view
- 8 cameras for vertical variation (pitch): ± 4, ± 10, ± 20 and ±45 degrees
- 6 cameras für horizontal variation (yaw): ± 4, ± 10 and ± 20 degrees

3 x 3D scanner

- complete scan of the whole face
- no holes due to shadowing effects or occlusions
Quality of testing depends on …

- quality / accuracy of specifications (standards, guidelines)
- quality of test methods
- reliability of test data.
Lacking precision in specification causes …

- less exact measurements
- vague conformance estimations
Lack of measure hinders …

- development of conformant systems
- production of conformant data
A scientifically defined “zero point“ is needed to …

- become a property measurable
- get a defined scale for measurement
- get comparable measurements
- determine whether a property is in line with a standard
Standardization has (at least) to define ...

- a scale
- a reference point (or “zero point“)
- value ranges

for every property / feature it deals with.
Thank You
For Your
Attention!
# Contact

<table>
<thead>
<tr>
<th>Name</th>
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