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BTAS-2015 – Washington DC, USA
Previous LivDet competitions

LivDet 2011

LivDet 2009

LivDet 2013

The Department of Electrical and Electronic Engineering of the University of Cagliari, in cooperation with the Department of Electrical and Computer Engineering of Clarkson University and the National Geophysical and Geomatics Institute of the University of Cagliari, is pleased to announce the third edition of the Fingerprint Liveness Detection Competition 2013 that will be hosted by the International Conference on Biometrics in Madrid.

Spoofing: The widespread use of personal verification systems based on fingerprints has shown some weaknesses related to the problem of security. Among the others, it is well-known that a fingerprint verification system can be deceived by submitting artificial reproductions of fingerprints made up of silicon or gelatine to the electronic capture device (optical or capacitive). These images are then processed as “true” fingerprints.

Liveness Detection: Therefore, a recent issue in the field of security in fingerprint verification (unsupervised especially) is known as “liveness detection”. The standard verification system is coupled with additional hardware or software modules aimed at certifying the authenticity of the submitted fingerprints. Whilst hardware-based solutions are the most expensive, software-based ones attempt to measure liveness from characteristics of images themselves by simply applying image processing algorithms.

Software Liveness Classification: The problem of vitality detection is treated as a two-class classification problem (live or fake). An appropriate classifier is designed in order to extract the probability of the image vitality given the extracted set of features. LivDet2013 competition is open to all academic and industrial institutions which have a solution for software-based fingerprint vitality detection problem.
Competition Overview

**Algorithms**

- Software-based systems
- Four data sets (sensors)
  - 2,000 live and fake fingers for training
  - 2,000 live and fake fingers for test
  - Seven materials (Ecoflex, Woodglue, Liquid Ecoflex, Silicone, Gelatine, Body Double/RTV, Play Doh)
- Four optical sensor (Biometrika, Greeenbit, Digital Persona, Crossmatch)

**Systems**

- Complete fingerprint systems with the ability to capture a fingerprint image as well as to produce a liveness detection score.
- Hybrid-based systems (even hardware-based fingerprint liveness detection)
- 2011 attempts were completed with 1010 live attempts from 51 subjects (2 images each of all 10 fingers) and 1001 spoof attempts across the five different materials giving approximately 200 images per spoof type.
- 500 spoofs were created from each of 5 fingers of 20 subjects for each of the five spoof materials.
- Two attempts were performed with each spoof.
The novelties of this edition

• **Algorithms Section**
  – Three 500 dpi, as usual
  – One sensor at 1000 dpi
    – is the sensor resolution **important** in fingerprint liveness detection?

• **Algorithms and Systems Sections**
  – Participants trained their systems with part of available materials: two of them were «hidden» and used only for testing
    – Is the liveness detector **robust** to attack typology change?

http://pralab.diee.unica.it
Fake creation with RTV and gelatine

http://pralab.diee.unica.it
Fake creation (cooperative method)
# Overview of sensors and materials

<table>
<thead>
<tr>
<th>Scanner</th>
<th>Model</th>
<th>Resolution [dpi]</th>
<th>Image Size [px]</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Bit</td>
<td>DactyScan26</td>
<td>500</td>
<td>500x500</td>
<td>PNG</td>
</tr>
<tr>
<td>Biometrika</td>
<td>HiScan-PRO</td>
<td>1000</td>
<td>1000x1000</td>
<td>BMP</td>
</tr>
<tr>
<td>Digital Persona</td>
<td>U.are.U 5160</td>
<td>500</td>
<td>252x324</td>
<td>PNG</td>
</tr>
<tr>
<td>Crossmatch</td>
<td>L Scan Guardian</td>
<td>500</td>
<td>640x480</td>
<td>BMP</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Live Image</th>
<th>Ecoflex</th>
<th>Gelatine</th>
<th>Latex</th>
<th>WoodGlue</th>
<th>Liquid Ecoflex</th>
<th>RTV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Bit</td>
<td>1000</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Biometrika</td>
<td>1000</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Digital Persona</td>
<td>1000</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Crossmatch</td>
<td>1500</td>
<td>300</td>
<td>270</td>
<td>281</td>
<td>297</td>
<td>300</td>
<td>-</td>
</tr>
</tbody>
</table>

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http://pralab.diee.unica.it
A Win32 console application:
LIVENESS XYZ.exe [ndataset] [inputfile] [outputfile]

- [ndataset]: id number of the data set to analyze.
- [inputfile]: text file with the list of images to analyze.
- [outputfile]: text file with the output of each processed image, in the same order of [inputfile].
Part 1: Algorithms - Protocol

- Four data sets created with four different sensors
- 4000 or more images for each of the data set
- Thirteen participants (academic and industrial institutions), one of them preferred to be anonymous
- LivDet never reached such a number of participants so far
Part 1: Algorithms 500 dpi vs. 1000 dpi
# Part 1: Algorithms vs. unknown materials

<table>
<thead>
<tr>
<th>Participant</th>
<th>Known</th>
<th>Unknown</th>
<th>Difference</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>nogueira</td>
<td>96,57</td>
<td>93,97</td>
<td>2,60</td>
<td>2,69%</td>
</tr>
<tr>
<td>unina</td>
<td>98,74</td>
<td>95,05</td>
<td>3,69</td>
<td>3,74%</td>
</tr>
<tr>
<td>jinglian</td>
<td>93,15</td>
<td>88,61</td>
<td>4,54</td>
<td>4,87%</td>
</tr>
<tr>
<td>titanzhang</td>
<td>92,16</td>
<td>86,94</td>
<td>5,22</td>
<td>5,67%</td>
</tr>
<tr>
<td>UFPE II</td>
<td>73,76</td>
<td>68,48</td>
<td>5,29</td>
<td>7,17%</td>
</tr>
<tr>
<td>hbirkholz</td>
<td>91,28</td>
<td>85,50</td>
<td>5,78</td>
<td>6,33%</td>
</tr>
<tr>
<td>CSI_MM</td>
<td>85,33</td>
<td>78,32</td>
<td>7,00</td>
<td>8,21%</td>
</tr>
<tr>
<td>CSI</td>
<td>83,42</td>
<td>75,57</td>
<td>7,85</td>
<td>9,41%</td>
</tr>
<tr>
<td>hectorn</td>
<td>88,11</td>
<td>79,44</td>
<td>8,67</td>
<td>9,84%</td>
</tr>
<tr>
<td>UFPE I</td>
<td>74,82</td>
<td>64,86</td>
<td>9,96</td>
<td>13,32%</td>
</tr>
<tr>
<td>anonym</td>
<td>94,93</td>
<td>84,65</td>
<td>10,29</td>
<td>10,84%</td>
</tr>
<tr>
<td>COPILHA</td>
<td>86,56</td>
<td>75,13</td>
<td>11,43</td>
<td>13,20%</td>
</tr>
</tbody>
</table>

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To sum up....

<table>
<thead>
<tr>
<th>Avg. Accuracy</th>
<th>Avg. Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LivDet 2011</td>
<td>73.6</td>
</tr>
<tr>
<td>LivDet 2015</td>
<td>85.9</td>
</tr>
</tbody>
</table>
Part 2: Systems - Protocol

System requirements:

• Running on either a Windows XP 32-bit or 64-Bit system.
• An .exe or similar executable file.
• The use of either a USB or Firewire connection.
• To output the collected image if the image is considered a live image and a liveness score in the range of 0 and 100 (100 is the maximum degree of liveness, 0 spoof)
Part 2: Systems - Protocol

- Participants were asked to ship a fingerprint system which captures a fingerprint image as well as outputs a liveness detection score.

- Three over five spoof recipes and methods were made available to the participants.

- In addition the systems were tested with two unspecified methods of spoofing.

- One participant for Systems Section.
Part 2: Systems - Results

- **Opposite results with respect to previous editions**
- **Motivation: colors of some known test data**
  - Yellow and White Playdoh ➔ high accuracy
  - Pink and Limegreen Playdoh
    - Misclassification of live with fake (around 100% error)
    - Misclassification of fake with live (28% error)
  - Brown and Black Playdoh ➔ the system would not collect an image
Conclusions

• The number of participants, from both academic and industrial institutions, is growing with respect to previous editions.

• Part 1 showed that
  – It is not yet clear if increasing the sensor’s resolution may lead to a significant performance improvement
  – Unknown attacks lead to a performance drop for all submitted algorithms
  – Overall increase of classification accuracy with respect to LivDet 2011 edition

• Part 2 let us discover that the fake colour may significantly impact in the classification accuracy, even if the attack is performed with spoofs made up of very cheap materials
LivDet and the Future

• LivDet datasets are made available after competition at: http://livdet.org/

• In last five years, over 100 requests have been made for datasets
  – approximately 75% academic, 25% industrial
  – representing over 25 countries.

• We look forward to meet novel competitors at LivDet 2017

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Many thanks to...

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