DSM generation with the Leica/ Helava DPW 770 and VirtuoZo digital photogrammetric systems

Other Conference Item

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DSM Generation with

the Leica/Helava *DPW 770* and *VirtuoZo*

Digital Photogrammetric Systems

Aims

- Comparison:
  Two digital photogrammetric systems
  DPW770 (Leica/Helava), VirtuoZo (VirtuoZo Systems),
  especially regarding DSM generation

- Test:
  Is automatic DSM generation in
 mountainous regions with glaciers possible?

Main System Characteristics

| Leica/Helava DPW 770	VirtuoZo
High price	Low price
Extended functionality	Limited functionality
Complicated to use	Easy to use, intuitive user interface
DSM Generation	
Uses epipolar images	Uses epipolar images
Image pyramid, 6 levels, set in the strategy file	Image pyramid, > 3 levels, automatically determined
Matching method: crosscorrelation + object space matching	Matching method: crosscorrelation + global relaxation matching technique
3 basic strategies and 7 new ones with the IOR matching method	5 strategies (actually not used)
Possibility to modify and create new strategy files	No parameters can be set except patch and grid size
Regular grid in object space	Regular grid in left image
Patch size set in strategy file for each pyramid level, can be changed by user	Basic patch size selected by user, changed automatically for higher pyramid levels
Patch size used in matching 15 x 15 pixels	Patch size used in matching 9 x 9 pixels

Glacier Data Set

- 2 aerial images of the Morteratsch glacier, image scale 1:10,000 with overlap 85%

- scanned on PS1 scanner with pixel size 15μm, reduced to 30μm for DTM generation

- Reference DTM measured on the analytical plotter AC1

- Orientation parameters from bundle adjustment

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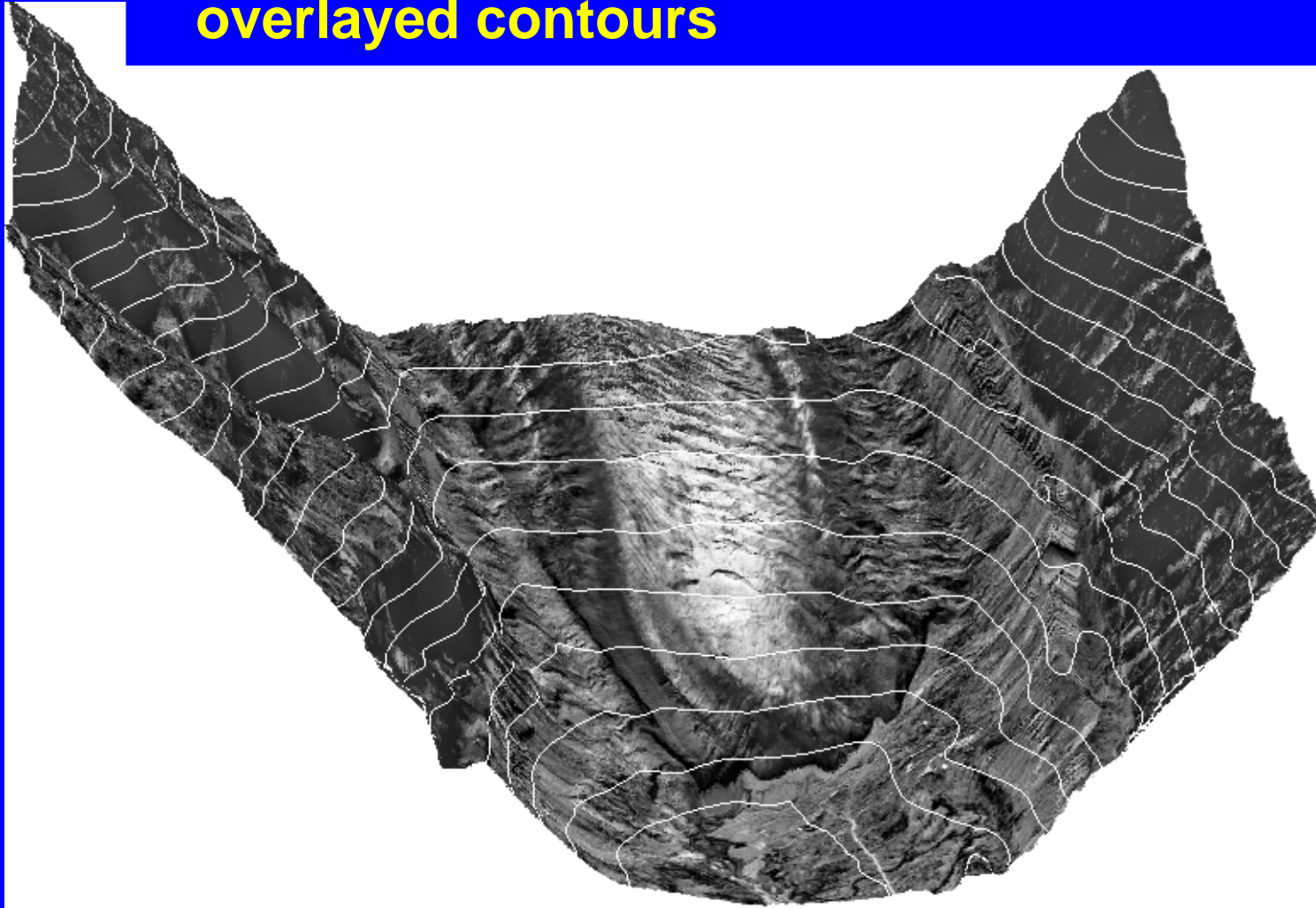# Contrast enhancement with Wallis Filter
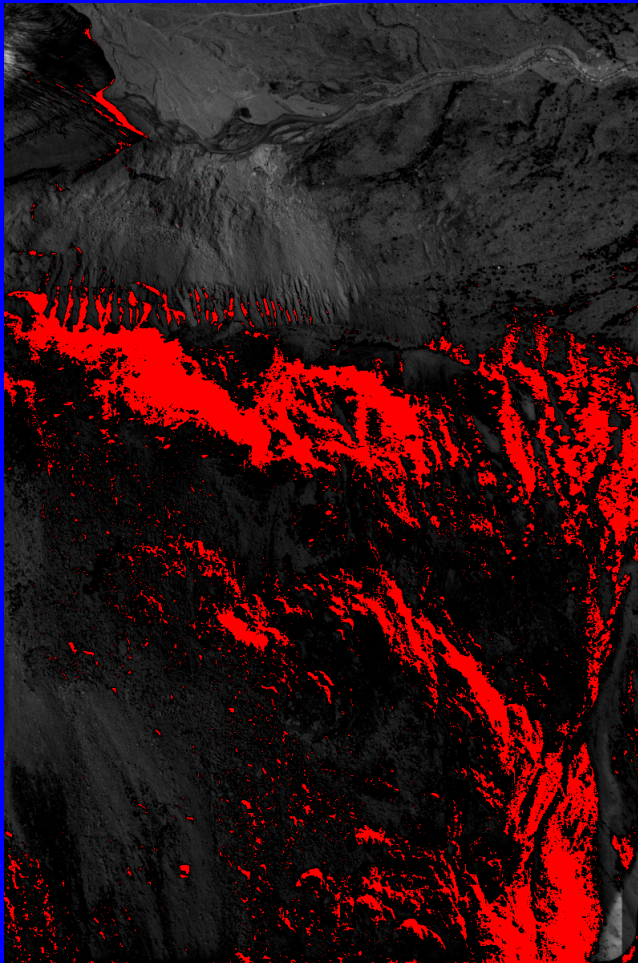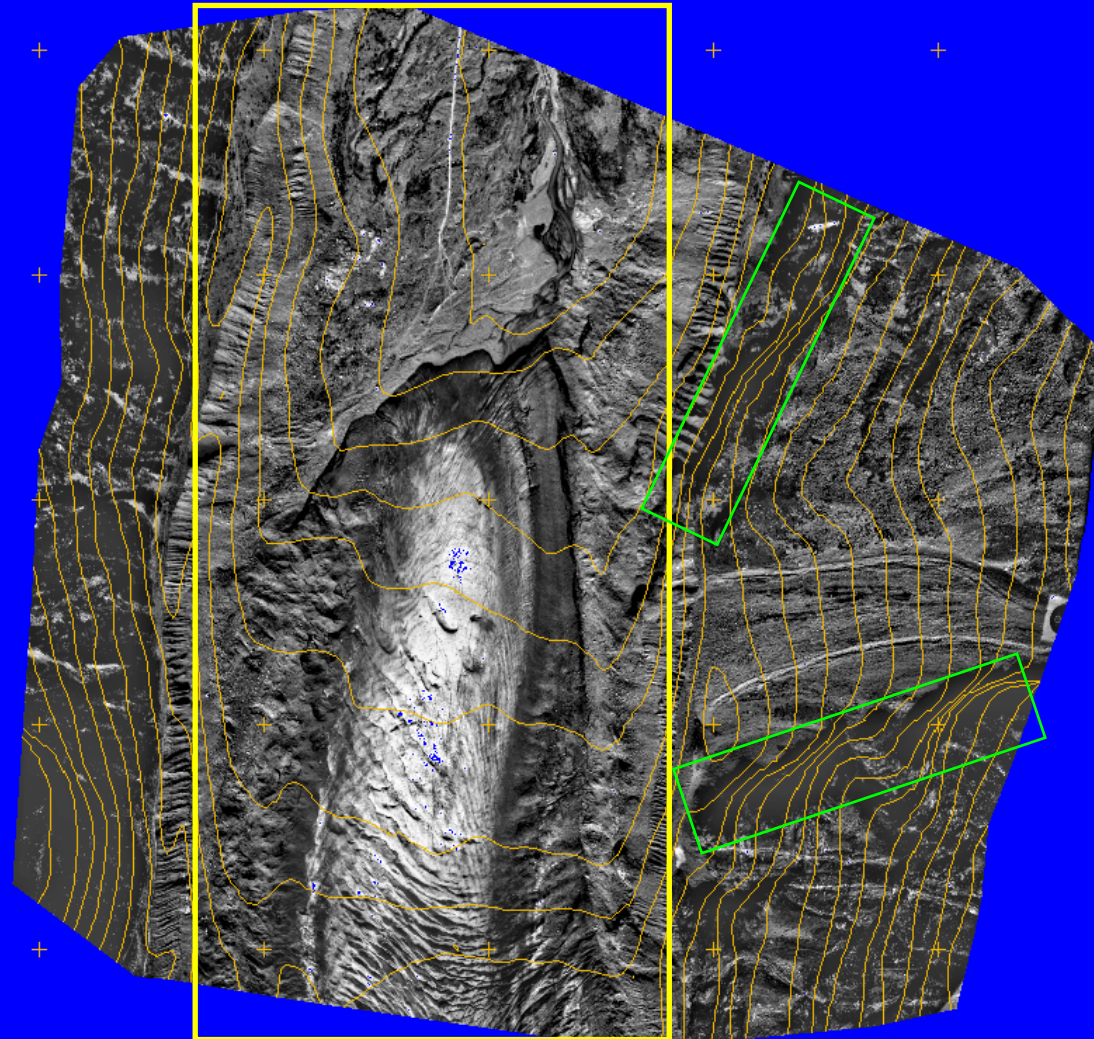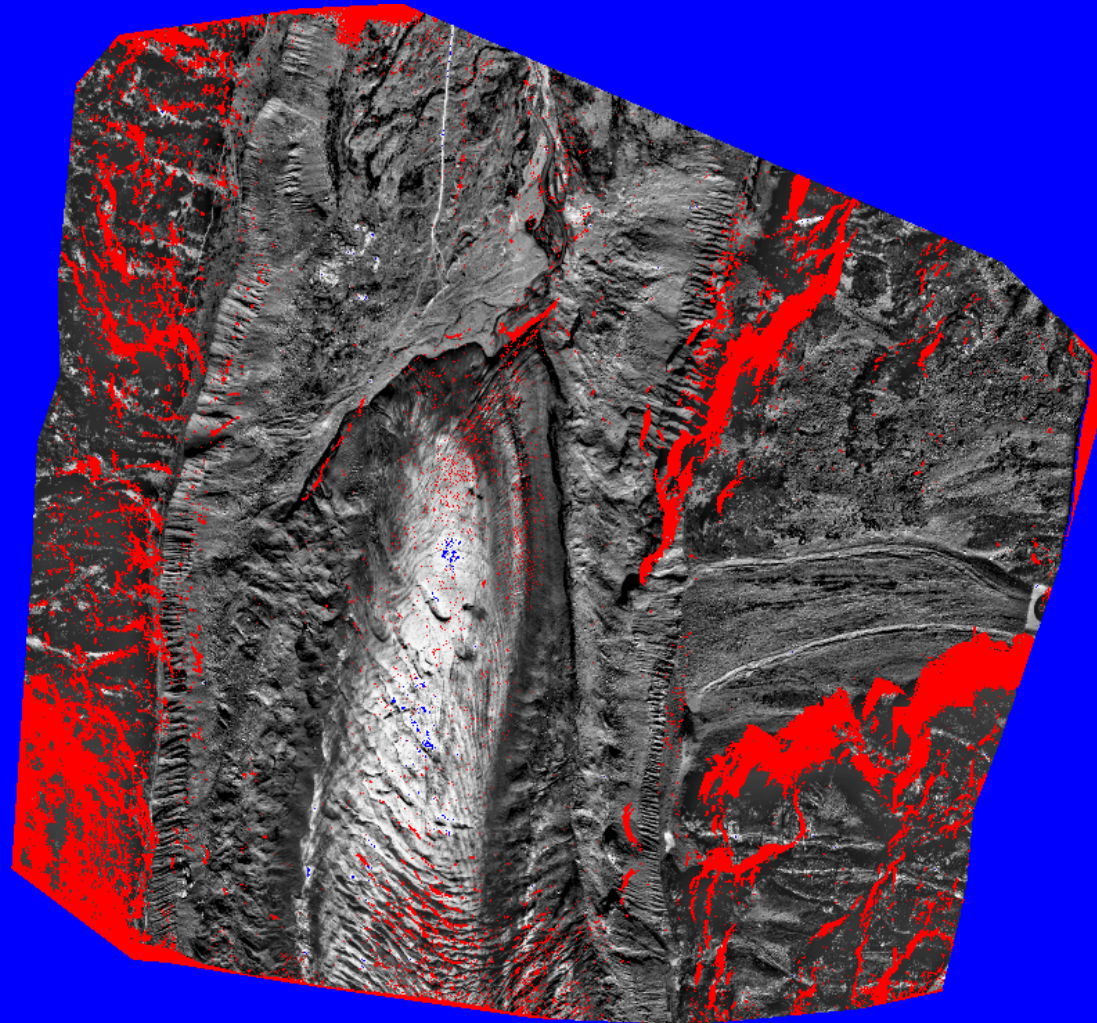

Original image
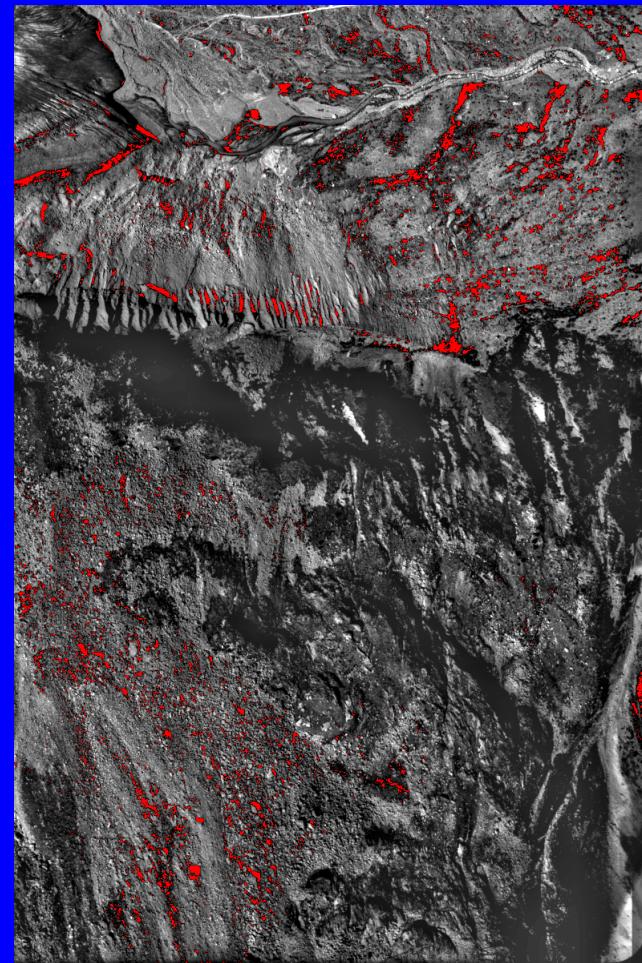
After Wallis filtering

Morteratsch glacier with overlayed contours

Orthoimage

Unreliable points
(determined automatically by DPW 770)

Statistics of height differences

Version	Number of points compared	Time / Number of match points	Maximum absolute (m)	Mean (m)	RMS (m)
DPW 770 (whole image): all points	8728	5340s / 462,000	87.0	0.28	3.53
DPW 770 (whole image): points with quality code* > 32	356,000		70.7	0.28	1.38
VirtuoZo (whole image)	8594	860s / 467,000	103.5	0.27	4.13
DPW 770 (region without big blunders)	3997		16.5	0.15	1.08
VirtuoZo (region without big blunders)	3997		14.6	0.21	0.96

* Code provided by DPW. Points with code > 32 are considered reliable.

Percentage of points
for various classes of differences

Version	0 - 2	2 - 3	3 - 4	4 - 6	6 - 9	9 - 15	> 15
DPW 770 (whole image): all points /	85.65	5.35	2.80	2.69	1.90	0.94	0.68
DPW 770 (whole image): points with code > 32	90.12	5.57	2.20	1.55	0.47	0.09	0.00
VirtuoZo (whole image)	89.17	3.99	2.26	1.87	1.05	0.81	0.85
DPW 770 (region without big blunders)	96.75	1.73	0.63	0.40	0.28	0.18	0.05
VirtuoZo (region without big blunders)	97.70	1.38	0.35	0.25	0.18	0.15	

**Accuracy analysis
in the region without
big blunders**

- 17 m   0 m   10 m

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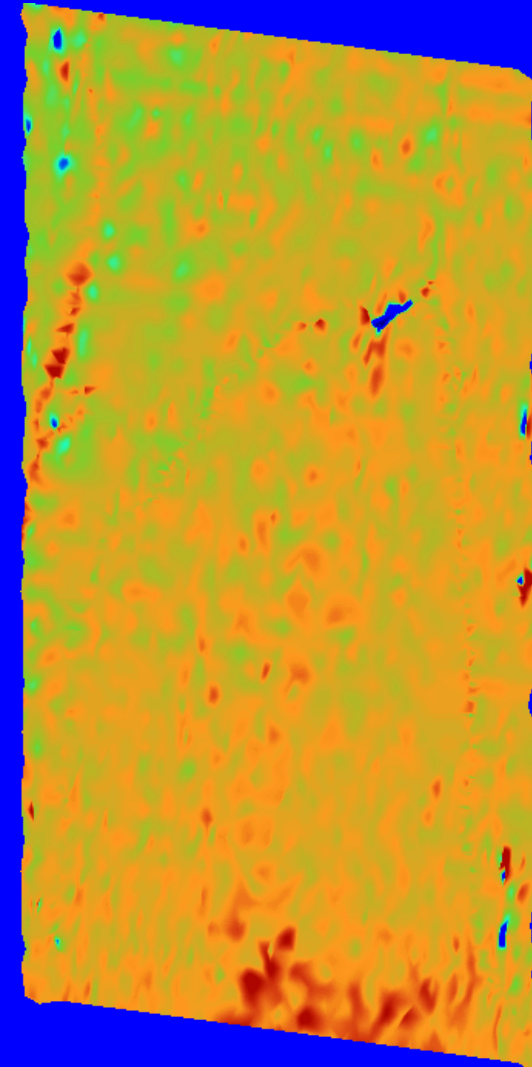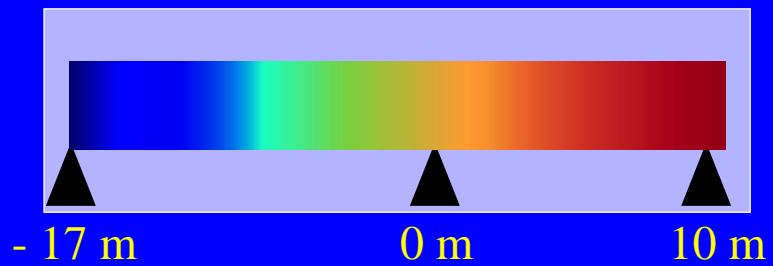
Yverdon Data Set

- **2 aerial images of Yverdon, Switzerland, image scale 1:68,000 with overlap 50%**

- **scanned with DSW 200, pixel size 12.5μm reduced to 25μm for DTM generation**

- **Reference DHM25 from Swiss Federal Office of Topography with RMS of 1.8m**

- **Orientation parameters from AC1**

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3D parallel view of Yverdon

13
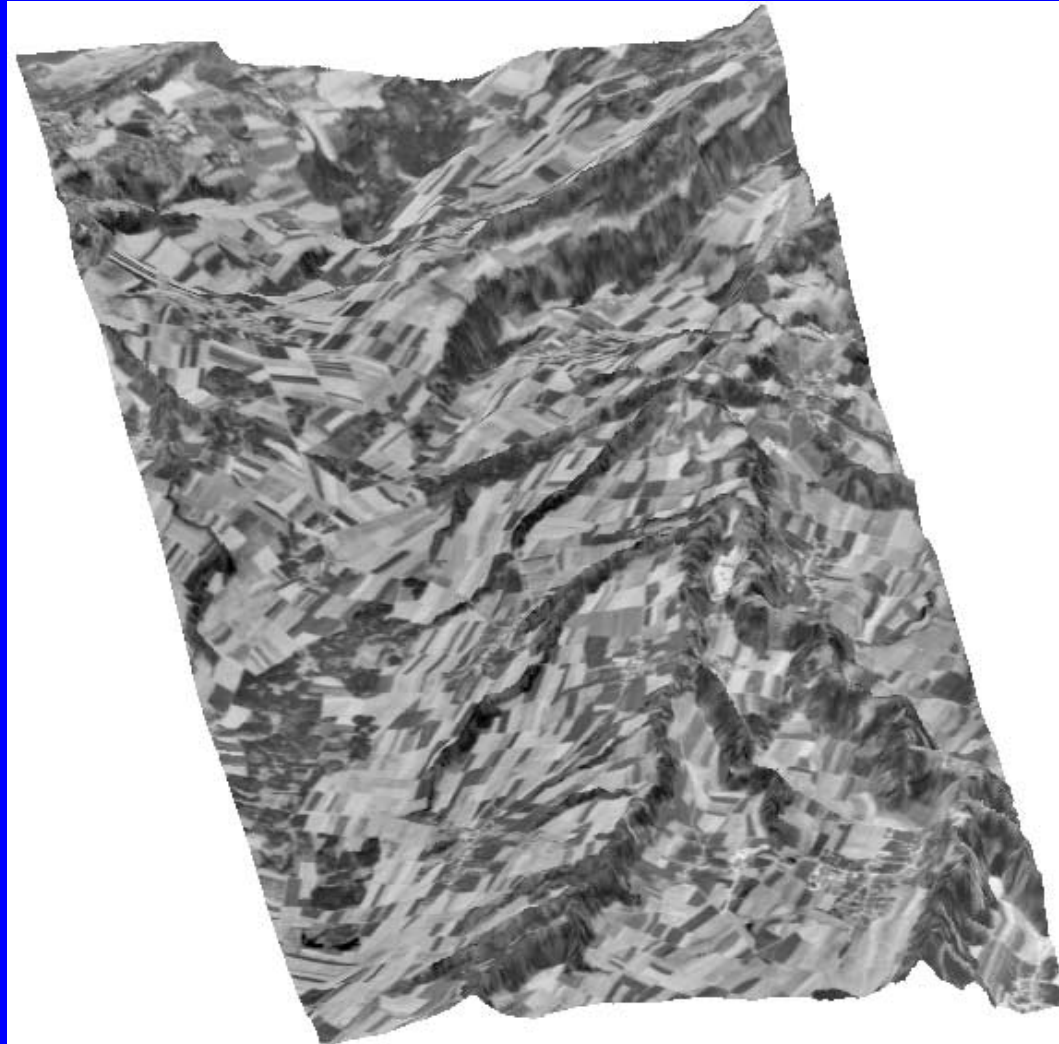
Portion of the test region

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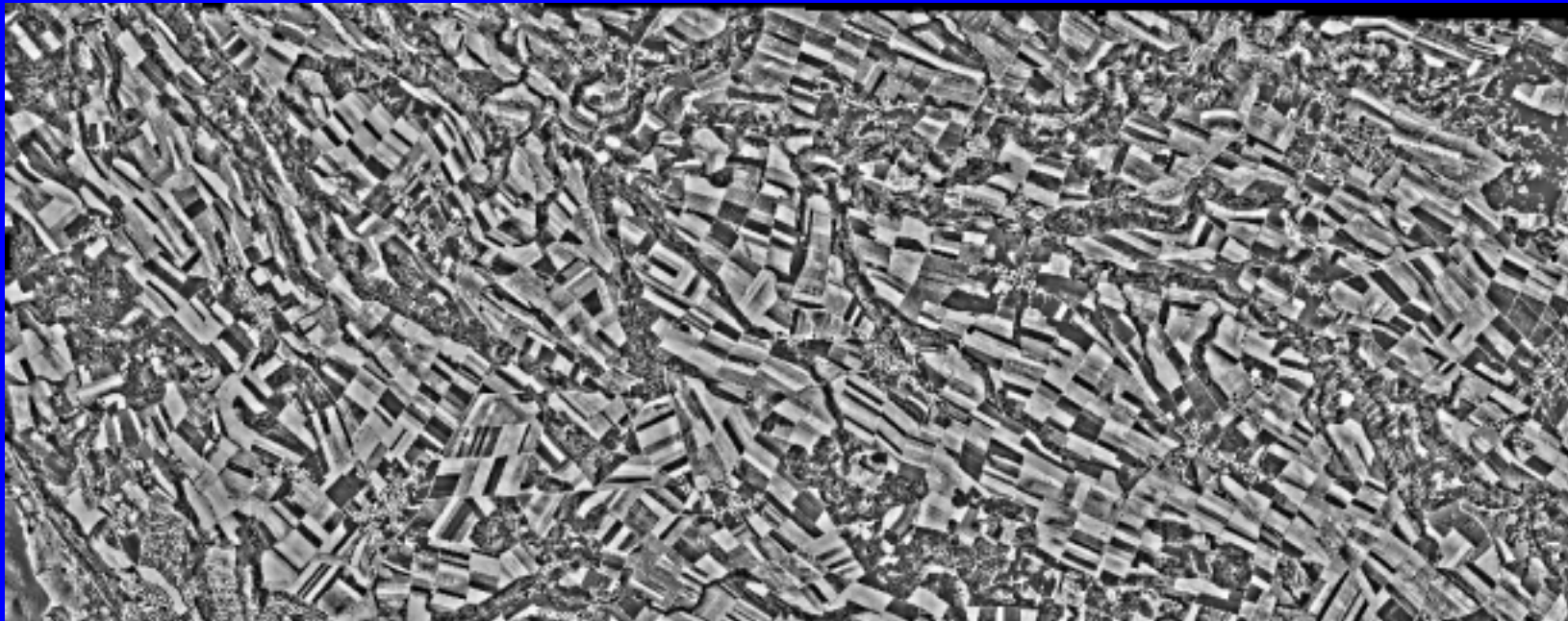Technische Hochschule
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DHM25 of Yverdon

- **rolling terrain**
- **height differences ca. 430m**
- **creeks, forests, urban areas**

Orthoimage of the test region

Statistics of height differences

Version	Number of points compared	Maximum absolute (m)	Mean (m)	RMS (m)
DPW 770 (nonforested area)	127,888	45.0	-0.4	2.6
DPW 770 (forest area)	42,370	62.8	8.6	12.9
VirtuoZo (nonforested area)	134,751	35.0	0.6	2.6
VirtuoZo (forest area)	44,909	47.6	11.9	15.6

Percentage of points
for various classes of differences

Version	0 - 2	2 - 4	4 - 8	8 - 16	16 - 24	24 - 50
DPW 770 (nonforested area)	67.0	24.5	7.4	0.9	0.2	0.1
VirtuoZo (nonforested area)	69.1	23.5	6.2	1.0	0.2	0.1
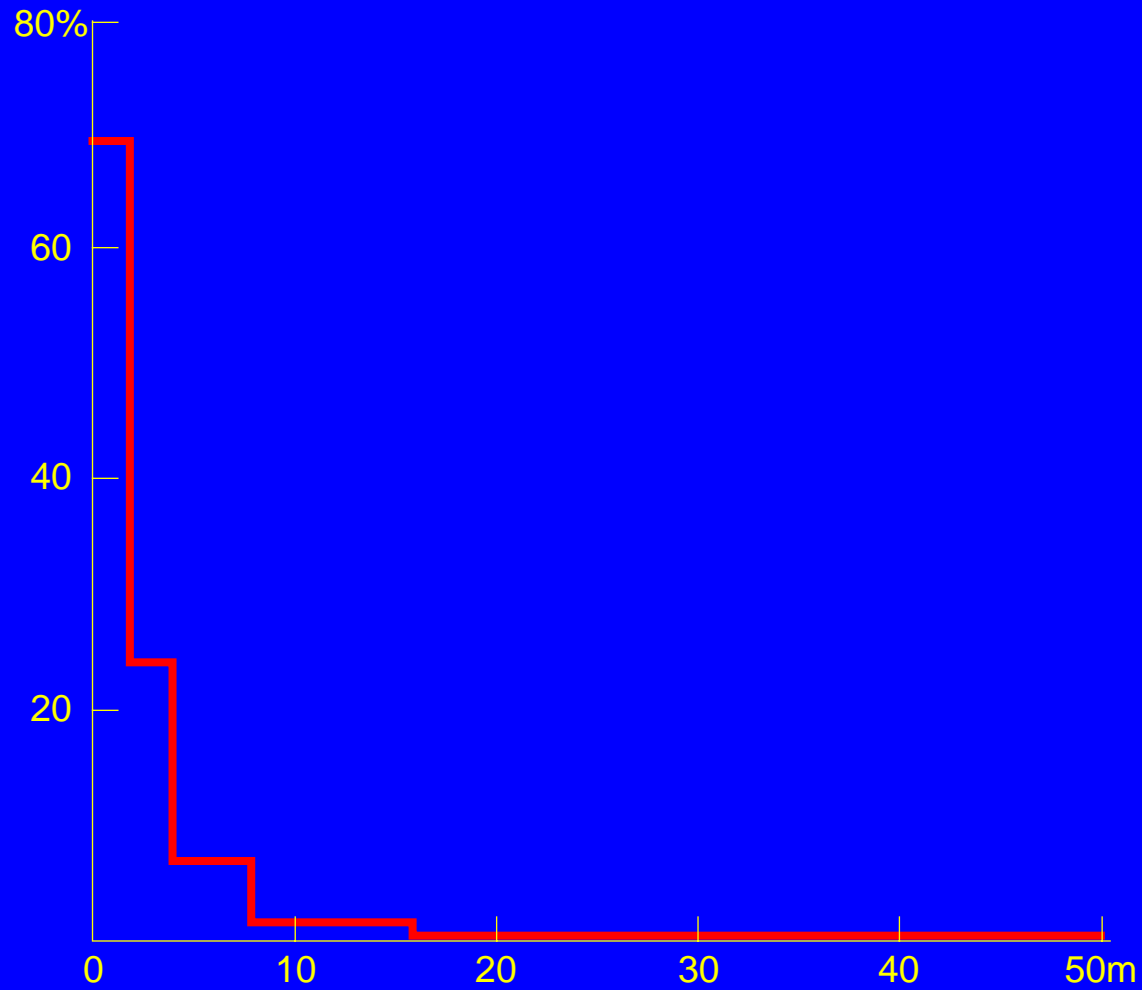
Distribution of the differences

Differences between VirtuoZo DTM and DHM25
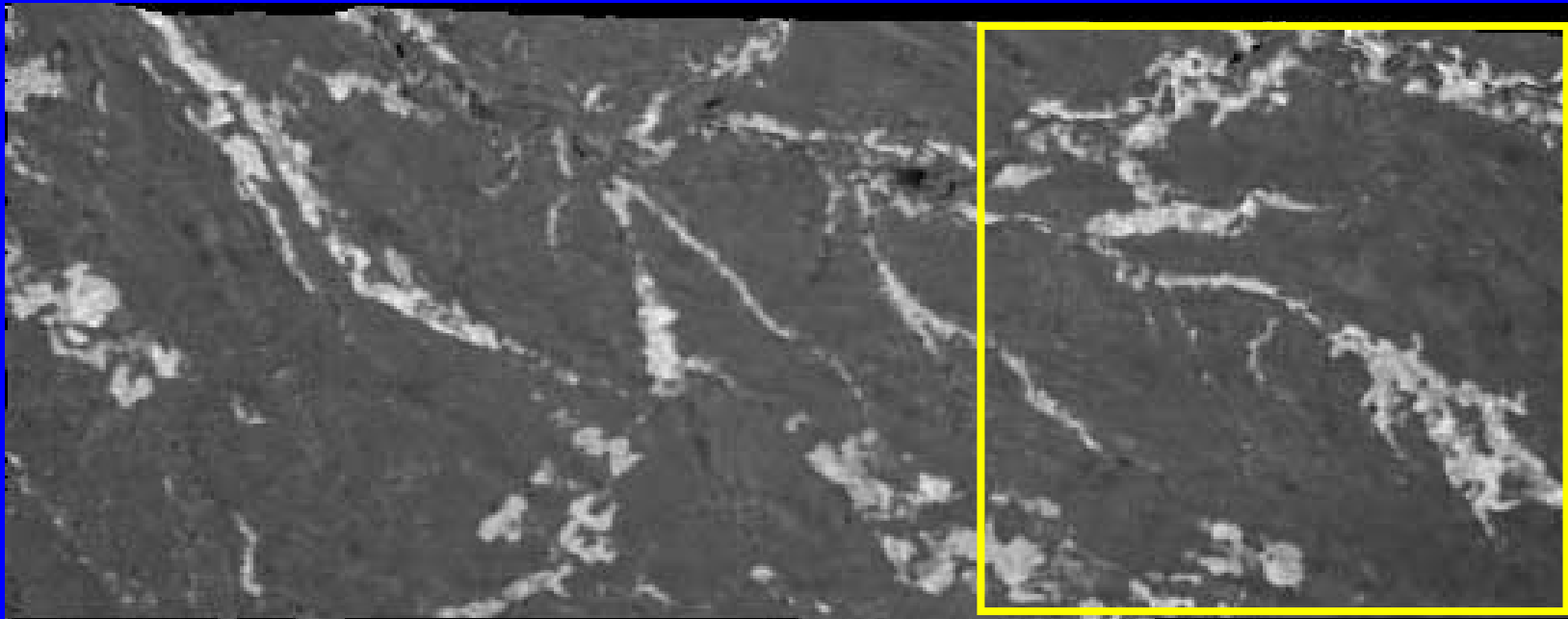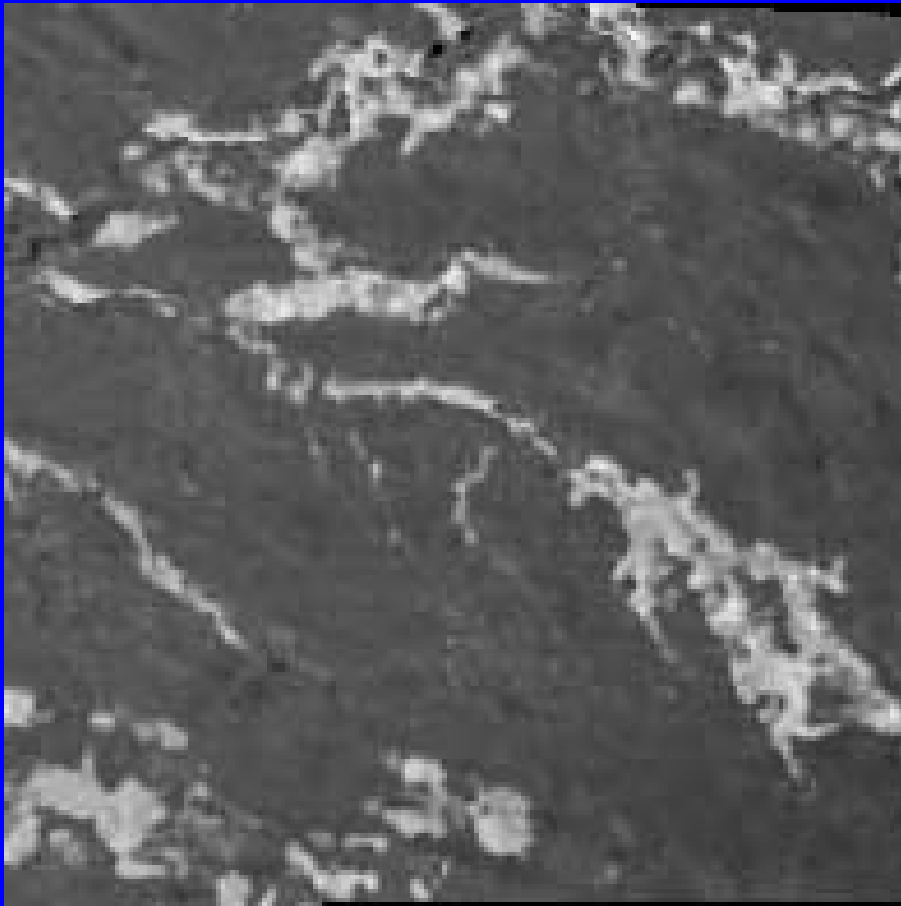
Difference of DTM

Orthoimage

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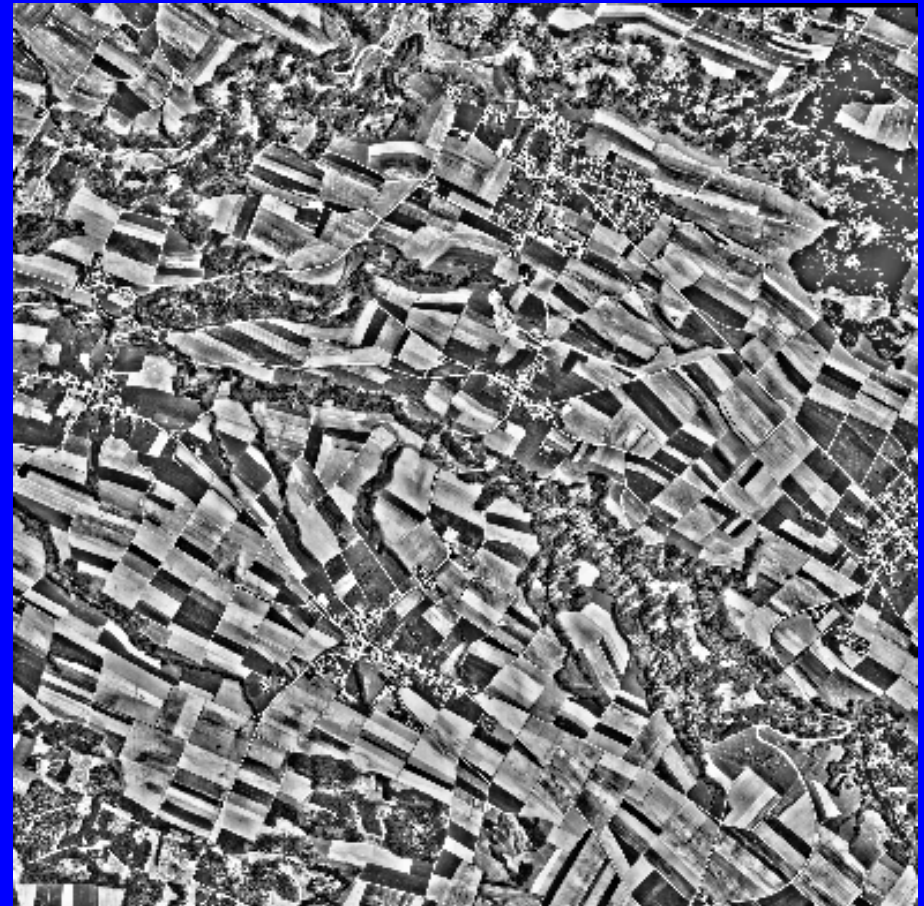
Strategies for DTM Generation

Leica/Helava DPW 770

- Strategy files and algorithms behind them generally positive, need improvement

- User with little knowledge will use the strategies as black box and might run into problems

- Sophisticated user needs more information about parameters, internal computations, etc.

VirtuoZo

- In reality all strategies delivered completely identical results

- Strategies are black box. User has no possibility to modify them or create its own

Both Systems

Matching parameters should be automatically adapted to terrain type, pixel footprint etc.

DTM Editing

Leica/Helava DPW 770

- Quality code accessible by user, not reliable enough

- Editing tools before matching

- Filtering of spikes, trees, houses possible but needs improvement

VirtuoZo

- Quality is coded with three colors, not accessible by user, not reliable enough

Both Systems

- Provide tools to check errors: contours, color coding of matching points

- Provide tools to edit data point- or regionwise

- Need additional quality criteria, e.g. differences of stereo orthoimages

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Advantages (compared to Analytical Plotters)

- Similar to much lower price

- Additional functionality (sensor models for satellite imagery, orthoimage, etc.)

- Advantages of automatic DTM generation:
    - processing speed (over 100 points per second)
    - possibility to derive a very dense DTM
        → more accurate terrain representation
          (implicit measurement of breaklines, etc.)

Disadvantages

- The systems are not open and flexible enough

- Both systems input uncommon image formats which leads to increase of required disk space and processing delays

- The documentation is poor

- Many processes appear as a black box to the user

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Conclusions

→ Both systems (DPW 770 and VirtuoZo) are useful for automatic DTM generation and deliver similar accuracy

→ DPW 770 has more functions, but is also more expensive and complicate to use; VirtuoZo offers user-friendliness and low price

→ Efficient, fast and comfortable methods for the automatic detection and exclusion of DTM blunders are still missing in both systems