UNIVERSITY OF TWENTE.

THE ISPRS/EUROSDR BENCHMARK ON MULTI-PLATFORM PHOTOGRAMMETRY:

RESULTS AND LESSON LEARNT

FRANCESCO NEX AND MARKUS GERKE

ITC FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION

Overview

- Summary of the results
- Statistics
- Data release
- What's next?

ISPRS / EuroSDR benchmark

AIM OF THIS BENCHMARK

Foster research concerning:

1) Fully automatic and reliable co-registration of multi platform/perspective imagery (Data available since September 2015)

2) Dense image matching within/across platforms (data available since Spring 2015)

terrestrial image blocks

UAV (nadir/oblique)

conventional airborne (nadir/oblique)

UNIVERSITY OF TWENTE.

CITY CENTER DATASET

See our homepage @ ISPRS, ICWG I/II website for details

Area 1: Dortmund City Centre (used for image orientation benchmark)

OBLIQUE SYSTEM

- *IGI PentaCam (80/80%), released 60/60%,*
- *GSD 10cm – 1260* images (yellow area)

UAV *(3 selected buildings)*

- oblique/nadir,
- GSD 1-2cm (red area)

TERRESTRIAL *(3 selected buildings)*

- GSD < 1cm (red area)

REFERENCE DATA

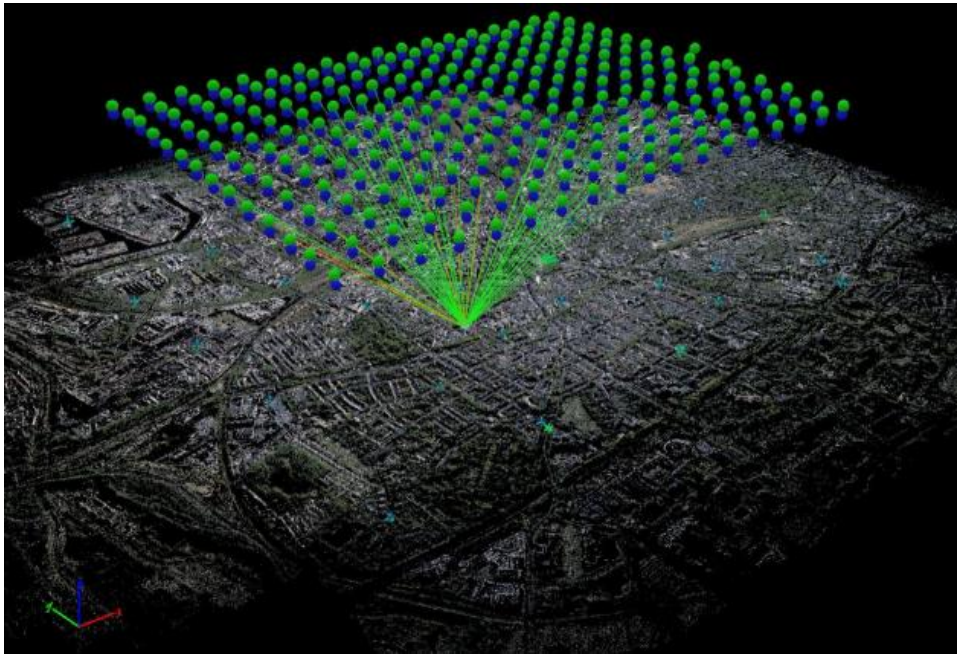
- GNSS, total station
- TLS, ALS

CITY CENTER DATASET

Results for PentaCam BBA

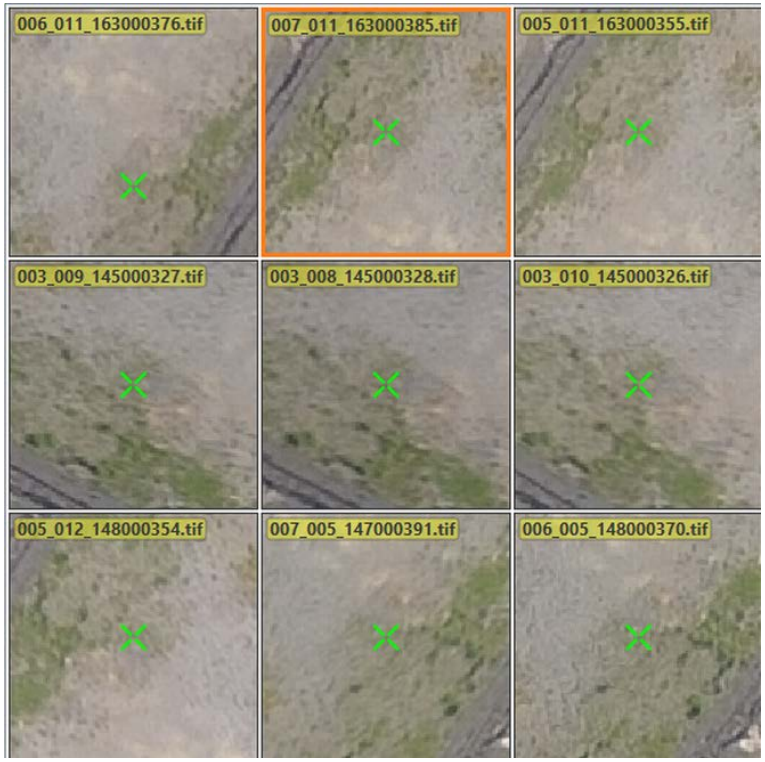
Focus:

- Tie point matching across viewing directions
- Nadir-only setup vs PentaCam
- 80/80 vs 60/60
- Distribution of GCP
- Software dependency



TIE-POINTS MATCHING

Analysis of tie point matching across viewing directions



- One main obstacle: to find matches between cameras on the platform: perspective transformation, occlusion
- Analysis using pix4d: 80/80 flight

TIE-POINTS MATCHING

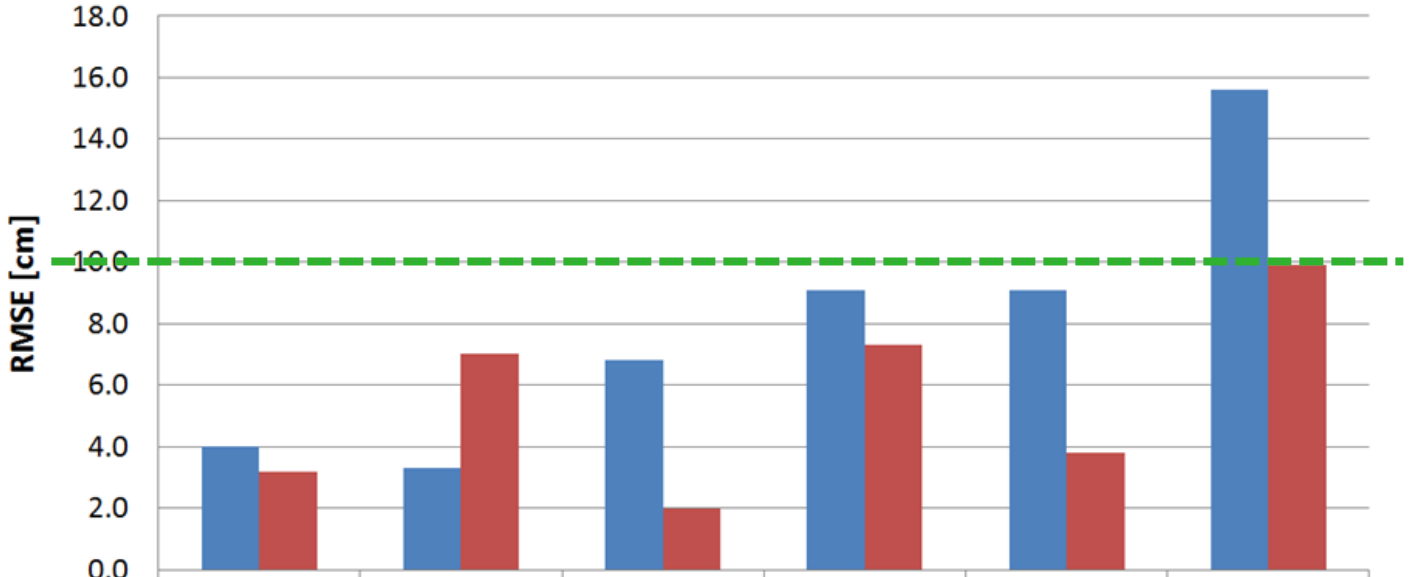
Analysis of tie point matching across viewing directions (75% percentile of all respective matching combinations)

	Right	*Back*	*Front*	*Left*	*Nadir*
Right	740	-	-	800	21
Back	-	566	767	-	39
Front	-	-	588	-	34
Left	-	-	-	711	7
Nadir	-	-	-	-	865

- Many matches for same camera, few oblique - nadir
- Cameras which share same cardinal direction (front/back, left/right) have many mutual matches

NADIR vs OBLIQUE IMAGES

PentaCam vs. Nadir-only: good GCP distribution, 80/80, av. GSD 10cm

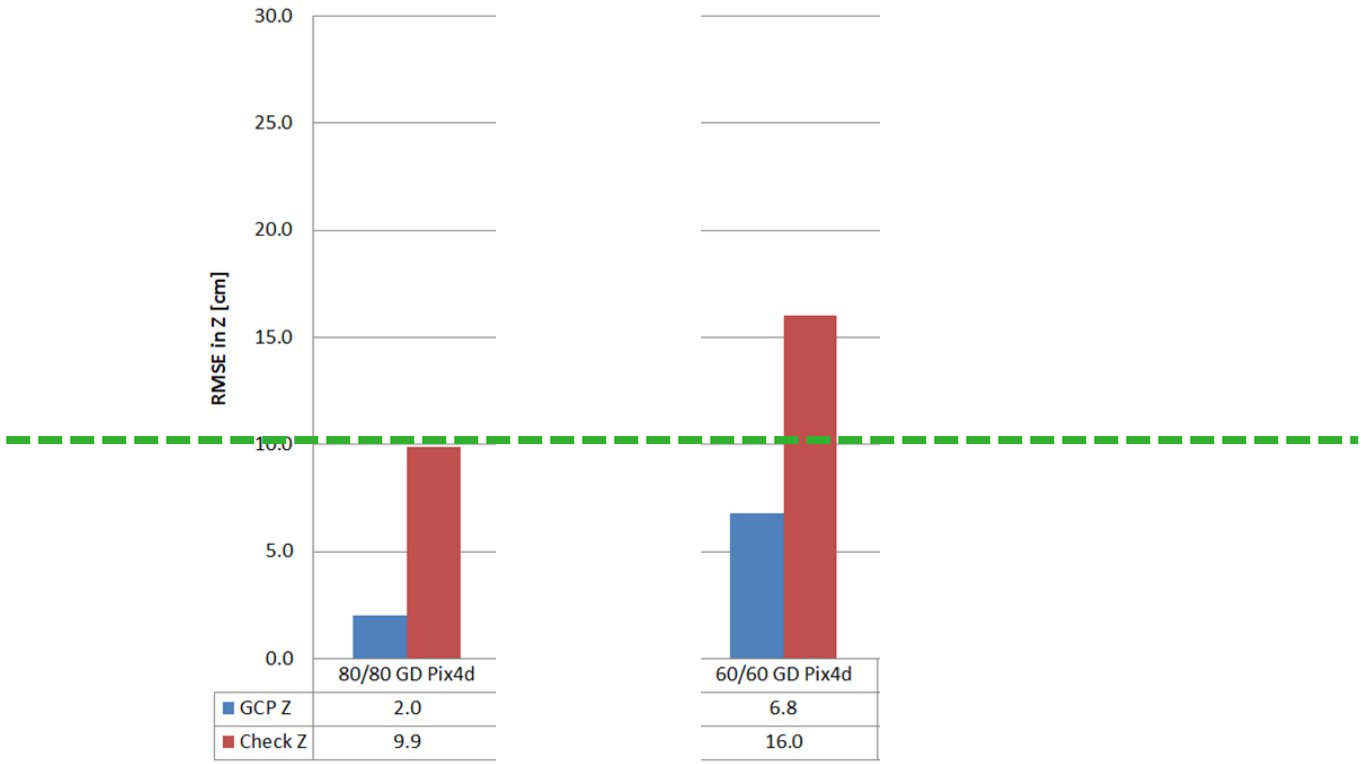


	GCP (25)			Check (8)		
	X	Y	Z	X	Y	Z
Nadir only	4.0	3.3	6.8	9.1	9.1	15.6
Pentacam full	3.2	7.0	2.0	7.3	3.8	9.9

- In PentaCam all RMSE below 1GSD
- Especially Z-component profits from oblique views

IMAGE OVERLAP

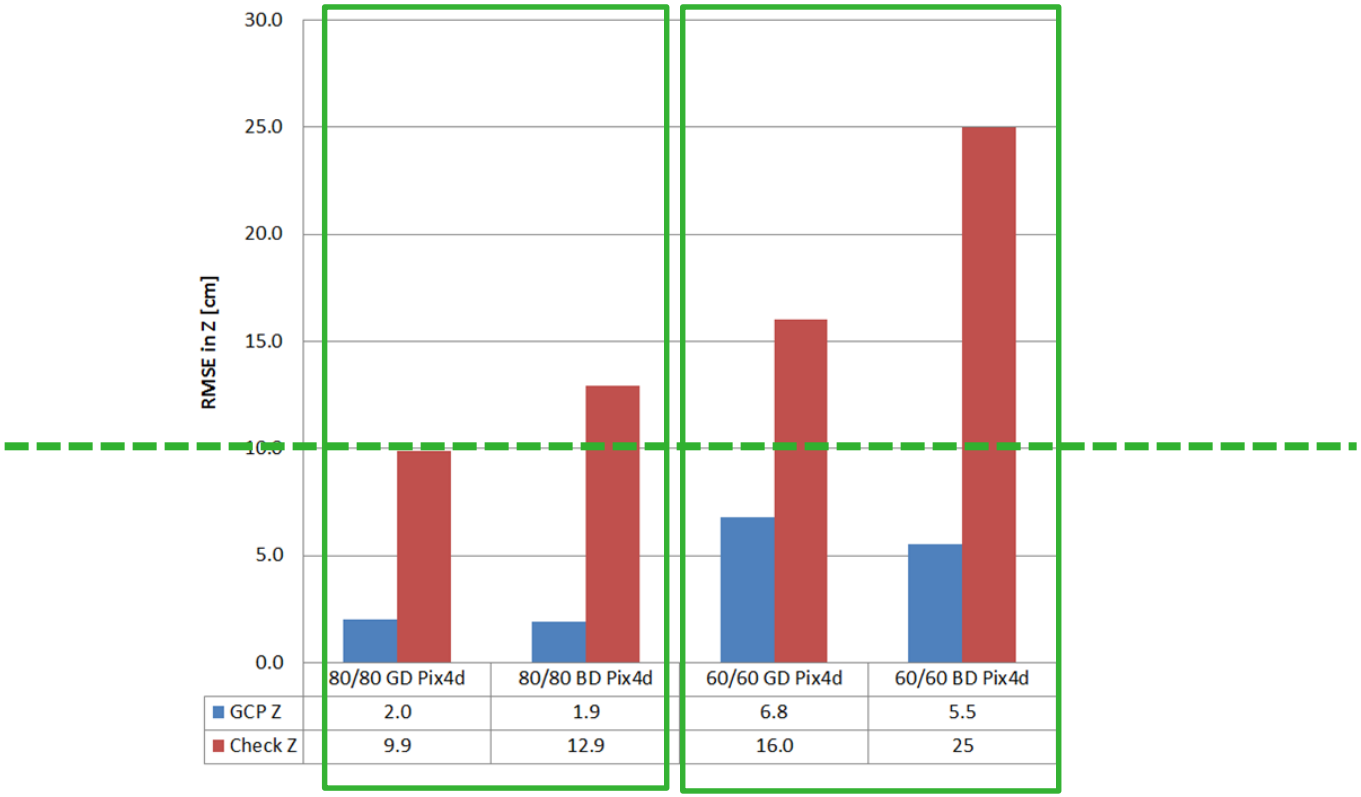
60/60 vs. 80/80



- Reduction of overlap leads to significant increase of Z-RMSE (from block deformation)
- Caused (also) by insufficient observations for self-calibration

GCP DISTRIBUTION

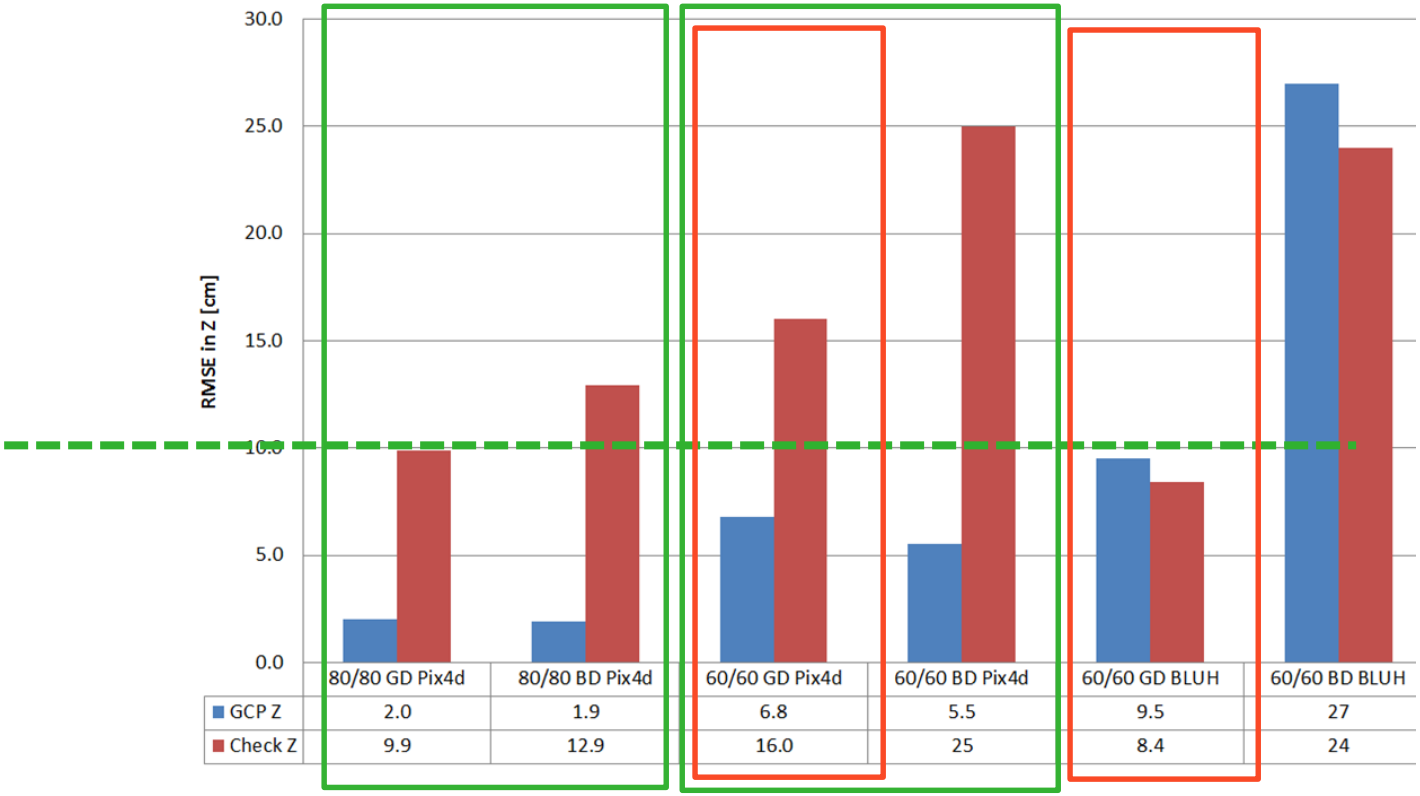
Good vs. bad GCP distribution



- Bad distribution of GCPs causes increase of Z-RMSE, as well

GCP DISTRIBUTION

Good vs. bad GCP distribution

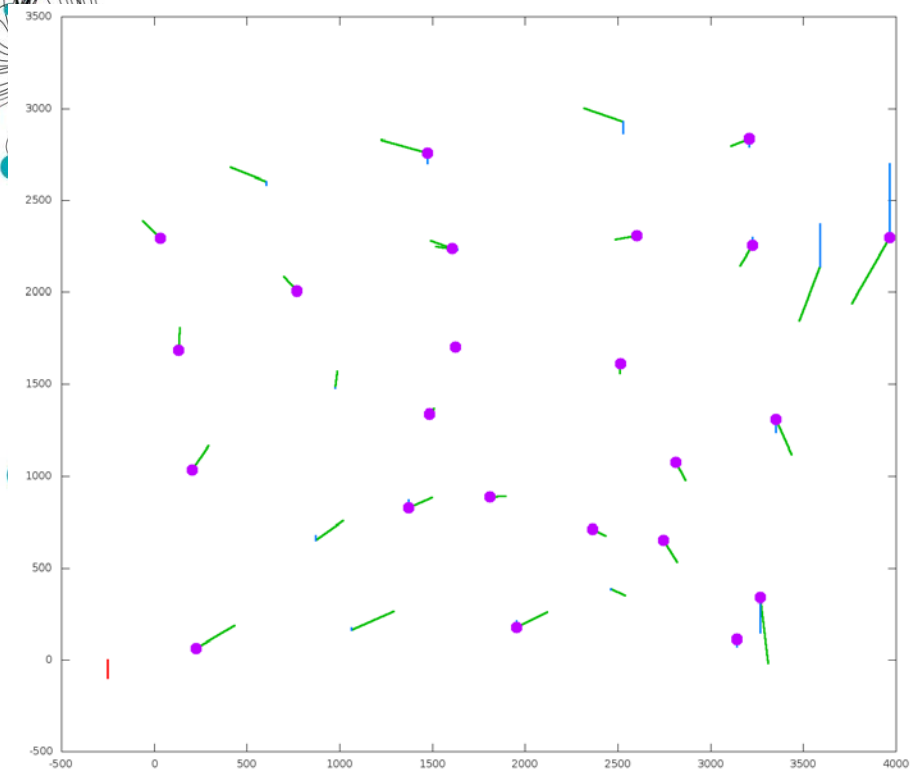


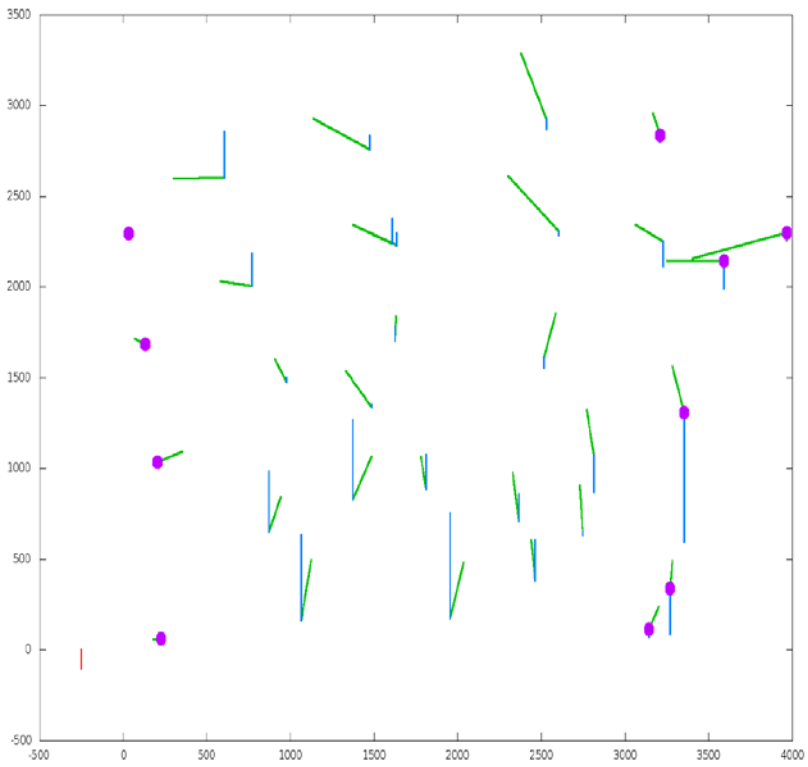
	80/80 GD Pix4d	80/80 BD Pix4d	60/60 GD Pix4d	60/60 BD Pix4d	60/60 GD BLUH	60/60 BD BLUH
GCP Z	2.0	1.9	6.8	5.5	9.5	27
Check Z	9.9	12.9	16.0	25	8.4	24

- Bad distribution of GCPs causes increase of Z-RMSE, as well
- However – BLUH´s additional parameters have positive effect with good GCP distribution

GCP DISTRIBUTION

Good vs. bad GCP distribution

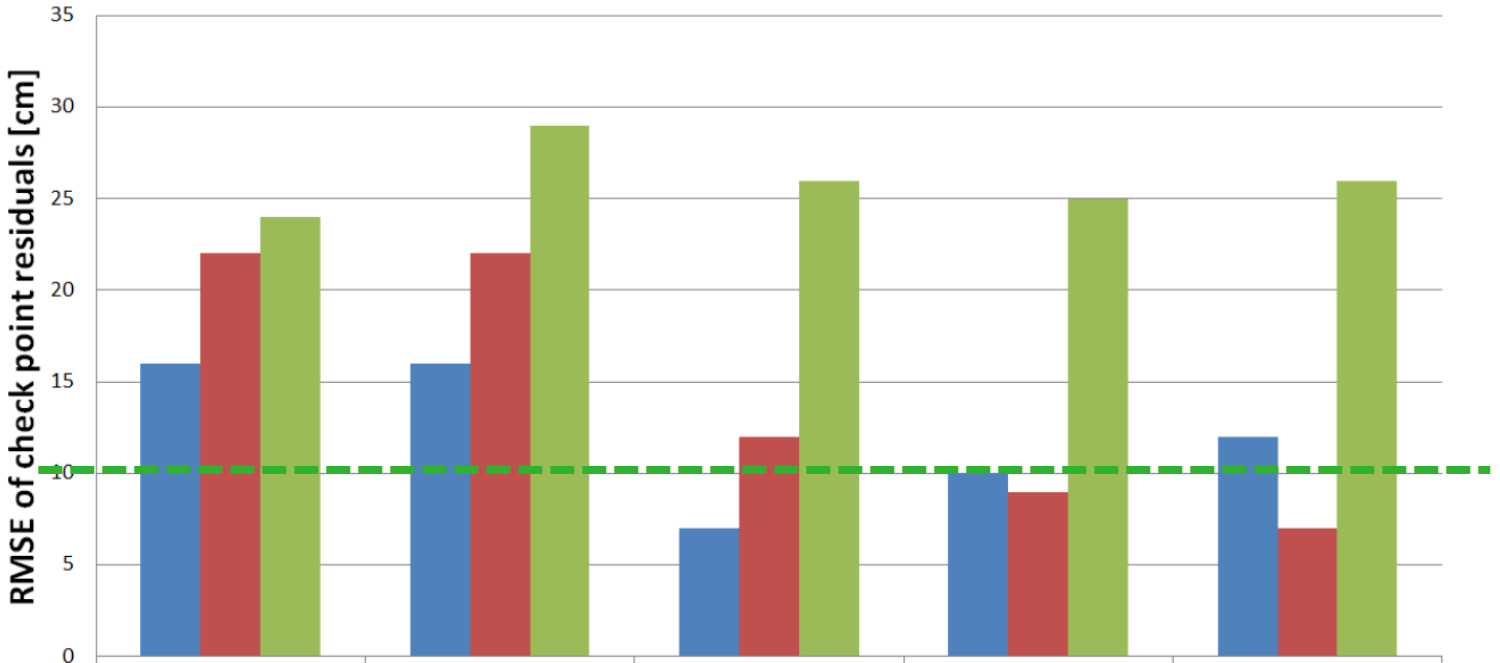




GCP | X-Y-residual vector | Z-residual vector | scale bar: 10cm

SOFTWARE DEPENDENCY

Software dependence, 60/60, bad GCP distribution: most challenging



	BLUH	ORIENTAL	SWJTU	Pix4D	AgiSOFT
X	16	16	7	10	12
Y	22	22	12	9	7
Z	24	29	26	25	26

- With this configuration (60/60, bad GCP distri), enhanced sensor modeling of research/Univ. approaches cannot be applied well

SUMMARY

- Tie point matching across viewing directions: not available, but presumably would help, especially for self-calibration
- Nadir-only vs Penta: Height estimation better in Penta, around 1GSD
- 80/80 vs. 60/60: Random and systematic error worse by factor 3 in 60/60 (but attention: unfavorable GCP distribution from benchmark)
- Distribution of GCP, influence on object point accuracy: systematic error a bit larger in bad GCP distribution
- Advanced sensor modeling from research approaches improves results, but needs good GCP input
- Software dependency: for the challenging dataset (60/60, bad GCP distribution) the packages optimized for unordered datasets, based on SfM, slightly outperform some research approaches

DOWNLOADS: SOME STATISTICS

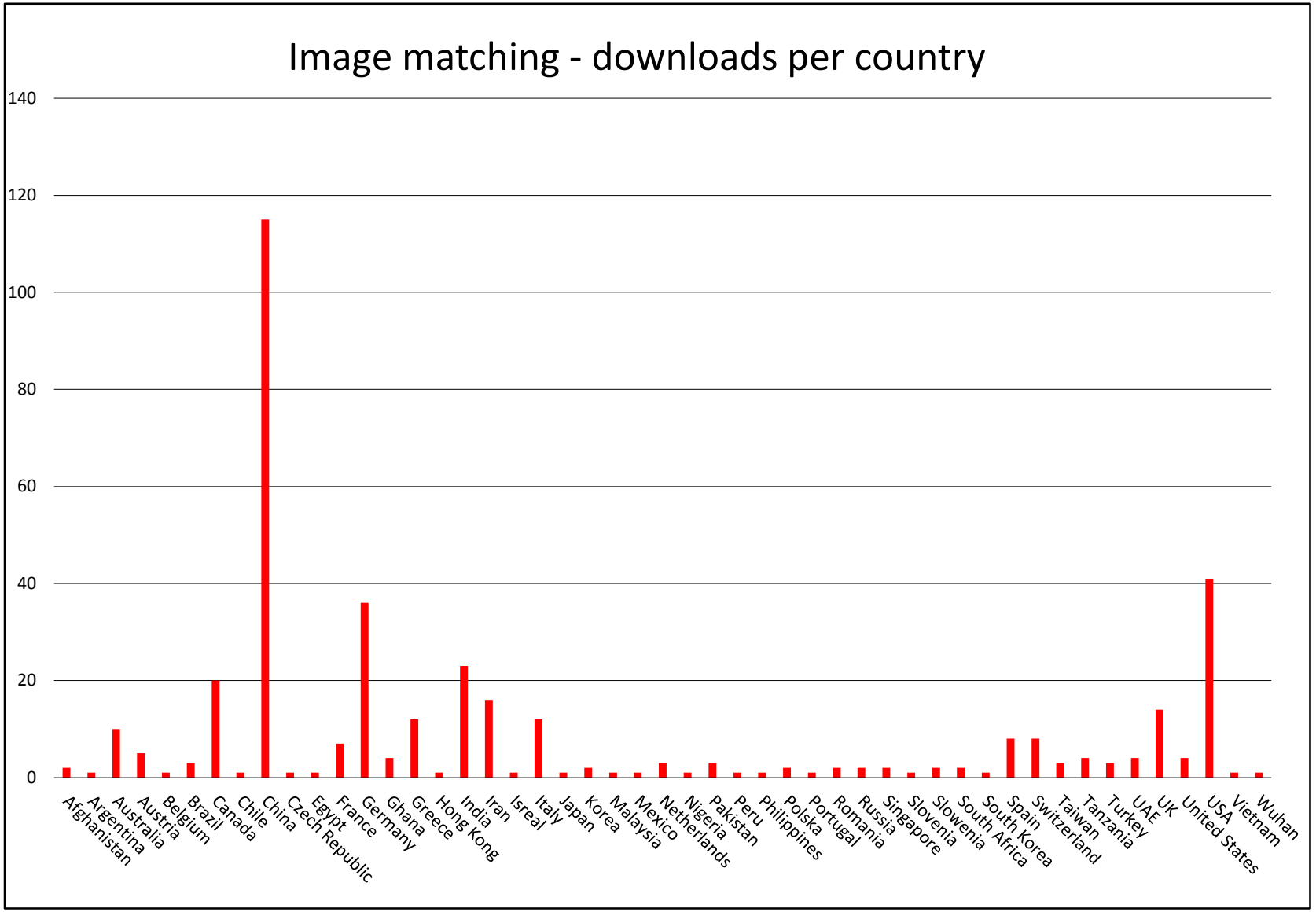
Point cloud generation	
Motivation	**Downloads**
Educational	317
Governmental	18
Private	58
Other	12
Total	405

Since April 2015

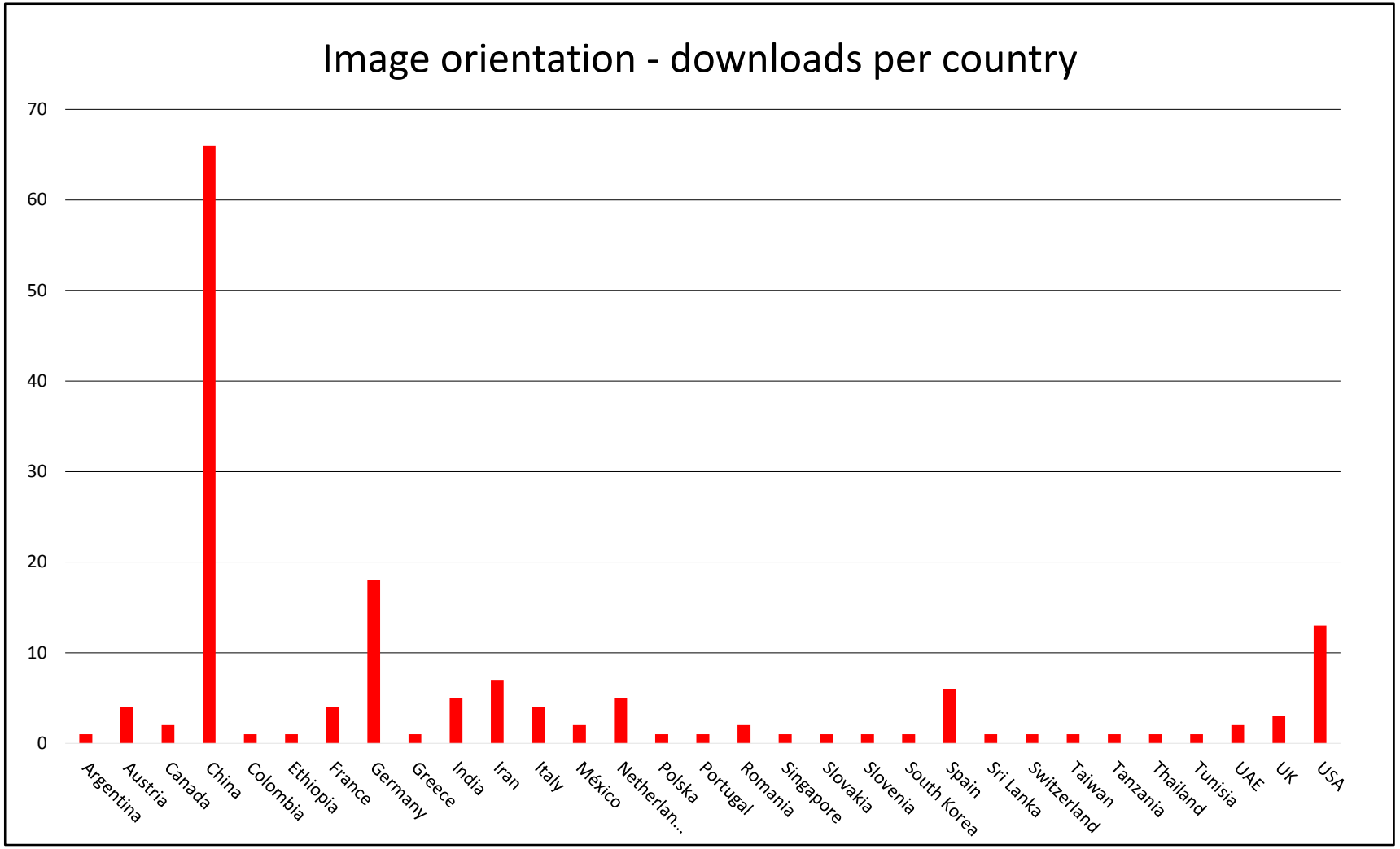
Since October 2015

Image orientation	
Motivation	**Downloads**
Educational	137
Governmental	6
Private	18
Other	6
Total	167

SOME STATISTICS



SOME STATISTICS



RELEASE OF THE BENCHMARK

ISPRS / EuroSDR Benchmark for Multi-Platform Photogrammetry

RELEASE of ALL THE DATA captured within the ISPRS Scientific Initiative "Multi-platform Very High Resolution Photogrammetry" cofunded by EuroSDR (2014-2015)

All the data acquired for the benchmark has been released on both the test areas. You are welcome to use in any activity where it might be helpful. If you intend to use it in a publication please acknowledge the data provision by ISPRS and EuroSDR. Please also refer to the paper:

Nex, F., Gerke, M., Remondino, F., Przybilla H.-J., Bäumker, M., Zurhorst, A., 2015. ISPRS Benchmark for Multi-Platform Photogrammetry. ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol. II-3/W4, pp.135-142.

A more detailed explanation about the complete dataset will be given by mail after having filled the registration form!

Three different sets of images on Dortmund-Centre, Dortmund, Zeche Zollern (Germany) and Zurich (Switzerland) are available for participants.
Details on the general aims of the benchmark and the data desctiptions (Dense Image Matching and Image Orientation) are given below.

General aim of the benchmark

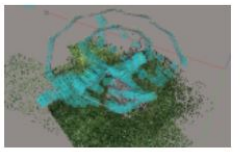
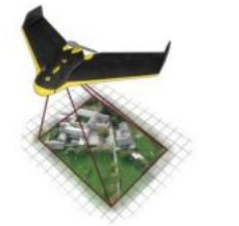
DENSE IMAGE MATCHING:

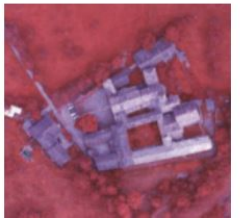
- Data description (Dortmund, Zeche Zollern)
- Data description (Zurich)
- Download data
- Submit your results

IMAGE ORIENTATION:

- Data description (Dortmund-Centre)
- Download data
- Submit your results

ISPRS ICWG I/II



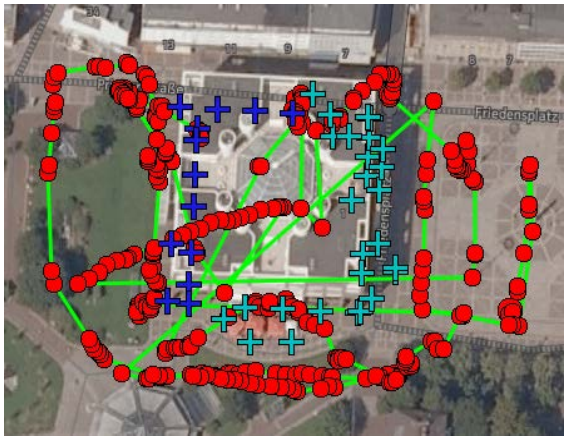
ITC UNIVERSITY OF TWENTE.

RELEASE OF THE BENCHMARK

What is now available:

- Imagery
  - Oblique datasets (80% - 80%): City center and Zoche Zollern
  - UAV images (several platforms), high resolution, high overlap

- Laser Scanning
  - ALS of the urban area
  - TLS of buildings acquired by UAVs and terrestrial images



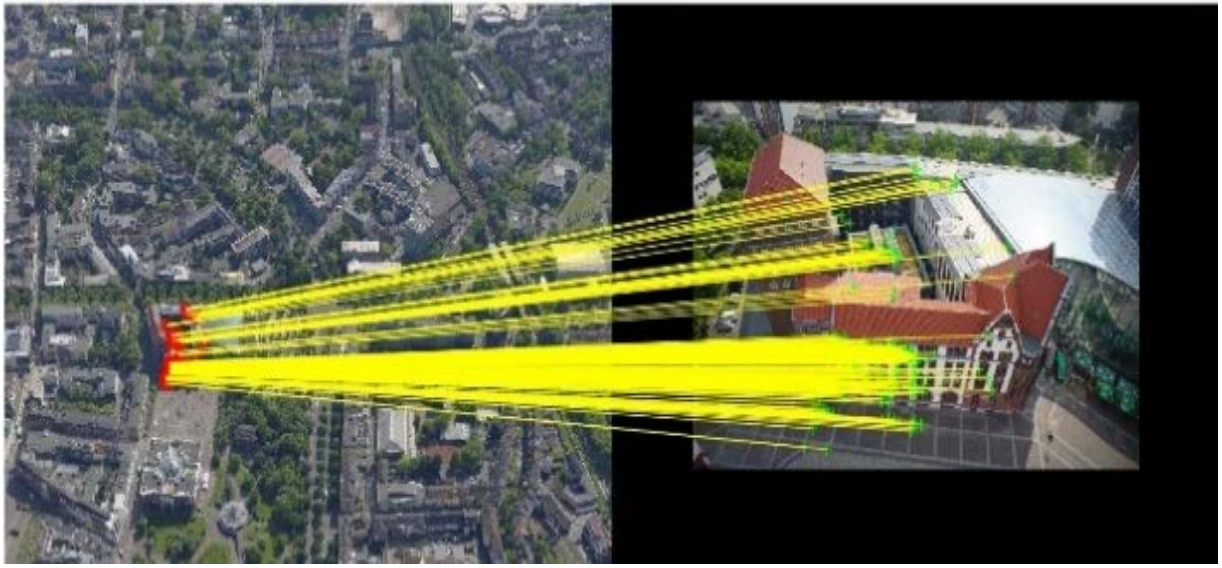
- Control points
  - On the urban area and on the buildings

LESSON LEARNT

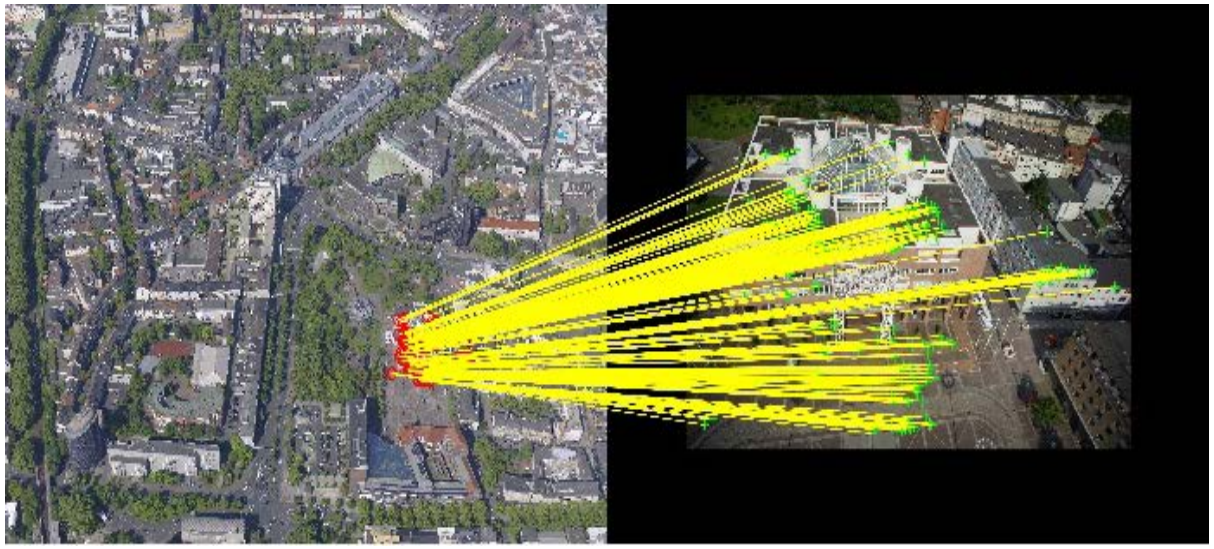
- The benchmark has been downloaded from many countries.
- Not only the ISPRS / EuroSDR community were interested in these images: listed in many Computer Vision lists
- Although the number of downloads is very high, the results received are very few. Why?
  - Our community is not very keen in comparing results
  - The topics are maybe a niche compared to other benchmarks: image classification/semantic analysis.
- The release of the benchmark will make researchers free to use these images for their own use.
- But what about the companies?

WHAT'S NEXT? MULTI-RESOLUTION

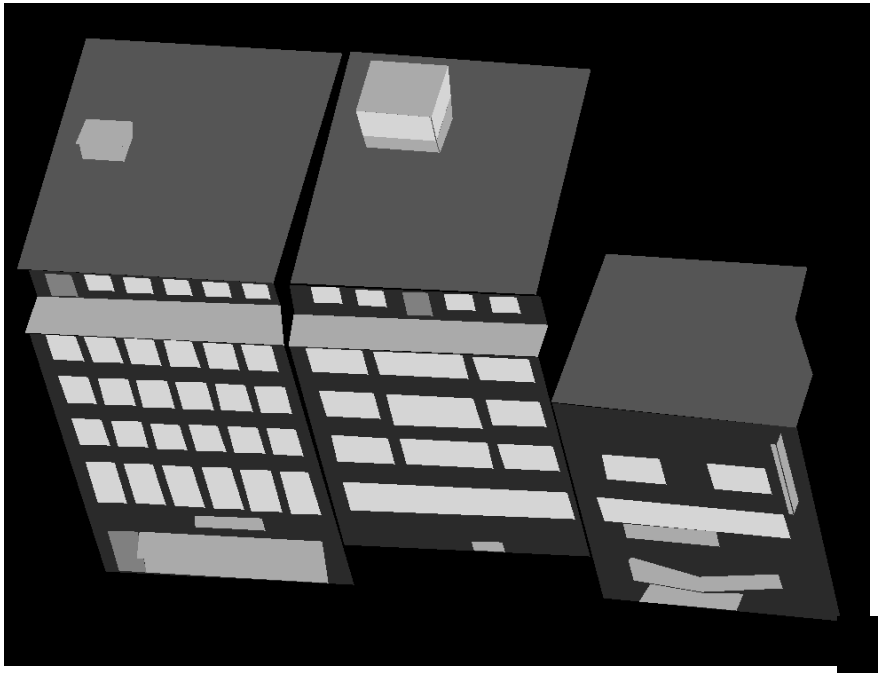
Multi-resolution integration in a unique block.



New methods to reliably co-register images acquired with different platforms



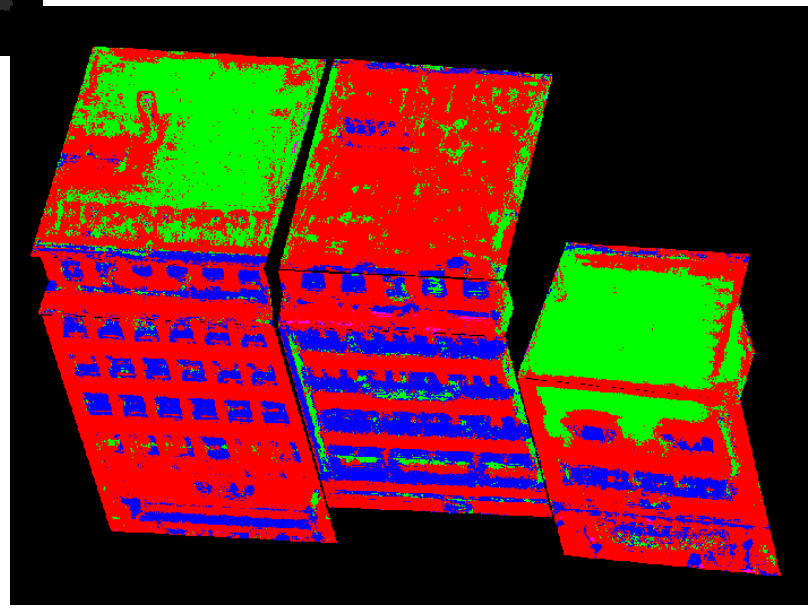
WHAT'S NEXT?



Generation of ground truth for façade classification

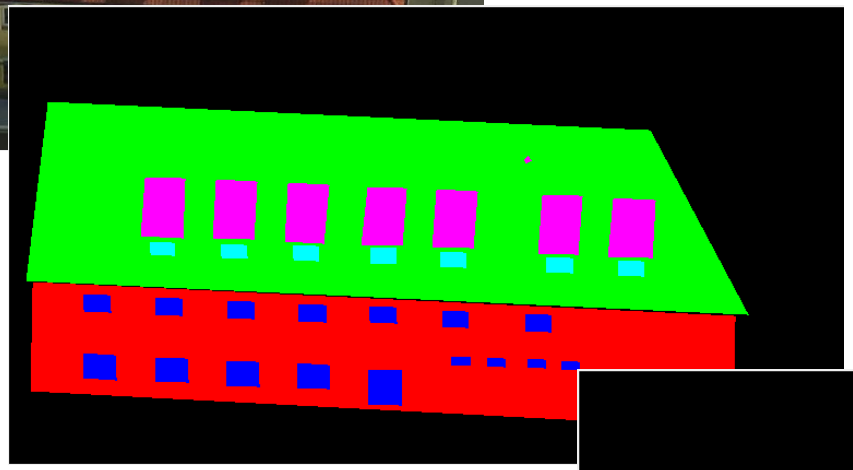
Classification of main components of the buildings: Roof, wall, windows, balconies, doors.

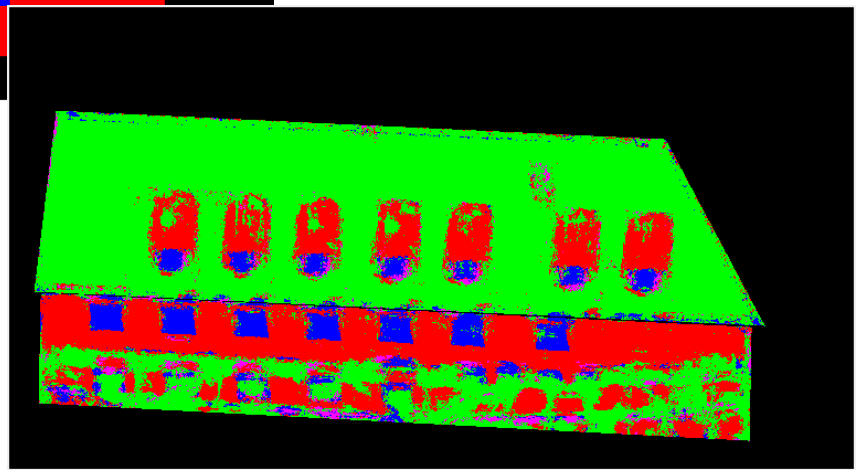
Towards LoD3 Models?



WHAT'S NEXT? TOWARDS LoD3

Generation of ground truth for façade classification





Towards LoD3?

UNIVERSITY OF TWENTE.

THE ISPRS/EUROSDR BENCHMARK ON MULTI-PLATFORM PHOTOGRAMMETRY:

RESULTS AND LESSON LEARNT

FRANCESCO NEX AND MARKUS GERKE

ITC FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION