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A new stereo dense matching benchmark dataset for deep learning

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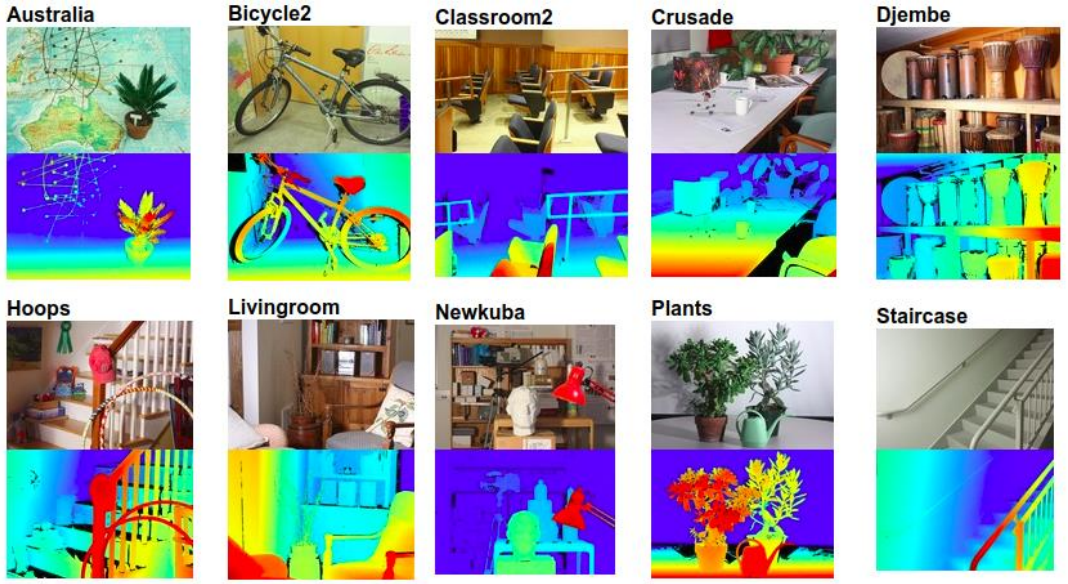
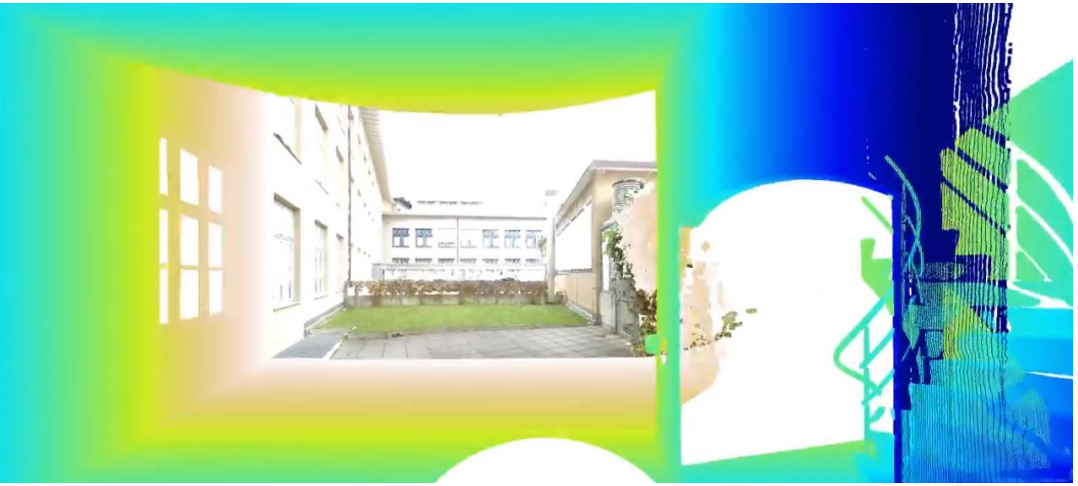


Middlebury



ETH3D

Many benchmark dataset in computer vision

real scenes:

Middlebury
ETH3D
KITTI
Drivingstereo
ApolloScape
…

virtual scenes:

Scene flow(FlyThings3D)
Vitural KITTI
Sintel
…

Easy to find training dataset in Computer vision

luction

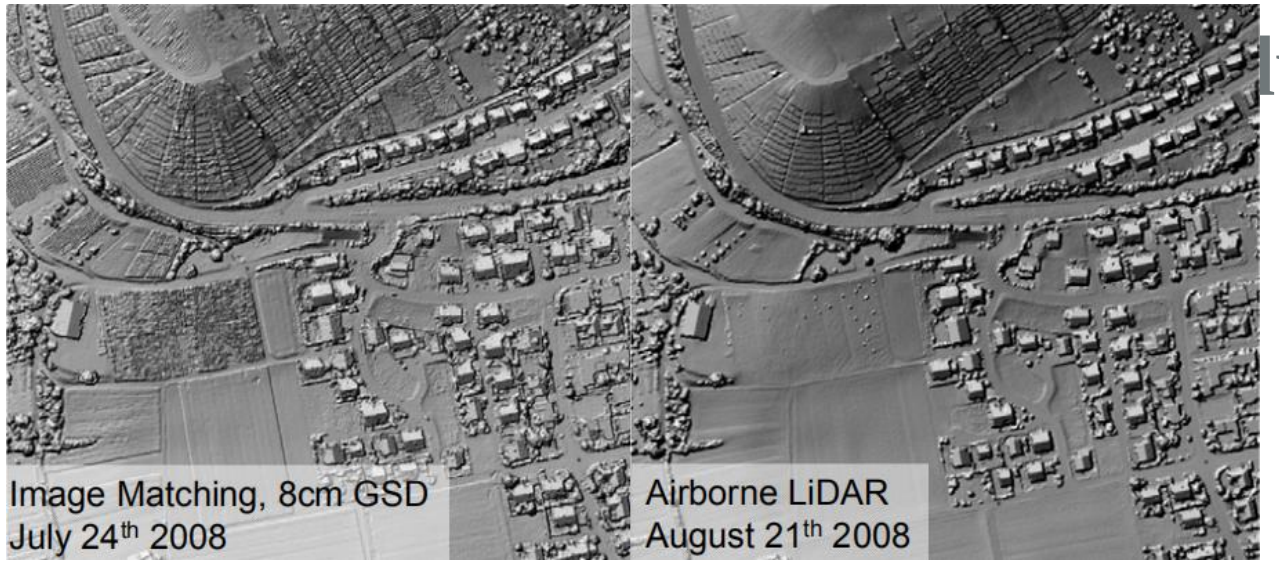


Image based DSM and LiDAR based DSM (Haala, N., 2013.)

DSM (image matching) – GT DSM = difference DEM

(Haala, N., 2013.)

LiDAR is sparse, use the median value from all the evaluated results as ground truth(GT).

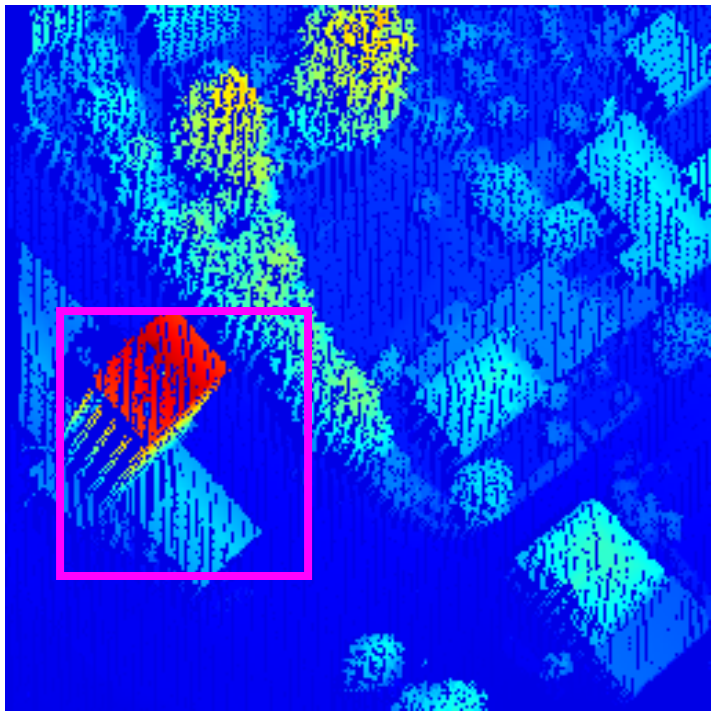
This is evaluation, not a benchmark data for training.

Introduction

Use LiDAR as ground truth, stereo matching dataset in photogrammetry:

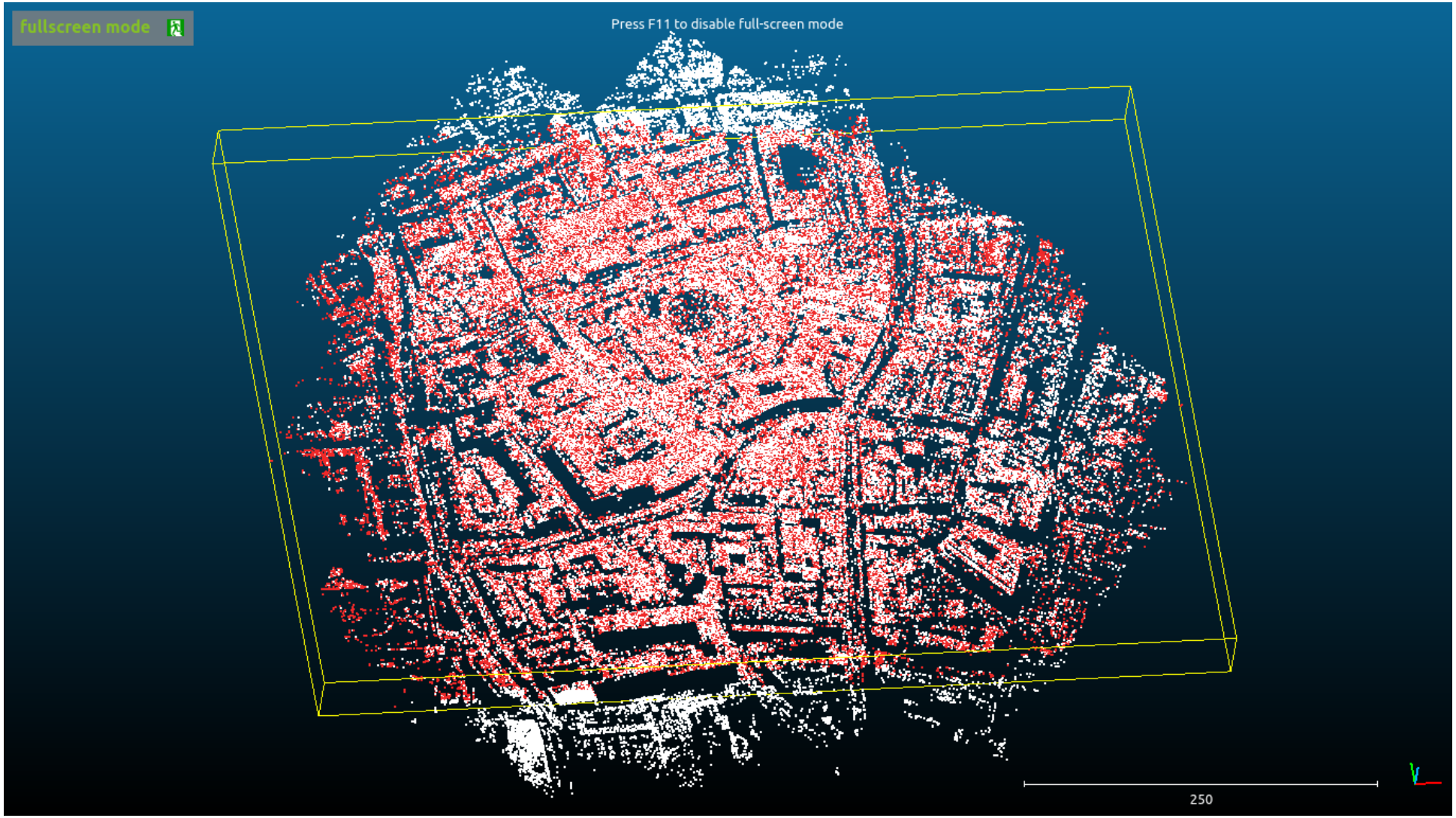
SatStereo(satellite)

IEEE DFC2019 (satellite)



1. **Difficult to find aerial dataset**
2. **Interpolation in DSM bring error**
3. **Points on walls are ignore when interpolation**

Methodology



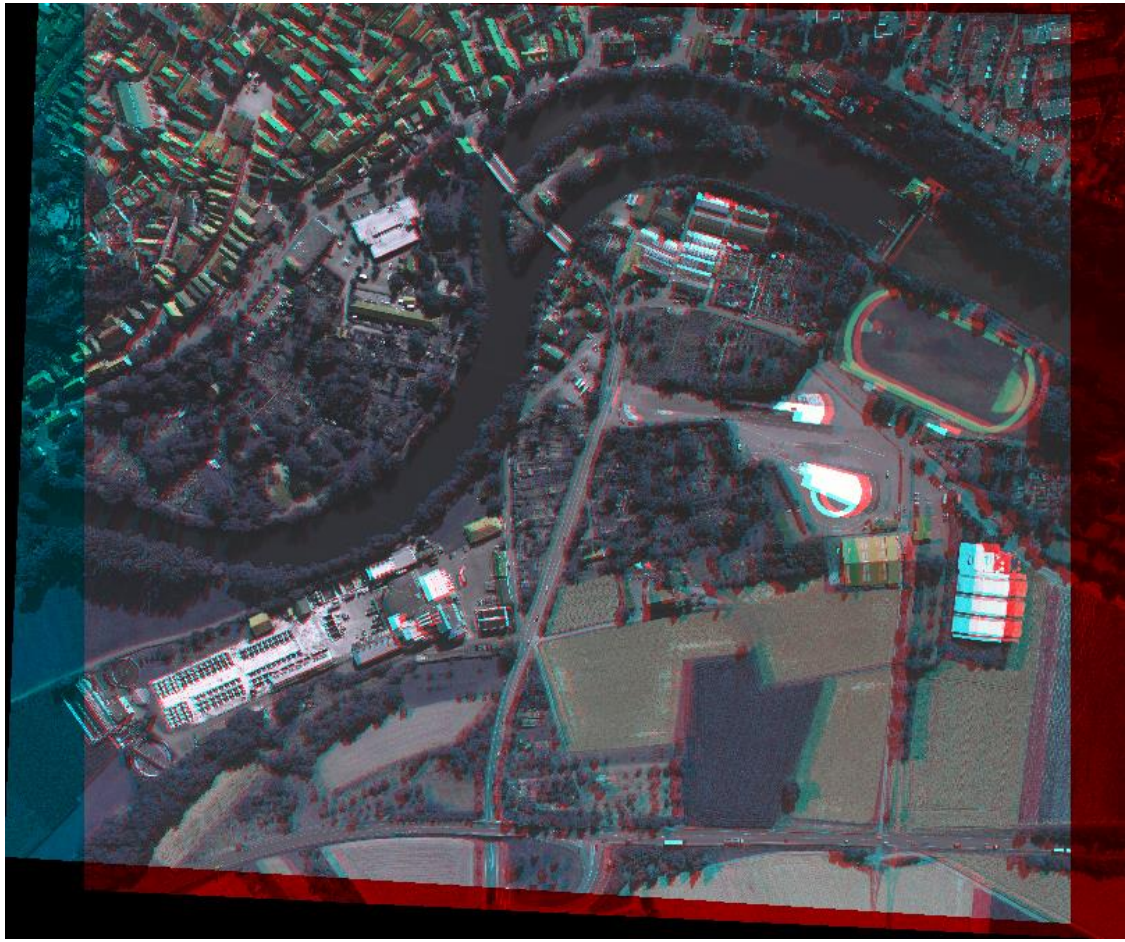
Orientation refinement

ICP
+
Bundle Adjustment

Methodology

left image

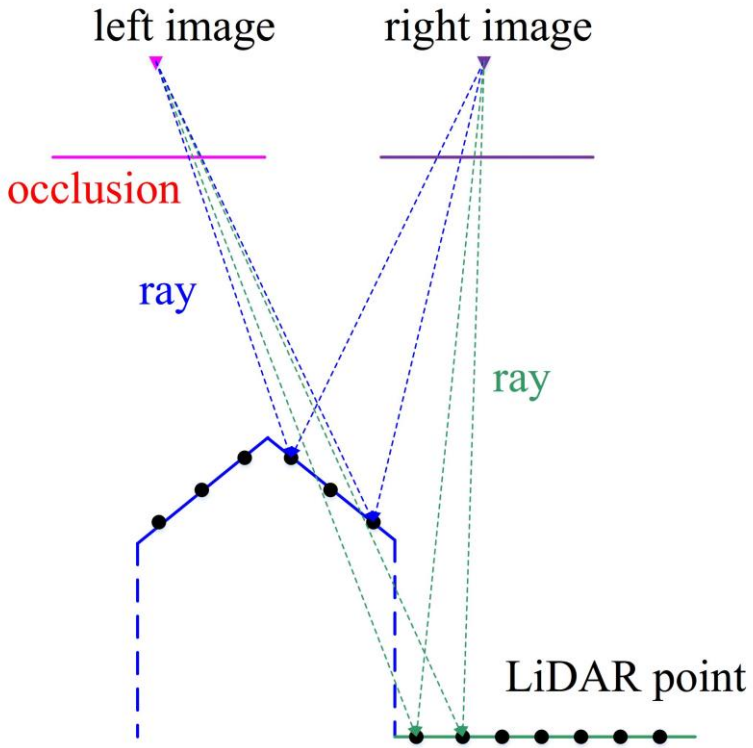
right image

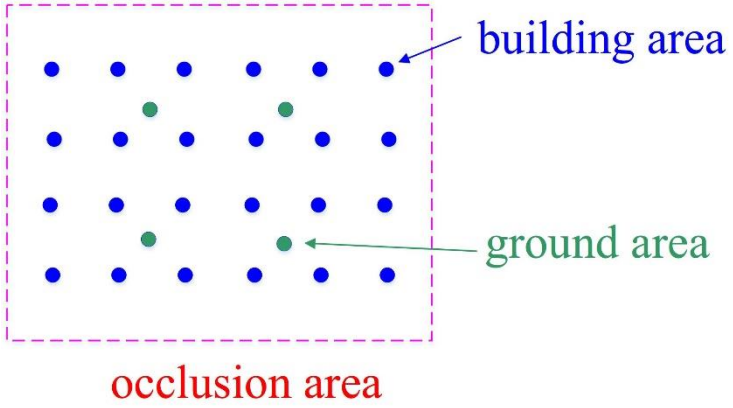


epipolar stereo image pair
in Red/Cyan mode

Methodology

occlusion when projecting
3D point to image plane





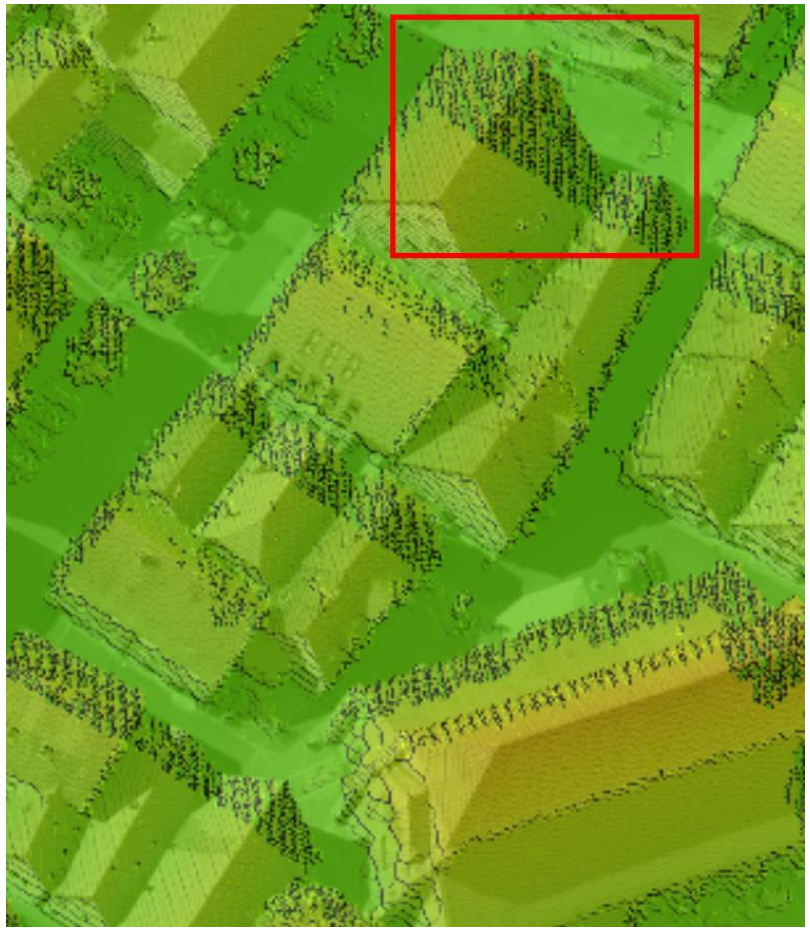
density is different

$$z = \frac{b \cdot f}{d}$$

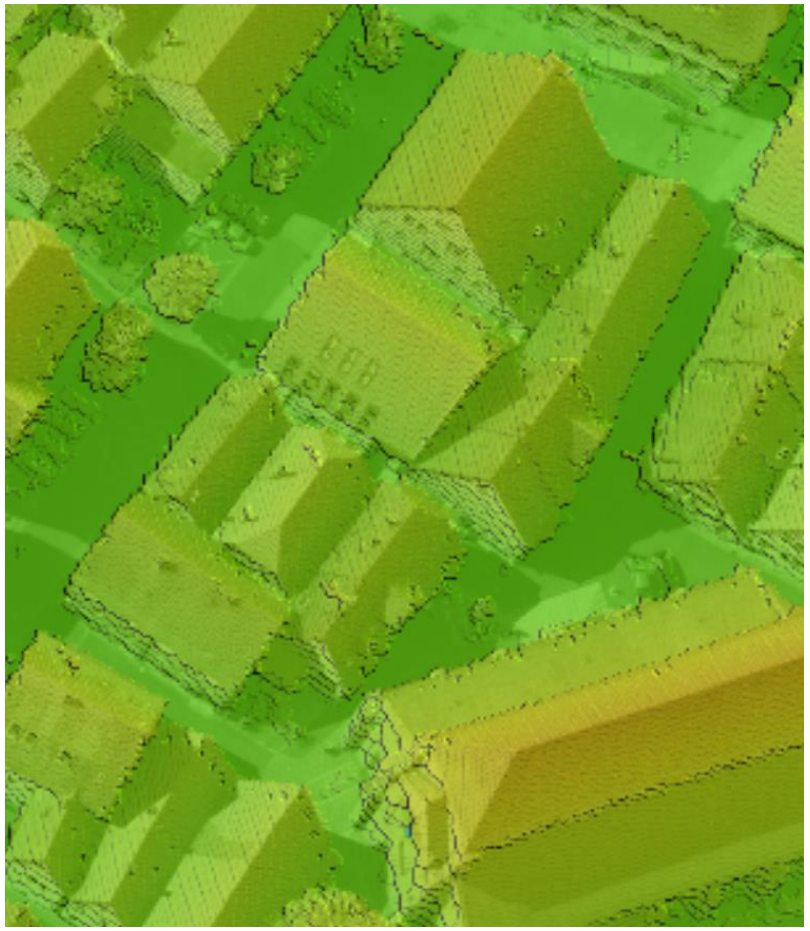
b: base line
f : focal length
z : depth
d : disparity

ray tracing +
a filtering base method according to the density and the disparity value

Methodology



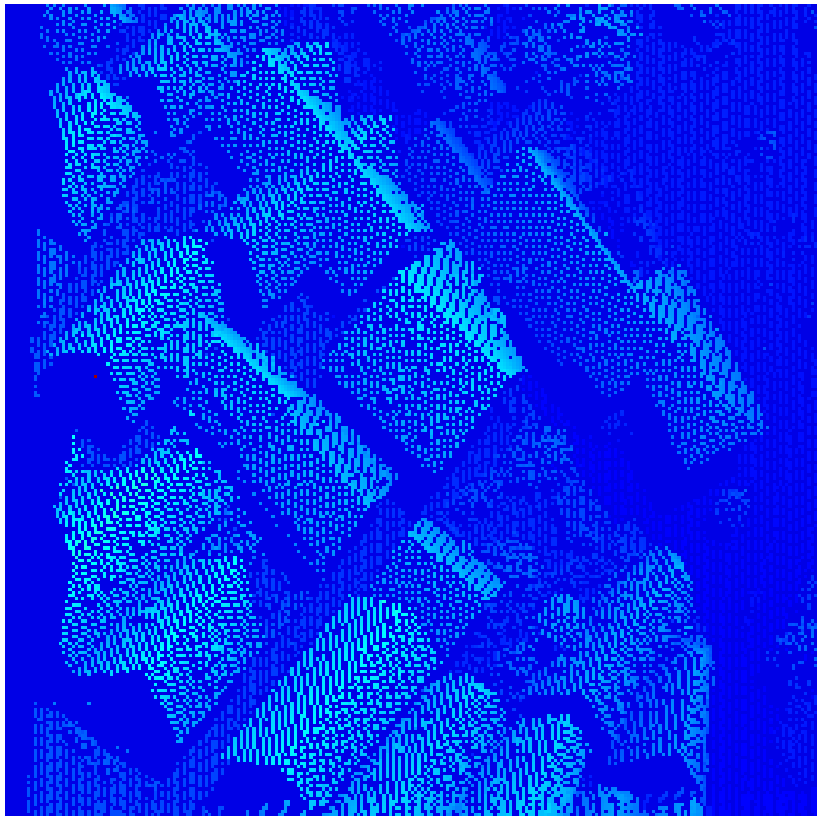
Disparity **without occluded points filtering** shown after nearest interpolation



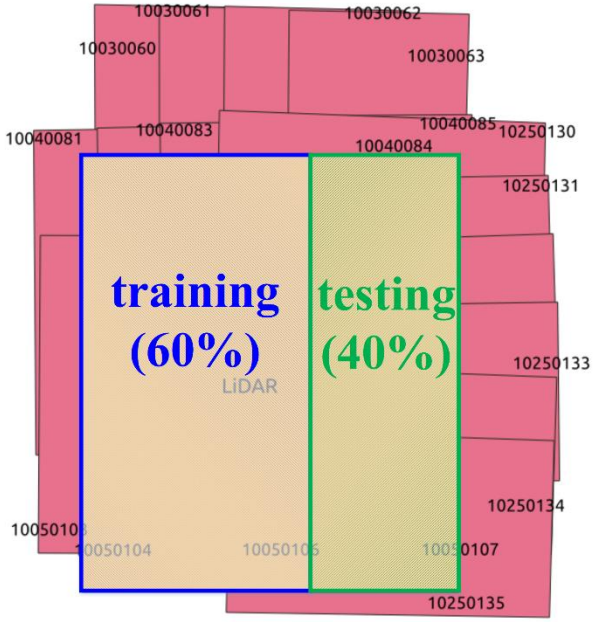
Disparity **with occluded points filtering** shown after nearest interpolation

left image

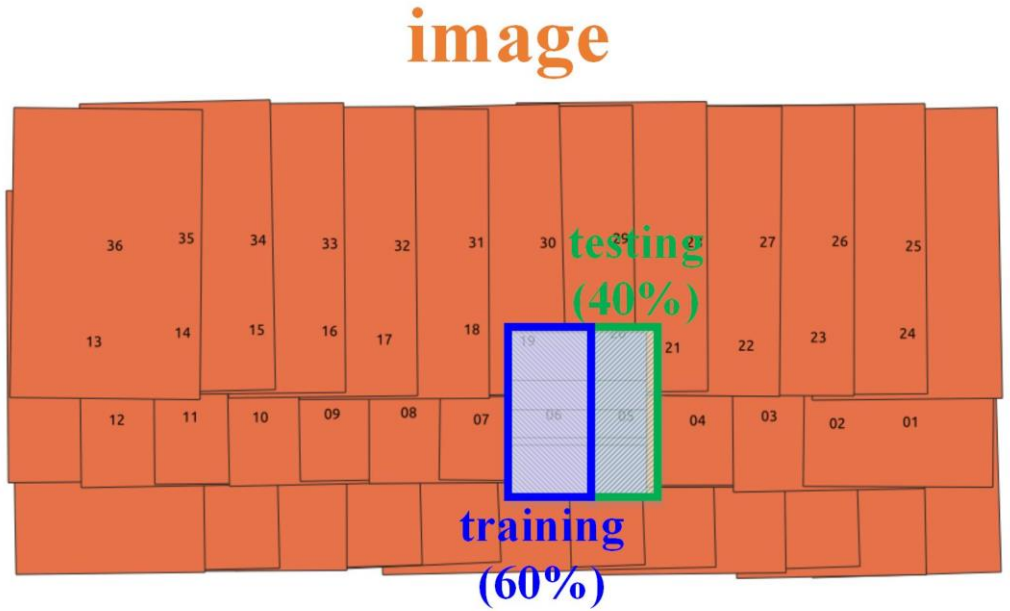
right image



disparity image

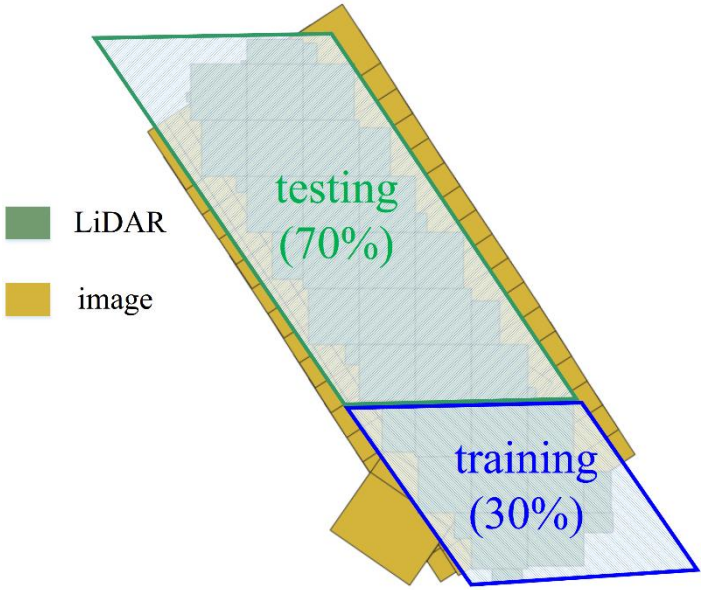


ISPRS Vaihingen

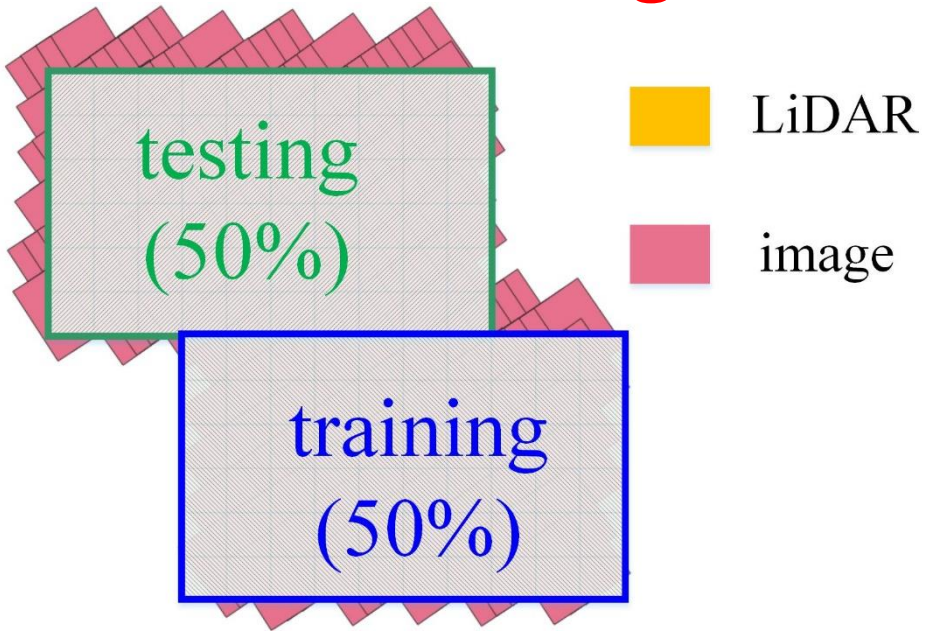


EuroSDR Vaihingen

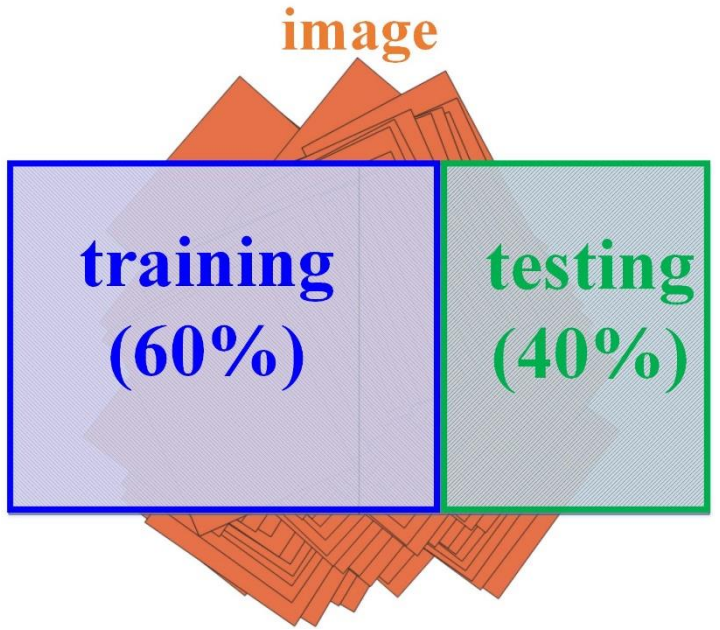
Enschede



Toulouse UMBRA



Toulouse Metropole



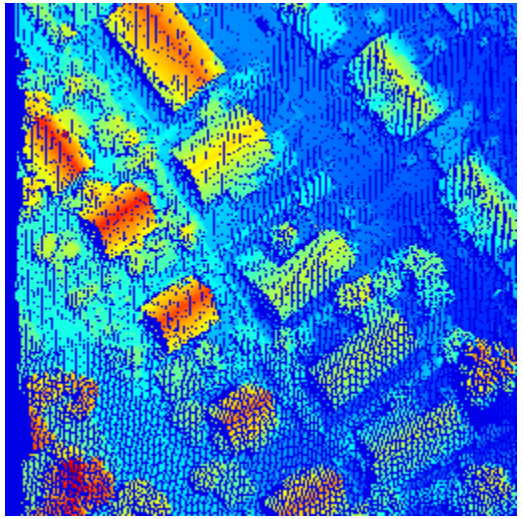
DublinCity

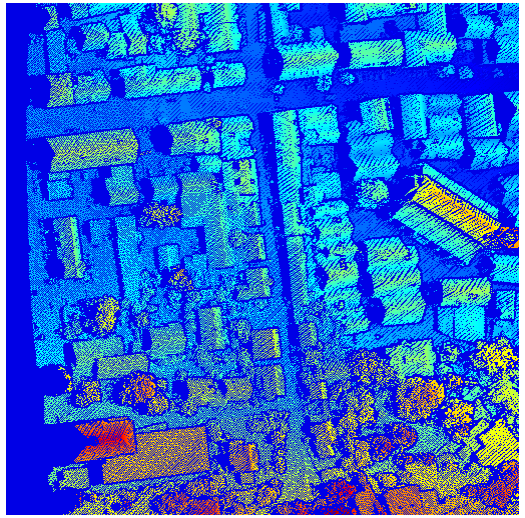
Experiment

Datset detail

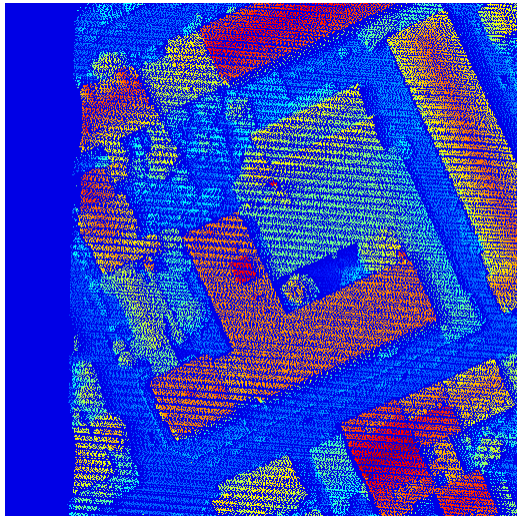
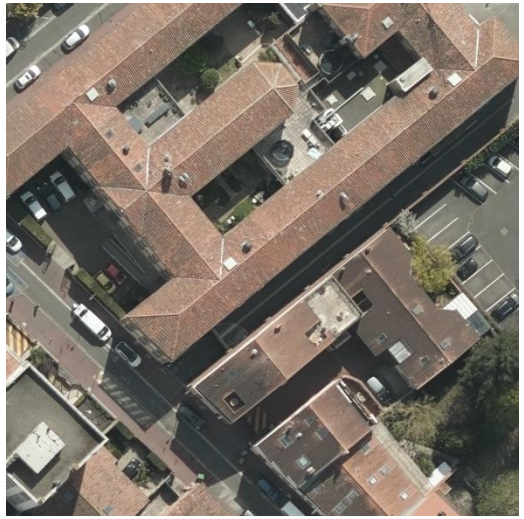
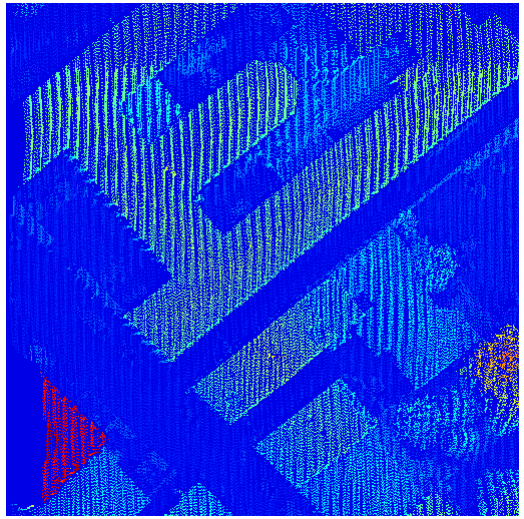
dataset	color	GSD(cm)	LiDAR (pt/m^2)	train+test
ISPRS-Vaihingen	IR-R-G	8	6.7	640 + 516
EuroSDR-Vaihingen	RGB	20	6.7	421 + 353
Toulouse-UMBRA	RGB	12.5	2-4	7409 + 21458
Toulouse-Métropole	RGB	5	8	9813 + 14241
Enschede	RGB	10	10	871 + 819
DublinCity	RGB	3.4	250-348	35128+6799

Experiment



Vaihingen

Toulouse

Experiment

Enschede

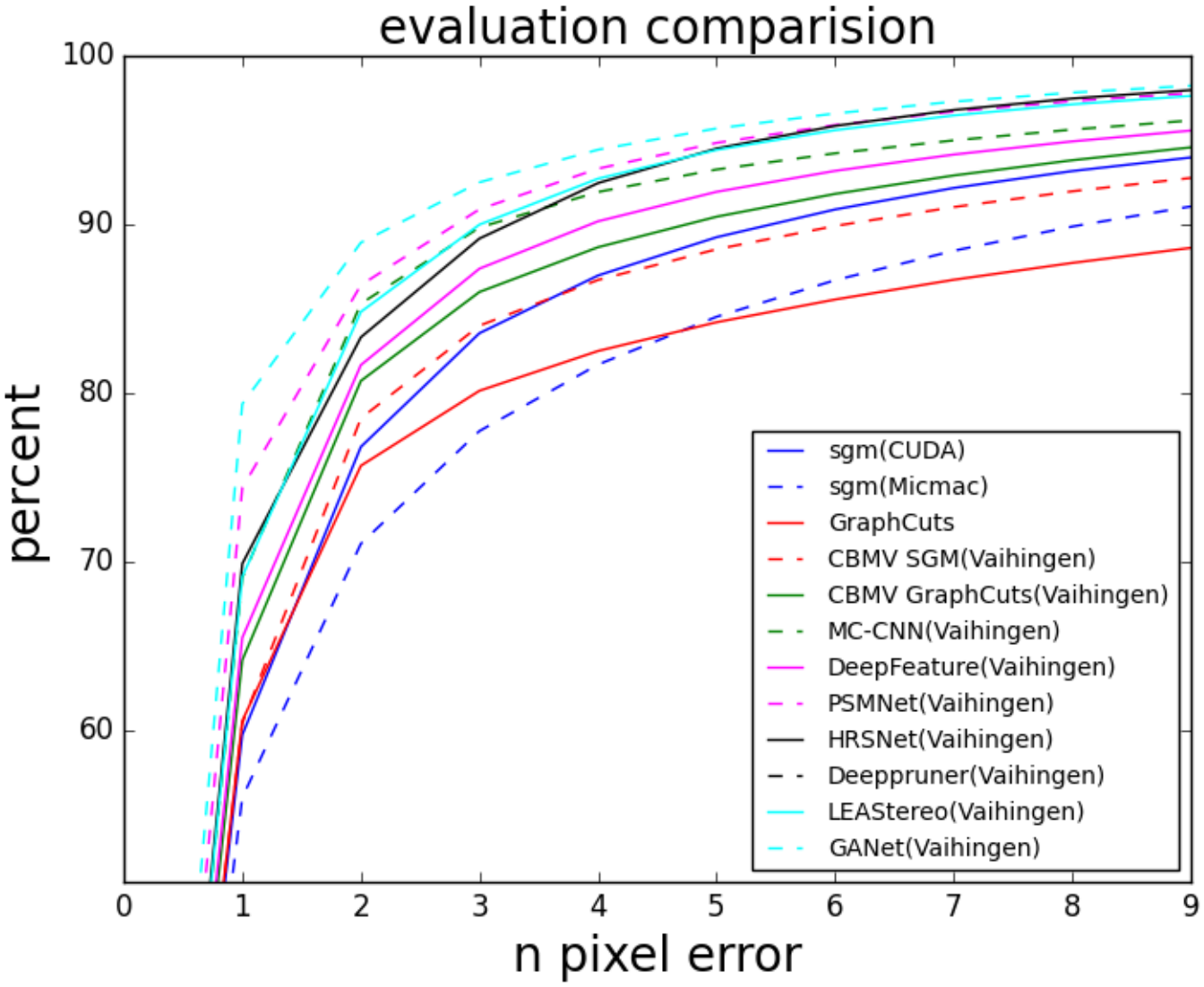
unprofessional camera

DublinCity

High dense

Left image Right image Disparity image

Experiment

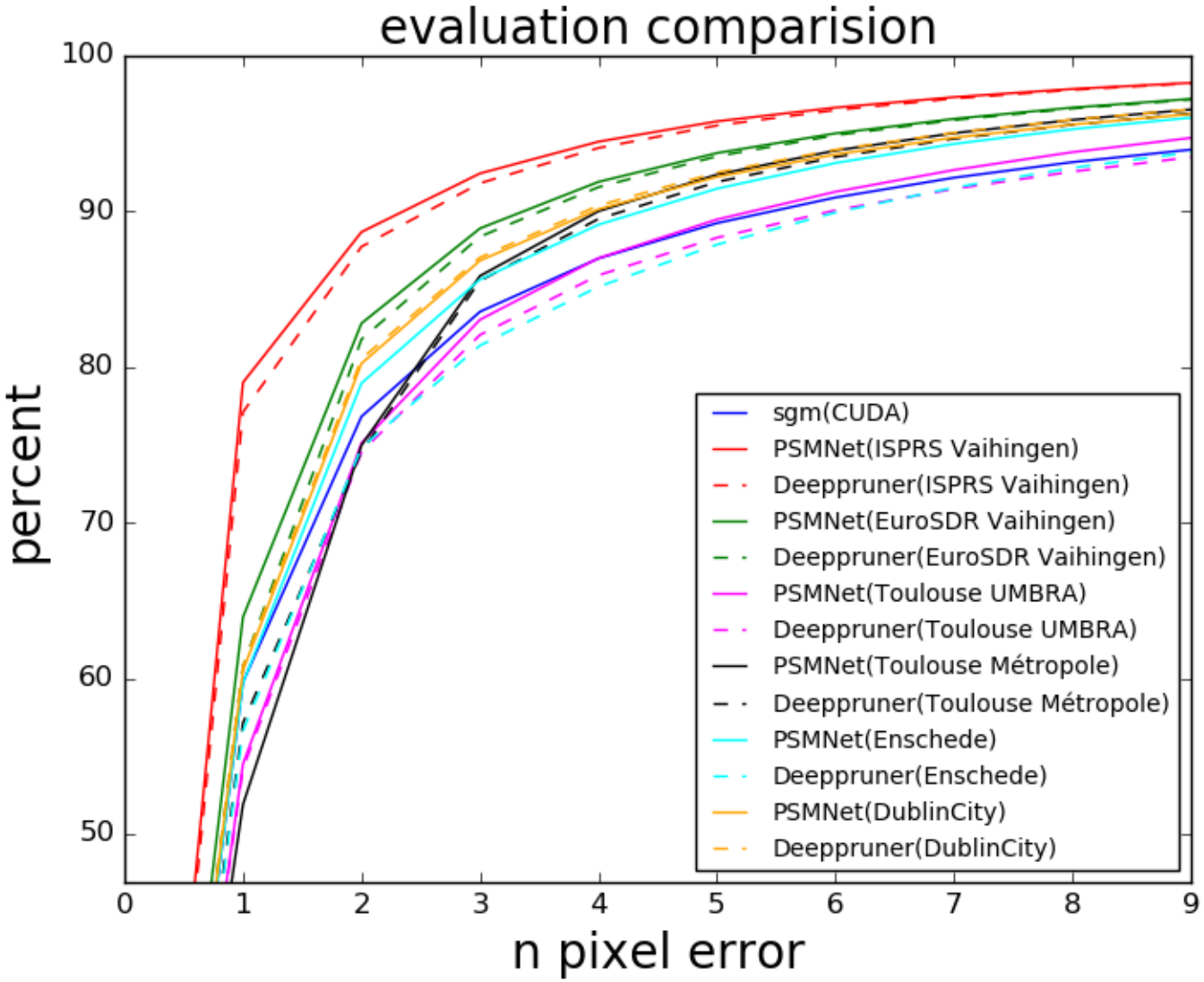


evaluated 11 stereo matching methods

7 deep learning based methods

1. **end to end methods perform better than hybrid methods**
2. **GANet is the best one**

Experiment



evaluated the transferability of deep learning based methods

EuroSDR Vaihingen is better than other dataset
the same area, even the resolution is different

MICMAC

SGM(CUDA)

GraphCuts

CBMV(SGM)

DeepFeature (Pre)

PSM net(Pre)

HRS net(Pre)

DeepPruner(Pre)

CBMV (GraphCuts)

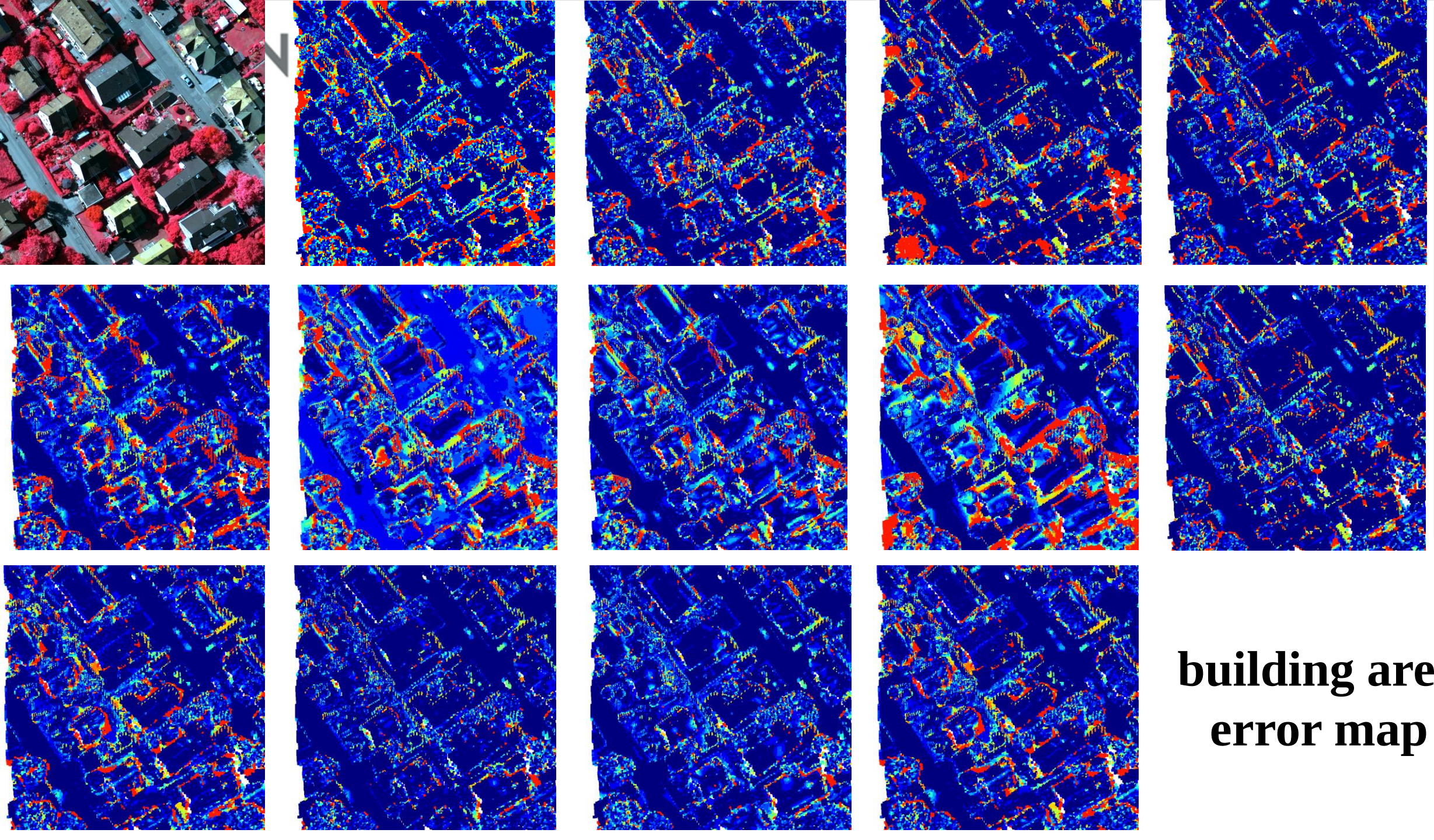
DeepFeature

PSM net

HRS net

DeepPruner

building area disparity visualization



building area error map

Conclusion and other work

Conclusion:

1. A large aerial dataset for deep learning.

2. Dataset quality and diversity is considered.

3. Evaluate 11 methods on 6 dataset.

4. Dataset shift is analysed.

Other work :

1. **Base height ratio influence**
2. **Multi-data training**

Reference

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Thank you for your attention

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More information:
Come to the poster 1183
https://github.com/whuwuteng/Aerial_Stereo_Dataset