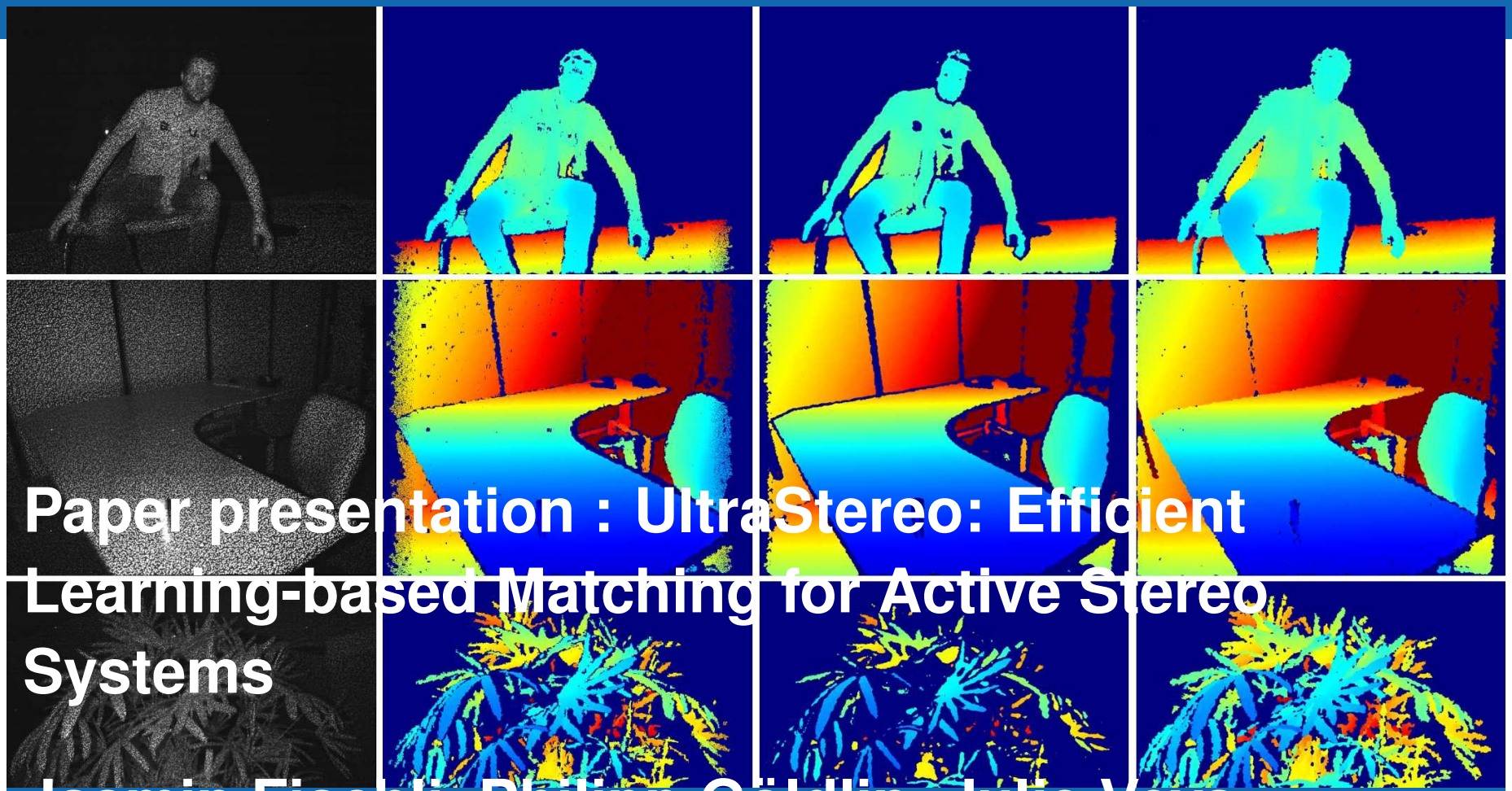

Paper presentation : UltraStereo: Efficient Learning-based Matching for Active Stereo Systems

Jasmin Fischli, Philipp Göldlin, Julie Veya, Jonathan Burkhard

Supervisor: Sattler Torsten

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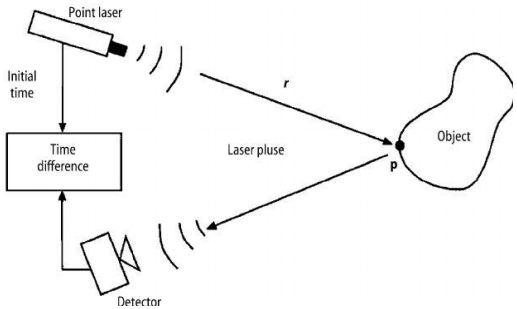
State of the art method, Time of flight

Using (varying) active illumination and reconstructing a scene from multiple images

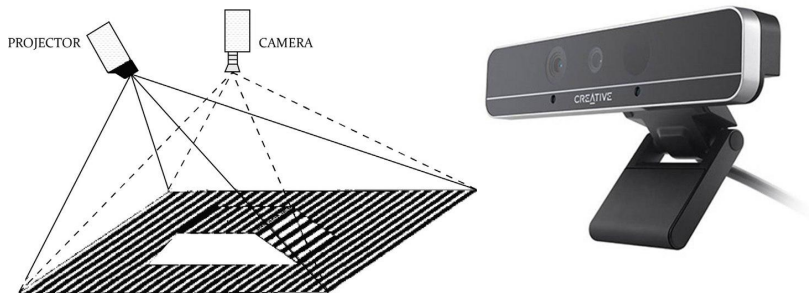


Shortcomings:

- Low mapping rate (30Hz)
- Motion artifacts
- Multipath-interference

State of the art method, Structured Light

Spatial patterns projected on the scene

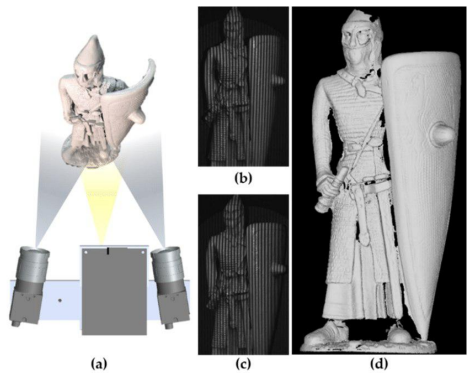


Shortcomings:

- Robustness issues
- Motion artifacts
- Limited depth-range
- Overlapping sensors cause interference

Solution to a lot of these issues: Active Stereo

Using 2 calibrated cameras and 1 pattern-projecting light source



- Mitigates multipath reflections
- Improves robustness
- Avoids interference between multiple systems
- BUT correspondence search has high computational cost

UltraStereo

UltraStereo

- two IR cameras: monochrome Ximea cameras, 1280x1024 pixel at 210Hz
- DOE projector
- rectified images
- same y but different x -> disparity
- big computational challenge

nice image with patches...

$$y = sign(x^T Z - \theta) \tag{1}$$

How to chose the parameters

image with a binary desicion tree with parameters theta and z and 32 nodes

$$I(\delta) = H(S) - \sum_{d \in L,R} \frac{S_d(\delta)}{S} H(S_d(\delta)) \tag{2}$$

Invalidation

Issues which the pixels from the final depth image won't contain any estimations :

- Occlusions
- Saturation of infrared sensors
- low signal noise ratio

How limits this errors ?

- an algorithms does an invalidation pass durint the post-processing step

Invalidation

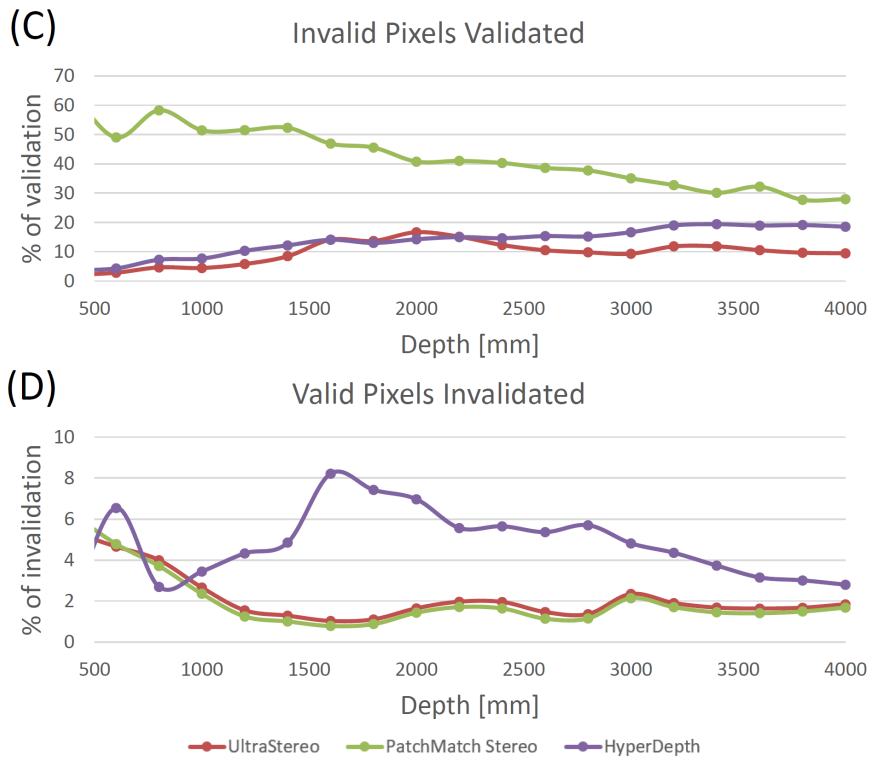


Figure: Quantitative results on syntatic data

Example of depth-map produced with UltraStereo

Look at the thin structures like plants

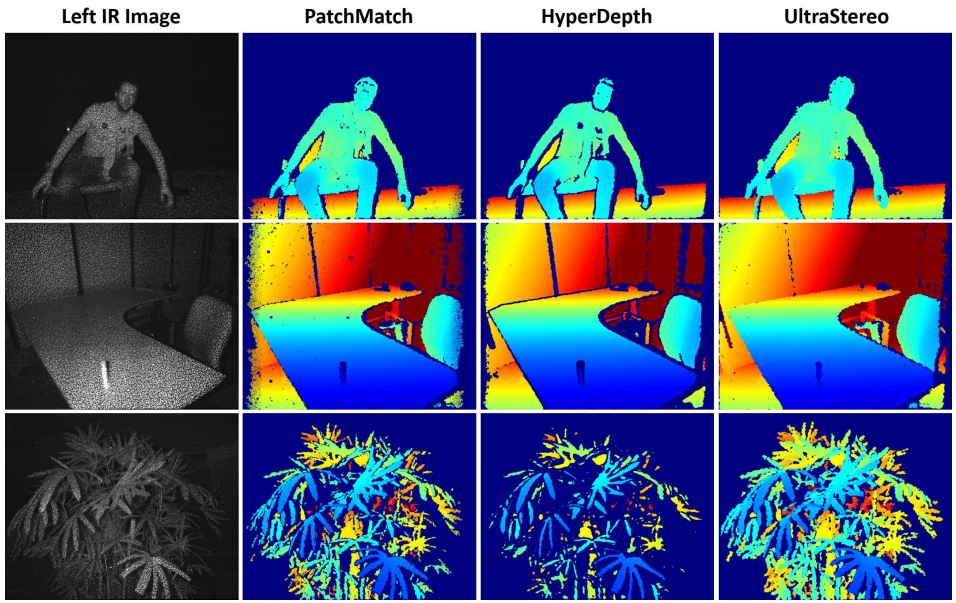


Figure: Qualitative Evaluation

Edge fattening

Other issiue is the edge fattening. To measure it they :

- used a hand to test their algorithms
- put a hand at 1 m from the sensors
- defined key hand pose for each frame

Edge fattening

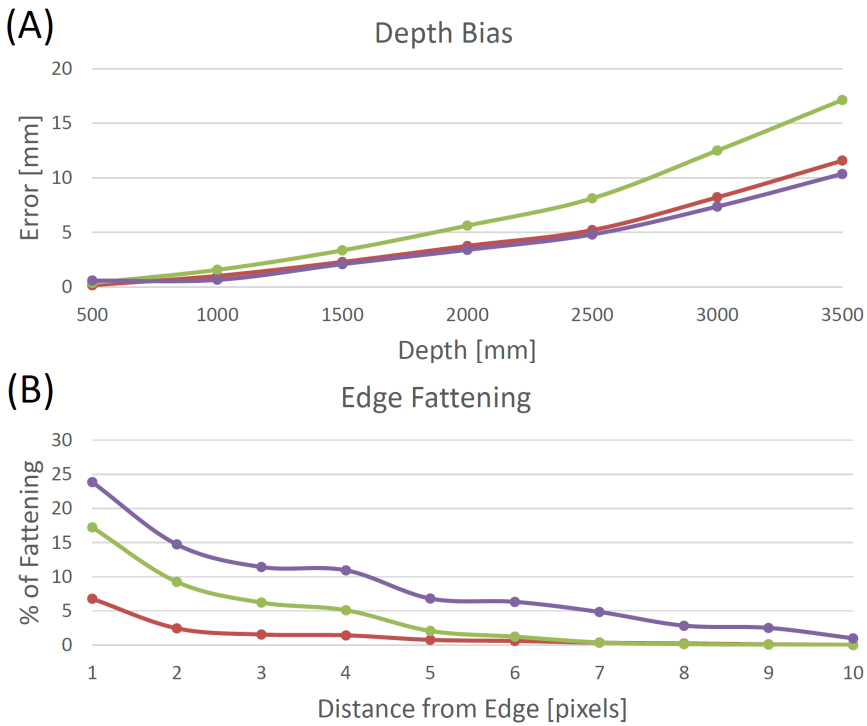


Figure: Quantitative results on syntatic data

Edge fattening

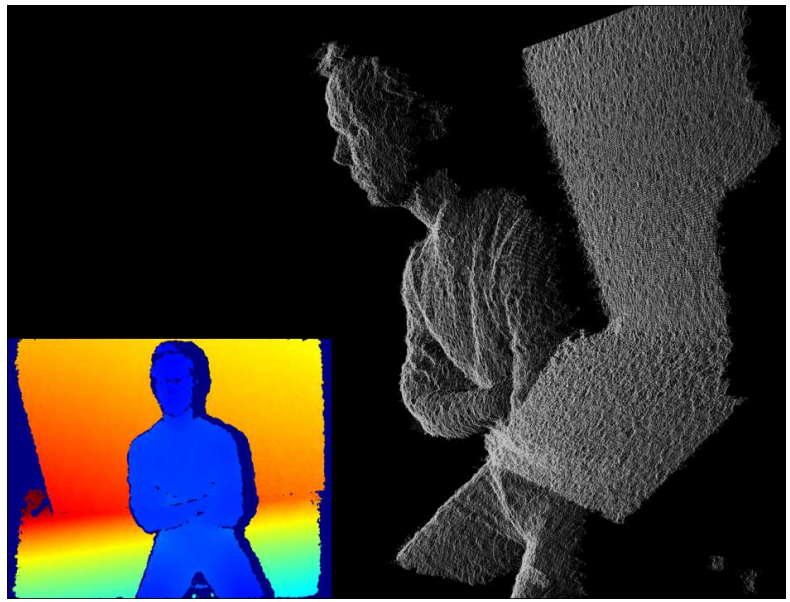


Figure: Example of pointcloud produced with our algorithm. Notice the absence of quantization and flying pixels

Binary representation

- Compare UltraStereo with Census and Locality Sensitive Hashing (LSH)
- Collect 1000 images with the Kinnect

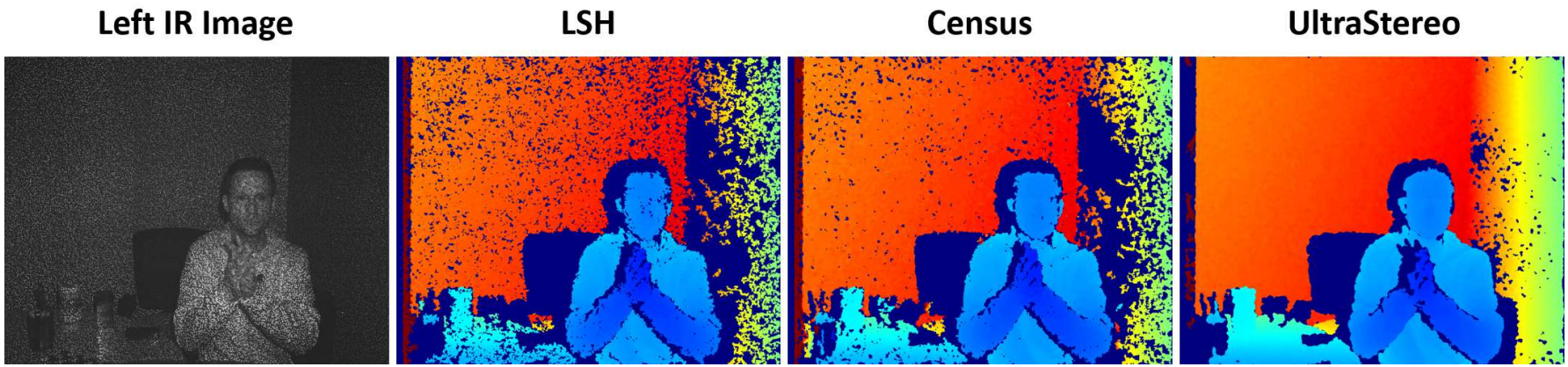


Figure: Census use 121 bits, LSH and UltraStereo use only 32 bits

Interference and Generalization

- interference caused by multiple sensors

Interference and Generalization

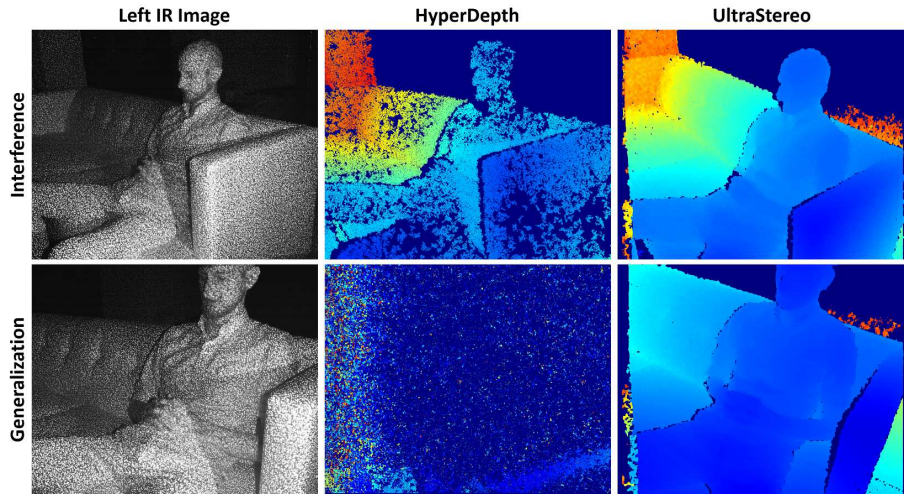


Figure: Examples of depth-maps produced with UltraStereo and state of the art competitors. Notice how the method in shows high invalidation in regions where the texture changes, the method is offline and still it fails delivering complete depth-maps especially in thin structures like the the plant.

Conclusion

Best algorithms ever made ! From the paper :

- breakthrough in the field of active stereo depth estimation
- does not depend of the e windows size nor the size of the disparity space
- use machine learning algorithms
- run on GPU
- does not suffer from pe camera calibrations nor interference problems

Questions

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Thank you for your attention !