Descriptors-Based Stereo Reconstruction Project

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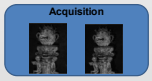
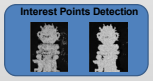
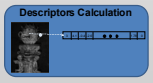
Abstract

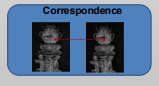
In our project we built a stereo reconstruction pipeline. We compared several descriptor algorithms and checked how they work for stereo reconstruction. We used various linear projections [1,2] to investigate the effective dimensionality of descriptors coming from stereo reconstruction.

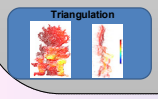
3D-Reconstruction Process







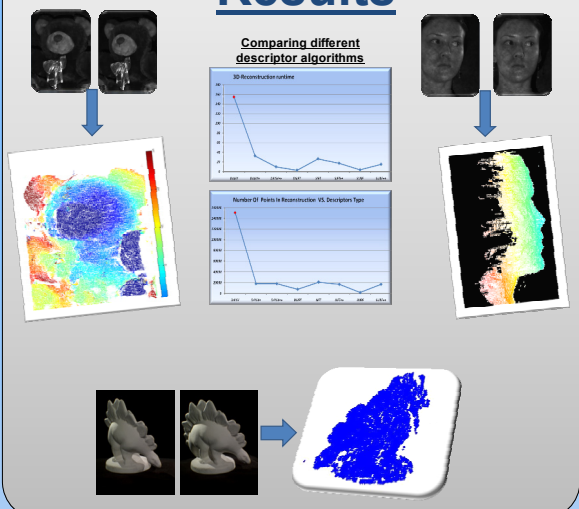




In the first phase we implemented the reconstruction process in a generic way which enables modifying each step of the process for future work and research. We compared between different descriptor and corresponding methods in order to find a good working point for the next phase.

1. **Acquisition** – acquire the two image files, the cameras' intrinsic matrices P1 and P2.
2. **Interest Points Detection** – using corner detection to eliminate background and unimportant points.
3. **Descriptors Calculation** – calculate a vector of information for each interest point.
4. **Correspondence** – In this step we aim to find for every interest point in one image a match among points of the second image. Similarity is determined using euclidian distance between the descriptors.
5. **Triangulation** - In the triangulation step we find the position of a point in space, given its position in two images, taken with cameras with known calibration and pose.

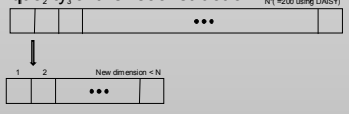
Results

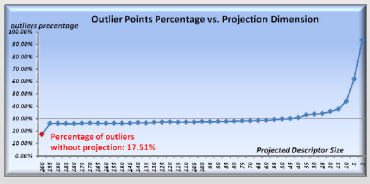


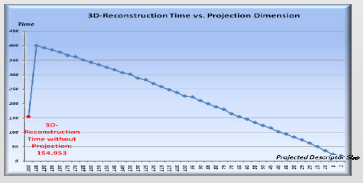
Descriptor Projection For Faster 3D-Reconstruction

During the second phase of the project we focused on the trade-off between performance and reconstruction quality.

- The correspondence stage takes most of the time of the reconstruction process due to the high search dimension (64-200 descriptors vector length).
- Most of the nearest neighbor algorithms lose their efficiency when it comes to a high search dimension.
- Using a projection matrix we can obtain smaller descriptors without affecting the matching accuracy.
- Projection matrix is obtained using the datasets of descriptor correspondences. We checked the training set size requirements and generalization with respect to different reconstructed objects.
- We used two types of projection matrix learning algorithms:
  - M-SIFT –"*Improving Descriptors for Fast Tree Matching by Optimal Linear Projection*" [1]
  - MAR - *LDAHash: Improved matching with smaller descriptors[2]*
- We've found that we can save more than 50% time without damaging the quality of the reconstruction result, using projected descriptors.



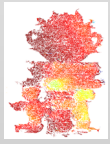




3D-Reconstruction using MSIFT descriptors projection of dimension 10

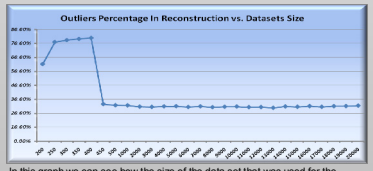
3D-Reconstruction using MSIFT descriptors projection of dimension 20

3D-Reconstruction using MSIFT descriptors projection of dimension 30



3D-Reconstruction using MSIFT descriptors projection of dimension 40

3D-Reconstruction without projection



In this graph we can see how the size of the data set that was used for the creation of projection matrix influences on the outliers percentage in the reconstruction. As we can see, using small data sets we get a high percentage of outliers.

[1] "Improving Descriptors for Fast Tree Matching by Optimal Linear Projection", Krystian Mikolajczyk and Jiri Matas.
[2] LDAHash: "Improved matching with smaller descriptors" , Christoph Strecha , Alexander M. Bronstein Michael M. Bronstein and Pascal Fua.