

Stereo Camera Odometry and Environment Depth Mapping

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Outline

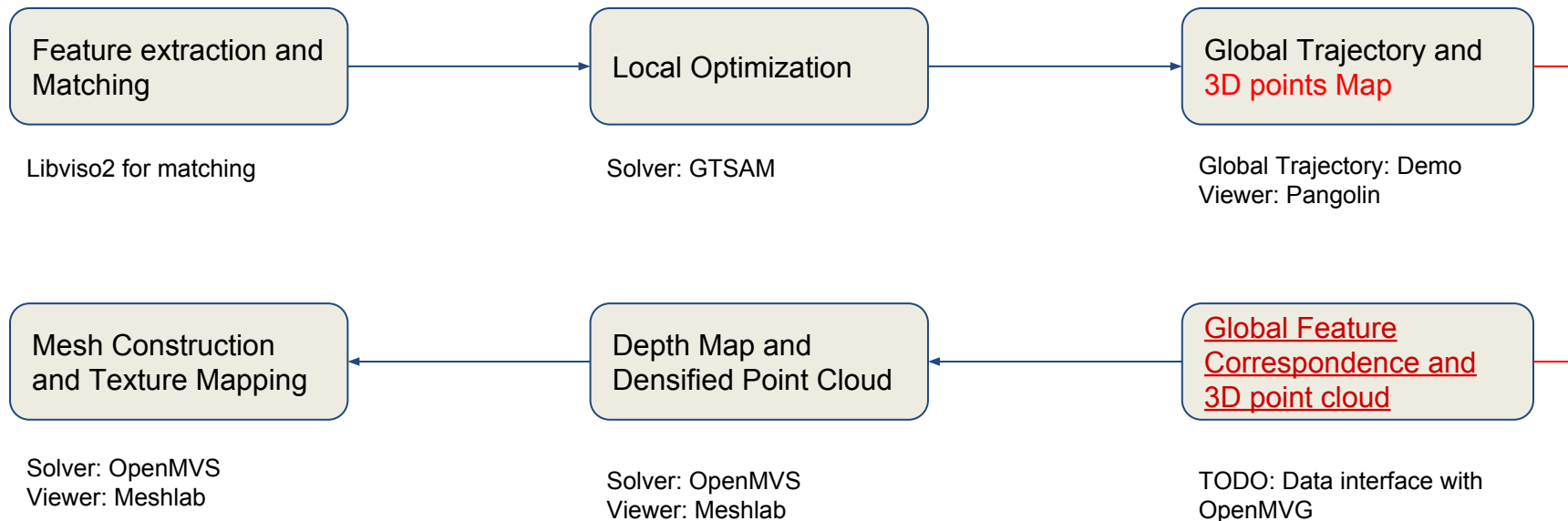
- ✓ Project Target
- ✓ Stereo Vision Model
- ✓ Pose Graph SLAM and Gtsam
- ✓ OpenMVG and OpenMVS
- ✓ Reference List

Project Target

- Using Stereo Camera for 3D Reconstruction and Depth Mapping
- Be familiar with the following libraries:
 - * libviso2[1]: A small efficient lib for stereo vision odometry
 - * GTSAM[2]: an efficient lib for nonlinear least-squares optimization
 - * Pangolin[3]: an lightweight lib for managing OpenGL displaying
 - * OpenMVG[4]: an lib for Multi-View Structure from Motion
 - * OpenMVS[5]: an lib for computing dense points cloud, surface etc.
 - * KITTI Dataset[6]: A novel challenging real-world vision benchmarks suite.

Project Target

•The Major Processes

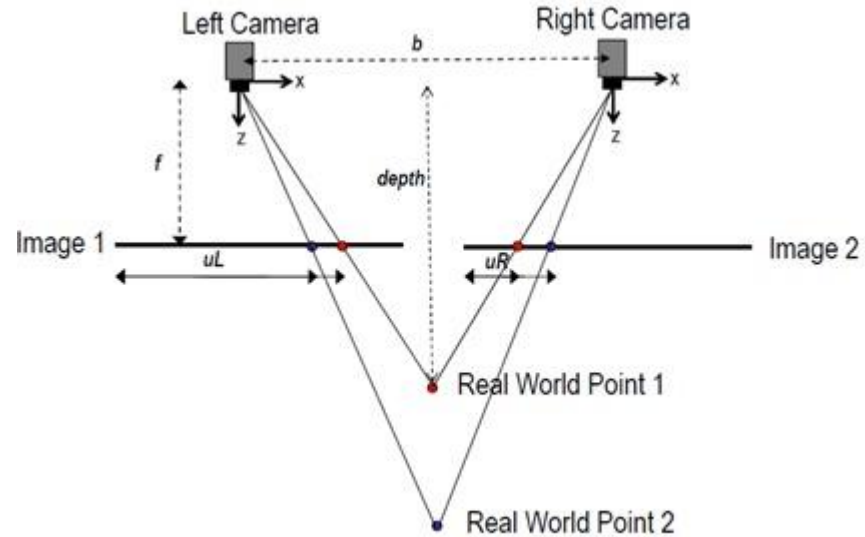


Stereo Vision Model

•Stereo Vision Measurement Model

$$\begin{bmatrix} uR \\ uL \\ vL \end{bmatrix} = \begin{bmatrix} f_x * \frac{P_x}{P_z} + c_x \\ f_x * \frac{P_x - b}{P_z} + c_x \\ f_y * \frac{P_y}{P_z} + c_y \end{bmatrix}$$

$$\begin{bmatrix} P_x \\ P_y \\ P_z \end{bmatrix} = \begin{bmatrix} (uR - c_x) \cdot \frac{b}{(uR - uL)} \\ (vL - c_y) \cdot \frac{f_x}{f_y} \cdot \frac{b}{uR - uL} \\ f_x \cdot \frac{b}{uR - uL} \end{bmatrix}$$



Local Optimization With GTSAM

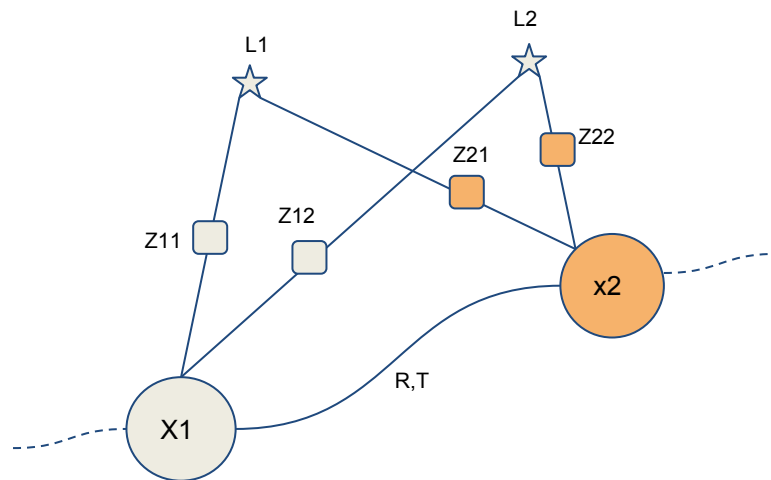
- Local Bundle Adjustment with GTSAM
- (GTSAM is a popular solver for weighted least squares)

The measurement function:

$$z_{ij} = h(x_i, L_j)$$

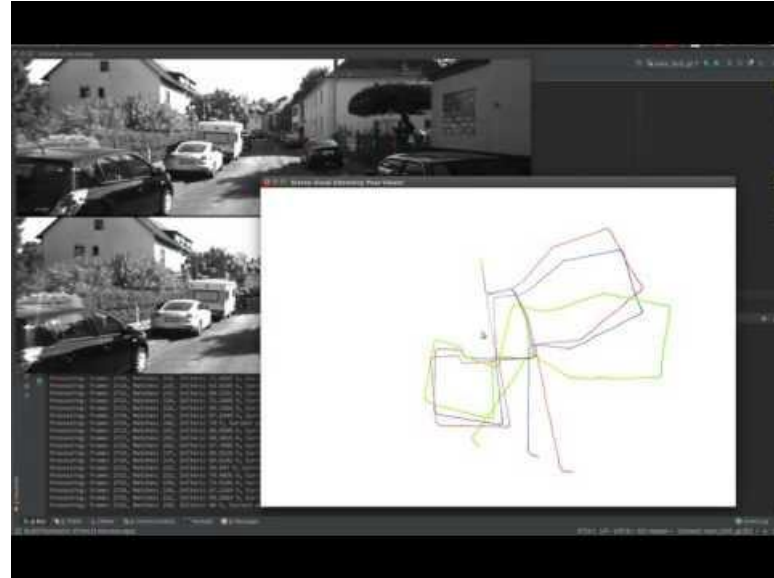
The cost function:

$$\sum_i \sum_j \|z_{ij} - h(x_i, L_j)\|_{(\Sigma_{ij})^{-1}}^2$$



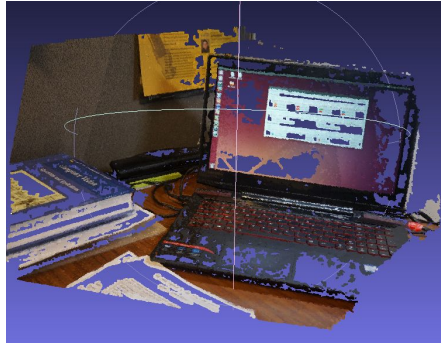
Stereo Vision Odometry Demo

System Setup For KITTI Dataset



- Complete Video : <https://www.youtube.com/watch?v=QbXD9BVGacc>
- Source Code: <https://github.com/yangyulin/SVO.git>

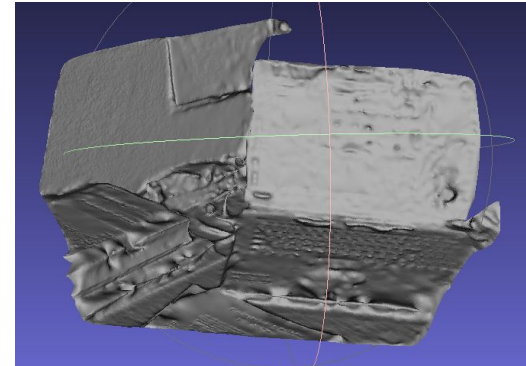
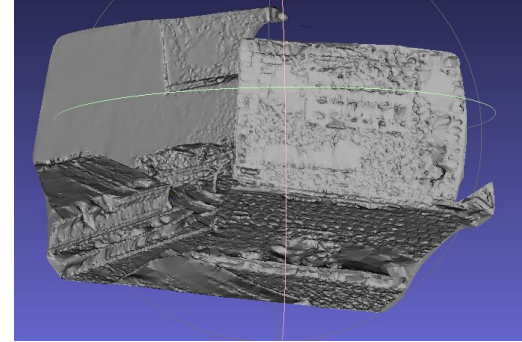
OpenMVG and OpenMVS



Densify Point
Cloud



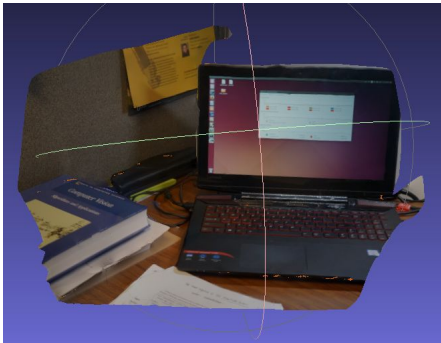
Reconstruct 3D
Mesh



3D Texture



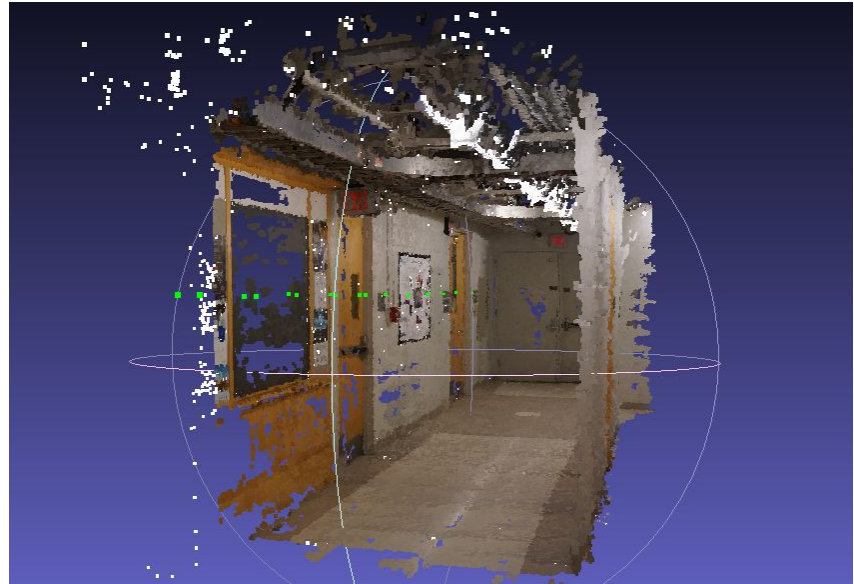
Refine 3D
Mesh



OpenMVG and OpenMVS Demo

- General Procedures for using OpenMVG

1. Image listing
2. Image description computation
3. Corresponding images and correspondences computation
4. SfM solving
5. OpenMVS for post processing
6. Meshlab for displaying



Reference List

- [1] A. Geiger, J. Ziegler, and C. Stiller, “Stereoscan: Dense 3d reconstruction in real-time,” in *Intelligent Vehicles Symposium (IV)*, 2011.
- [2] F. Dellaert, “Factor graphs and gtsam: A hands-on introduction,” 2012.
- [3] R. Mur-Artal, J. M. M. Montiel, and J. D. Tardós, “ORB-SLAM: a versatile and accurate monocular SLAM system,” *IEEE Transactions on Robotics*, vol. abs/1502.00956, 2015.
- [4] P. Moulon, P. Monasse, and R. Marlet, “Openmvg (open multiple view geometry),” 2012.
- [5] P. Moulon, “Openmvs (open multiple-view stereo),” 2012.
- [6] A. Geiger, P. Lenz, and R. Urtasun, “Are we ready for autonomous driving? the kitti vision benchmark suite,” in *Conference on Computer Vision and Pattern Recognition (CVPR)*, 2012.

Thanks a lot!

Q&A