Calibration and Absolute Pose Estimation of Trinocular Linear Camera Array for Smart City Applications

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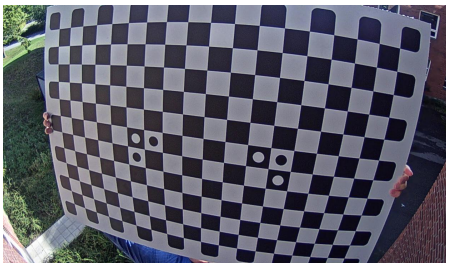


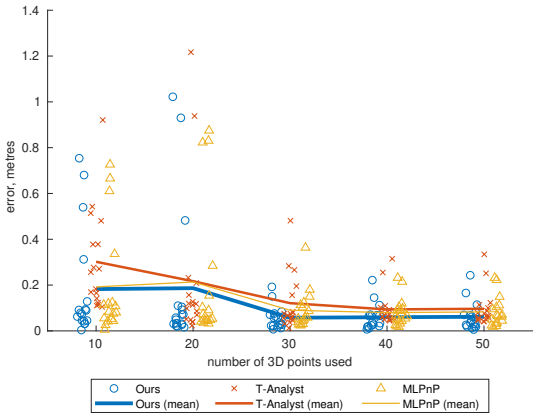
Generalized stereo setup. Three lenses are placed on straight line to allow joint rectification.

Data sources:
- 2D-3D point correspondences
- Checkerboards close to the TLCA

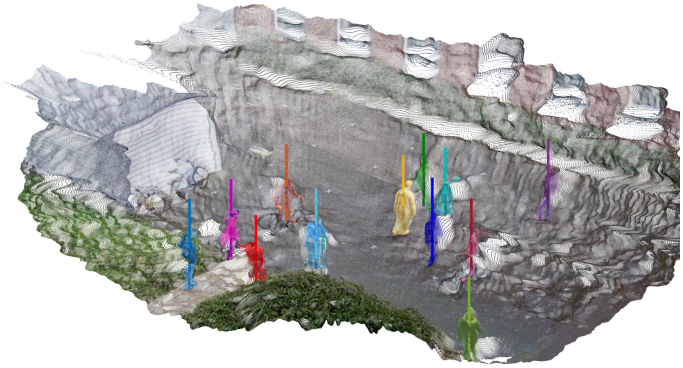
Six-step calibration procedure:
1. Radial and tangential distortion
2. Intrinsics
3. Rectification
4. Initial estimates of camera and checkerboard poses
5. Optimization over only camera poses
6. Joint optimization over camera and checkerboard poses

$$
\begin{aligned}
C_2 &= -R^T \cdot t_2, \\
P_1 &= K[R, \quad -R \cdot (C_2 + (d_{2,1} + \epsilon_{2,1})R_1)], \\
P_2 &= K[R, \quad -R \cdot C_2], \\
P_3 &= K[R, \quad -R \cdot (C_2 - (d_{2,3} + \epsilon_{2,3})R_1)],
\end{aligned}
$$

$$
\begin{aligned}
res_{1x} &= (P_i V_l)_x/(P_i V_l)_z \; - \; (v_{il})_x/(v_{il})_z, \\
res_{1y} &= (P_i V_l)_y/(P_i V_l)_z \; - \; (v_{il})_y/(v_{il})_z, \\
res_{2x} &= (P_i T_j U_k)_x/(P_i T_j U_k)_z \; - \; (u_{ijk})_x/(u_{ijk})_z, \\
res_{2y} &= (P_i T_j U_k)_y/(P_i T_j U_k)_z \; - \; (u_{ijk})_y/(u_{ijk})_z,
\end{aligned}
$$



Better calibration results than standard methods, especially when triangulating 3D points along the ground surface



Demo application where the calibration was used with PSMNet to get a dense 3D reconstruction of the scene. Mask R-CNN was used to find pedestrians in 2D, and the corresponding pixels in 3D give the locations of the people.

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