Indoor RGB-D Compass from a Single Line and Plane

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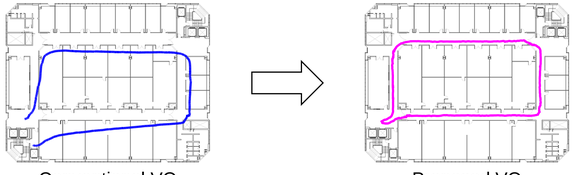
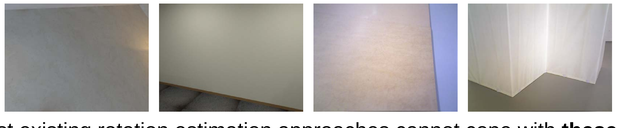
Motivation

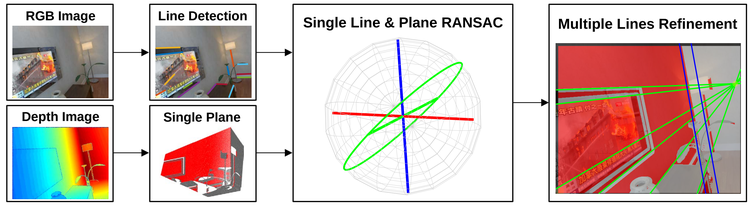


- **Accurate & drift-free 3-DoF camera orientation** is a key component in many vision applications such as VO, SLAM, scene understanding, etc.



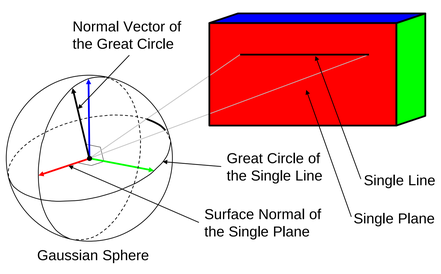
- Most existing rotation estimation approaches cannot cope with **these visually sparse, uncharacteristic** environments.

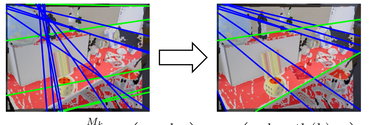
Contributions



- Accurate & drift-free camera rotation **from only a single line and plane**
- **Refinement of initial rotation estimate** with parallel & orthogonal lines
- **Evaluations & comparisons** with other state-of-the-art algorithms

A Single Line & Plane in RANSAC





$$vote\,(v_k) = \sum_{i=1}^{M_k} w_1 \underbrace{\left(1 - \frac{d_{i,k}}{t_a}\right)}_{\text{orthogonal distance}} + w_2 \underbrace{\left(\frac{length\,(l_i)}{max(length(l))}\right)}_{\text{line segment length ratio}}$$

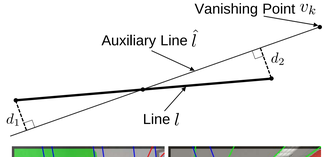
v_k: k-th vanishing point (VP)

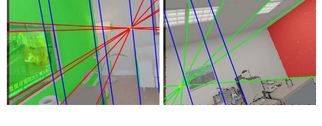
t_a: certain threshold by user

w_1, w_2: weights of each term

- We recognize the camera orientation from only a single line and plane, which corresponds to **the theoretical minimal sampling** for 3-DoF rotation.
- We find the largest consensus line set utilizing both **the average orthogonal distance** and **the length of a line segment**.

Multiple Lines Refinement





$$\theta^* = \arg\min_{\theta} \sum_{k=2}^{3} \sum_{i=1}^{M_k} \underbrace{\left(d_{i,k}\,(\theta)\right)^2}_{\text{orthogonal distance}}$$

θ: 1-DoF orientation angle in axis-angle

M_k: the number of lines for k-th VP

$d_{i,k}$: orthogonal distance of the i-th line segment with the k-th VP

- We refine the initial rotation estimates from the RANSAC **by minimizing the average orthogonal distance** with parallel and orthogonal lines (inliers).
- The additional refinement step makes the estimated camera orientation **more accurate and consistent** by utilizing multiple lines.

Evaluations

- **ICL-NUIM Dataset**

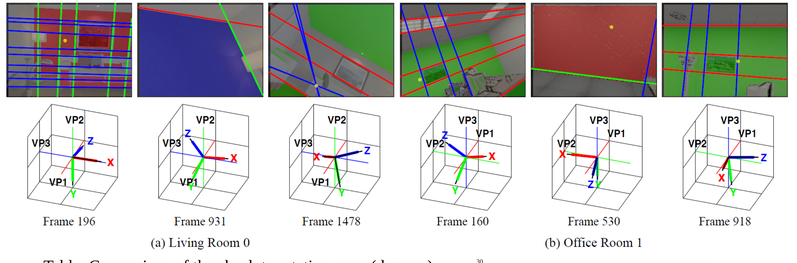
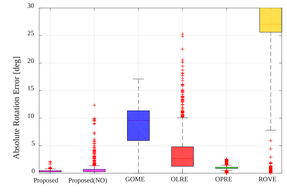


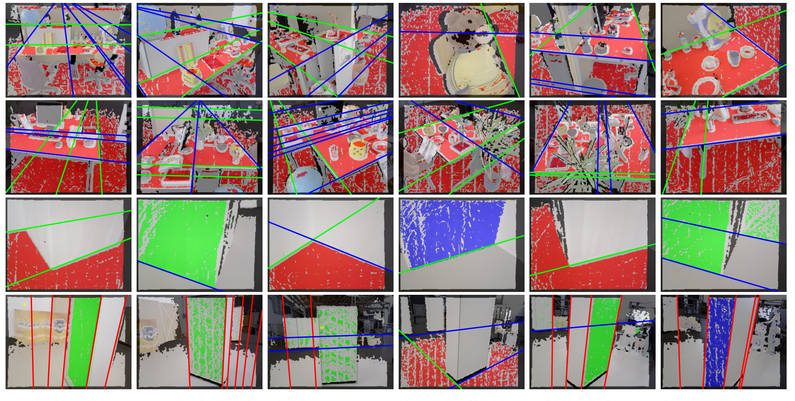
Table. Comparison of the absolute rotation error (degrees)

Experiment	Proposed	GOME	OLRE	OPRE	ROVE	# of frame
Living Room 0	**0.31**	×	×	×	×	1507
Living Room 1	**0.38**	8.56	3.72	0.97	26.74	965
Living Room 2	**0.34**	8.15	4.21	0.49	39.71	880
Living Room 3	**0.35**	×	×	1.34	×	1240
Office Room 0	0.37	5.12	6.71	**0.18**	29.11	1507
Office Room 1	0.37	×	×	**0.32**	34.98	965
Office Room 2	0.38	6.67	10.91	**0.33**	60.54	880
Office Room 3	0.38	5.57	3.41	**0.21**	10.67	1240



- The average rotation error of the proposed method is **0.36 degrees**.

- **TUM RGB-D Dataset**



- The proposed method shows **consistent line & plane clustering results**.