The Probabilistic Normal Epipolar Constraint for Frame-To-Frame Rotation Optimisation under Uncertain Feature Positions

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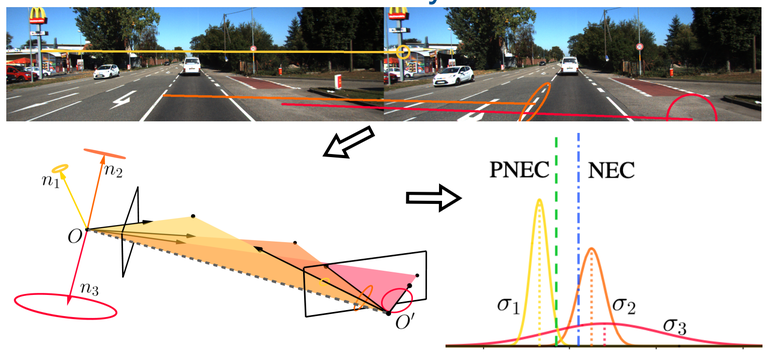
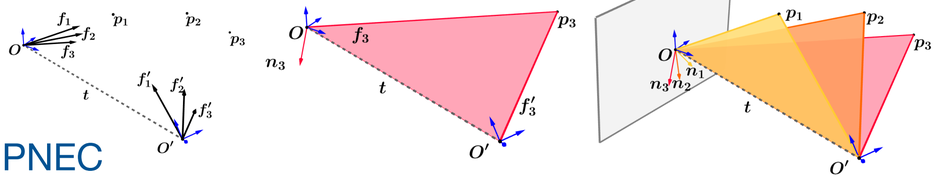
Summary

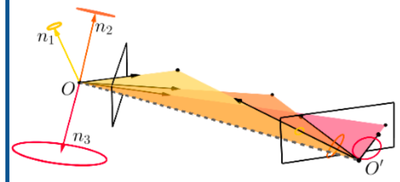


The probabilistic normal epipolar constraint (PNEC) accounts for uncertainty in the feature positions that lead to improved accuracy for frame-to-frame rotation estimation.

NEC

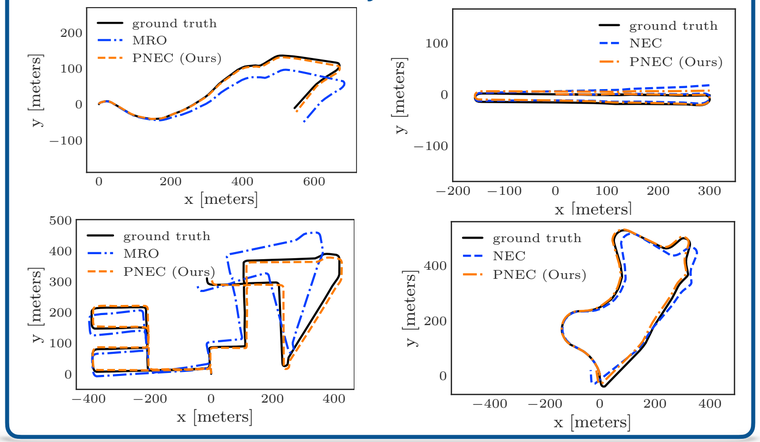


PNEC



The NEC enforces the coplanarity of the epipolar plane normal vectors. The PNEC extends this by accounting for uncertainty information in the image plane.

Trajectories

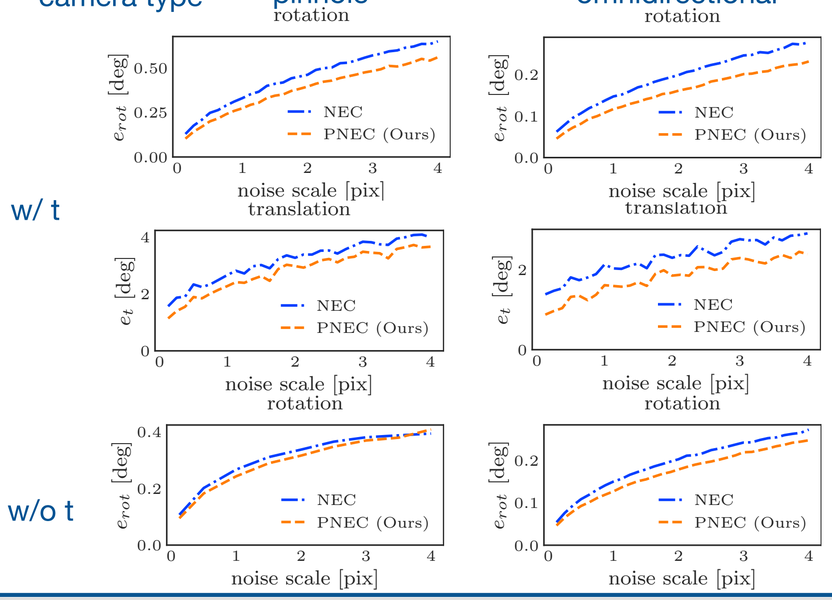


Contributions

- The PNEC, a novel **constraint for frame-to-frame relative rotation estimation** that incorporates uncertainty information into the normal epipolar constraint (NEC)[1].
- An efficient two-stage optimisation scheme for the PNEC with real-time capability.
- A regularisation scheme to **overcome** singularities in the optimisation in the loss.
- Experimental evaluation on simulated data and as a VO system on **KITTI**.

Simulated Data

camera type: pinhole | omnidirectional



KITTI Evaluations (selected seq.) - against MRO[2]*

	RPE_1 [°] ↓			RPE_n [°] ↓		
	MRO	KLT-NEC	KLT-PNEC	MRO	KLT-NEC	KLT-PNEC
00	0.360	0.125	**0.119**	8.670	5.922	**3.429**
03	0.280	0.073	**0.059**	5.470	2.728	**1.411**
05	0.250	0.079	**0.070**	11.360	4.489	**3.203**
06	0.180	0.073	**0.042**	4.720	3.162	**2.322**
07	0.280	0.105	**0.074**	7.490	4.640	**2.065**
08	0.270	0.070	**0.060**	9.210	5.523	**3.347**
10	0.380	0.073	**0.072**	13.250	**3.959**	4.094
Avg	0.261	0.082	**0.074**	8.713	4.127	**3.354**

	Features	Opt.
MRO	ORB	NEC
KLT-NEC	KLT-Tracks	NEC
KLT-PNEC	KLT-Tracks	PNEC

*all w/o loop-closure and rot. avg.

Code
Paper
Data

[1]L. Kneip, R. Siegwart, and M. Pollefeys. Finding the exact rotation between two images independently of the translation. *European Conference on Computer Vision (ECCV)*, 2012
[2]C.-K. Chng, Á. Parra, T.-J. Chin, Y. Latif: Monocular Rotational Odometry with Incremental Rotation Averaging and Loop Closure, DICTA 2020