

CurviTrack: Curvilinear Trajectory Tracking for High-Speed Chase of a USV



Parakh M. Gupta, Ondřej Procházka, Tiago Nascimento, Martin Saska
[guptapar@fel.cvut.cz | <https://mrs.felk.cvut.cz>]

Motivation



- Landing on a moving vessel that has the freedom to move in a curved path
- Track a moving USV with a UAV through high-speed curves
- Predict the motion of the USV using only a camera-based pose estimation
- Find optimum landing opportunity based on the relative velocity and tilt of the USV

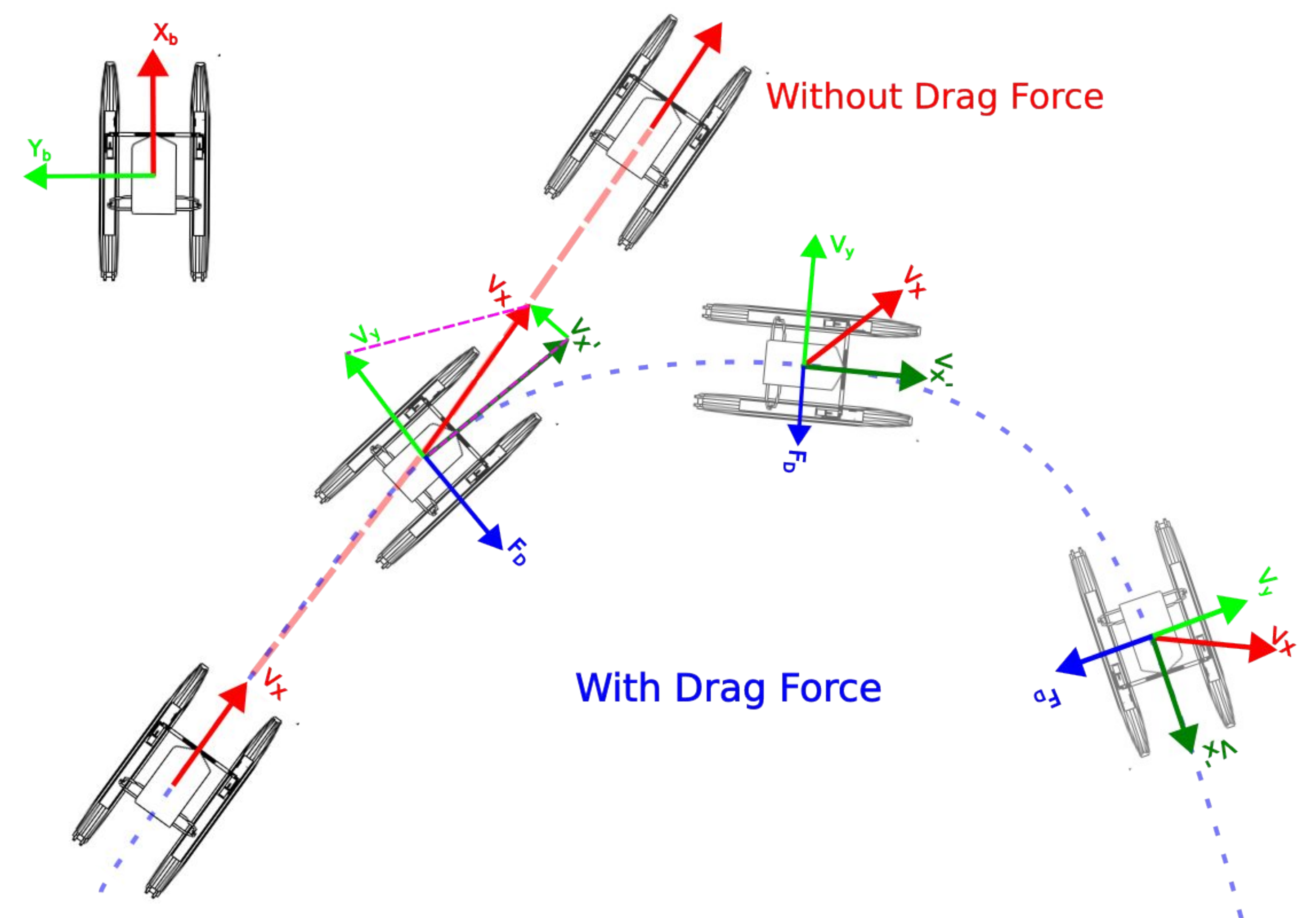
Methodology

$$\mathbf{b} = [x_b \quad y_b \quad z_b \quad \eta_b \quad \dot{x}_b \quad \dot{y}_b \quad \dot{z}_b \quad \dot{\eta}_b]^T$$

$$\mathbf{b}^{(k+1)} = \mathbf{A}\mathbf{b}^{(k)} + \mathbf{B}\mathbf{u}_b^{(k)}$$

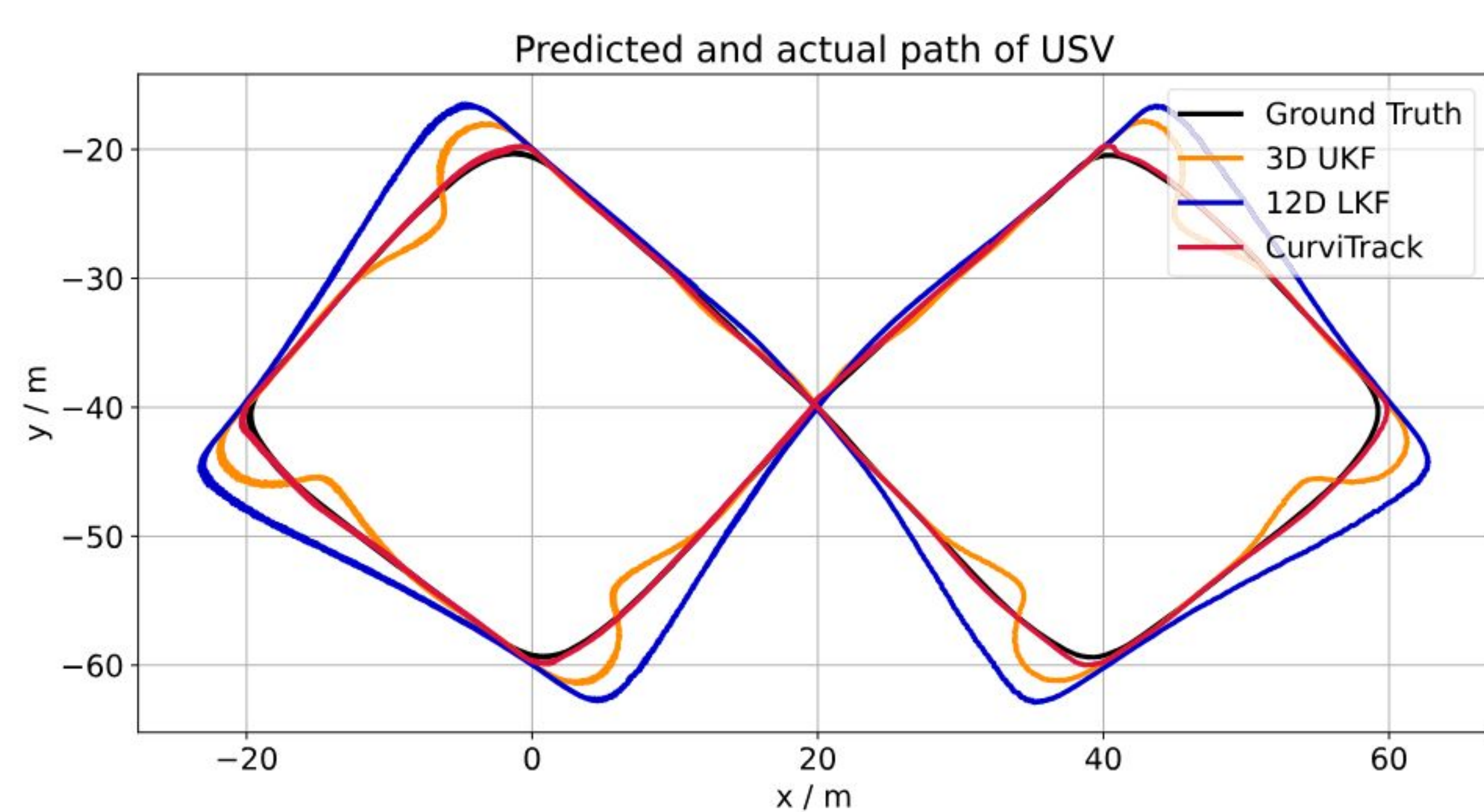
$$\mathbf{F}_d = m \begin{bmatrix} a_x \\ a_y \end{bmatrix}_b = - \begin{bmatrix} K_x & 0 \\ 0 & K_y \end{bmatrix} \begin{bmatrix} \dot{x}_b \\ \dot{y}_b \end{bmatrix}_b$$

$$m \begin{bmatrix} a_x \\ a_y \end{bmatrix}_w = {}^w\mathbf{R}_b \begin{bmatrix} 0.0 & 0.0 \\ 0.0 & -K_y \end{bmatrix} {}^b\mathbf{R}_w \begin{bmatrix} \dot{x} \\ \dot{y} \end{bmatrix}_w,$$



Results

- 40% decrease in prediction RMSE and 3x decrease in std. dev.
- 30% improvement in tracking RMSE and 40% more success in landing



(b) Predictions — 2.0 s into the future

t	Method	Mean (m)	Max (m)	Std. Dev. (m)
1.0 s	12D LKF	1.71	4.01	1.31
	3D UKF	0.79	2.03	0.51
	CurviTrack	0.48	0.95	0.18
2.0 s	12D LKF	2.56	5.92	1.97
	3D UKF	1.28	3.35	0.89
	CurviTrack	0.90	1.66	0.34

