Data-driven Conflict Detection Enhancement in Closest Point of Approach Problem

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SESAR JOINT UNDERTAKING

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Data-driven Conflict Detection Enhancement with Machine Learning

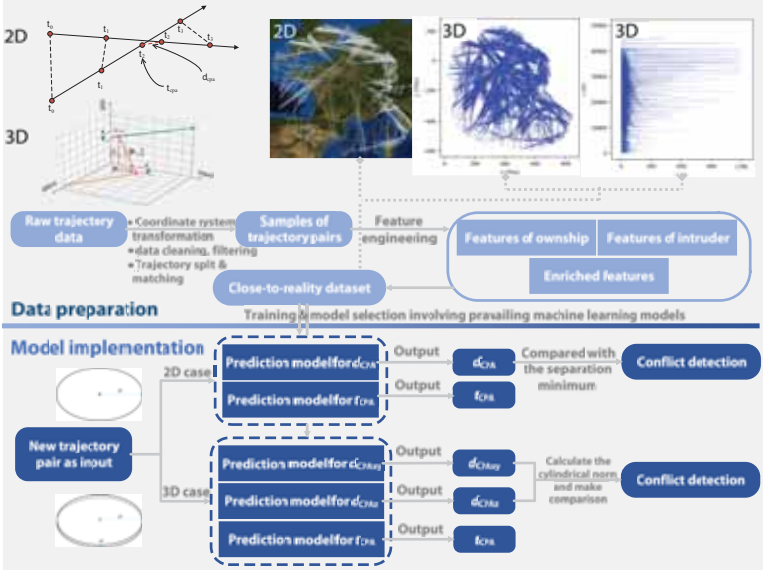
Objective:

To propose a novel data-driven conflict detection framework with machine learning for performance enhancement in actual operations.

Methodology:

Closest Point of Approach (CPA): Positions at which two dynamically moving objects reach their closest possible distance. It is a key concept in the algorithmic level for conflict detection.

Main problem of conventional model: Assumption cannot be ensured in real operations.



Results:

CPA prediction

2D case:

Models	$d_{CPA_{xy}}$(Nm)		t_{CPA}(s)	
	MAE	RMSE	MAE	RMSE
Baseline	3.76	8.01	85.05	766.31
MLR	22.25	31.36	227.71	280.63
SVM	6.20	10.29	98.84	156.12
FFNNs	1.96	3.51	43.40	80.53
KNN	3.79	10.43	76.11	125.14
GBM	**1.42**	**2.03**	**28.11**	**63.66**
RF	2.14	4.20	54.26	92.28

3D case:

Models	$d_{CPA_{xy}}$(Nm)		d_{CPA_z}(ft)		t_{CPA}(s)	
	MAE	RMSE	MAE	RMSE	MAE	RMSE
Baseline	4.52	9.63	29.01	203.3	42.73	67.83
FFNNs	0.30	0.56	9.32	66.85	**3.83**	**13.05**
KNN	1.56	2.13	12.88	95.96	13.67	30.85
GBM	**0.20**	**0.43**	**7.35**	**49.22**	4.63	13.39
RF	0.51	0.80	20.13	90.22	5.08	15.24

Conflict detection

2D case:

Models	TP		FN		TN		FP	
	Num	Rate	Num	Rate	Num	Rate	Num	Rate
Baseline	6359	92.15%	542	7.85%	10293	95.81%	450	4.19%
FFNNs	6551	94.93%	350	5.07%	10377	96.59%	366	3.41%
KNN	5729	83.02%	1172	16.98%	9852	91.71%	891	8.29%
GBM	**6673**	**96.70%**	**228**	**3.30%**	**10517**	**97.90%**	**226**	**2.10%**
RF	6514	94.39%	387	5.61%	10418	96.97%	325	3.02%

3D case:

Models	TP		FN		TN		FP	
	Num	Rate	Num	Rate	Num	Rate	Num	Rate
Baseline	18543	72.62%	6992	27.38%	221191	99.35%	1453	0.65%
FFNNs	24088	94.33%	1447	5.67%	222148	99.78%	496	0.22%
KNN	18742	73.40%	6793	26.60%	217772	97.81%	4872	2.19%
GBM	24914	97.57%	621	2.43%	214018	96.13%	8626	3.87%
RF	23917	93.37%	1618	6.34%	212627	95.50%	10017	4.50%

* TP: True Positive FN: False Negative TN: TrueNegative FP: False Positive

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