

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

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Data-driven Conflict Detection Enhancement with Machine Learning

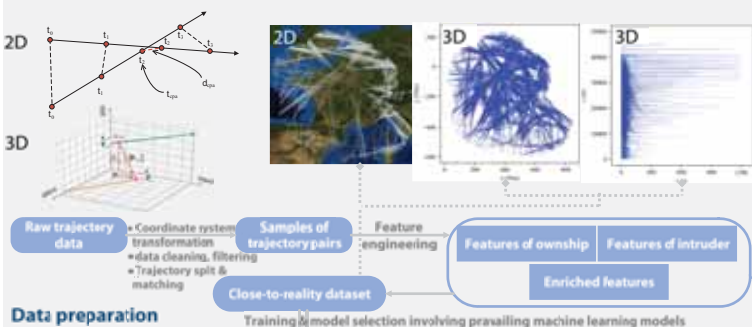
Objective:

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

| Models | $d_{CPA}(Nm)$ | | $f_{CPA}(s)$ | |
|----------|---------------|-------|--------------|--------|
| | MAE | RMSE | MAE | RMSE |
| Baseline | 3.76 | 8.09 | 83.05 | 766.31 |
| FFNN | 22.23 | 31.36 | 227.11 | 280.63 |
| KNN | 6.20 | 16.26 | 98.44 | 194.12 |
| FFNNs | 1.96 | 3.51 | 41.40 | 30.33 |
| KNN | 3.79 | 10.48 | 78.11 | 122.11 |
| GBM | 0.42 | 2.83 | 28.81 | 45.66 |
| RF | 2.14 | 4.20 | 94.26 | 72.28 |

| Models | $d_{CPA_2}(Nm)$ | | $d_{CPA_3}(ft)$ | | $f_{CPA}(s)$ | |
|----------|-----------------|-------------|-----------------|--------------|--------------|--------------|
| | 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

| 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 | 5720 | 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% |

| 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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