Drone Intention Prediction using Complementary Learning of Data Driven Techniques with Flight Physics

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**Background**

- Increased proliferation of drones and autonomous systems can disrupt critical national services (e.g., airports).
- The challenge with current detection systems is false positives.
- The rapidly changing design, flexible capabilities, and diverse underpinning algorithms of drones makes distinguishing malicious from naïve intentions difficult.
- Inference of drone intention using observational data alone is unreliable.

**Methodology**

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Drone Physics

- Intention
  - Euler angles \( \phi, \theta, \psi \)
  - Thrust \( \mu \)

- Nonlinear Control

Observables

- Positions \( x, y, z \)
- Velocities \( \dot{x}, \dot{y}, \dot{z} \)

Reward Behaviour discrimination

Trajectory intention classes

Data Cleaning & Trajectory Reconstruction

- Anomaly Detection
- Multi-Expert Prediction
- Reward Intention Inference

Control Input Data

- Trajectory Intention Inference

Observable Data

- Intent Classification & Novelty Detection
- Intent Regression

Preliminary Results

Conclusions

- Intention ranges from trajectory to reward goals.
- Trajectory intention includes the purpose of use and the intended destination.
- Reward intention provides the most succinct and robust definition of the task that the drone aims to perform.
- The incorporation of physics-informed model regularizes the learning manifold of data-driven models.