
Correlated Bayesian Model of Aircraft Encounters in the Terminal Area Given a Straight Takeoff or Landing

Andrew Weinert

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Correlated Encounters between Aircraft in Terminal Airspace

- **Revision A of the DAA MOPS by RTCA SC-228 permits UAS terminal operations in Class C, D, E and G airspaces**
- **To support MOPS certification, MIT LL developing a statistical model of how aircraft behave near within terminal airspace, traffic patterns, and runway operations**
 - **Class C, D, E, G aerodromes with single or multiple runways**
 - **Ownship assumed to be a fixed-wing landing straight-in or taking off straight-out**
 - **Intruder can land or takeoff by any means and also merely transit through the airspace**
 - **Intruder classified as either fixed-wing or rotorcraft**
 - **Prototype unvalidated model available for Class B aerodromes**
 - **Out of scope was vertiports and aircraft operating from nearby aerodromes**
- **An encounter was defined based on the geometry between aircraft and a runway**
 - **Aircraft within 4 nautical miles laterally and 2000 feet vertically of each other**
 - **Separation criteria must be satisfied once over at least a thirty second duration**
 - **Both aircraft must be within 8 nautical miles laterally and 5000 feet vertically of a runway**

Datasets and Model Training

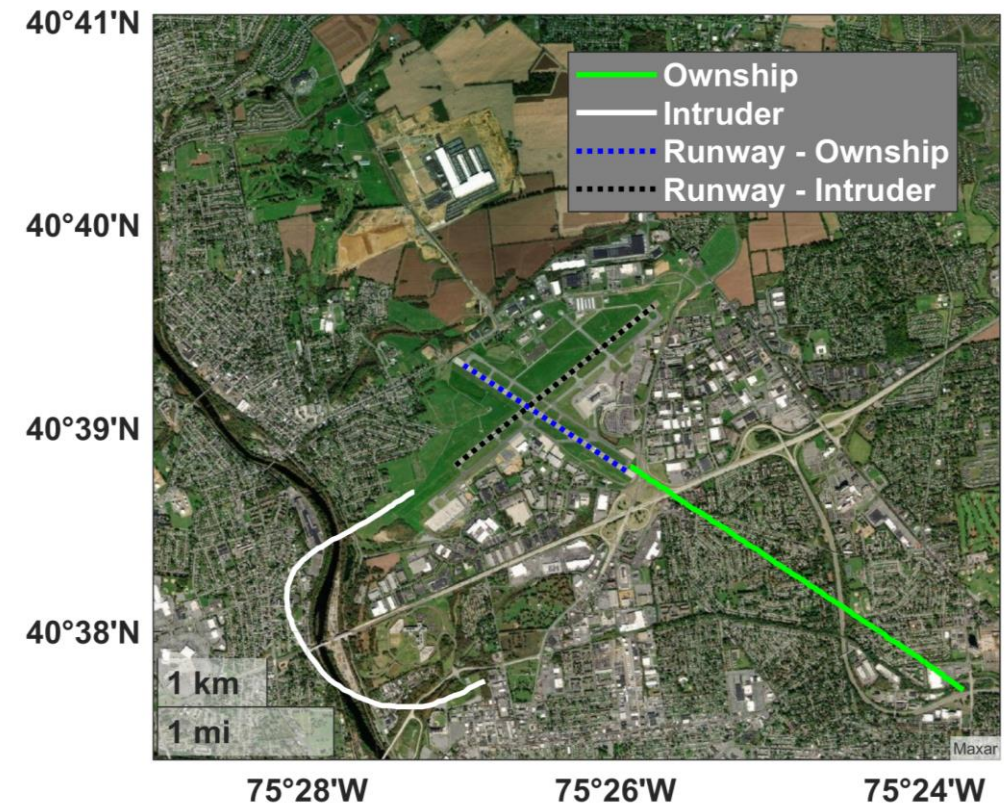
- Track intent based on altitude, vertical rate, heading relative to runway, runway orientation, and aerodrome design
- For model robustness, two variants of model trained using different datasets[†]
 - Terminal area radars (ASR-9) observations of Mode C equipped aircraft
 - OpenSky Network crowdsourced observations of ADS-B equipped aircraft

Identified Encounters

Airspace Class	Terminal Radar	OpenSky Network
B	2,396,048	1,038,390
C	103,566	81,253
D	85,514	45,066
Other (E/G)	1,209	432

Example Training Encounter

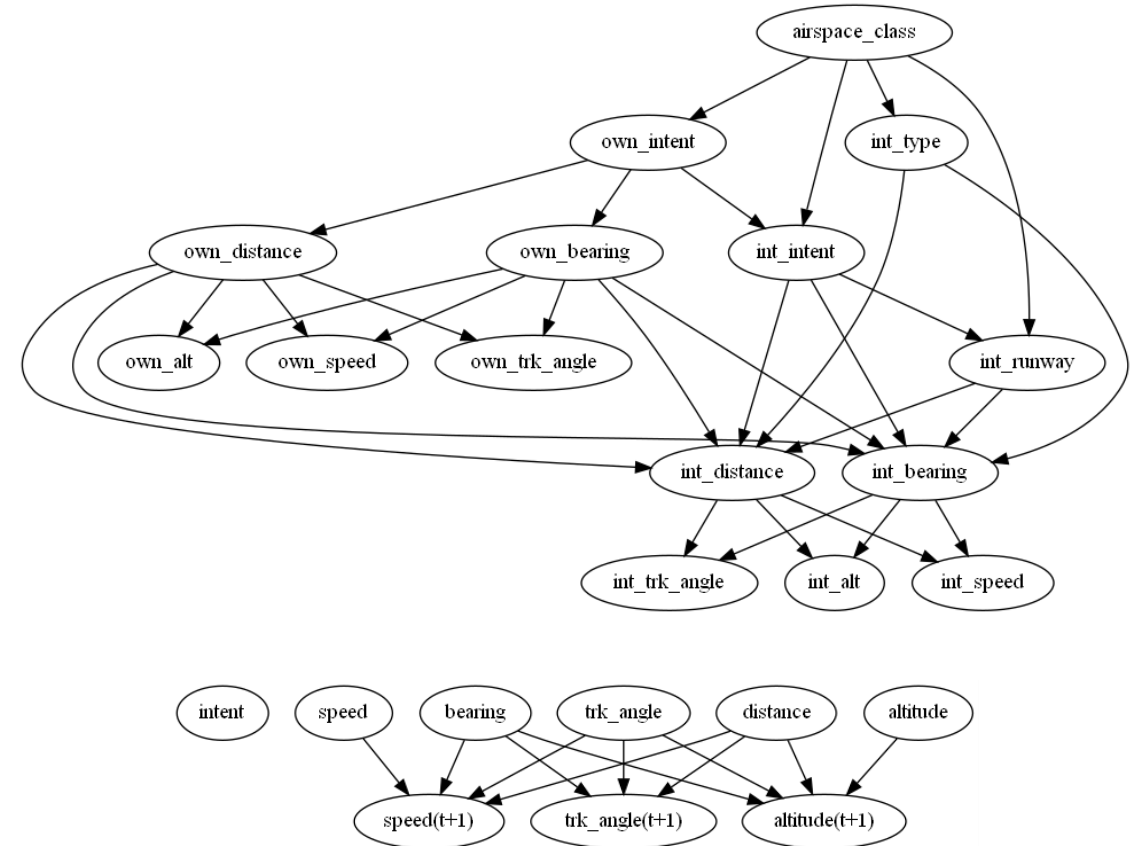
Ownship landing while intruder taking off from crossing runway at Class C ABE



Model Structure and Statistics

- Unlike other MIT LL encounter models, this correlated model consists of multiple distinct Bayesian Networks
 - Geometry model is a static Bayesian Network that represents the relative geometry of the aircraft with the respect to the runway at CPA
 - Ownship and intruder each have a trajectory model, a dynamic Bayesian network, for the aircraft kinematics
- Rejection sampling of the models used to model ownship to behave similar to UAS defined by RTCA SC-228
- Sampled sets of encounters based on each dataset provided for RTCA SC-228 SRMD

Geometry and Trajectory Models





Correlated Terminal Model History

Attribute	Feature	V1 (June 2020)	V2 (March 2021)	V3 (June 2021†)
Ownership Intent	Landings – Straight In	○	○	✓
	Take offs – Straight Out	✘	○	✓
Intruder Intent	Landings – Any	○	○	✓
	Take offs – Any	○	○	✓
	Transit - Any	✘	○	✓
Airspace Class	B	✘	✘	○
	C	✘	○	✓
	D	✓	✓	✓
	Other (E/G)	✘	✓	✓
Aerodrome Design	Single Runway	✓	✓	✓
	Multiple Runways	✘	✘	✓
	Heliports / Vertiports	✘	✘	✘
Technology Transfer	Publicly Available Models*	✘	✘	○
	Sampled Encounters Dataset	✓	✘	○



No Support



Prototype feature with update in a future version



Full Support



Thank You!



Questions?

Feedback?

Presenter: Andrew Weinert
Contributors (alphabetical): Marc Brittain, Randal Guendel, Christine Serres, Ngaire Underhill
Homeland Protection and Air Traffic Control Division
Email: andrew.weinert@ll.mit.edu