NYU

Autonomous Crosswind Landing

Project 1 - Autonomous Space Robotics (ROB-GY 7863, CSCI-GA 3033 7863), Fall 2025

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Motivation

- Crosswind landings are among the hardest flight phases, even small yaw or roll errors can cause runway excursions.
- Current classroom simulators use constant winds; they miss real-world turbulence and shear.
- Our mission: simulate a 3° glideslope approach under variable crosswinds, test control behavior, and validate a physically consistent wind-field model.

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Concept of Operations

Scenario

- Fixed-wing GA aircraft (C172 surrogate)
- 2 NM straight-in final, 3° glideslope, 75 kt TAS
- Runway heading 090°
- Controllers: roll ↔ heading hold, γ ↔ glideslope hold, autothrottle ↔ TAS hold
- Test cases: 0 / 10 / 20 / 30 kt steady crosswinds + 1-cosine gust + hybrid turbulence case

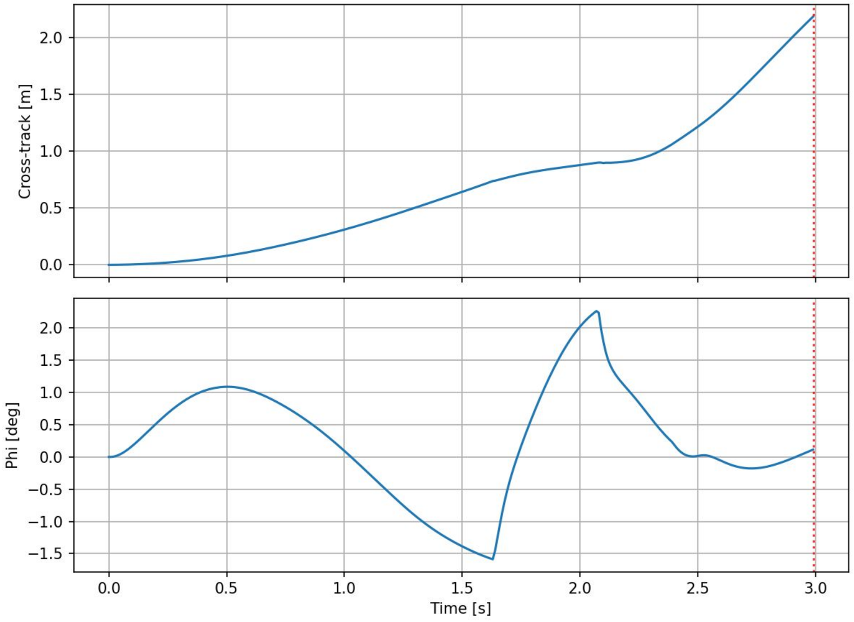
Hybrid Atmospheric Model

Combines Monin–Obukhov surface-layer shear (MOS)
Adds stability corrections (ψ□) for unstable / neutral / stable stratification

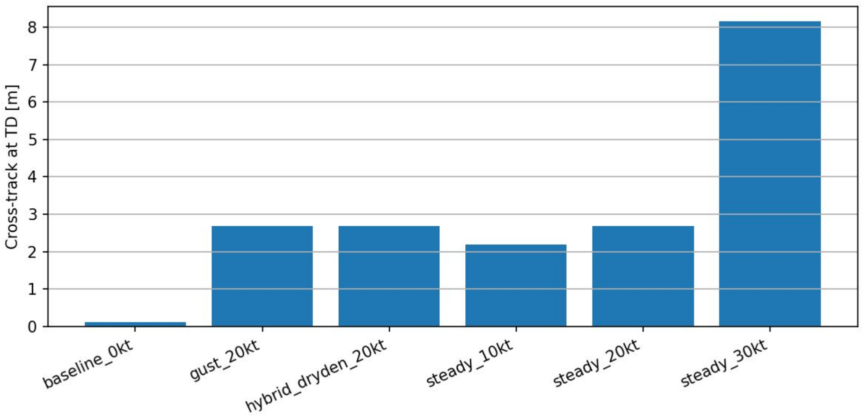
Produces altitude-dependent crosswind & near-surface decay

Dryden 3D turbulence via autoregressive (AR) filters
PSD validated against theoretical Dryden spectra

Results



Cross-track [m]
Phi [deg]
Time [s]
0.0
0.5
1.0
1.5
2.0
2.5
3.0
−0.5
−1.0
−1.5



Cross-track at TD [m]
0
1
2
3
4
5
6
7
8
baseline_0kt
gust_20kt
hybrid_dryden_20kt
steady_10kt
steady_20kt
steady_30kt

Conclusion & Next Steps

Delivered

- Physics-informed hybrid wind model (MOS + Dryden AR)
- Validated spectral fidelity and dynamic behavior
- Introduced “virtual threshold-plane” touchdown metric

Next Steps

- Add localizer / cross-track controller (PN or ILS-like).
- Use transport-class model with better ground reaction.
- Extend atmospheric modeling for full boundary-layer variability.