

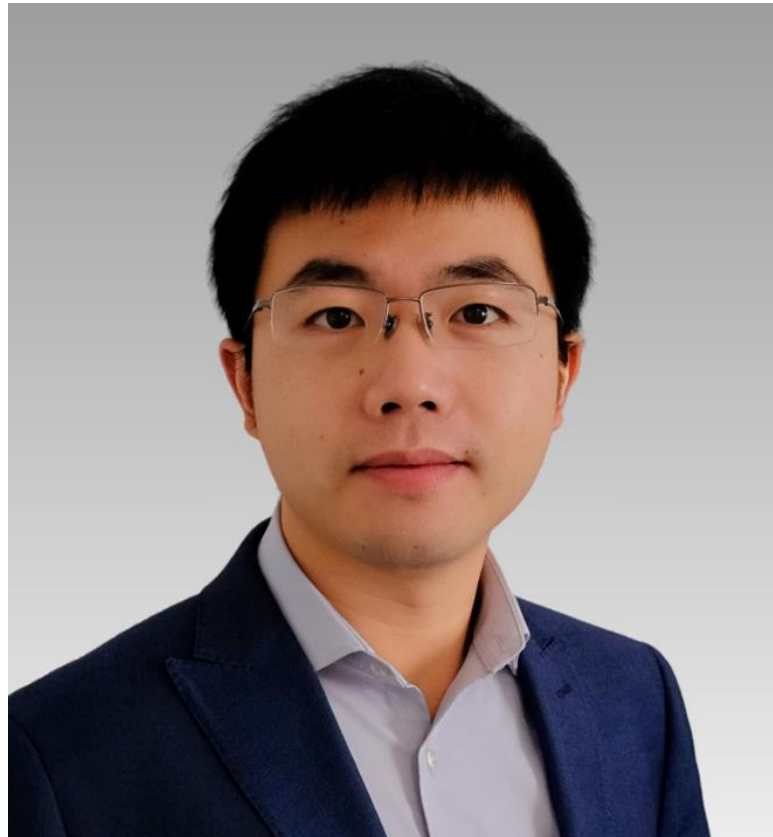
NSF CRII: MUSE: Multi-Modal Security Enhancement for Cyber-Resilient UAV Operation



Year 1 Progress on GPS-Independent UAV Security

ASTAR Lab, College of Information Science & Technology, University of Nebraska at Omaha

NSF Award #2451471 | 2025–2027 | <https://pjiang93.github.io>



Peng Jiang, PI



Challenge Content

Key problem(s) and significance

..... Spoofed GPS Signal
- - - Diverted (spoofed) Path
— Intended Safe Path



UAVs depend heavily on GPS for localization and navigation.



GPS spoofing can mislead trajectories, hijack missions, or cause crashes.



Urban canyons, occlusion, and degraded GNSS conditions reduce reliability.



Secure autonomy requires resilient sensing, detection, and safe navigation in real time.



Scientific Impact

How project contributions generalize to other SaTC research

- Advances GPS-independent localization for autonomous systems
- Connects CV, LiDAR, motion sensing, and secure autonomy.
- Provides a framework for spoofing-resilient UAV operation.
- Contributes infrastructure and datasets useful to cybersecurity, AI, remote sensing, and autonomous systems research.



Core research themes:

cross-view localization, sensor fusion, spoofing detection, resilient path planning.



Solution

Technical approach, key innovations, and current research

1. Inputs

- Camera
- LiDAR
- IMU
- Aerial Imagery Reference

2. Multi-Modal Localization (MML)

Cross-view localization and sensor fusion

3. Trajectory Comparison

Compare sensor-reconstructed path vs. Reported GPS path

4. Spoofing Detection

Detect inconsistencies and potential attack

5. Cyber-Resilient Path Analysis & Planning (PAP)

Plan safe, feasible paths using trusted data

6. Safe UAV Control / GPS-Independent Navigation

Execute safe missions with resilient autonomy

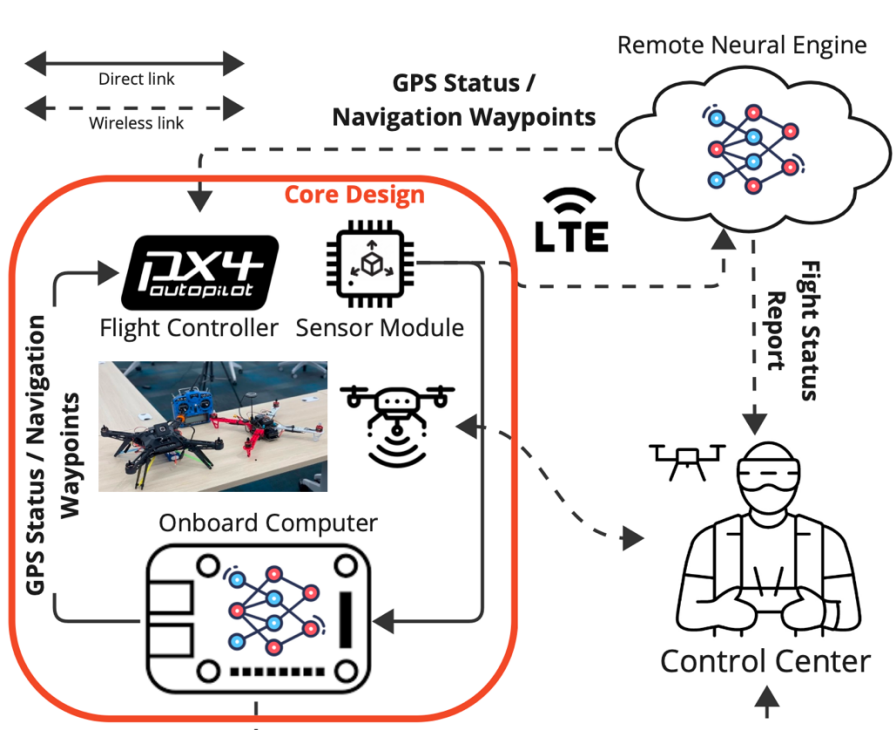
MM-AIR testbed:

flight-operational UAV research platform
LiDAR, camera, telemetry radio, and computing power.



Douglas County GIS data:

4 TB of aerial imagery covering the Omaha area, plus airborne LiDAR



Wireless UAV Sensing Testbed:

Distributed CSI and RSSI sensing for outdoor UAV detection, tracking, and RF-source analysis.



Broader Impact

Impact on society — who will care



Safer UAV operations for emergency response and public safety



More trustworthy infrastructure inspection and monitoring



Support for agriculture and delivery applications



Improved public confidence in secure autonomous systems



Broader Impact

Education and outreach



Recruited and supported the project's first Ph.D. student in 2026.



Mentored 2 REU undergraduates and 2 graduate students on UAV security



Hands-on training in UAV operations, sensing, and machine learning



Builds an interdisciplinary workforce spanning cybersecurity and aviation



In the News

Local media and community engagement



Featured by WOWT First Alert 6 and UNO News
Advancing safer, cyber-resilient UAV operations in Nebraska^{4,5,6}



Progress Made So Far and Next Steps

Timeline and status

- Initial MM-AIR integration and outdoor flight testing
- Camera, telemetry, ground control, and motion sensing operational
- Douglas County GIS data-sharing collaboration established
- D-SYNC published at IEEE PerCom 2026
- First Ph.D. student recruited

Year 1 / Completed

Year 2 / Planned

- Integrate and calibrate LiDAR with camera and motion sensors
- Complete preprocessing of aerial imagery and airborne LiDAR
- Establish baseline MML localization accuracy
- Implement spoofing detection and initial path-planning prototype
- Conduct field experiments at UNO's Glacier Creek Preserve
- Release code/data products consistent with the Data Management Plan



Publications & References

- P. Jiang, L. Zhu, R. Ning, H. Wu, C. Xin, "D-SYNC: Enhancing Vehicle Localization with Dashcam-Satellite Image Synchronization," in Proc. of IEEE PerCom 2026.
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- S. Babb, "UNO researchers developing drone hacking defenses for Omaha," WOWT First Alert 6, Feb. 2026.
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The 7th NSF Security, Privacy, and Trust in Cyberspace Principal Investigators' Meeting
August 6-7, 2026 | College Park, Maryland

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