RAFAL KRZYSIAK

CONTACT INFORMATION

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EDUCATION

Ph.D.	Mechanical Engineering (GPA: 4.0)	University of California, Merced	*2022 - 2025*
M.S.	Mechanical Engineering (GPA: 4.0)	Northern Illinois University	*2019 - 2021*
B.S.	Mechanical Engineering (GPA: 3.8)	Northern Illinois University	*2017 - 2019*

SKILLS

Software: SolidWorks, NX, ANSYS (Thermal, Mechanical FEA), MATLAB, Python, C/C++

Programming & Frameworks: TensorFlow, Explainable AI, Robotic Operating System (ROS)

Technical Expertise: Machine Learning, Structural & Thermal Analysis, Mechatronics, Robotics, Small Drone (VTOL & Fixed-Wing) Design and Implementation

EXPERIENCE

Mechanical Engineer (Subcontract) NASA Jet Propulsion Laboratory, CA
Jan 2022 - Jan 2024

· Conducted FEA thermal and structural analysis on a JPL flight instrument for the International Space Station (ISS), verifying performance and survival under launch loads.

· Designed, built, and utilized a tunable laser spectrometer to quantify total water concentration of lunar regolith for NASA's Artemis program.

· Constructed a Level-II digital twin of a miniature tunable laser spectrometer to measure ISS water quality, verified via environmental chamber testing.

Mechanical Engineering Intern NASA Jet Propulsion Laboratory, CA
Summers 2018, 2019, 2024

· Applied 3D mechanical design and simulation software to improve designs of sensitive instruments for drone-based planetary science missions.

· Designed and laid out a power distribution circuit for a drone gas sensor and verified its performance.

· Integrated a methane gas sensor with robotic platforms using ROS.

· Collaborated with Chevron to upgrade and implement a robotic H2S sensor with wireless data collection.

· Provided mechanical substantiation for NASA's next-generation fire detection instrument in collaboration with NASA Armstrong Flight Research Center (AFRC).

· Conducted thermal analysis on radar technology for JPL's airborne program for planetary Earth science missions.

PROJECTS

Explainable AI (XAI) Research

· **XWFDT (Explainable Wildfire Digital Twin):** Developed a hybrid physics-ML digital twin integrating 3D wind, fire spread dynamics, and UAV-based multispectral sensing. Integrated XAI methods (GradCAM, LIME) to inform control strategies for prescribed burns.

- **Planetary Health Monitoring:** Advanced multi-task learning with Fractional Order SGD for land use classification, using Quantus-assessed explainability.
- **Health Monitoring:** Developed XCardio-Twin, an explainable framework to aid in monitoring and analysis of cardiovascular status using wearable IoT devices.

Robotics & Autonomous Systems

- **Master's Thesis:** Developed information-based control methodologies for multi-robot teams in search and rescue missions, accounting for human prior knowledge.
- **UAV/UGV Systems:** Developed a ROS2-based agricultural scout system with a UGV and UAV for autonomous remote sensing and crop monitoring.
- **Human-Robot Interaction:** Created a human-following robot using iRobot Create 2, ROS, and OpenCV.

Instrument Design & Analysis

- **Miniature Tunable Laser Spectrometer:** Conducted FEA and thermal analysis for a JPL flight instrument for CO2 detection on the ISS.
- **Smart Battery Management:** Developed a deep learning model for a self-aware smart battery system to modify mission plans and prevent battery-related failures.
- **Invasive Species Sampler:** Designed and manufactured an autonomous device for sampling spiny waterflea, including simulations and field testing.

PUBLICATIONS

1. F. Winiberg, M. Fradet, K. Schwarm, I. Sanders, M. Bryk, V. Cretu, R. Krzysiak, K. Mansour, N. Tallarida, J. Wallace, P. Dodd, A. Noell, L. Christensen, "Tunable Laser Spectrometer for the Miniaturized Total Organic Carbon Analyzer", Acta Astronautica (Accepted).

2. D. Hollenbeck, R. Krzysiak, et al., "Developing An Optimal Mobile Measurement sUAS using Digital Twins and the Observability Gramian", ICCMA 2025 (Accepted).

3. R. Krzysiak, "Modeling and Control of a Prescribed Fire with UAVs as Sensors and Actuators", ICCMA 2025 (Accepted).

4. S. Giri, R. Krzysiak, et al. "Aviris-Ng-Like Smart Virtual Remote Sensing via Spectra-Aware Physics Informed Gans", IDETC, 2025.

5. R. Krzysiak et al., "Advancing Multi-Task Learning With Fractional Order Sgd and Quantus-Assessed Explainability for Planetary Health Monitoring", IDETC, 2025.

6. R. Krzysiak et al., "Explainable Multi-task Learning for Improved Land Use Classification in Planetary Health Monitoring", DTPI, 2024.

7. F. Winiberg, M. Fradet, R. Krzysiak et al. "Design and Performance of Indium Seals for Size-Constrained Tunable Laser Spectrometers", Review of Scientific Instruments, 2024.

8. R. Krzysiak et al. "Human prior knowledge estimation from movement cues for information-based control of mobile robots during search", Submitted to ACM Transactions on Human-Robot Interaction (THRI), 2024.

9. R. Krzysiak et al. "Thermally conductive-radiative driven digital twin of miniature tunable laser spectrometer in micro-gravity", Submitted to Journal of Applied Thermal Engineering, 2023.

10. D. Hollenbeck, An, Di, R. Krzysiak et al. "Towards Cognitive Battery Monitoring on Hybrid VTOL Fixed-Wing sUAS with Maximized Safe Endurance", ICCMA, 2023.

11. An, Di, R. Krzysiak et al. "A Proximal Point Sensing System for Mapping Soil Moisture Using A Miniaturized Spectrometer", ICCMA, 2023.

12. R. Krzysiak, et al. "XCardio-Twin: An Explainable Framework to Aid in Monitoring and Analysis of Cardiovascular Status", DTPI, 2023.

13. An, Di, R. Krzysiak, et al. "Long Endurance Site-Specific Management of Biochar Applications Using Unmanned Aircraft Vehicle and Unmanned Ground Vehicle." IFAC-PapersOnLine 56.2 (2023): 8908-8913.

14. An, Di, R. Krzysiak, et al. "Battery-health-aware UAV mission planning using a cognitive battery management system." 2023 International Conference on Unmanned Aircraft Systems (ICUAS). IEEE, 2023.

15. R. Krzysiak et al., "XAI – The future of wearable Internet of Things", IEEE/ASME MESA conference, 2022.

16. R. Krzysiak, "Human-aware information-theoretic control of robotic swarms", Master's Thesis, Northern Illinois University, 2021.

17. R. Krzysiak and S. Butail, "Information based control of robots in search and rescue missions with human prior knowledge", IEEE Transactions on Human-Machine Systems, 2021.

TEACHING & MENTORSHIP EXPERIENCE

Teaching Assistant   University of California, Merced
2022, 2024

· Taught labs and discussion courses for Electrical Circuits, Statics, and Drones. Graded quizzes, assignments, and exams.

Teaching Assistant   Northern Illinois University
2018 - 2019

· Graded assignments, projects, and exams for Mechanism Design and Analysis. Consulted with student teams on project designs.

Graduate Assistant   Northern Illinois University
2020 - 2021

· National Science Foundation, Great Journeys Assistantship.

Mentorship

· **UCM AIAA Graduate Mentor (2022 - Present):** Advise graduate students in the American Institute of Aeronautics and Astronautics chapter.
· **UC Merced MesaLab Mentor:** Guide underrepresented minority students in conducting research.

LEADERSHIP & PROFESSIONAL ACTIVITIES

Mars Rover Team Vice President (2018 - 2019) & **Secretary** (2019)

Member, Pi Tau Sigma (The International Mechanical Engineering Honor Society)

Outreach, Northern Illinois University STEMFEST & Honors Outreach Program