May 28 – 29 2025 Field Experiment Demos

AVIATE Seminars

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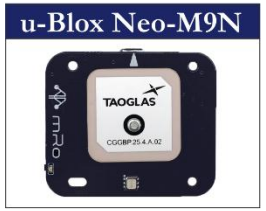
Credits: NASA / Lillian Gipson

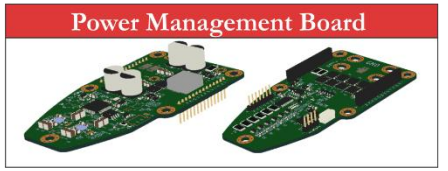
Day 1 Theme: Autonomous Emergency Landing

Gannet

- Amphibious Self-Sustainable Aerial System /w Deep Learning-based detection of high-risk environment conditions

- Capabilities & Specifications
  - Pixhawk-based Autopilot /w Ardupilot stack & ROS-based Autonomy stack
  - ARM-based 8-core High-Level Computer
  - 6.0 TOPS Neural Processing Unit
  - Tiltrotor (hybrid VTOL / Fixed-Wing flight)
  - Increased flight endurance
    - ~20 min, depending on hybrid flight profile use
  - Amphibious
    - Perform a) water-based landing, b) stay in water for prolonged periods of time, c) water surface take-off, d) hovercraft-like maneuvering
- Goal:
  - Medium-footprint field evaluation of developed learning-based autonomy components
  - Unique capability to test edge emergency conditions involving water-based landing





Towards Perpetually-Deployable Ubiquitous Aerial Robotics: An Amphibious Self-Sustainable Solar small-UAS

Stephen J. Carlson, Prateek Arora, and Christos Papachristos

This material is based upon work supported by the NASA Award: "ULI: Robust and Resilient Autonomy for Advanced Air Mobility" and the NSF Award: 2008904: RI: Small: "Learning Resilient Autonomous Flight"

Robotic Workers Lab

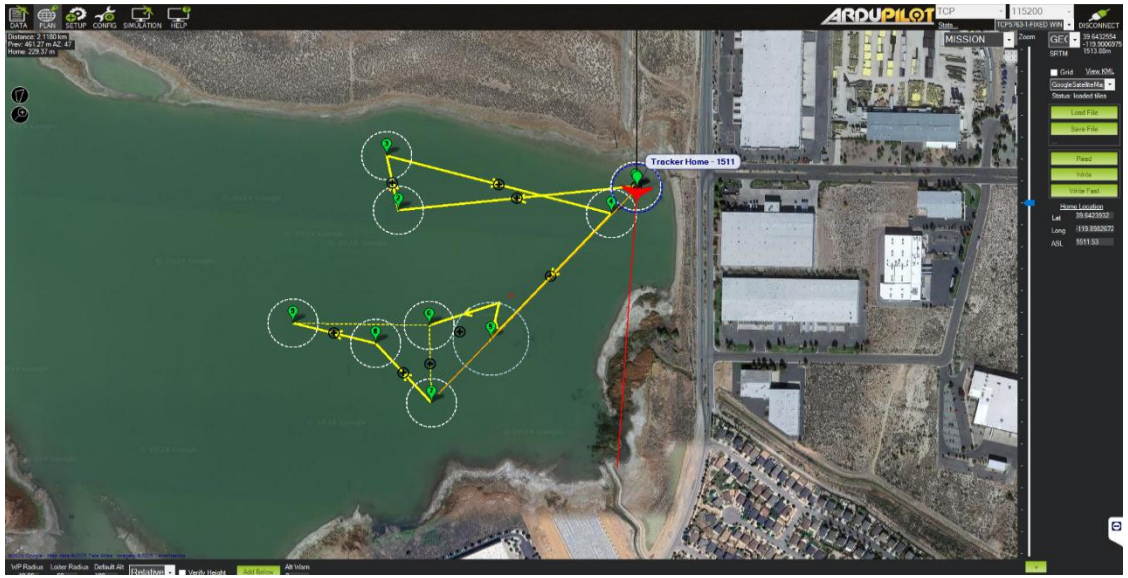
University of Nevada, Reno

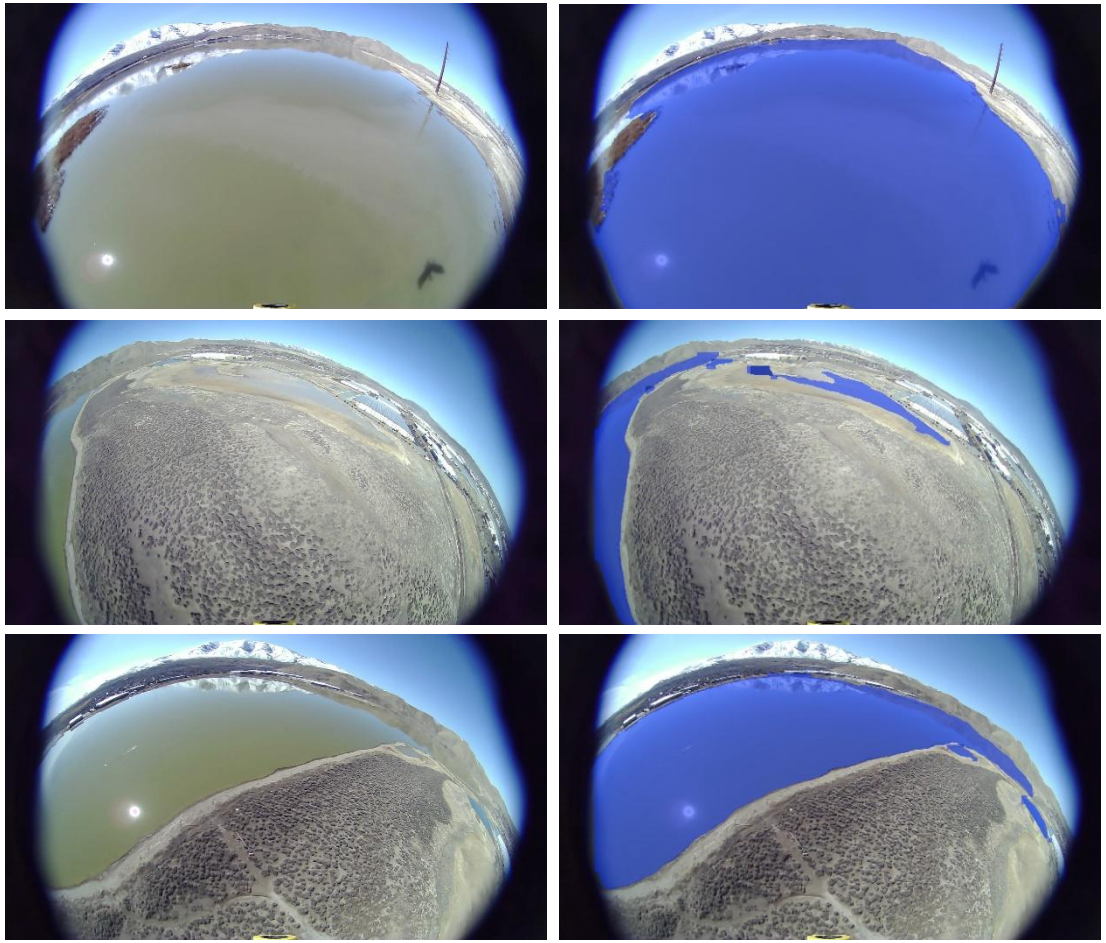
Prior Examples: **Deep Learning**-supported Intelligent Autonomous Landing

Day 1 Theme: Autonomous Emergency Landing

Field Experiment 1:

- Autonomous Emergency Landing on local water body, detected via real-time onboard perception
  - Preplanned survey mission, interrupted by **simulated fault condition**
- Water body detection & segmentation
  - Yolov8 instance segmentation network: **`yolov8-seg`** predicts pixel-wise masks in addition to bounding boxes and per-class confidence/probabilities
  - Converting the floating-point weights to a lower-bandwidth, integer weights using affine symmetric quantization scheme
  - The quantized Neural Network is deployed on Firefly ROC board that allows the multi-core NPU utilization, facilitating onboard inference ~30fps





Day 1 Theme: Autonomous Emergency Landing

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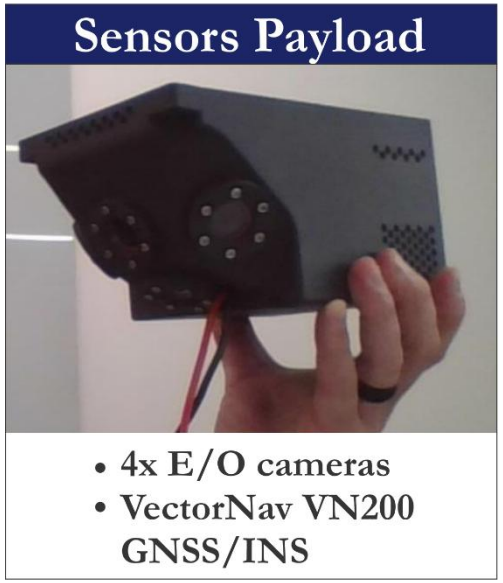
- Amphibious Self-Sustainable Aerial System /w Deep Learning-based detection of high-risk environment conditions

- Capabilities & Specifications
  - Pixhawk-based Autopilot /w Ardupilot stack & ROS-based Autonomy stack
  - NVIDIA Jetson Orin NX state-of-the-art High-Level Computer
    - ARM-based 8-core CPU
    - NVIDIA Ampere GPU w/ 1024 CUDA cores and 32 Tensor cores
  - Tiltrotor (hybrid VTOL / Fixed-Wing flight)
  - Increased flight endurance
    - ~90 min, depending on hybrid flight profile use
  - Multi-modal Payload
    - 4x Electro-Optical cameras
    - Tactical-grade GNSS/INS solution
- Goal:
  - Full-scale footprint field evaluation of developed learning-based autonomy components



Day 1 Theme: Autonomous Emergency Landing

Field Experiment 2:

- Autonomous Emergency Landing on known-class landmark, detected via real-time onboard perception
  - Preplanned survey mission, interrupted by **simulated fault condition**
- Safe landing zone detection & segmentation
  - Location: Doyle, CA
  - Yolov8 instance segmentation network: **`yolov8-seg`** predicts pixel-wise masks in addition to bounding boxes and per-class confidence/probabilities
  - Network is fine-tuned for 100 epochs with augmentation like rotation, translation, scale, shear, perspective, vertical flip (flipping around vertical axis), mosaic, mixup, HSV channel augmentation
  - Onboard execution on native NVIDIA Ampere GPU with 1024 CUDA cores

Day 2 Theme: Robust Obstacle Avoidance

Minihawk

- Small-scale Self-Sustainable Aerial System /w Deep Learning-based detection of known-class environment entities

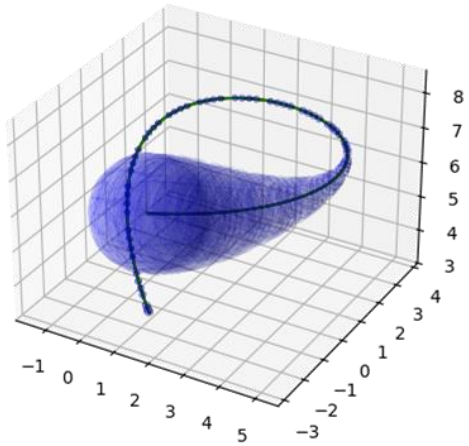
- Capabilities & Specifications
  - Ardupilot Flight Control stack
    - Pixhawk-based Flight Controller
  - Visual-Inertial Mapping for GPS-denied odometry estimation
    - Intel T265 System-on-Chip (SoC) low-power solution
  - Robot Operating System (ROS)-based autonomy & mission planning pipeline
    - ARM-based 6-core High-Level Computer
  - Deep Learning-based policy deployment
    - 5.0 TOPS Neural Processing Unit (NPU) capable of real-time Convolutional Neural Network (CNN) execution
  - Tiltrotor (hybrid VTOL / Fixed-Wing flight)
  - ~10 min flight endurance
    - Depending on hybrid flight profile use

- Goal:
  - Small-footprint field evaluation of developed learning-based autonomy components

Day 2 Theme: Robust Obstacle Avoidance

Field Experiment 2:

- Obstacle Avoidance during landing-zone approach maneuver with safety guarantees
  - Covariance Steering to formally ensure collision-free landing trajectory
- Simulation testing
  - Covariance Steering execution with SITL autopilot simulation
  - Minihawk flight dynamics testing via commercial RealFlight simulator
- Field Experiment testing (Reno, NV)
  - Preplanned landing approach, interrupted by **simulated obstacle detection** and replanned obstacle-avoiding trajectory execution with Covariance Steering



Thank You !

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Robotic Workers Lab

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