NRI INT: Safe Wind-Aware Navigation for Collaborative Autonomous Aircraft in Low Altitude Airspace

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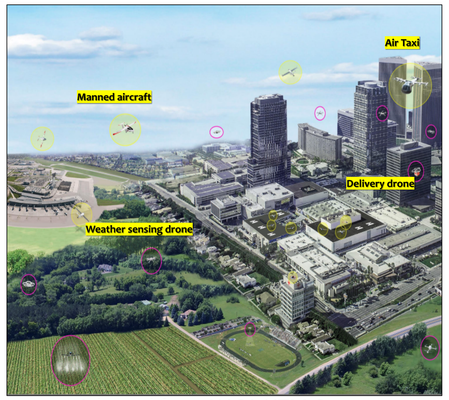
Background and Challenges

- Small unmanned aircraft systems (sUAS) technologies found many civil, commercial, and military applications.
- Infrastructure, such as NASA UAS traffic management (UTM) for low-altitude airspace management and monitoring, is being developed.
- Safety and efficiency of sUAS operations are strongly impacted by low-altitude gusts:
  - Negatively affect pilot operations, reduced flight time, damage
  - Airspace management and allocation made conservative and inefficient

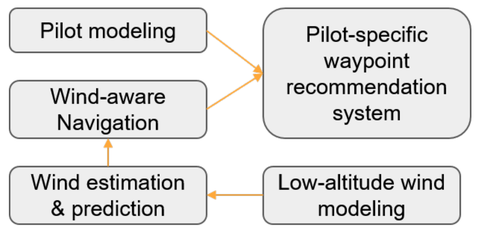


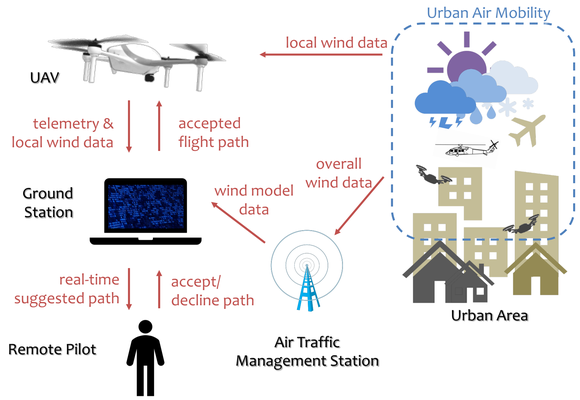
Adapted from NASA UTM Concept

Improve safety and efficiency of low-altitude UAS operations

Technical Approach

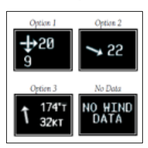
'In-time' or 'real-time' wind field information, communicated effectively to pilots and traffic management, can enhance safety, efficiency, and robustness of future sUAS operations in low-altitude airspace.

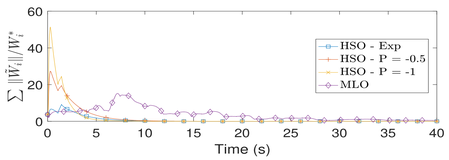


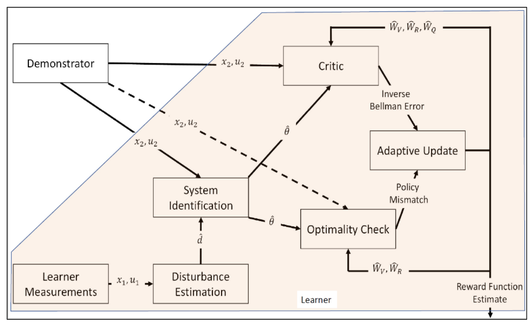


Pilot intent modeling

- Developed inverse reinforcement learning (IRL) techniques to support pilot intent modeling
- Integrated joystick control in a ROS-Gazibo simulator for human-in-the-loop experiments
- Surveyed UI for manned aircraft

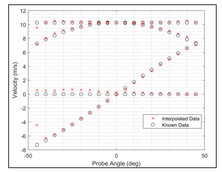




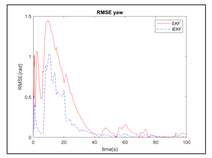


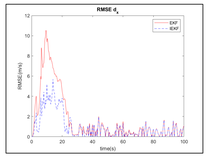
Wind estimation and prediction


sUAS with novel wind sensors



10m/s Alpha Sweep

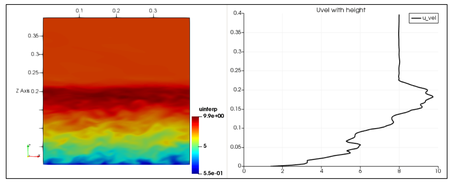


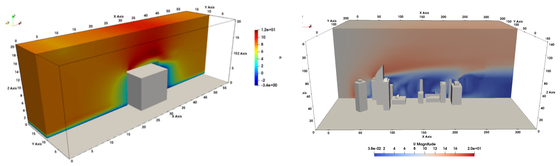


Invariant EKF

Wind modeling and simulation

- Large-Eddy Simulations (LES) for low-altitude wind with different terrains

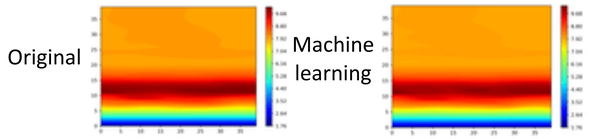




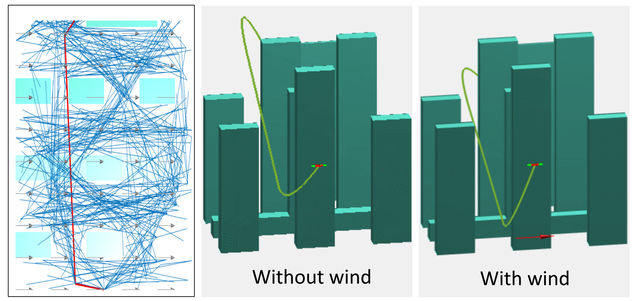
- Dynamic LES data integrated into a ROS-Gazebo quadcopter simulator

Wind-aware path planning

Assimilate local wind estimates to predict wind



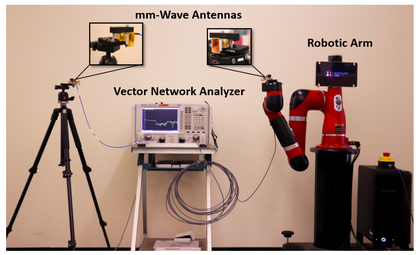
- Sampling based methods



Broad Impacts

- sUAS integration into the National Airspace, particularly challenging urban environments: wind impacts sUAS navigation and pilot operations
- Impacts on UTM and Urban Air Mobility (UAM) efforts, package delivery, reconnaissance, etc.
- Potential enhancement of low-altitude wind estimation, prediction towards micrometeorology and atmospheric sensing
- Contribute to future aviation networks and other applications, e.g., sUAS-assisted wireless communication, first response, etc.

Emulating sUAS motion for wireless communication channel modeling



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