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UAS Risk Analysis In And Around Airports

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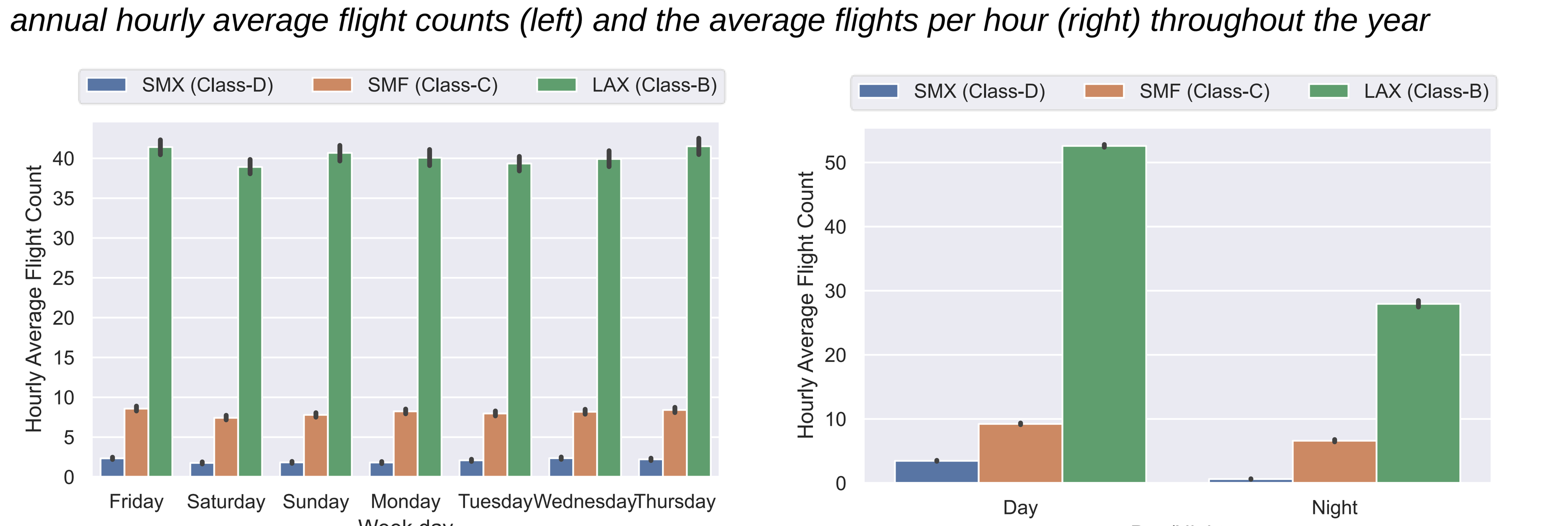
Introduction

- The operation of Uncrewed Aircraft Systems (UAS) at airports is becoming more common. The increased use of small and inexpensive drones pose various challenges associated with integrating UAS operations in the national airspace system.
- An unintentional malfunction resulting in uncontrolled UASs poses multiple risks, particularly when operated in a busy airport environment. This includes infrastructure, ground, and air risk.
- UAS risk associated with crewed aircraft flying below 1000 ft altitude within a 5 mile radius of an airport, risk associated with infrastructure and GPS uncertainty are investigated.
- Historical ADS-B data is analyzed statistically to identify the highest volume of traffic for a given day. Flight trajectories from that time interval are then extracted for analysis.
- The UAS-flight risk assessments are carried out for various scenarios that include the velocity of the aircraft, traffic volume, and the probability distributions of the UAS's trajectory.

ADSB Analysis

- Automatic Dependent Surveillance–Broadcast (ADS-B) is a surveillance technology that broadcasts an aircraft's GPS location, altitude, speed, and other information periodically, thus enabling it to be tracked. ADS-B out refers to the outgoing information from the aircraft, whereas ADS-B in refers to the receiving information from other aircraft.
- The trajectory of aircraft in three-dimensional space is determined using actual historical Automatic Dependent Surveillance-Broadcast (ADS-B) data.

Three airport classes, namely Class-B, Class-C, and Class-D, have been identified. A comparative analysis of temporal flight traffic patterns is conducted across these three airport categories. Visualizations showcase the annual hourly average flight counts (left) and the average flights per hour (right) throughout the year

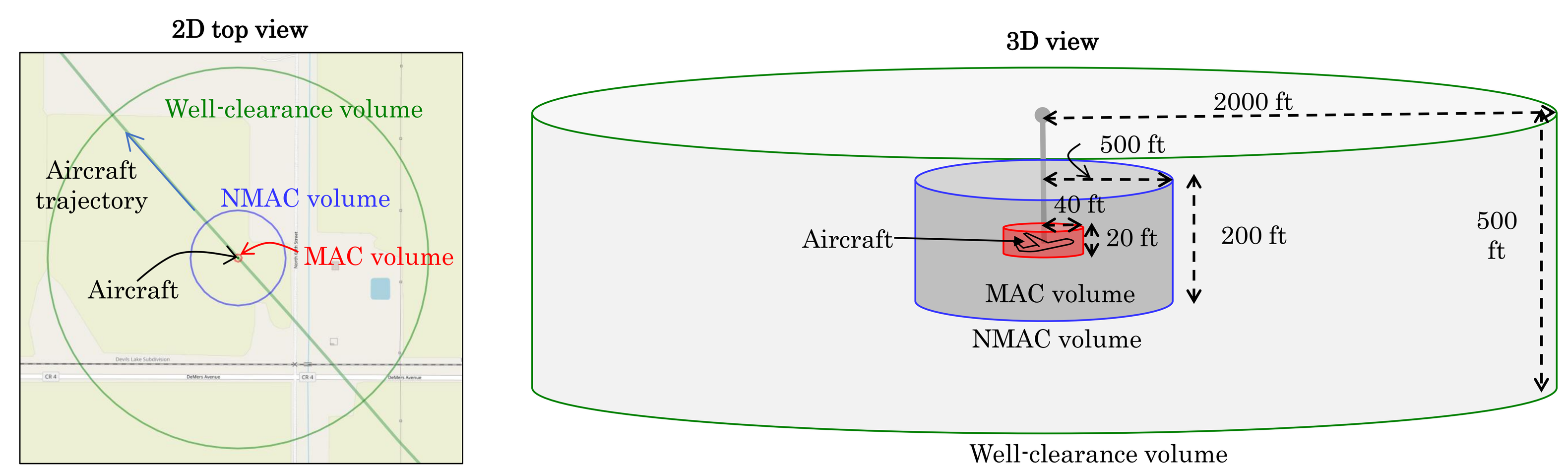


A comparative analysis of temporal flight traffic patterns is conducted across these three airport categories. Visualizations showcase the weekly hourly average flight counts (left) and the day and night variations in the hourly average flight counts (right).

Methodology

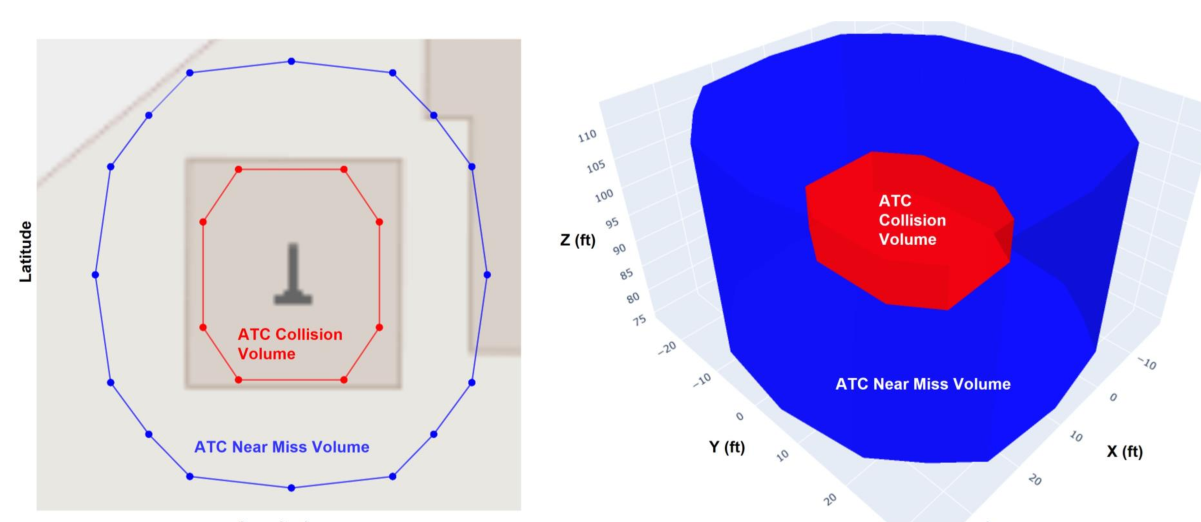
- Probabilistic risk assessment (PRA) is used in the present study as a methodical and all-inclusive procedure utilized to assess the hazards related to UAS operations with moving aircraft within the airport environment given a well-clearance violation

Crewed aircraft risk volumes



Schematic diagram showing the different risk volumes and their dimensions used in the present study, 3D view (top) and 2D top view (bottom) (not to scale)

Critical infrastructure risk volumes

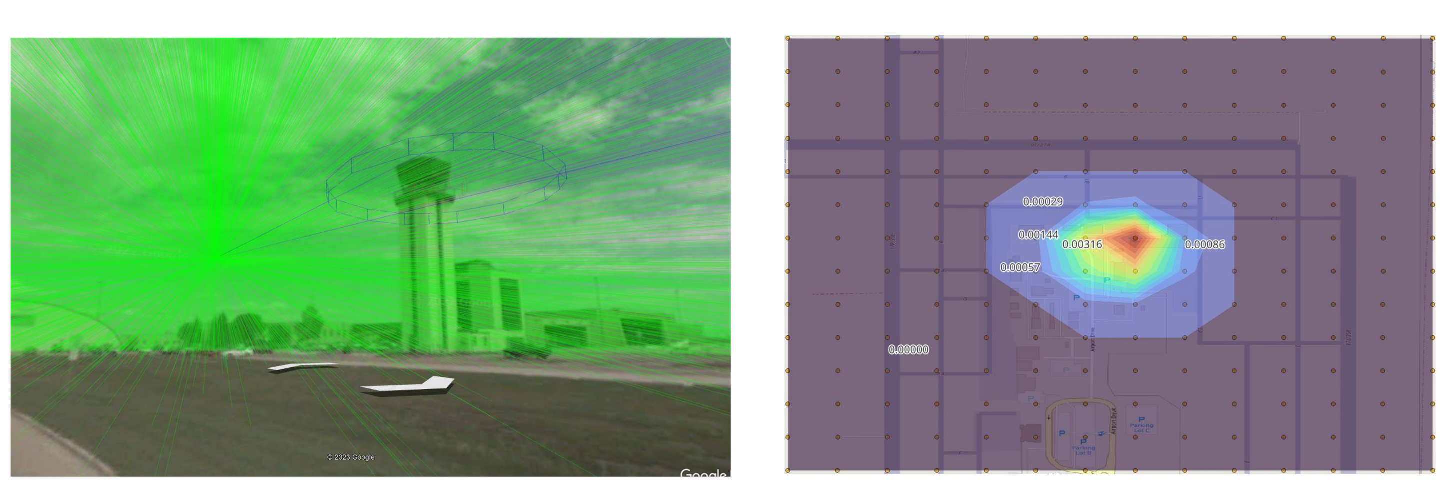


ATC 2D view on map (left) and 3D vie (on right). The red volume the encompasses the ATC volume is identified as Collision Risk Volume (CRV) and the buffer zone 50 feet outside of the collision zone is identified as Near-Miss Risk Volume (NRV)

- The likelihood of collision is determined as a single measurement, assuming that both the aircraft and the UAS are operating without the knowledge of each other's presence and without any separation maneuver to reduce the risk of collision.

Risk Analysis

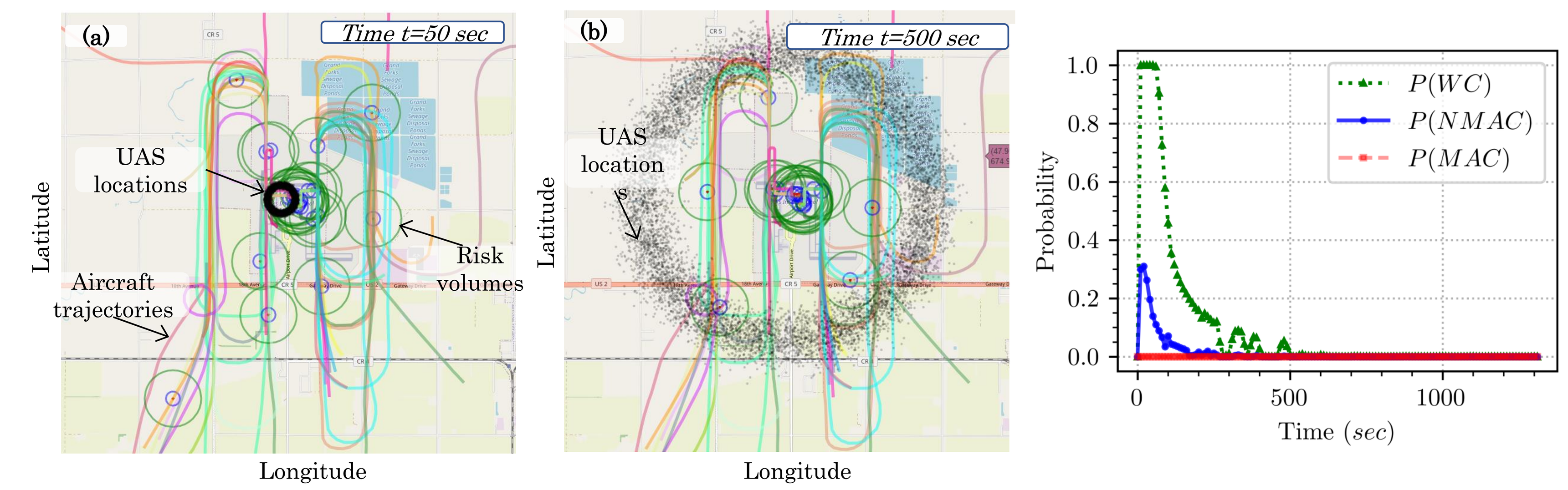
Risk associated with critical infrastructure



UAS risk analysis associated with critical infrastructure. Stochastic UAV paths and ATC location in the Grand Forks airport (left). Collision risk probability (right)

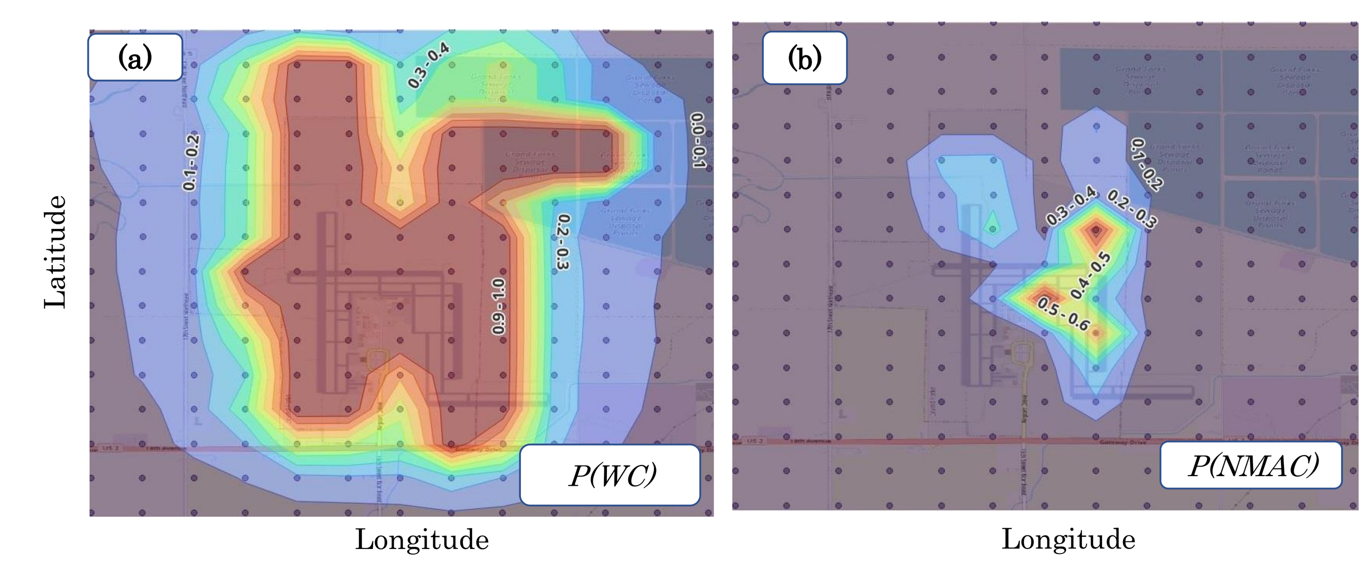
Risk associated with crewed aircraft

Scenario-I: Probabilistic risk assessment during the peak traffic



The figure shows the 2D top view of simulation scenario-II; crewed aircraft paths, risk volumes, and probable UA positions (a) at time t=50 sec and (b) at time t=500 secs.

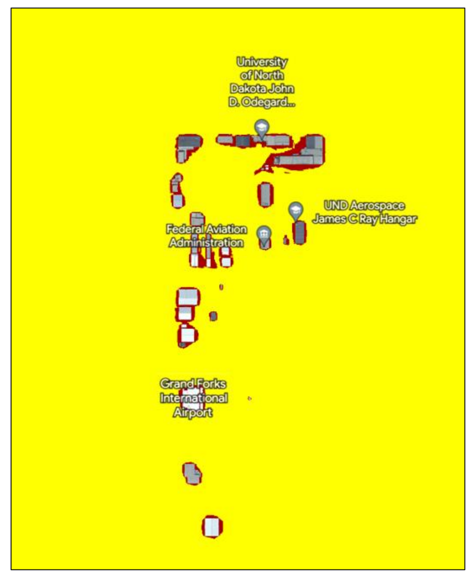
Scenario-II: Probabilistic risk assessment - UAS fail location



Risk probability dependence on the UAS failure location simulated in scenario-III (a) risk probability associated with well-clearance (b) risk probability associated with NMAC

Ref: P. Pothana, J. Joy, P. Snyder and S. Vidhyadharan, "UAS Air-Risk Assessment In and Around Airports,", doi:10.1109/ICNS58246.2023.10124319.

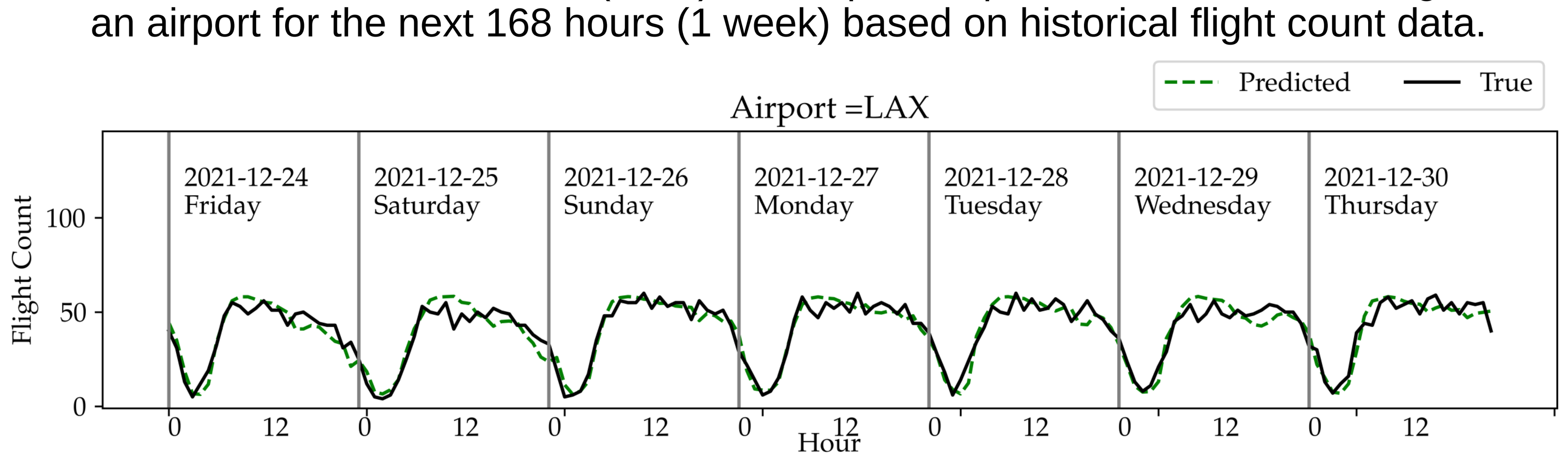
Risk associated with GPS uncertainty



- Position accuracy can be attributed to the extent to which the computed or observed location and/or speed of a UAV at a specific instance aligns with its actual location or speed.
- Geometric/Position Dilution of Precision (GDOP/ PDOP) plays a role by indicating how satellite positions relative to each other accuracy.
- Satellite time and location accuracy influence precision, as inaccuracies impact signal calculations.

Risk mitigating - Machine learning analysis

Recurrent Neural Networks (RNN) techniques to predict the number of flights at an airport for the next 168 hours (1 week) based on historical flight count data.



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