Ground Risk Assessment for Safety Operation of UAS

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Since unmanned aircraft system (UAS) without airworthiness certification must be assumed to fall, it is important to determine the flight area by assuming the impact on the ground. Therefore, we have devised two ground risk assessment methods; one is to evaluate the assumed airspace so that drone operators can be shown which airspace has a low risk when deciding on a flight plan. The other is to evaluate the risk of a decided flight plan. The latter is evaluated using simulation, and the former achieves fast evaluation of a wide range of airspace using machine learning based on simulation results.

Key Words: Ground Risk Assessment, SORA, Simulation, Deep Learning

1. Introduction

UAS operator is supposed to assess the ground risk of the UAS operation based on JARUS SORA, the manual assessment procedure causes inefficiency and inaccuracy. A simulation-based risk assessment, whose core TLOS model is same as the SORA, enables operator to assess it easily and accurately. In the model, the product of the probability of loss of control, λ_{LOC}, the probability of hitting a person when loss of control occurs, and the probability of serious injury when a person is hit, P_{fatal}, is kept below the target probability. $TLOS = \lambda_{LOC} \times D_{pop} \times F_{exp} \times AC \times P_{fatality}$, where D_{pop} is the assumed maximum population density, F_{exp} is the fraction of people exposed to harm from the operation, and AC is the critical area.

2. Ground risk assessment

We propose two risk assessments from the perspective of the objective and propose different methods for each. One is for drone operators to assess which airspace has low ground risk when deciding on a flight plan, and the other is to assess the flight plan when it has been decided.

First, for the latter purpose, a fall simulation is performed from the flight path. The simulation uses models specified by an aviation authority or a manufacturer. Hazard value is defined on the ground, considering factors such as population density, and the expected value of this hazard value is obtained using a Monte Carlo simulation, taking into account the probability distribution of wind speed and speed during flight, and the probability distribution of the fall area on the ground.

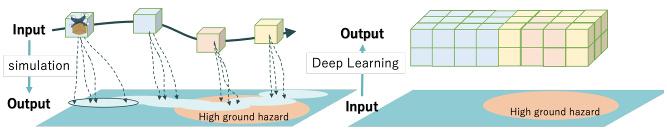

Fig. 1. Simulation-based risk assessment(left) and ML-based risk assessment (right)

By using machine learning (ML) on big data obtained from simulation evaluation under various weather, environmental and ground hazard conditions, a ML model that emulates the simulation can be obtained. This model can calculate the risk if it were to fall from the airspace for the entire airspace, so it can be calculated quickly. The explanatory variables for the supervised learning are the hazard values and weather conditions on the ground, and the object value is the ground risk value.

3. Experiment

The result of fall simulation from a flight plan and risk value obtained by the machine learning using CNN are shown in Fig. 2. Fig. 3 shows the results for a multi-copter and a fixed wing. There is a railway, whose hazard value is high, in the valley in the figure. Because the fixed wing has a large fall dispersion, the impact of the ground hazard value appears to spread.

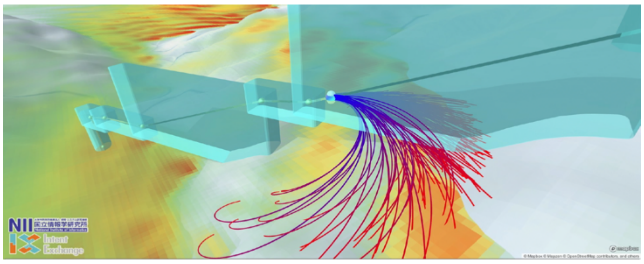

Fig. 2 Fall simulation and ML-based risk assessment.

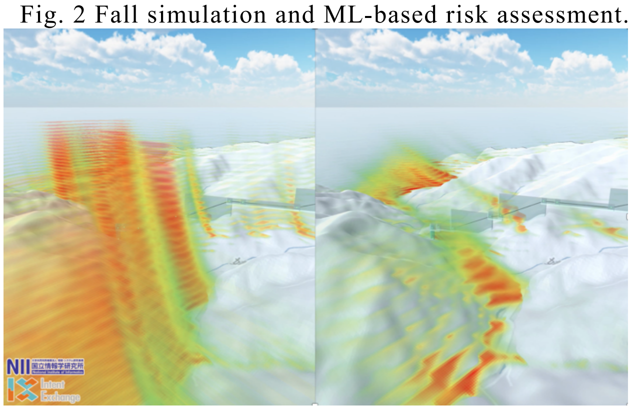

Fig. 3. Multi-copter (left) and Fixed-wing (right).

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References

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