Review: Flying on Point Clouds with Reinforcement Learning

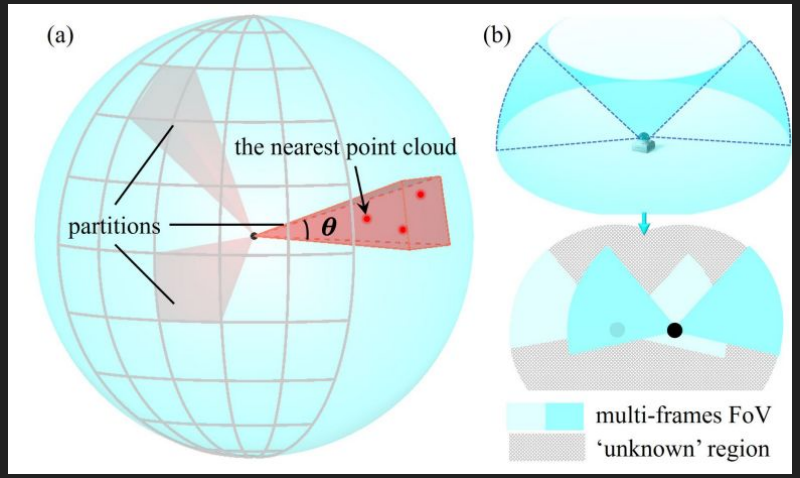
Ryan Le

Background

Challenge: How can we design a drone that is able to navigate cluttered environments autonomously, using onboard sensing and computation?

Shortcomings: Vision sensors such as depth cameras are traditionally used to model environments, however the sensory data produced is noisy, which needs to be addressed through methods such as occupancy grid maps. These methods have their own drawbacks, such as losing detection of small objects.

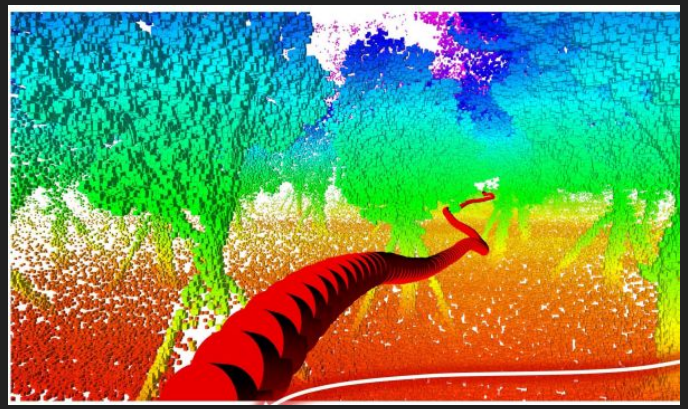
Innovations



New challenge: How can we combine 3D lidar sensing (which excel at detecting small objects), with sim-to-real RL and implement a deployable autonomous flight system which can navigate through clutters, as well as small obstacles?

https://en.wikipedia.org/wiki/Lidar

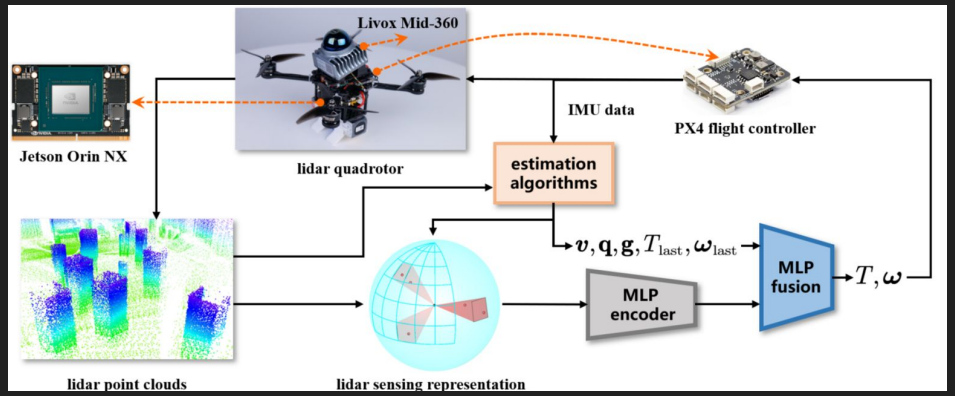
Challenges Faced



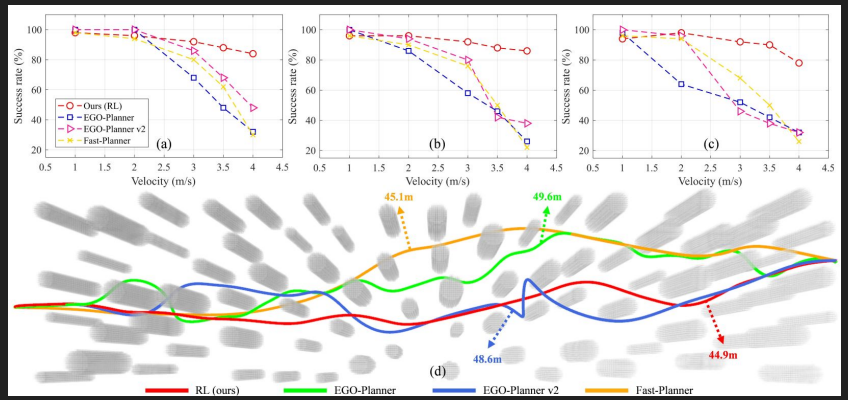
1. Raw point clouds produced by lidars are large in volume, and native downsampling risks losing detection of small objects.

2. Occupancy maps transformed from point clouds or depth maps by local state estimation must balance between high-dimensionality and accuracy.

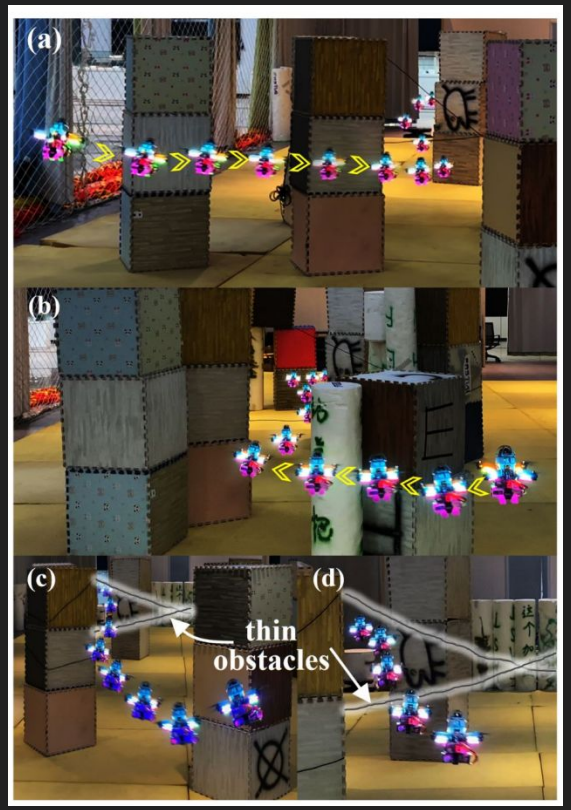
Solution



Combine downsampling and occupancy maps by dividing perceived point clouds importance (i.e. less distance, more importance).



Conclusion



Without excessive downsampling, it is possible to retain the perception of small obstacles and narrow spaces while maintaining lightweight policies.

However thin obstacles cannot always be avoided, which may be due to reflectivity in different materials or simulation methods used.

Next Question: How can we implement an effective yet efficient simulation method for lidar sensing?