Vision Cued LIDAR for Autonomous Navigation

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New Materials and Devices: Modular Optical Aperture Building Blocks (MOABB)

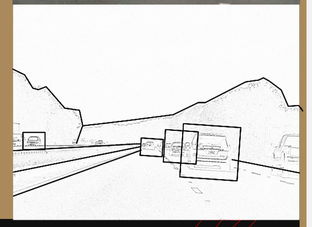
Background: Current sensors for small autonomous platforms (e.g. stereo vision, flash LIDAR, scanning LIDAR) lack adequate range, resolution, and speed for fast navigation in cluttered environment with low collision rate

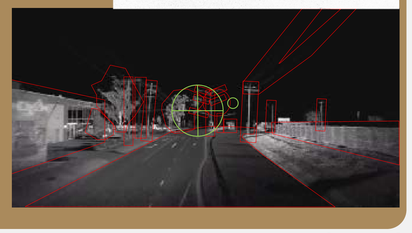
Overview: A unique, chip-scale photonic LIDAR enables a paradigm shifting navigation approach

- Random access pointing with no moving parts
- Microseconds response time
- Narrow nearly diffraction limited beam
- High range resolution

Approach: Intelligent vision-cued LIDAR

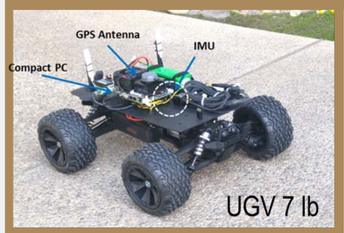
- Precise stabilized pointing in presence of challenging platform jitter, no gimbal
- AI enabled camera vision identifies and classifies objects and regions of interest and cues the LIDAR
- Keep-out zones assigned around the detected objects
- A small number of LIDAR points orient the keep-out zones around objects
- Forward-looking obstacle avoidance scan as a backup
- LIDAR data limited to several hundred of points as opposed to hundreds of thousands
- System world model can be shared over low bandwidth data link

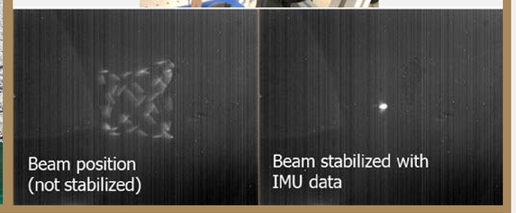


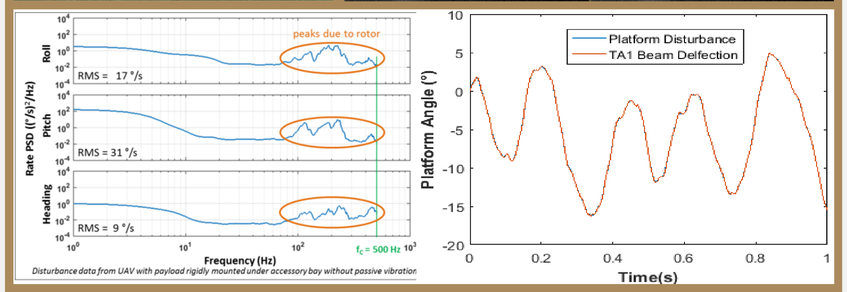


Stabilized pointing with EO beam steering

- Gimbal simulates measured platform jitter
- Feed forward correction predicted with onboard IMU data stabilizes pointing
- Phased array steering in one dimension, fast tunable laser steers in the second dimension

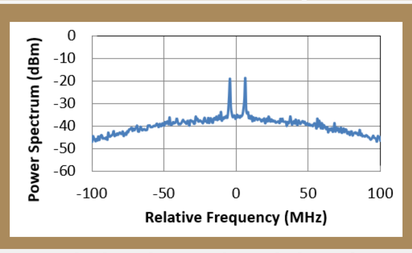






Measured platform disturbance and Matlab Simulink model line of sight stabilization

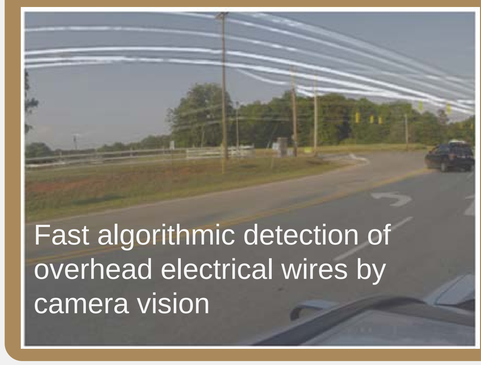
FMCW ranging capability with fast random access tunable chirped laser under test

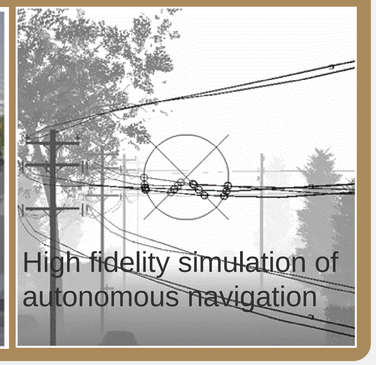


Frequency difference between the two sharp peaks corresponds to 3m path difference

High fidelity simulation

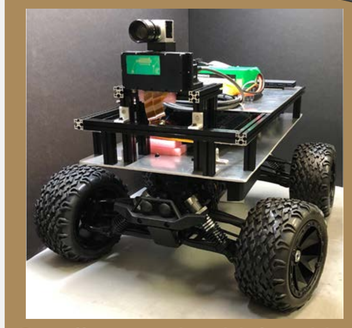
- Demonstrate navigation around wires
- Simulated approach within MS AirSim
- AI trained to detect overhead wires, and algorithm ported to simulation environment
- Modelled MOABB LIDAR, IMU, and camera vision within simulator
- Implemented stabilized pointing as well as obstacle avoidance within simulator



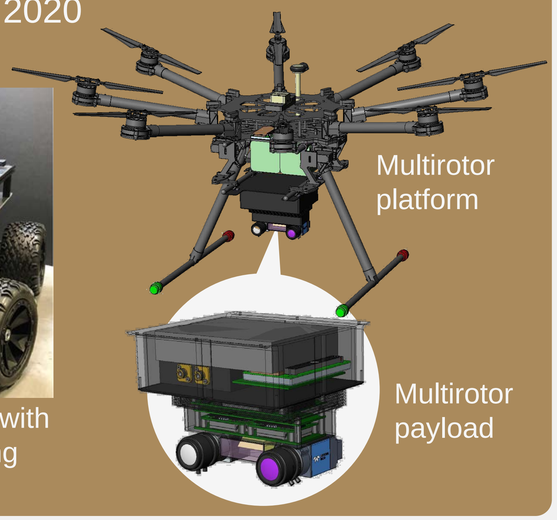


Towards platform demonstrations

- Ground vehicle being used as surrogate before flying on multirotor
- Human in the loop in the current phase, autonomous in 2020



Small ground vehicle with MOABB beam steering hardware



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Photonic integrated circuits and peripheral components provided by Analog Photonics
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