Multi-UAV Slung Load Carrying for Methane Emissions Measurement

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Methods - UAV Coordination

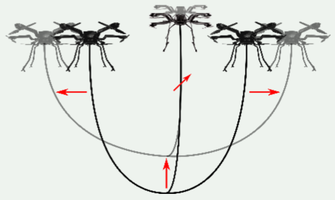
Software and Controls

- ROS2, PX4, Python.
- Quasi-static, distributed formation control.
- Gazebo simulation with multiple rigid-link tethers.

Hardware

- Offboard control through networked Raspberry Pis.
- Drones: Platform independent, heterogeneous groups.



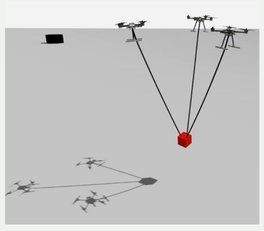


Results - Quadrotors

Simulation

- Control position and orientation of a 1.5 kg load travelling at 1 m/s.
- Works with varied trajectories during takeoff, mission and landing sequences.





Background and Motivation

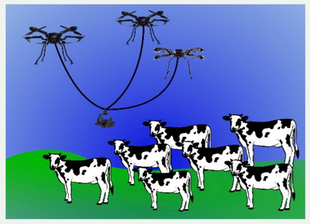
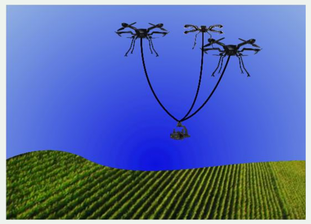
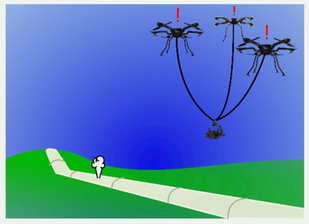
An autonomous platform for emissions quantification across domains.

Aerial Methane Monitoring

- 50-60% of global methane emissions are due to livestock, natural gas leaks and waste degradation[1].
- Aerial solutions are easy to deploy over many outdoor environments.
- Only single-drone slung measurement has been investigated in literature[2].
  - Multiple drones means more stability, indirect downwash and larger payloads.

Cattle Breath Methane Quantification

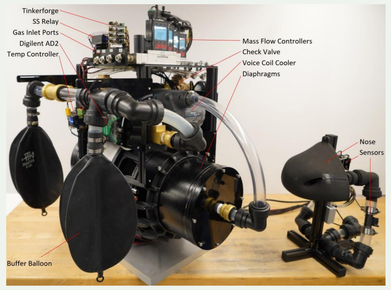
- Respiration chambers, tracer gas techniques and breath analysis are complex, costly and/or laborious[3,4].


Methods - Methane Imaging

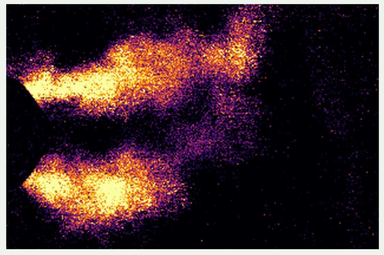
Optical Gas Imaging

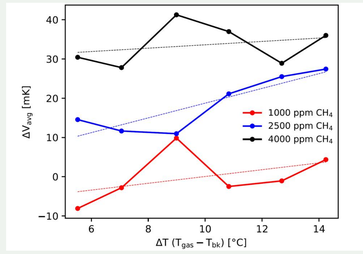
- Accurate, time-varying information on an entire gas plume.
- Physical bovine breath simulator.
- Background subtraction, frame differencing, optical flow.



Results - Imaging

- Pixel temperature deviation ΔV can be used to predict the methane concentration in a gas plume.
- ΔV varies with breath-background temperature differences (ΔT).





References

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