AIOLOS: Autonomous Inventory or Laboratory Operations Suite

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Introduction

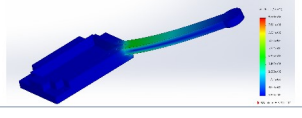
- Modular drone platform for inventory management and laboratory data collection
- Quad-copter capable of autonomous navigation in GPS-denied environments
- Performs automated data-collection to reduce cost and improve accuracy
- Can easily be adapted to use many different measurement tools and instruments
- Autonomous docking and charging for hands-off operation

Methodology

- LiDAR array enables localized 3D position awareness
- 2D LiDAR measures distance to in-plane obstacles
- 1D LiDAR provides continuous elevation data
- LiDAR-derived coordinates computed and displayed
- Modular payload supports additional sensing instruments
- Integrated camera system enables barcode imaging
- Onboard Raspberry Pi allows high degree of adaptability

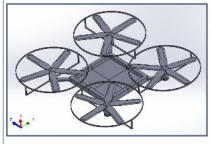
Data Collected

- System-level and subsystem-level programming and testing performed
- Evaluated flight performance, sensing, and barcode imaging
- LiDAR data used for indoor localization and obstacle detection
- Image tests conducted across distance, lighting, and camera settings
- CAD and hardware testing supported design validation
- Full documentation on replication, operation, and troubleshooting methods



AIOLOS

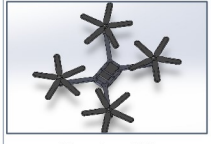
Autonomous Inventory or Laboratory Operations Suite



Icarus V1

Alcyone V0

AIOLOS V1



Sisyphus V2

AIOLOS V0

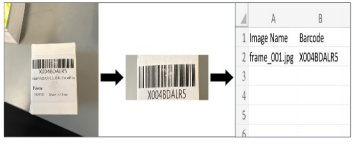
System Specs

- Platform: Custom quadcopter
- Flight Controller: Pixhawk 2.4.8 (Radiolink integration)
- Onboard Computer: Raspberry Pi 4 Model B
- Offboard Processing: NVIDIA Jetson Orin Nano
- Localization: 2D LiDAR (SLAMTEC M2M3 RPLiDAR) + MakerFocus TF-Luna
- Camera: Arducam IMX477 Pi HQ camera module (manual focus)
- Detection Method: Python-based barcode decoding (image processing pipeline)
- Data Output: CSV file with unique barcode entries

Modular Payload Design

- Interchangeable sensor platform enables multiple mission types
- Inventory mode: camera system for barcode detection and data logging
- Experimental mode: anemometer integration for wind tunnel testing
- Payloads can be swapped with minimal hardware and software changes
- Design supports rapid adaptation to different data collection tasks
- Enables simple reproduction & repair

Automated Barcode Detection Pipeline



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Results

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- Successful integration of flight, LiDAR, and imaging system
- Real-time coordinate output achieved from LIDAR data
- Demonstraded feasibility of autonomous indoor operation
- Barcode detection achieved under controlled conditions

Limitations

- Reduced barcode readability at longer distances
- Full autonomous navigation remains a complex challenge

Ongoing improvements

- Intergration onto drone platform currently in progress
- Navigation for large scale autonomous flight
- Mapping, control, and software integration
- Hardware efficiency

Conclusions

- AIOLOS demonstrates a viable platform for autonomous indoor data collection
- Successful integration of flight, LiDAR, and imaging systems
- Current limitations include large scale autonomous navigation and barcode readability
- Ongoing improvements focus on enhanced imaging and navigation capabilities
- All key design specifications met, including
  - Be able to fly / hover manually
  - Determine its location in space
  - Decible reading under 70dB
  - Blades cannot be exposed
  - Modular design
  - Manual Override
  - Fly for 20 minutes uninterrupted
  - Simple autonomous flight

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