Intelligent Radiation Awareness Drone (iRAD): Creation of an Unmanned Aerial Vehicle with Radiation Hazard Guided Navigation

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Introduction

- Current radiation survey methods are time consuming or not comprehensive, creating barriers for essential surveying
  - Characterize background radiation to recognize changes caused by human activity
  - Rapidly respond to actual or threatened radiological events
- Unmanned aerial vehicles could solve this issue
  - Data-informed algorithms allows for reconstruction of a radiologically contaminated area using nonuniform, incomplete sampling
  - Autonomous operation
  - Opportunities to scale to multiple vehicles

Technical Approach

- Modified drone hardware bundle
  - Current iteration utilizes a hobbyist drone frame and motors capable of maneuvering a system of 2.1kg
- Open-source control software (PX4 Autopilot) running custom firmware on PixHawk 4
- On-board companion computer (RPi 4)
  - Data-informed navigation algorithm
  - LiDAR-driven terrain holding
  - Collision avoidance
- Modular payload
  - Radiation detector (SiPM scintillator), not reasonable for large-scale testing but necessary for application
  - Wi-Fi sensor detects signal intensity, for use in large-scale system testing

Figure 1: Modified DJI F550 drone kit showing focal points of individual undergraduate student efforts to be integrated into the system.

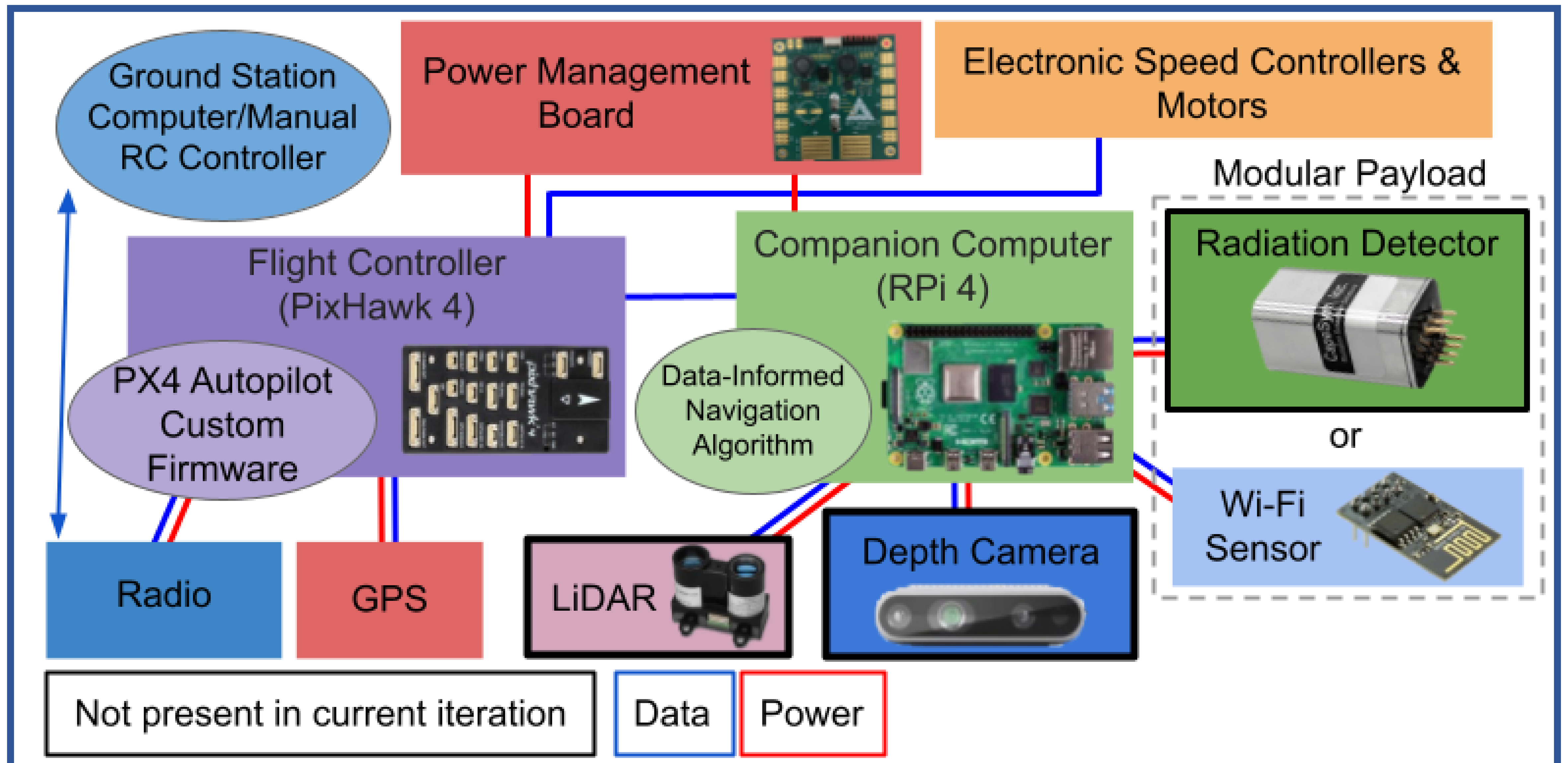

Figure 2: Power and data flow between main components integrated into iRAD.

Results

- First iteration of full system designed
- Wiring harness for essential flight hardware created and integrated
- Stand alone collision avoidance and terrain holding implemented
- Data-informed navigation algorithm created and undergoing optimization
- Firmware to interface algorithm and PX4 Autopilot completed

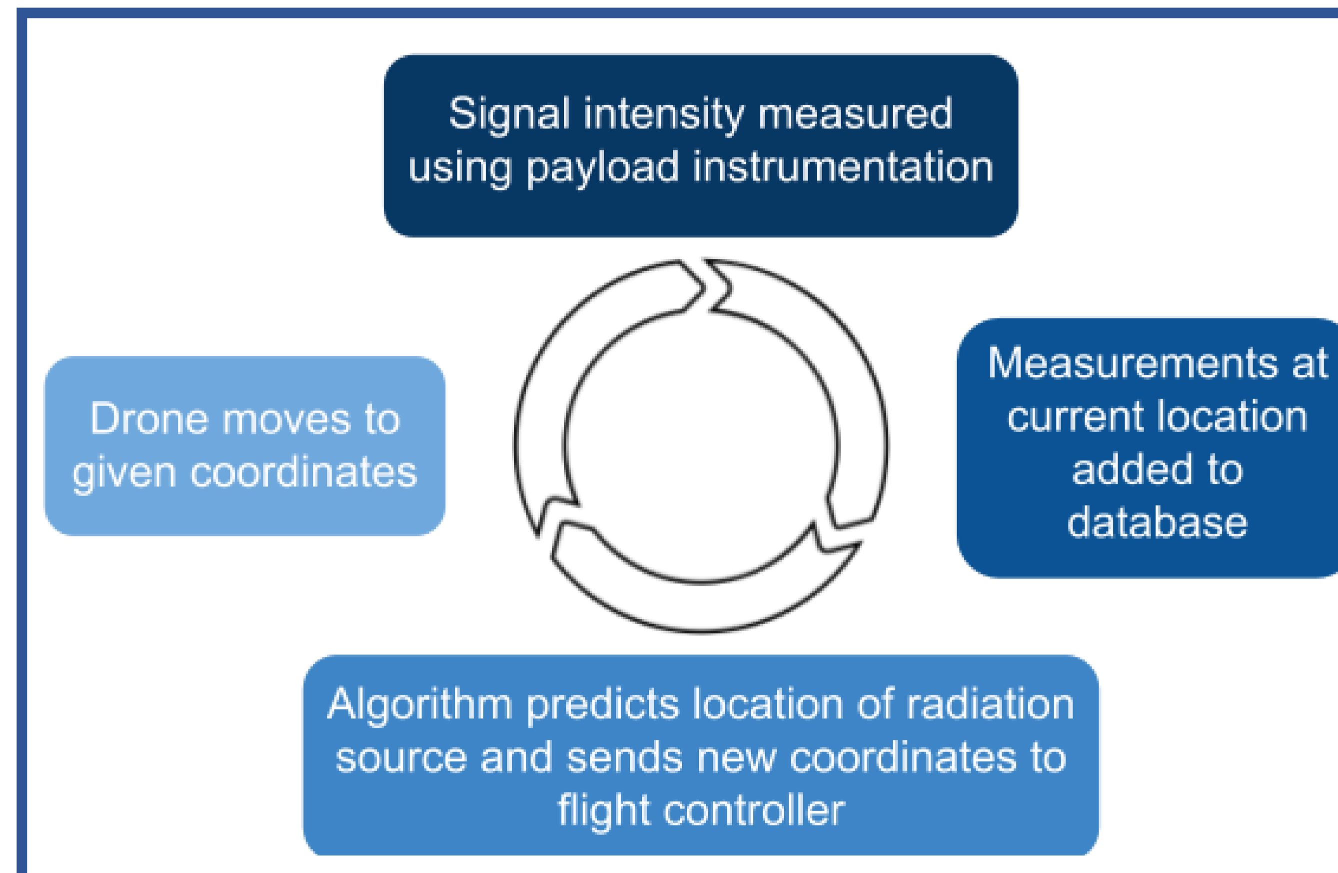

Figure 3: High-level operational control loop.

Conclusions

- All individual subsystems are nearly completed!
- Efforts will result in a useful system for several different application spaces
  - Routine surveying
  - Information for first responders
- Data-informed navigation algorithms are unique and appear viable
- Achievable using an interdisciplinary team of engineering undergraduates

Next Steps

- Radiation detector crystal and interface selection
- Individual subsystem bench testing
- Full system integration of iteration 1
- Radioactive source testing (small scale)
- Wi-Fi source testing (larger scale)
- Research and development cycles (2 ,3, etc)
  - Focus on increasing system mass in order to integrate equipment to allow for autonomous operation

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