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

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Introduction and Motivation

* Current radiation survey methods are time consuming or not comprehensive
  => Algorithmic source reconstruction provides full maps with nonuniform, incomplete sampling
  => Search paths could be optimized based upon existing information
  => Multiple, coordinated moving sensors possible
* Attenuation and scatter confound measurements
  => Line-of-sight airborne detectors (minimize attenuation for surface contaminations)
  => Spectroscopic SiPM-scintillators
* Robotics and drones are popular with students
  => Combine with nuclear application

Mission Relevance

* Characterize background radiation to recognize changes caused by human activity
* Rapidly respond to actual or threatened radiological events
* Encourage undergraduates to pursue graduate degrees in relevant areas

Technical Approach

* Modified drone hardware bundle (DJI F550)
* Open-source control software (PX4 Autopilot)
* Additional on-board computer (RPi 4)
* Modular payload (SiPM scintillator, WiFi sensor)
  * Data-informed navigation and mapping algorithm
  * Interdisciplinary undergraduate team
* Design/build/test cycle

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

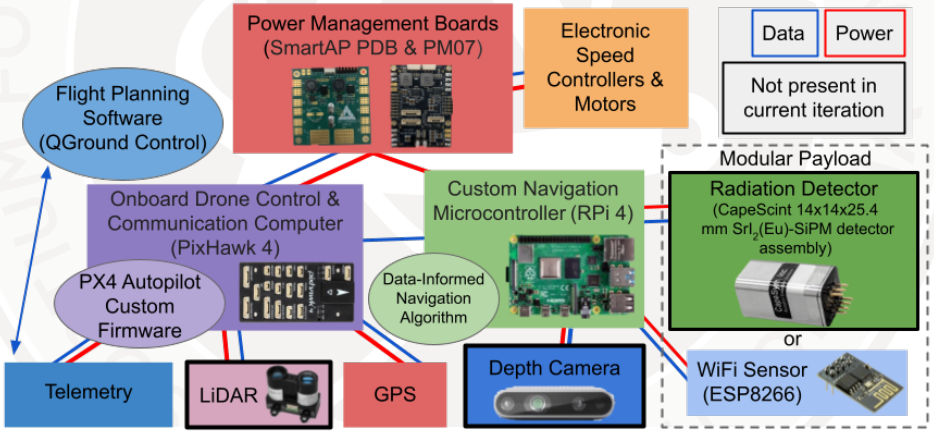

Figure 2: Power and data flow between main components integrated into iRAD.

Results

* Full system designed (first iteration)
* Wiring harness for essential flight hardware created
* Stand alone collision avoidance and terrain holding implemented
* Firmware for interfacing mapping algorithm with PX4 in development

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Expected Impact

Ability to rapidly survey and map areas for radiation contamination or Wi-Fi emitters

MTV Impact

* Only source of external funding
* 9 undergrads directly engaged in research

Project designed around student's interests to progress individual academic goals

* Opportunities for presentations and publications

Conclusion

* Individual subsystems are nearly completed!
* Efforts will result in a useful system for several different application spaces
* Data-informed navigation algorithms are unique and appear viable
* Achievable using an interdisciplinary team of undergraduates:
* Students are being introduced to nuclear topics, encouraged to engage in research, and ultimately prepared for graduate programs

Next Steps

* Radiation detector selection
* Full system integration
* Flight testing
* Radioactive source testing (small scale)
* WiFi source testing (larger scale)
* Research and development Cycle (2, 3, etc.)

National Nuclear Security Administration