Communications and Computational System for an Intelligent Radiation Awareness Drone (iRAD)

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Introduction and Motivation

* Detecting and evaluating widespread radiological contamination currently requires inefficient methods of survey such as scanning over an entire area
* Creating a drone capable of performing an intelligent survey would greatly improve monitoring thoroughness, speed, and accuracy
* Such a drone requires sensors and additional computers that a typical consumer drone would not
* This work focuses on the underlying design of the communication software for such a drone

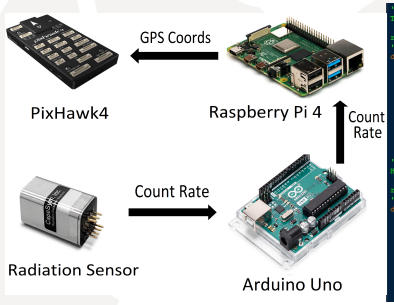
Mission Relevance

* Verification and monitoring of radiological sources is critical for material security and non-proliferation.
* This work seeks to create a faster and more efficient means of widespread monitoring to address those concerns.
* With such a tool as iRAD, it becomes possible to better identify and monitor both routine and anomalous widespread radioactive emissions

iRAD

Technical Approach

* The drone contains a PixHawk 4 flight controller, Raspberry Pi 4, and Arduino Uno
* PX4, an open-source firmware for drones has code added to interact with the various onboard computers and sensors
* Modifications to PX4 and sensor code for the Arduino will be written in C++, while driver code for the Raspberry Pi will be written in Python



▲ High-level system overview

```
'''
Take data from hasnav algorithm to be encoded into packet

returns byte string of packet
'''
def encode_packet(lat, lon, alt):
    packet = b""
    packet += generate_header(0, lat+lon+alt)
    header += lat.to_bytes(4, "big")
    header += lon.to_bytes(4, "big")
    header += alt.to_bytes(4, "big")

    packet = cobs_encode(packet)

    return packet

'''
Helper function to generate packet header

returns byte string of packet header
'''
def generate_header(dev_id, checksum):
    header = b""

    time_stamp = int(time.time_ns/1000)

    header += time_stamp.to_bytes(8, "big")
    header += dev_id.to_bytes(4, "big")
    header += checksum.to_bytes(4, "big")

    return header
```

▲ Packet encoding code on Raspberry Pi

Results

* Documentation has been written for PX4 sensor driver development for the PixHawk4
* A packet protocol has been designed for transferring data between the computers
* Code for the flight controller to receive packets and code for the Raspberry Pi to send packets has been written

Expected Impact

This work will provide a safe, fast, and efficient method of detecting radiological sources across a wide area

MTV Impact

* Working in my MTV-sponsored undergraduate team has allowed me to be involved in research with peers, graduate students, and staff
* My team has provided me with guidance on preparing and giving presentations
* My research has allowed me to explore the NNSA mission and the importance of the computer science field to it
* The ultimate iRAD would be of great use for both routine and incident-responsive radiation surveys for monitoring, decommissioning, cleanup, and surveillance for nuclear power, weapons, and existing contaminated sites

Conclusion

* The necessity of multiple computers onboard a single drone has required careful development of communications protocols
* The addition of multiple computers reduces the workload and thus increases the performance of each individual computer
* Thus far, the Raspberry Pi4 appears to be an adequate choice for running a source-seeking algorithm in terms of its performance and its input/output connections

Next Steps

Work will be continued on the communications systems and computers to create a working drone

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National Nuclear Security Administration