**Goal**

- Hybrid OTA/UW communication scheme
- Implement necessary software to UAV/UUV in air and water

**Motivations and Objectives**

**Motivations**
- Current drones (ie. multirotors) have no capability to travel underwater and as such no need to communicate underwater. However, through recent research new multi-medium drones have arrived. RF(Radio Frequency) works well in the air but is not capable UW [1]. Using WHOI Modems we have created the first **Mixed Air-Water protocol for drones!**

**Objectives**
- Use WHOI Micromodems to control the drone underwater

**Research Challenges**

- Learning the MAVLink protocol and how it is used in modern GCS for remote drone control.
- Creating a full scale GCS that has all capabilities of a GCS and is able to send commands to the drone underwater.
- Create a new communication protocol for use underwater that would transmit the high rate MAVLink packets using the low rate underwater WHOI packets [2].

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**Methodology**

- Implement both ends of communication scheme
  - Custom ground control software
  - Custom underwater protocol remapping

**Goal**

- Limited to 13 bit UW commands [3]
  - MAVLINK (Micro Air Vehicle Link Protocol) messages are too large
  - A Command mapping necessary
- Raspberry Pi multiplexes data from RF radio/acoustic modem
  - Maps acoustic commands
- UW communication range fluctuation
- Effects of transceiver orientation

**Results**

- UW Commands take approximately 1s to send
  - Sends basic "move" command
- Latency unavoidable - distribute control

**Future Work**

- Drone with autonomous control
  - UW packet latency too high for real time navigation
  - Move intelligence to autopilot computer
  - Reduce latency and detect necessary conditions that need to be send back to GCS
  - Reconfigure UW packet mapping to accommodate independent intelligence
  - Higher level commands (Close-Loop Operation)

**References**