1 Introduction

In this project we set out to implement an effective underwater communication scheme for a hybrid/multi-media drone developed by a team at Rutgers’ Mechanical and Aerospace Engineering department called the Naviator. The Naviator has the ability to navigate in the air as well as to transition smoothly into underwater. Currently no reliable air and water communication protocol exists. Because of this, the Naviator lacks a wireless control channel underwater (a tether was used previously).

![Figure 1: The Naviator underwater.](image)

Although a tether allows for easy closed-loop control of the drone underwater, it could become snagged on an obstacle in the water. A tether also introduces the practical limitation of how much wire must be brought to experiment sites, as well as adding cost and decreasing the drones deployability.

We have implemented a complete hybrid communication protocol that allows communication with the drone Over The Air (OTA) as well as Underwater (UW). To accomplish this, we use underwater acoustic modems (WHOI Micromodems) supplied by Prof. Pompili’s lab.

![Figure 2: Proposed communication scheme.](image)

If a Radio Controller (RC) override message is sent, the software also creates a corresponding underwater packet and transmits it using the acoustics modem.

2 Design

In order to integrate OTA and US communication seamlessly, the drone needs a method of multiplexing the two different communication channels. To that end, the drone will carry a small microcontroller (the Mediator) that receives both channels and polices what messages are passed along to the Naviator’s autopilot. The sending software has a telemetry connection and a connection to the modem.

![Figure 3: WHOI acoustic modem.](image)

Future work is currently being done to further this technology, whether it be through the acoustic hardware, communication software or controls software.

3 Conclusion and Future Work

By combining the use of these modems with the use of standard Radio Frequency (RF) receivers, communication links established OTA are able to continue UW with a limited set of commands. In addition to providing control of the Naviator underwater, with this project we also aimed at illustrating the current limitations of communication underwater and the need for advancement of the current technology before large-scale missions or data collection can take place. Although these acoustic modems are capable of transmitting small commands to a simulated drone, this proof of concept is far from a communication scheme that can be used in practice.

Future work is currently being done to further this technology, whether it be through the acoustic hardware, communication software or controls software.

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