‘Buoyless’ Lobster Trap

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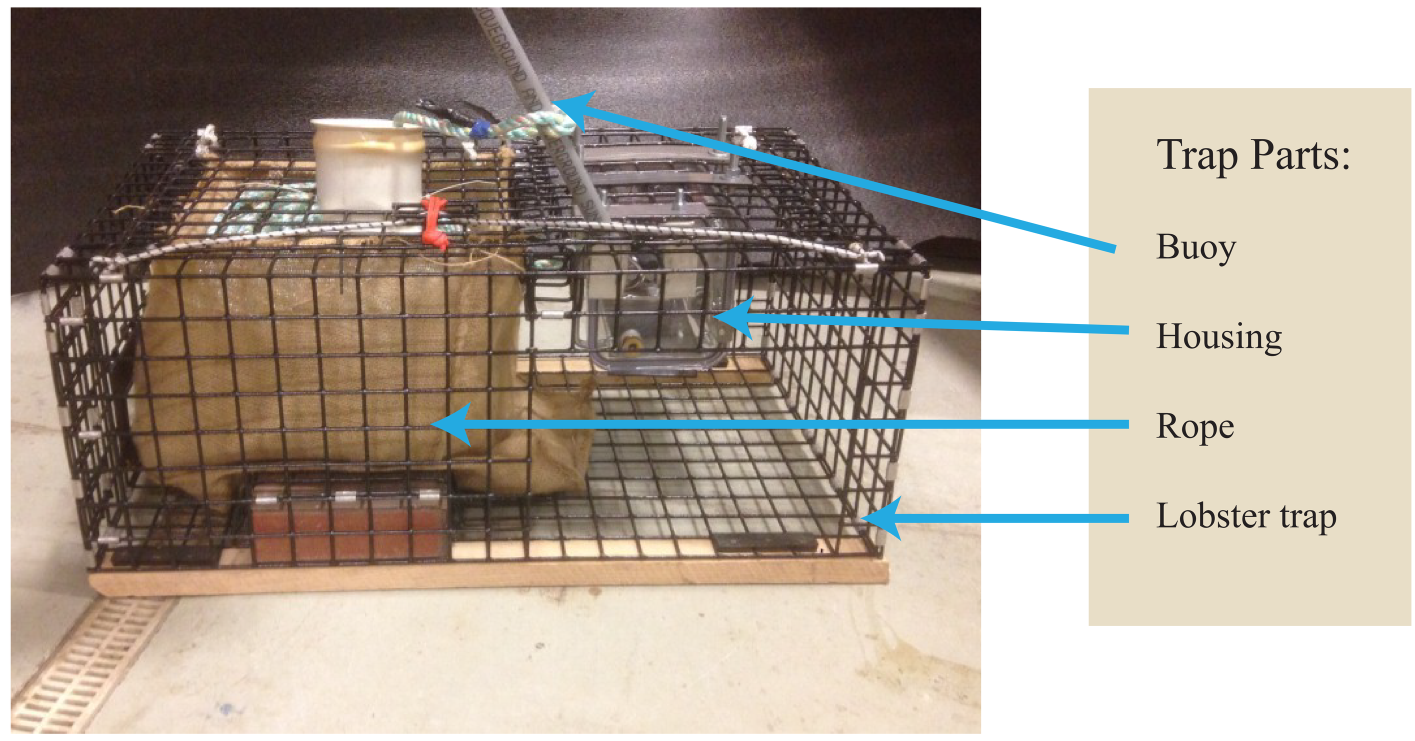
Background

Buoys are used for many marine applications: for moorings, lobster traps, and ocean data collection. Though they are widely used, few are aware of the hazards these present to marine mammals. Buoys use rope or chain to anchor the buoy to the seafloor. Where many buoys are present, large marine mammals struggle to navigate through the forest of lines. They can become ensnared, leading to starvation and ultimately death. Removing these lines that span the water column is a step towards preservation of the marine ecosystem.

While also proactively protecting marine mammals, removing buoys also simplifies marine traffic and prevents the loss of fishing gear from ships and storms.

This proof-of-concept design focuses on recreational lobster trap applications.



Current iteration of buoyless lobster trap design.

Design Problem and Solution

General design constraints:

- Lines spanning the water column must be removed.
- Gear must be able to be retrieved from the seafloor.
- Design must minimize number of moving parts to prevent failure.

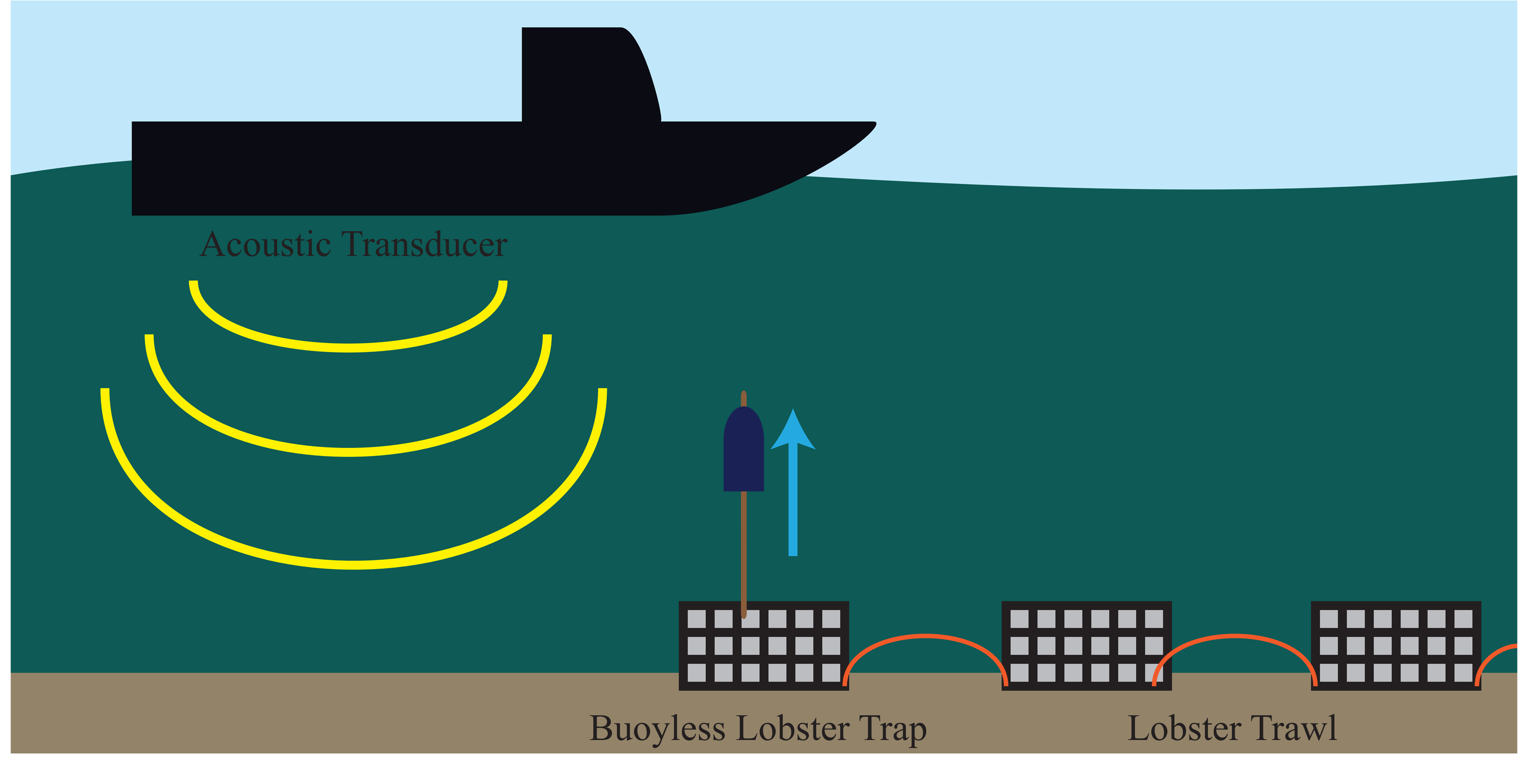
Recreational lobster fishing design constraints:

- Design must focus on low cost.
- Design should be easily integratable to lobster trawls.
- Design shouldn’t significantly increase workload on fisherman.

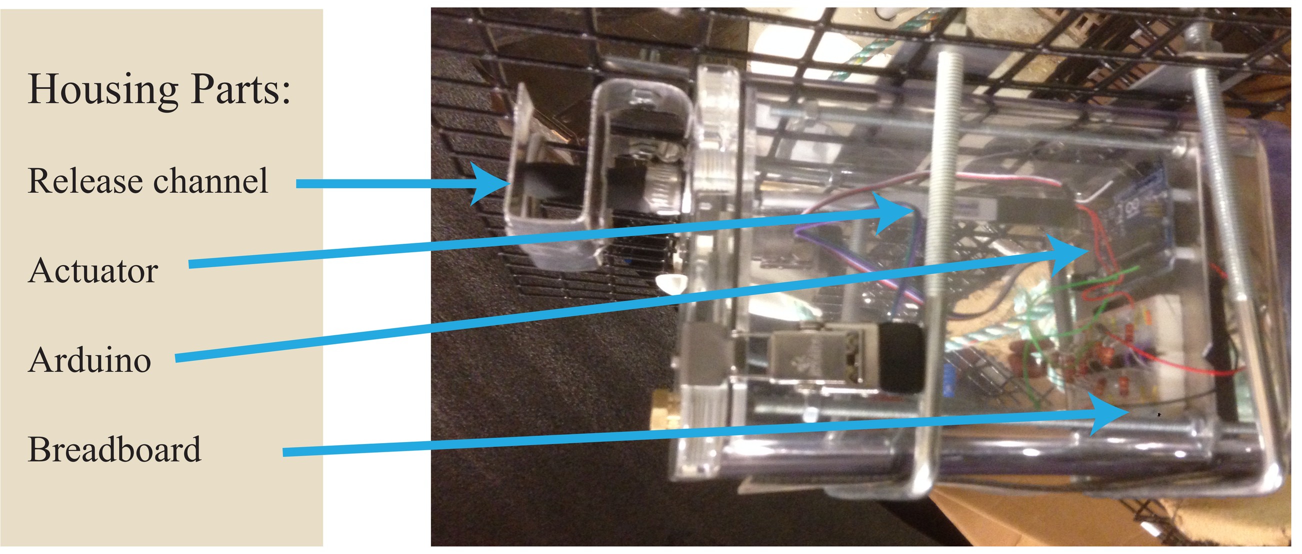
Design choice:

House buoy within a lobster trap to be released to the surface after a 1 kHz acoustic signal (sent by the fisherman) is received.

- Housing with a lobster trap allows the device to be easily attached to a lobster trawl.
- Releasing the buoy only when the fisherman is retrieving the trawl significantly minimizes the time the line spans the water column.



Graphic illustrating buoyless lobster trap operation.



Mechanical Design

Release mechanism:

The buoy is locked to the lobster trap using a metal loop on the buoy. This loop is held within a channel using a pin. This pin is contained within the electronics housing but is able to slide through a deformable rubber cover, allowing the buoy to become ‘unlocked’ from the trap. Pushing away the now-empty rubber cover, the buoy will rise to the surface using its own buoyant force. The buoy also unreels neutrally buoyant line attaching the buoy to the trap. The trawl is then retreived using conventional methods.

Waterproof electronics housing:

The clear acryllic housing is a modified Ikelite housing kit. It encapsulates the electronics required to trigger the release mechanism. This design requires two modifications to allow the hydrophone and pin to pass through the housing wall. The two holes are watertight using brass fittings. The hydrophone, which is stationary, is epoxied in place. The pin is sealed using a deformable rubber cover, allowing for maneuverability.

Pin in rubber cover locking buoy into trap.

Acknowledgements

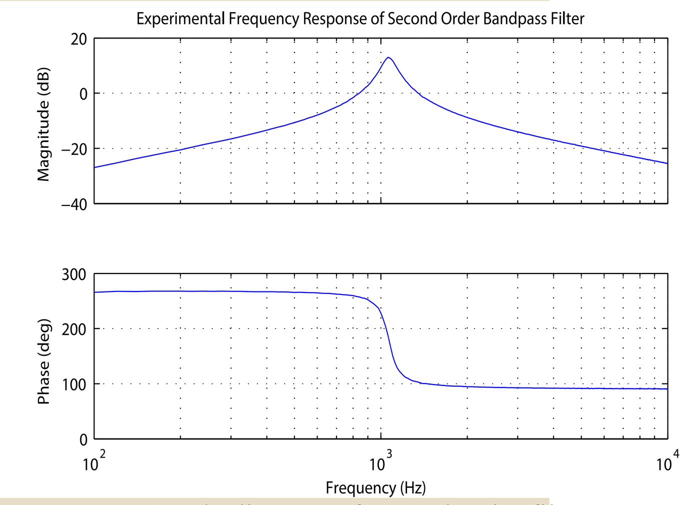
We would like to thank our faculty advisor, Kenneth Baldwin, for his support and guidance on this project. We would also like to thank the Mechanical and Ocean Engineering Departments for the use of their resources.

All pictures from Buoyless Lobster Trap group.
All illustrations created in Adobe Illustrator.

Electrical Design

Breadboard and Filter:

The acoustics around the trap are converted to a voltage using an Aquarian H1c piezo hydrophone. This voltage is sent to a filter. This second-order bandpass filter is designed to amplify frequecies within a 500 Hz band around 1 kHz. The resulting signal is amplified and offset by 3V to be accepted to the Arduino’s 0-5 V analog-in pin. The breadboard and Arduino are powered using a 12 V battery pack.



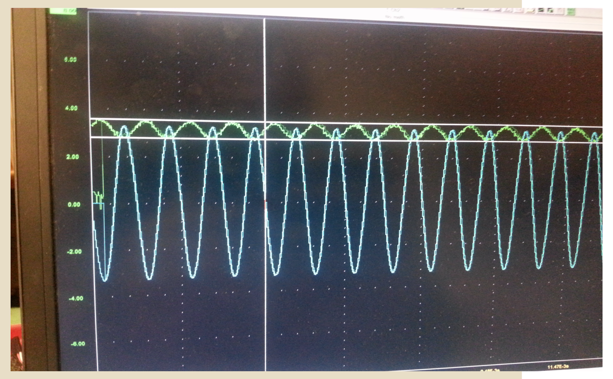
Bode diagram of second order filter

Arduino:

The Arduino computes the offset voltage and subtracts this value from the input signal, leaving the original amplified and filtered sinusoidal wave. The root-mean-squared voltage of the wave is calculated over a period of 10 ms. If the root-mean-squared voltage is greater than a set threshold 50 times consecutively, the Arduino activates the Trossen Robotics Firgelli Mini Linear Actuator. Once activated, the actuator retracts and pulls the pin into the housing. After waiting, the actuator returns to its original position.

Tests and Results

All tests were performed in UNH’s Chase Ocean Engineering Lab. The electrical system was tested across the width of the wave tank (~3m). A hydrophone was back driven with a function generator to produce an acoustic wave. The trigger hydrophone received this signal across the tank. The actuator only triggered when the driven signal frequency was within the 500 Hz bandwidth of the filter. This success will allow the system to be tested in the housing and submerged in the tank.



Oscilloscope display of driven signal (blue) and Arduino input signal (green) during tests.

Future Work

In the immediate future, the next step for this project is to test the whole system at various depths. Success here would lead to testing in Great Bay.

In the future, this design could be refined. The electrical system could be optimized for a more easily adopted signal, such as the 50/200 kHz waves used in fish-finders. Signal frequencies could be customized so that a certain pattern of frequencies unlocks the buoy: a personal password. The actuator can be replaced by one that can handle stronger buoyancies to implement this in an industrial fishing trawl at larger depths and with larger buoys.