Supplemental Material

Adaptable Swarm Sensing in Coastal Waters: Design and Performance of the μFloat System

Harrison *et al.*

1 External Sensors

1.1 Hydrophone Data

In both Lake Washington and Agate Pass, four floats were equipped with external hydrophones (icListen HF) to provide diagnostic data for the localization system and to demonstrate float adaptability. The hydrophone was mounted to the external fixtures on the side of the float, with soft rubber spacers for vibration isolation (Fig. 1). Hydrophones recorded with 156kHz sample rate and output raw time series .wav files.

Figure 1: Hydrophone mounted to the side of the μFloat.

An example spectrogram from Lake Washington computed from the hydrophone record is provided in Fig. 2, along with associated float behavior. Here, the float is holding depth at 40 m. Around 65 seconds, a recovery command is sent, and the float extends the piston at full speed. At 100 s, the piston is fully extended and the float is accelerating toward the surface. The localization pings are clearly identifiable in the 24-28 kHz band. Motor noise and noise from a vessel (likely the science team) are also evident in the 0-3 kHz band.

A set of three, 1-minute, compressed .mp4 files corresponding to this time period are included. For original full-fidelity .wav files, contact the first author. Note that 0 sec corresponds to 19:40 27 July 2020 UTC. Files are timestamped accordingly.

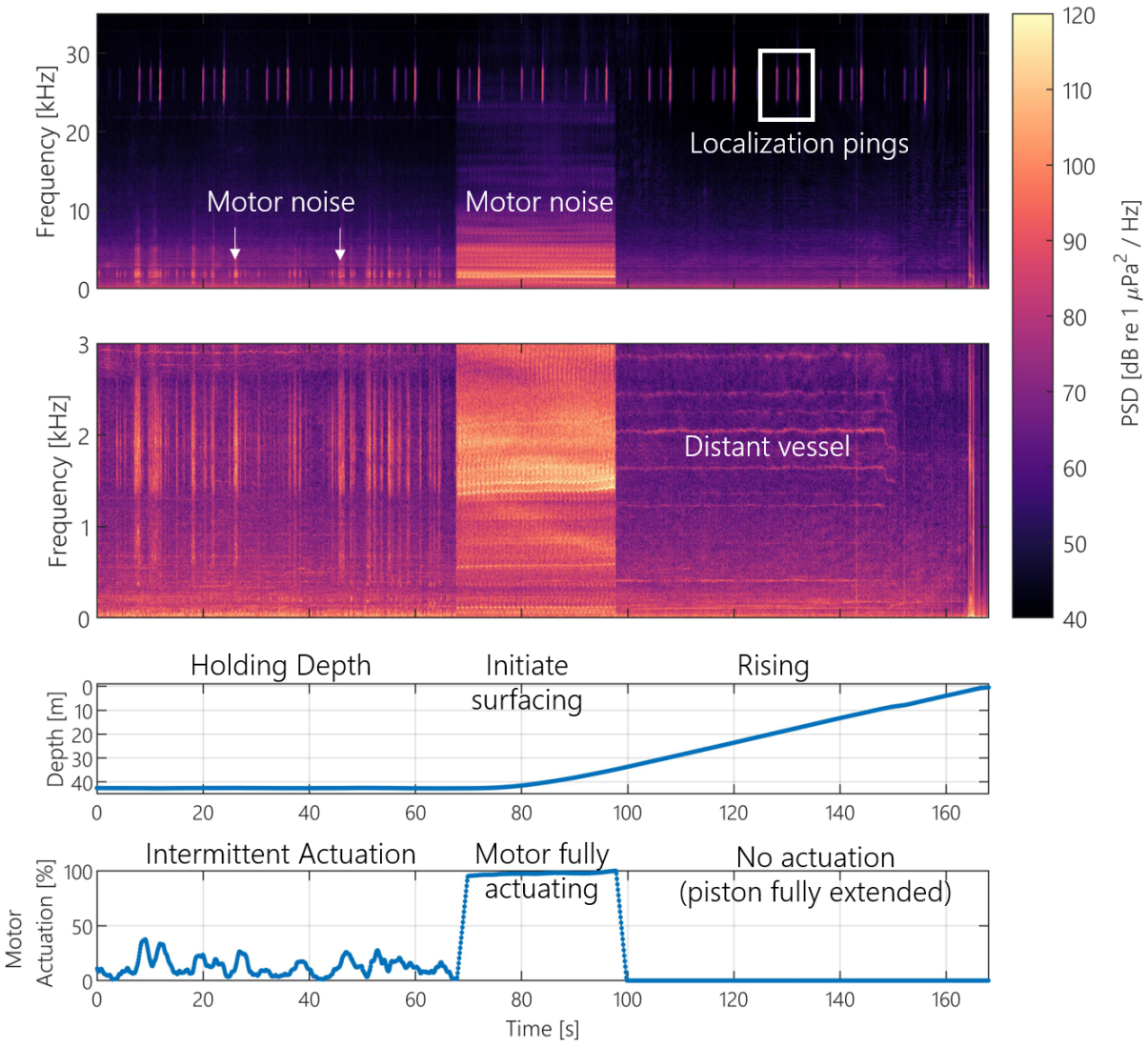

Figure 2: Example hydrophone data series. Upper two panels are spectrograms from hydrophone data. The upper-middle panel highlights 0-3 kHz frequency band, where motor noise is most pronounced, allowing alignment with motor actuation (lower-middle). Float depth (bottom) is shown for reference. The recorded nanomodem ping time stamps are overlaid on the hydrophone spectrogram (top panel). Note the ping indicators (circles and squares) are plotted near the 24-28 kHz nanomodem transmission band, but the y-values are arbitrary and offset vertically for clarity between original and shifted data.

1.2 GoPro Data

In both Lake Washington and Agate Pass, GoPros were attached to the outside of the float for supplementary diagnostic data (e.g., Fig. 3). In Agate Pass, we additionally sought to characterize channel bottom, in support of a future science effort there. For those tests, the GoPro was attached in a downward facing orientation. The included GoPro footage is from the first 1.5 minutes of a deployment around slack tide (low water velocity, 12:30 20 Aug 2020 local), at the south end of the channel, slightly to the east of the location of the flood exit jet. Note the float lacks awareness of the bottom depth and thus distance from the bottom varies through the video. Rotation of the float and camera is caused by conservation of angular momentum induced by the piston motor.

Figure 3: GoPro and supplementary light mounted to the side of the μFloat.

2 Operations

Supplemental media includes a video of float deployments from an early field test (May 2019) at the inlet to Sequim Bay, WA on a flood tide. This video demonstrates the ease of deployment and μFloat robustness. Video credit to Paul Murphy, APL.