Unmanned Aerial Systems (UAS) for marine mammal detection and underwater noise assessment

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Introduction: Underwater sound fields play a dominant role in the sensory perception of all marine mammal species. These species use acoustics passively and some actively for many of their critical life functions such as communication, navigation, foraging, predator avoidance and nurturing. Anthropogenic generated noise sources introduced into already complex acoustic environments has been the subject of intensive investigation for the last couple of decades. Potential impacts caused by the introduction of anthropogenic sound into marine habitats include physiological injury, either directly or indirectly, and changes in both long and short term behaviour. It is therefore necessary to assess these noise sources and keep them to known safe levels. Hydrophones are used to assess the sound fields, which are deployed via boats, drifting systems or moored long term acoustic data loggers. These operations are often expensive and complex requiring complicated equipment deployments, boat operations and personnel in what can be difficult and dangerous environments.

Figure 1) UAS used for deployment of underwater acoustics sensors

Concept: An add on system has been developed which can be rapidly flown from land or control vessel to a deployment site via a waterproof UAS platform. The UAS lands on a waters surface and deploys an underwater hydrophone, which would acquire and record acoustic data at a site, with the potential for real time transmission of the recorded signals to a central control point. The whole system would either quickly self retrieve back to base or redeploy to a new location. Multiple systems of this kind can be used to provide wide spatial acoustic array configurations, with the ability to dynamically reconfigure the acoustic sensors , which is difficult with boat-based deployments.

Figure 2a) Prototype UAS System flying to station

System Development: An initial proof of concept prototype was developed based on the Splashdrone (or Mariner II) small quad-copter UAS platform. This has a waterproof housing and is capable of landing and taking off from water with a total vehicle takeoff weight of 3 kg, which provides a payload capacity of 1 kg. A dedicated wide band data acquisition system has been developed using a National Instruments MyRIO platform which has 12-bit resolution and can log at a rate of 500 kS/s. This was integrated with a bespoke wideband (100Hz to 100 kHz) preamplifier and Brüel & Kjær 8103 hydrophone. Data was acquired continuously and written to an onboard solid state storage device.

Figure 2b) In-flight deployment of hydrophone system

Figure 2c) Hydrophone deployment (landed)

Results: Initial tralas were carried out using a calibrated noise source in the Loughborough University test tank. Open water trials were carried out in July 2016 in Bloody Bay, Isle of Mull, Scotland in the presence of both calibrated noise sources and harbor porpoise from an active aquaculture site. These trials showed that it was feasible to use a UAS for underwater based acoustic noise measurements, including marine mammal detection. The platform self-noise (in-flight and landed) was identified as an area of concern.

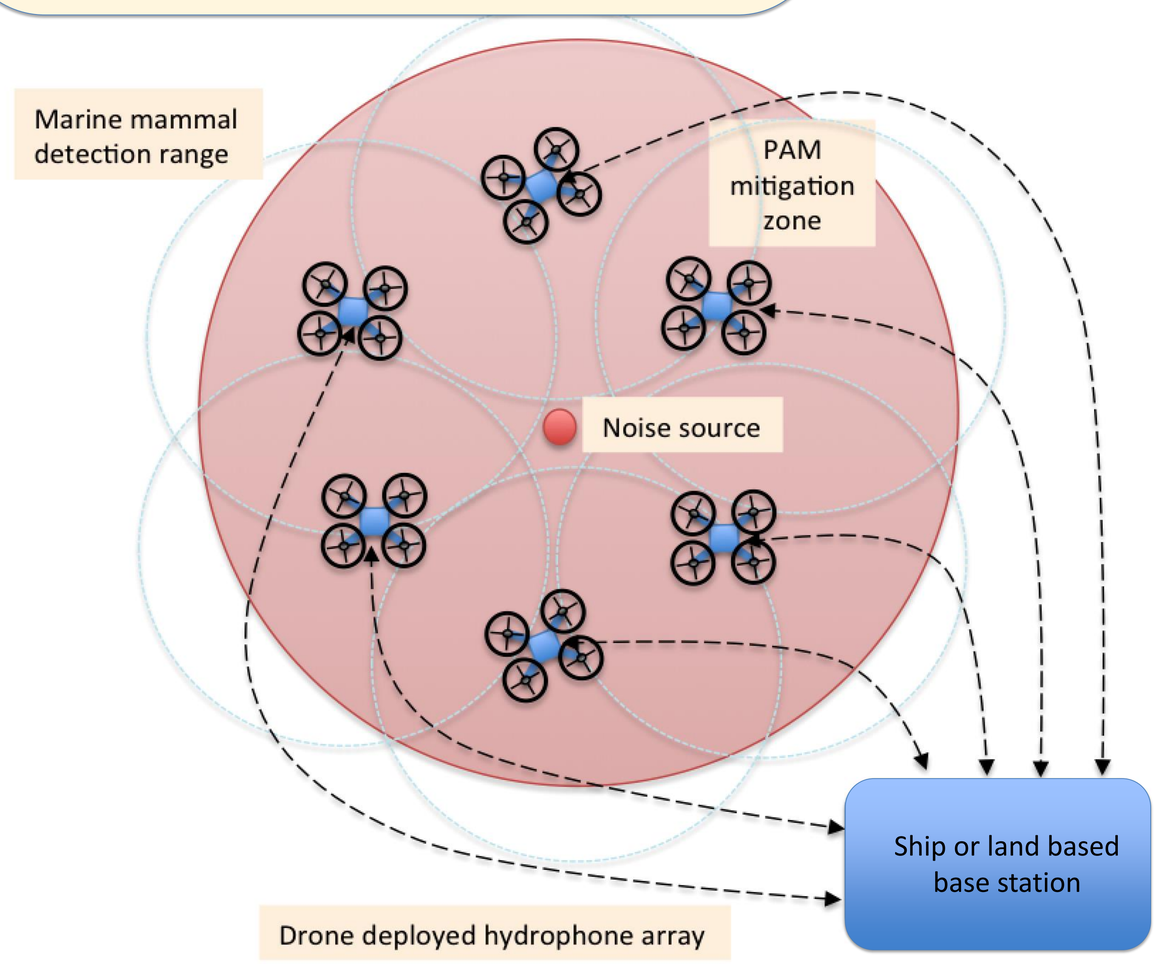

Figure 3) Large scale hydrophone array deployment concept

Conclusions: Data from a range of measurements and trials show that the UAS based underwater acoustic platform can be used for detection and assessment purposes. The system has the potential to rapidly deploy / retrieve large arrays of 'listening systems' which opens itself up to a wide range of applications including passive acoustic monitoring operations for noise events (piling, construction), long and short term monitoring of marine mammals, and underwater environmental acoustic surveys in a range of environments.

Future Work: A new improved waterproof housing for the logging system is being developed which will improve access to the hardware, as well as the ease in which the system is attached tot the UAS. The programming on the MyRIO will be upgraded to improve the way that it logs the data to the solid state storage, and make it easier for users to start and stop the system logging data from the hydrophone. The second version of the system will be tested against a conventional hydrophone setup under the same conditions to see if improvements have been made, and to assess how close the system is to a conventional one.

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