Use of Unmanned Aerial Vehicles (UAV's) for underwater noise assessment

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Introduction:

The underwater and airborne acoustic environment forms a critical part of many marine mammals life cycles. Assessment and development of understanding of these acoustic soundscapes is often vital in understanding many marine life and human operation interactions as well as species to species interactions in the natural acoustic environments. Traditional passive acoustic methodologies used for underwater sound and noise measurements include static hydrophones, autonomous loggers, boat-based deployments, towed arrays, drifter systems etc. Most of these systems however also rely on expensive and sometimes hazardous deployments and retrieval methods.

Concept:

The rapid growth in Unmanned Ariel Vehicles (UAV) technologies in recent years has lead to investigation of these platforms to act as enhanced aerial visual platforms for observing marine mammal behavior, abundance estimation etc. These systems are however often limited by battery life to relatively short in flight deployments. However these platforms can also offer the opportunity for rapid deployment of smart hydrophone systems over a relatively large spatial areas to include acoustic behaviors and sound scape analysis by flying to a site, landing on the water and then deploying underwater sensors. Whilst on the waters surface relative power consumption is significantly lower than in-flight allowing significantly longer deployments. Smart systems will then return to some base point with minimal human interaction.

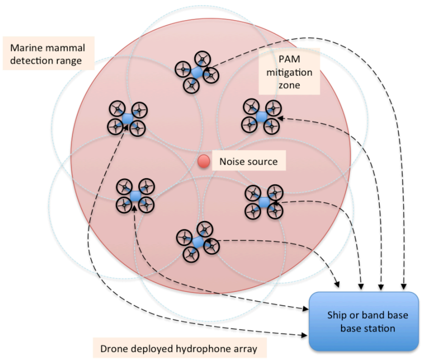

Figure 1) Large scale hydrophone array deployment concept

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Figure 2) Deployment of hydrophone system from a surface landing UAV

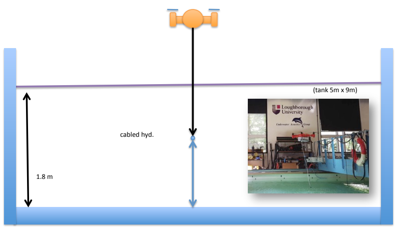

Figure 3) In-flight and landed self noise testing at Loughborough University acoustic test tank

Testing:

A prototype multi-rotor system has been developed and tested in July 2016 in Bloody Bay, Isle of Mull, Scotland , with a system capable of flying to site, landing on the water, deploying a wideband hydrophone for underwater noise assessment and then returning to base. Measurements include underwater noise self-noise analysis in-flight, landing, static and take-off and potential implications to marine wildlife. These developments and trials have demonstrated the overall feasibility of wide-scale rapid hydrophone deployment using UAVs for sound field and marine mammal behavior analysis. Current trials include calibration of on-board accelerometer packages for wave surface assessment as well as detailed in flight and landed self noise .

System Development:

A initial proof of concept proto-type was developed based on the Splashdrone (or Mariner II) small quad-copter UAV platform. This has a water proof housing and is capable of landing and taking off from water with a total vehicle carrying capacity of around 2.8 kg allowing a payload of around 1 kg. A dedicated wide band data acquisition system has been developed using a FPGA myRIO platform from National Instruments (12-bit 125 kS/s) . This was integrated with a bespoke wideband (20Hz to 200 kHz) preamplifier and Brüel & Kjær 8103 hydrophone. Data was acquired continuously and written to onboard solid state storage.

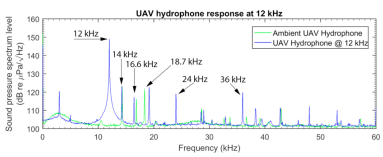

Figure 4) Acoustic measurements acquired from UAV of calibrated sound source during tank trials

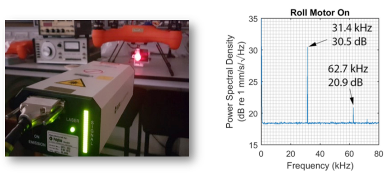

Figure 5 a-b) Camera gimbal self noise using laser Doppler vibrometer

Figure 6) Initial open water trials conducted in Bloody Bay, West coast of Scotland

Conclusions:

Data from a range of measurements and trials show that the UAV based underwater acoustic detection and assessment can be achieved on highly mobile and flexible platforms. The potential to rapidly deploy / retrieve large arrays of 'listening systems' for a wide range of applications for example PAM operation for noise events and long and short term monitoring of marine mammals and underwater noise in a range of environments.

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