Case Study: New Eyes for Marine Mammal Monitoring

By Seiche Ltd

The renewable energy sector is fast overtaking the demand for fossil fuel energy. In the North Sea and United States east coast, high resolution geophysical surveying, impact pile driving, ordnance removal and dredging operations are required for the construction of infrastructure to harness offshore wind, wave and tidal energy. Likewise, geophysical exploration for the remaining reserves of hydrocarbons and new exploration for deep ocean minerals are pushing offshore operations to ever more complex and remote environments. Despite improved awareness and global efforts to manage our marine resources sustainably, the impacts of offshore activities including the potential to injure or disturb marine wildlife remains a major challenge for marine conservation. There is, therefore, a continued need to provide comprehensive and effective 24-hour marine mammal monitoring and mitigation to ensure industrial operations proceed efficiently while minimizing the impact on the marine environment.

Marine mammal monitoring is achieved using visual and acoustic methodologies which follow mitigation guidelines designed to minimize the risk of injury and disturbance to marine mammals in the vicinity of industrial operations. Visual monitoring is carried out by marine mammal observer's (MMO) and acoustic monitoring is achieved using hydrophones which are towed astern of a survey vessel or suspended vertically from a platform. Hydrophone arrays are interfaced with a passive acoustic monitoring (PAM) system which is monitored in real-time to detect and locate marine mammals by their vocalizations. MMO and PAM methods are complementary and when used concurrently provide an effective strategy for marine mammal mitigation.

Visual monitoring methods rely on brief encounters of animals at the sea surface, whereas PAM requires the animal to produce vocalizations which are detectable audibly and by specialist detection software. The main limitations of observing marine mammals by visual methods is the availability of light and adverse environmental conditions resulting in reduced visibility which may include sea state, sun glare, precipitation and fog. The effectiveness of PAM is limited by underwater noises which result in the masking of animal vocalizations. Sources of background underwater sounds may include shipping traffic, industrial operations in the vicinity of the hydrophone sensors, self-noise generated by the survey platform or vessel and system noises generated by the PAM equipment itself. Despite efforts to optimize design and deployment of PAM hydrophone arrays, it remains a challenge to eliminate low frequency background sounds which may mask the vocalizations produced by some baleen whale species.

Seiche Ltd is a private UK company specializing in the design, development and manufacturing of underwater acoustic systems. Seiche was formed in 1996 to undertake underwater acoustics research projects, as the company was involved in the early stages of PAM with various university research groups. The company is now considered the worldwide leading supplier of PAM equipment to the oil and gas industry and expanding in the offshore renewables industry. With over 105,000 days of deployments across all systems, Seiche is fueled by technological innovations and interprets complex problems to solve some of the toughest challenges faced by academics and industry.

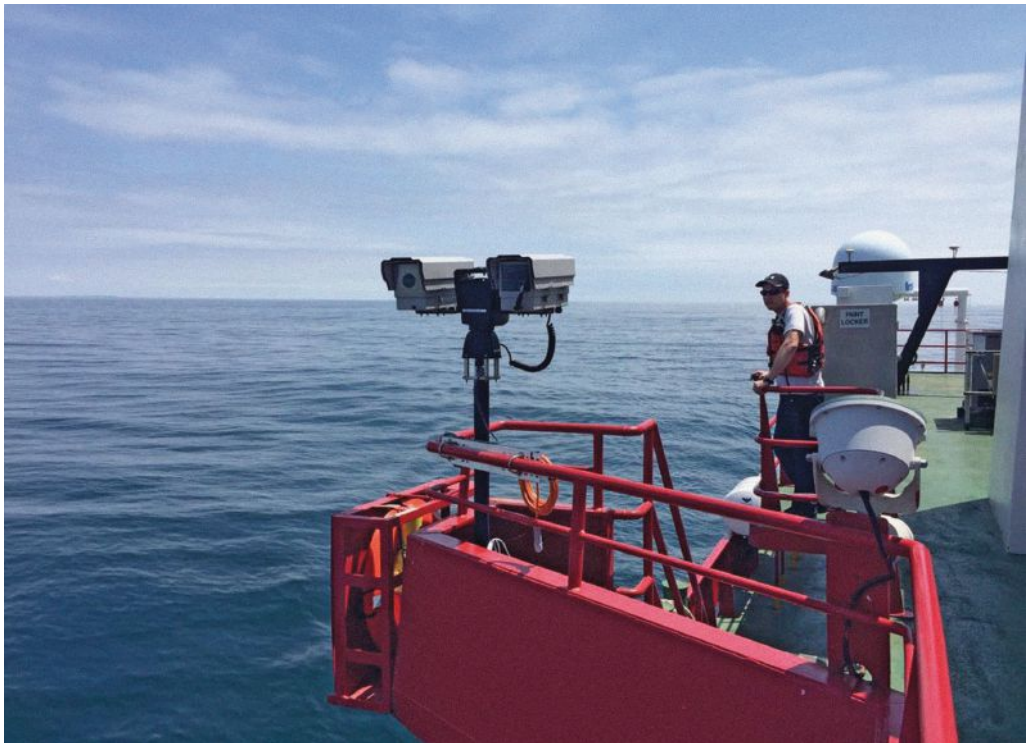
Seiche Camera Monitoring System

In 2013, Seiche began development of a Camera Monitoring System (CMS) to provide a solution to the challenge of low-visibility monitoring. The system uses dual thermal imaging and HD cameras mounted on an electronic pan and tilt unit to detect targets at sea including marine mammals, vessels, sea ice and other objects with a contrasting thermal signature to the water surface. Multiple camera units may be configured to scan segments of the horizon and provide a 360-degree view surrounding the vessel. The camera units are interfaced, and the CMS is operated in real-time from a camera monitoring station within the vessel. The CMS uses image processing software which enables automated horizon detection and distance calculation of thermal targets in real-time. Additional features of the software enable the automated detection of whale blows and calculation of the animals position relative to an exclusion zone surrounding the vessel, which significantly improves mitigation for marine mammals during the hours of darkness. The CMS provides an innovative solution to marine mammal mitigation and monitoring in poor visibility and, when paired with a PAM system, provides a comprehensive suite of technology which overcomes the challenges and limitations of low visibility mitigation for industrial operations.

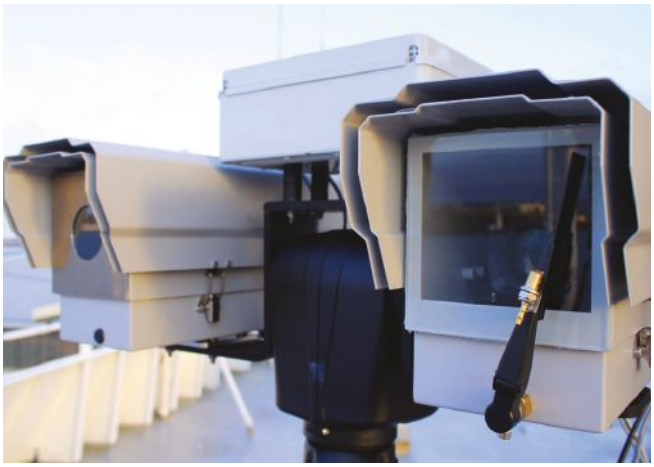
The CMS was developed at Seiche by Ladipo Baruwa and first trialed in South Africa in 2014 to detect southern right whales in the Western Cape. A single camera unit CMS was then installed and trialed aboard the NOAA vessel RV *Henry Bigelow* during an Atlantic Marine Assessment Program for Protected Species (AMAPPS) survey off the coast of Massachusetts for Northern right whales and sei whales in 2014. The voyage proved valuable for providing feedback on camera stability in sea conditions, for improving software design and GUI. Thermal images were monitored in real-time during the hours of darkness alongside a towed array PAM system, and concurrently with MMO visual monitoring during the daylight in good visibility. The CMS demonstrated its ability to detect whale blows at distances of up to four kilometers.

Its first commercial project was aboard the geophysical survey vessel RV *Geo Caspian* offshore Sakhalin Island, Russia in the summer of 2015 as part of the Western gray whale mitigation program. The first fully integrated three camera unit CMS was installed on the Fugro vessel RV *Fugro Enterprise* as part of a comprehensive mitigation suite for a geophysical survey of the inshore waters at New Bedford MA and Long Island NY in the United States. The system was operated at night alongside a Seiche PAM system while a team of MMOs covered daylight hours during a five-month project in 2017. In the summer of 2018, a three-camera unit CMS system was installed on the RV *Vyacheslav Tikhonov* to provide low-visibility monitoring during a geophysical survey offshore Sakhalin Island[1]. The system proved to be technically robust, handling long duration exposure to low temperatures and permitting 24-hour operations to proceed over a 10-week deployment. Dense fog reduced the visibility to less than one kilometer for more than half (53 percent) of the survey.

Despite the difficult conditions, the CMS recorded 49 detections of marine mammals, including five detections in low-visibility directly resulting in mitigation actions involving either a delay or shut-down of the seismic source. In a comparison trial with MMOs on board the survey vessel, 41 percent of CMS detections were by the CMS operator before being visually detected by the MMO, demonstrating the potential of the CMS for identifying marine mammals that may otherwise remain undetected by other visual methods.



The CMS continues to be used regularly throughout the United States east coast wind farm development and on geophysical surveys throughout the world. It has to date, provided over 500 low-visibility detections of marine mammals, contributing to more than 100 mitigation actions. The system has detected marine mammal blows at a distance of up to four kilometers, and has recorded verified detections of a number of species of whales including fin, sei, humpback, northern right, southern right, gray, sperm and minke, as well as orcas, common dolphins, stellar sea lions and a number of seal species sitting on sea ice.



In the United States, night-vision binoculars have been used to detect marine mammals during offshore surveys for several years. However, high quality night-vision binoculars are relatively expensive and require the MMO to be located outside at night, often in challenging conditions and with a clear vantage of the exclusion zone surrounding the vessel. The CMS enables its operator to remain within the safety of the vessels survey room where the monitoring station is located, while having a clear 360-degree view of the horizon. Besides the clear health and safety benefits of the CMS over night-vision binoculars, the thermal cameras used in the CMS have a significantly improved detection range than conventional night-vision binoculars. Even the highest quality night-vision binoculars have a limited range, which falls short of the range required to monitor an exclusion zone of 500 meters; meaning that marine mammals detected using night-vision are typically already well within the mitigation zone.

The CMS revolutionizes low visibility visual detection by providing a solution that enables a safe, robust solution to low-visibility monitoring at sea. The CMS also benefits from the specialized software Real-time Automated Distance Estimation at Sea (RADES) which was developed at Seiche specifically for integration with the CMS. RADES uses image processing techniques and horizon detection functions to accurately calculate distance and GPS location while overlaying the exclusion zone to enable quick and accurate mitigation decisions to be made for detected targets in real-time. CMS images and video recordings can be stored, reviewed and logged within the shared network storage system and detection events may be plotted to a georeferenced map display. The CMS augments the role of the MMO where conventional visual monitoring is limited by light. At present, as with all visual monitoring, fog and humidity remain a challenge for the CMS. It is therefore recommended that the CMS is used in combination with PAM to minimize missed detections of marine mammals due to any one systems limitation and to provide a comprehensive monitoring suite in low visibility.

From the first concept through to product release, the Seiche camera monitoring system has undergone several overhaul improvements including streamlining the electronics to reduce cabling, the inclusion of fully waterproof and robust camera and electronics housing, simple assembly and software configuration. The present version of the CMS is flexible and adaptable for different sized vessels and monitoring space and its networked storage device uses only two cables per camera unit for power and cat6 connectivity and horizon detection capability eliminates the need for expensive stabilization gimbles. The next generation of the Seiche camera monitoring system will focus strongly on improving the algorithms for automated detection of whale blows. This is now in the final stages of development and will be released later in the year. The CMS will also show improvements to horizon detection in the presence of humidity and fog, which is key for distance estimation and automated detection in difficult conditions. There are also planned improvements to the graphical user interface which will include improved map displays for plotting and tracking whale detection in real-time, and mechanical stabilization improvements to maximize camera coverage area in relation to vessel pitch and roll. In addition to improvements to the standard CMS, there is also the development of a low power system for integration and deployment on unmanned surface vehicles for autonomous long-duration surveys.

As the awareness of humankinds' impact on the marine environment continues to grow, there is ever increasing urgency to ensure that industrial practices resolve to minimize their footprint on marine wildlife. Physical injury from ship strikes and exposure to industrial sounds are a real threat to many vulnerable species of marine mammals. The behavioral disturbances that cause subtle changes in life strategy including breeding success, communication between family groups, predation and the nurturing of juveniles during the delicate early years of their lives are often difficult to quantify. It is therefore profoundly important that environmental mitigation continues to develop using improved technologies and techniques to provide a comprehensive marine mammal monitoring capability.

Ref:

1: Grigory Tsidulko (Independent Observer), Report of the Independent Observer on the 2018 Sakhalin Energy's Piltun-Astokh 4-D Seismic Survey, Western Gray Whale Advisory Panel 19th meeting, WGWAP-19/7 (corrigendum), 14-16 November 2018.

More Info:

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