

International workshop. Cetacean echolocation and outer space neutrinos: ethology and physics for an interdisciplinary approach to underwater bioacoustics and astrophysical particles detection



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3D multiple whale tracking

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First we present our real-time multiple whale tracking on large or short hydrophones array. Our algorithm is based on the transitivity of the Time Delay of Arrival (TDOA) computed from correlation of each couple of hydrophones [Glotin et al. 2008, 2009, patent USA,EU]. It results a high precision track without false alarm (online demonstrations at <http://www.youtube.com/watch?v=0Szo3gdiTRk>, <http://sabiiod.org/tv> : real fine tracking results computed on the widely spaced hydrophones of DCL 2005 Monaco challenge, record from Bahamas AUTECH). The TDOAs were computed after Teager-Kaiser or Stochastic Matching Filter which was more efficient [Benard 2010, 2011]. The shape of the track demonstrates some interesting observation and predation behaviours of the whale. Second we show that our algorithm is compatible with short spaced hydrophones base (2 meters square) as demonstrated using the Nemo Onde data (from INFN, CIBRA and the NEMO, data distributed within the 2009 DCL challenge by G. Pavan). In this purpose we firstly detect each click on each channel. A first static method consists in computing the position of each target, relative to the platform, using directly TDOA estimates, resolving the acoustic model with a maximum likelihood estimator for example. In parallel, we proposed a more dynamic tracking system base on particle filtering in presence of false alarms and an unknown and varying number of targets. This takes into account the problem of data association and is called the Rao-Blackwellized Monte Carlo data association (RBMCD) algorithm. Thus, we trajectography the whales and we can increase the state dimension to estimate other features such as speed. We compute the Cramér-Rao Lower Bound (CRLB) for the given array geometry and the confidence ellipses. This method allows us to locate several sperm whales with a reasonable accuracy [Benard and al. 2011]. This method opens new perspectives for compact military or civil whale monitoring and various behavior feature extractions. Third we show how sparse coding allow efficient TDOA estimation without knowledge on the pattern of the target. We demonstrate simple cosine metrics results on couple of hydrophone of the Mink whale data set (Hawaii) distributed at DCL 2011, and we discuss on the advantages of this approach for scaled tracking methods (Glotin with Razik, ASA ICA Montreal proceeding 2013). This work was supported by the inter-institute MASTODONS CNRS project Scaled Acoustic Biodiversity <http://sabiiod.org> & Institut Universitaire de France. Universitaire de France.

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