Real time classification of sperm whale clicks and shipping impulses from fixed ocean observatories.

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Abstract. *The automated acoustic detection of cetaceans in real time is an important tool to study their behaviour and distribution and for activating mitigation measures in the context of harmful anthropogenic activities at sea. Acoustic data from the NEMO ONDE deep sea observatory (Sicily) indicated that sperm whale clicks were present in 15 % of the recordings and impulsive ship noise in 10 %. The ship noise poses a serious challenge to the detection of sperm whale clicks, since it is an important source of false positives. As part of an integrated classification system, we present a classification module aimed at the automated and real time classification of impulses from sperm whales and shipping. The achieved classification performance indicates that it reliably separates a large proportion of sperm whale clicks from shipping impulses.*

Keywords. *Signal processing, bioacoustics, ocean observatories, shipping noise.*

INTRODUCTION

The automated acoustic detection of cetaceans in real time is an important tool to study their behaviour and distribution in the field and for activating mitigation measures related to human activities that are potentially harmful to them. However the classification in a fully automated way is challenging due to the diversity of acoustic events and background noises. Acoustic data from the NEMO ONDE deep sea antenna (-2000 m) indicated that impulsive ship noise was present in 10 % of the recordings and sperm whale clicks in 15 %. The ship impulses pose a serious challenge to the detection of sperm whale clicks, since they often share similar time frequency properties and hence could be the cause of many false positive detections.

As part of an integrated classification system, we present a classification module for the automated and real time classification of clicks from sperm whales and click-like sounds produced by shipping. The system also addresses the classification of other acoustic events (e.g. cetacean calls, ultrasonic cetacean clicks, tonal sounds from ships), which are not discussed here.

METHODS

The data used to assess the module's accuracy consisted of 42 and 70 segments containing Impulsive Ship Noise (ISN) and Sperm Whale Clicks (SWC) respectively. These segments have been chosen manually from data recorded at the NEMO ONDE deep sea observatory between 6 and 20 of May 2005.

The module is composed of two stages: The first stage, detects segments that contain mid frequency impulses and returns their location. The second stage only processes segments that contain a sufficient number of mid frequency impulses. It first extracts a set of features, which describe the temporal and spectral shape of each impulse. Then, it uses a feed forward neural network that returns, for each impulse, an estimated probability of being a Sperm Whale Click, p(SWC).

In order to assess the classification accuracy, a cross validation was performed, where data from an entire day was left out for testing and the remaining data used to train the neural net.

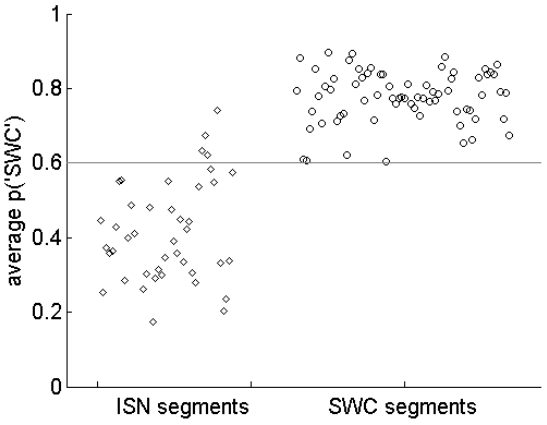

Fig. 1. The predicted probability of being a Sperm Whale Click p(SWC) has been averaged for each segment and is plotted as diamonds (ISN) and circles (SWC). For illustration a possible decision threshold is drawn at p = 0.6.

RESULTS

In order to obtain a decision value representing the whole segments, the average of p(SWC) was computed for each segment (Fig. 1). When a threshold is set at p = 0.6, such that all SWC-segments were correctly classified, 4 out of 42 ISN-segments were falsely predicted to contain SWCs.

DISCUSSION

The first stage detects segments containing SWCs but also many segments with ISN. Therefore this detector cannot be used as a proper SWC detector. Its main usefulness is to selectively return a reduced volume of data to the second stage, which divides the data into SWCs and ISN. The classification obtained from long data series could be used to estimate the relative changes in sperm whale presence around an observatory.

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