Detection and Identification of Marine Mammals sounds

Report

10th, May, 2022

Bioacoustics

Introduction

The detection and identification of acoustic emissions from audio files is a complex task that requires precise parameterisation operations to obtain the most reliable results possible.

The use of the PAMGuard software allows the detection of clicks and whistles of marine mammals, in particular sperm whales and striped dolphins. Documentation work was carried out to determine the characteristics of the sounds emitted and the implementation of the PAMGuard software.

This report provides an overview of what has been done and what remains to be done.

Figure 1: PAMGuard logo

Documentation

Sperm whale and Striped dolphin emission patterns

In order to implement the PAMGuard software, it is first necessary to know the means of communication of the marine mammals concerned (i.e. Sperm whales and Striped dolphins).

The first important element of this documentation is that it is known that dolphins emit whistles unlike sperm whales. This difference is important in the implementation of the signal detection and classification modules later on.

A second element to be documented is the component of clicks emitted by the two species. Indeed, in order to be able to identify them, it is necessary to be able to find differences in the way they emit this type of signal. From the articles on this subject and by cross-checking the information, it was possible to draw up an overview of the energy and frequency ranges mainly used by the two species.

References : National Research Council. 2003. Ocean Noise and Marine Mammals. Washington, DC: The National Academies Press.

	Sperm Whale	Stripped Dolphin
Frequency Range	100 Hz − 40 000 Hz	1 000 Hz − 30 000 Hz
Mean Frequency	3 000 Hz	15 000 Hz
Energy Bands	180 dB − 223 dB (2 000 − 40 000 Hz)	109 dB − 125 dB (7 000 − 20 000 Hz)

Figure 2: Table of characteristic parameters of the two species

PAMGuard Software

The implementation of a strategy for the detection and identification of characteristic spectra to classify a species requires a documentation work on several fields.

The first step was to carry out an assessment of what the PAMGuard software can do.

Indeed, from the documentation and tutorials available on the official website, it was possible to make an inventory of how to detect and identify acoustic signals.

References : PAMGuard tutorial

PAMGuard has modules that allow the DETECTION of clicks and whistles of marine mammals. These modules are very important for our project.

They are divided into two parts : A module for detecting whistles and a module for detecting clicks.

Moreover, they seem to be reliable and the documentation about them is very satisfactory to implement our own detection system.

PAMGuard also has IDENTIFICATION modules to allow the recognition of the species responsible for the characteristic noises.

These modules are also divided into two groups :

The whistle classification module

This module is useful for the identification of striped dolphins. Indeed, among the two species which interest us, only the dolphins emit whistles. The identification is thus facilitated and the implementation of this module does not seem to pose particular problems.
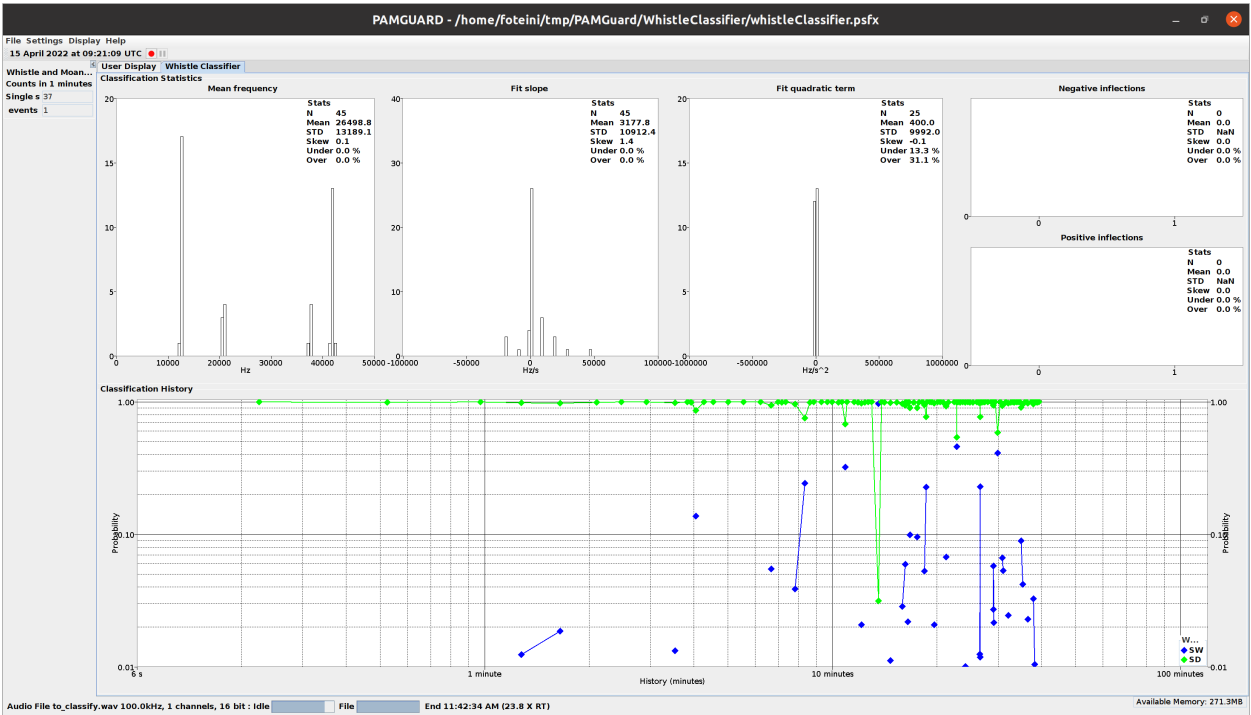

Figure 3: Probability of presence of a Striped dolphin (green) or Sperm whale (blue)

The click classification module

This module of PAMGuard is the one that poses the most problems in its implementation. Indeed, the clicks of sperm whales and striped dolphins are emitted in a very wide frequency range which does not allow a certain classification in all cases. It is therefore necessary to determine the best possible parameters to allow a satisfactory identification with the lowest possible false positive and false negative rates.

Difficulties

The classification of clicks is the most important objective of this part of the project, but it is also the most difficult.

The development of parameters for the classification between Striped dolphin and Sperm whale species is a complex task that requires precision. In addition, this module has very little documentation which gives the effect of going blindly through the software. Other classification modules available on PAMGuard have been considered but these have little or no functionality or documentation.

For a moment it was considered that the classification of clicks with the PAMGuard software was a dead end.

Other strategies

In the meantime, strategies to facilitate the classification of clicks have been outlined.

Data files Pre-processing

A first strategy would be to clean the signal before sending it to the PAMGuard software for analysis. Indeed, the sounds of the audio files are sometimes very noisy and the signal of interest can sometimes be very largely camouflaged. One idea would be to amplify this signal and to perform a succession of filters to clean up the signal and make it as clean as possible before analysis.

Classification of the detected clicks on MATLAB

A second option for the classification of the clicks would be to perform the detection on the PAMGuard software and to recover the data for processing on the MATLAB software. Some research has been done on the possibility of retrieving the data. This will require time to understand the structure of the data stored in software specific files.

Refercences : PAMGuard Binary files

Results

After having tried again to understand the functioning of the click classification module, it seems that a coherent result was obtained. Indeed, on 6 randomly selected audio files, we notice a trend in the identification of clicks that seems to correspond to the species concerned.
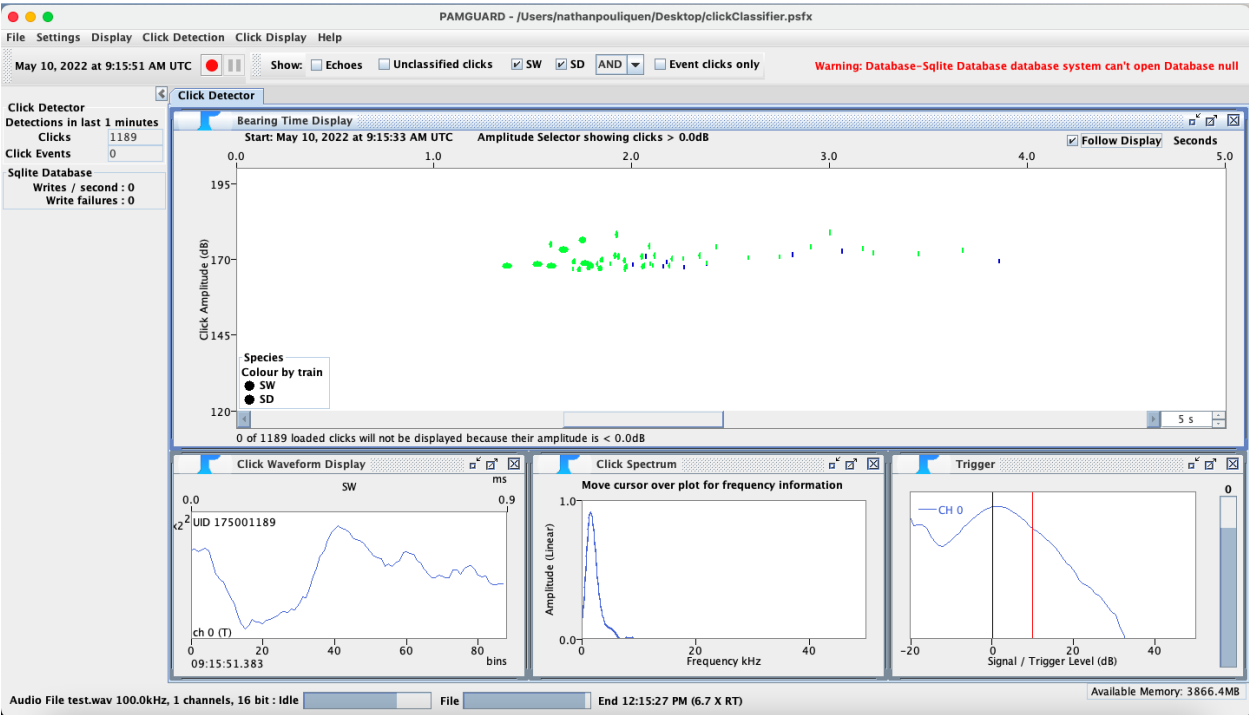

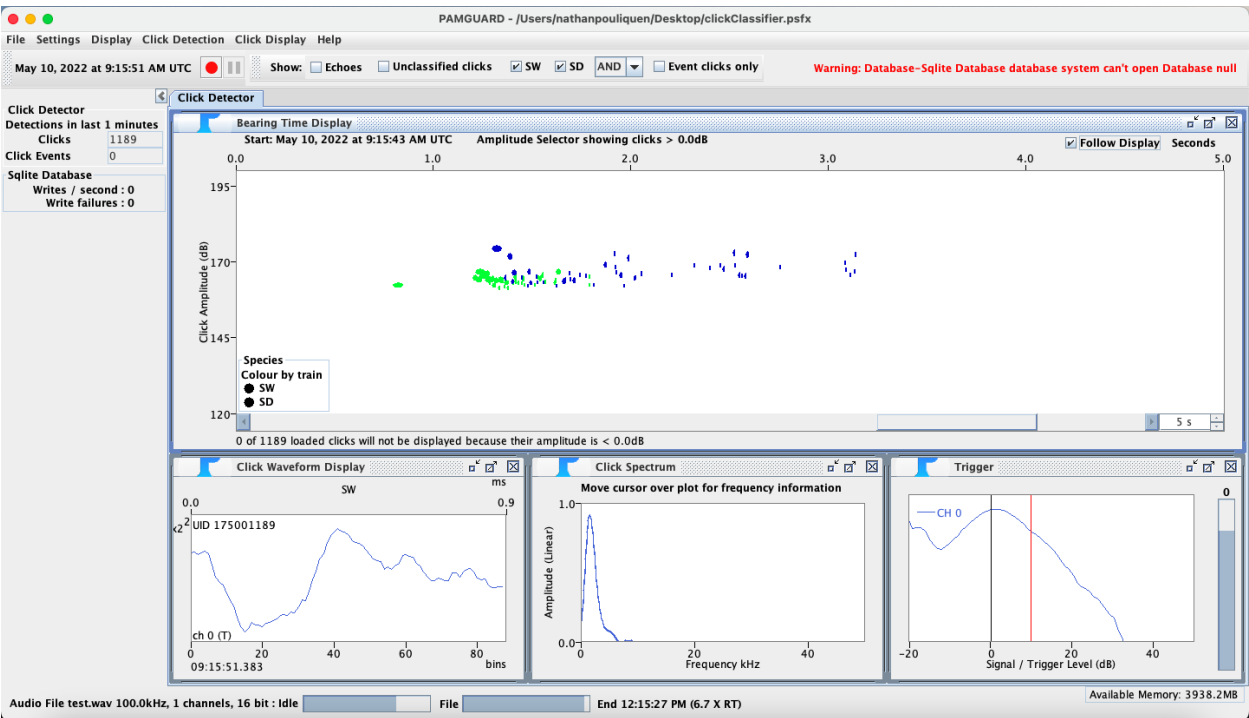Figure 4: Classification of clicks for a sound of Striped Dolphin (green)

Figure 5: Classification of clicks for a sound of Sperm Whale (blue)

It would therefore be interesting to work on the details to reduce the probability of error and thus make the classification module fully operational.

Conclusion

After this week of research and familiarisation, many avenues were explored and the first click classification results were obtained. However, it seems necessary to verify these results in greater depth to validate their credibility. If this is the case, it could be interesting to finalise the parameterisation and to test on other audio files.