COMPARISON OF TWO METHODS FOR DETECTION OF NORTH ATLANTIC RIGHT WHALE UPCALLS

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ABSTRACT

In this paper, a study is carried out for detecting North Atlantic Right Whale upcalls with measurements from passive acoustic monitoring devices. Preprocessed spectrograms of upcalls are subjected to two different tasks, one of which is based on extraction of time-frequency features from upcall contours, and the other that employs a Local Binary Pattern operator to extract salient texture features of the upcalls. Then several classifiers are used to evaluate the effectiveness of both the contour-based and texture-based features for upcall detection. Detection results reveal that popular classifiers such as Linear Discriminant Analysis, Support Vector Machine, and TreeBagger can achieve high detection rates. Furthermore, using LBP features for call detection shows improved accuracy of about 3% to 4% over time-frequency features when an identical classifier is used.

Index Terms— North Atlantic Right Whale, Local Binary Patterns, Spectral Denoising, Upcall Detection.

1. INTRODUCTION

Noth Atlantic Right Whale (NARW) is one of the critically endangered whales as the decline in its population is not compensated with its low birth rate [1]. It is recorded that some 300-500 individuals remain off the east coast of North America [2]. Therefore, it is important to be able to detect the presence of such animals in high-risk areas in order that mitigation measures protecting them from such damages as collision with ships may be activated. Passive acoustic methods have been shown to be the most effective mechanisms for determining whale presence in critical habitats [4]. Upcalls are narrow-band frequency-modulated chirps in the 50-250Hz frequency band produced by NARW for long-range communication [3].

The detection of NARW upcalls has attracted researchers in the field of bioacoustics since these species are highly endangered and automatic detection systems have to be developed in order to find right whale calls amidst other marine mammal vocalizations. Mellinger [5] compared the performance of spectrogram correlation and neural network methods. The former uses an optimization program to find the synthetic kernel that best correlates to a sample space of 20 right whale upcalls. The latter method trains weights of a NN via backpropagation on 9/10 of the test dataset. The neural network performed better, achieving an error rate of less than 6%. Munger *et.al* [6] also used spectrogram cross-correlation with a synthetic kernel [7] for automatically detecting right whales using the software program *Ishmael* [8]. Despite the high number of false detections and missed individual calls, Munger's spectrogram cross-correlation helped a human analyst identify segments of data that contained right whale calls with high probability. Gillespie [9] constructed a two-stage detector where the vocalization outlines are extracted from a smoothed spectrogram using an edge detection method. In the second stage, parameters measured from time-frequency contours are fed into a classifier to determine the sounds associated with right whales. The problem was also addressed by Urazghildiiev *et.al* [10] who used a generalized likelihood ratio test (GLRT) detector of polynomial-phase signals with unknown amplitude and polynomial coefficients observed in the presence of locally stationary Gaussian noise. The closed form representation for a minimal sufficient statistic was derived and a realizable detection scheme was developed. The performance was shown to be superior to other detection techniques. Urazghildiiev and Clark [11] designed an automatic detector for a passive acoustic NARW monitoring system that determines the time of signals' occurrence but a human operator makes the final decision after spectrogram inspection of the marked areas.

In this paper, we propose two new texture-based techniques for NARW upcall detection. The first method performs elaborate pre-processing in order to isolate a spectrogram contour associated with an upcall and drives time-frequency parameters from the contour to use feature vectors for classification. The second approach applies the Local Binary Pattern (LBP) operator on a region of interest in the spectrogram to capture important texture features. Finally, both types of features are fed to classifiers and detection results are evaluated.

2. PROPOSED FEATURE EXTRACTION ALGORITHMS

Both procedures for NARW upcall detection proposed in this section consist of several steps to extract either contour features or texture features for the purpose of upcall detection.

2.1. Contour-based approach

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