Detection and Analysis of Irrawaddy Dolphin Signals

Mirza Imran Baig Abdul Raheman¹, Dr. Sanjay L. Nalbalwar²

¹²Electronics and Telecommunication Department Dr. Babasaheb Ambedkar Technological University, Lonere, Raigad, M.H., India.

Abstract— Many initiatives are being carried out in order to understand and protect the underwater life of marine mammals such as whales, dolphins and porpoises. For the purpose of conservation of these mammals, it is necessary to understand their ecology, especially their underwater behavior in the wild environment. In this paper, we present a method using wavelet denoising, spectrograms, etc to detect and analyse the sound signals produced by the Irrawaddy dolphins found in the Chilika Lagoon area of the Indian Sub-continent. The data is obtained from long passive acoustic monitoring recordings in the Chilika Lagoon Lake.

Keywords— Echo-location clicks, Irrawady Dolphin, Spectrogram.

I. INTRODUCTION

River dolphins and porpoises are among the world’s most threatened mammal species. The habitat of these animals has been highly modified and degraded by human activities, often resulting in dramatic declines in their abundance and range (Reeves et al., 2000)[1].

Attempts to conserve the critically endangered population of Irrawaddy dolphins (Orcaella brevirostris) are an example of the challenge of conserving endangered species in complex economic, political, and social situations. This Irrawaddy dolphin population is small, declining, and facing numerous threats to its survival.

The Irrawaddy dolphin inhabits inshore coastal, freshwater isolated and semi-isolated habitats in south and south-east Asia, where it frequently competes with humans for space and resources. It is globally classified as ‘Data Deficient’ by IUCN (2007) standards and five of the seven known subpopulations worldwide are listed as “Critically Endangered”. This represents almost half of all the subpopulations of cetaceans which are “Critically Endangered” worldwide. Fisheries by-catch and tourism related mortality are the two main factors which serve as direct human threats on the Irrawaddy dolphin. They are also the two main platforms on which the dolphins and humans interact.

Chilika is the largest brackish water Lake and a Ramsar site, located along the east coast of India.

It is identified as one of the most significant hotspots of biodiversity in the region that harbours the largest population of Irrawaddy dolphins (Orcaella brevirostris). Irrawaddy dolphins species is found only in South and South East Asian waters. The dolphin population of Chilika Lake in India and Songkhla Lake in Thailand are two isolated or partially isolated lake populations.[2]

Every year a large amount of marine mammal vocalizations are recorded and studied for a variety of purposes such as research on behavioral and contextual associations, animal detection and localization and census surveys. Most of these natural signals of interest are non-stationary waves that are well suited for analysis using time-frequency representations (TFRs). This thesis focuses on the analysis of dolphin vocalizations using spectrograms, which are TFRs based on the short-time Fourier transform (STFT).

The frequency of the sounds produced by dolphins ranges from 0.2 to 150 kHz. Higher frequency clicks (40 to 150 kHz) are primarily used for echolocation whereas the lower frequency vocalisations (about 0.2 to 50 kHz) are likely used in social communication.

From a research perspective, scientists are more and more interested in passive acoustic monitoring (PAM) of cetaceans: Classic cetacean surveys have used visual detection methods and were mainly based on observations of surface behavior, but there is a growing awareness that many species of interest may be easier to hear than to see since the daily life of cetaceans is mainly based on acoustics. PAM systems allow humans to eavesdrop on cetaceans without interfering too much with their activities.

As part of the monitoring process, one has to deal with the limitations of archival systems when storing and processing audio data.

Dolphin whistles form time-frequency contours that are complex, overlapping, and unpredictable.

The proposed method is for denoising and processing the sound data can vary significantly and are mostly adapted to the specific purpose of the algorithm. One approach is to search for peaks in the time and frequency domain using spectrogram analysis, whereas other methods focus on tracking tonal sounds using Bayesian filtering.
II. THE SONAR OF DOLPHINS

From the classification of whales, as Odontocetes (toothed whales) and Mysticetes (baleen whales), the Odontocetes are capable of echo locating the objects using the echo location clicks. The sonar clicks or pulses generated by dolphins are broadband signals.

Sonar clicks typically come in groups of four to eight, which are known as click trains[5]. Their duration is typically 40 to 70 μs. However, recorded echolocation clicks of the northern right whale showed mean click train duration of 310 μs and a maximum click train duration of 630 μs. Sonar click trains are produced at time intervals, known as click intervals or interclick intervals that are typically 20 to 40 ms longer than the time they expect the echo to arrive. Dolphins generate sonar signals of a wide range of frequencies and intensities. Data analysis have shown that there is a linear relationship between center frequency and signal intensity in decibels. High intensity signals often correspond to higher frequencies of 100 kHz or higher. Low intensity signals often correspond to lower frequencies of 30-60 kHz[9].

III. DATA COLLECTION

Passive acoustic monitoring is increasingly being used for towed hydrophone line transect surveys and for remote, long term monitoring of populations using autonomous instruments [8]. Recent technological advances allow long term recordings to reach higher bandwidths, which prompts research into use of higher frequency calls for species classification. In Chilika Lagoon, array of six hydrophones is used to obtain the recordings during daylight hours. The data is sampled with sampling frequency 500 kHz per channel and resolution of 16 bits.

IV. DATA ANALYSIS

For the analysis purpose two different sound files were tested through this algorithm.

The files were randomly selected through manual process, first file was manually edited at the 10th minute of the original recording which was about 3 seconds long whereas second was edited manually at the 10th minute of the second recording obtained which runs for about 4 seconds.

In this algorithm, the dolphin sound signal to be analyzed first is denoised using Stationary Wavelet Transform with the help of different mother wavelets. The spectrogram is used to perform analysis of the dolphin sound signal. Based on the spectrogram data, the total energy of the dolphin signal at each spectrogram time slot is computed. This total energy at each time slot is then used to determine when actual dolphin sound activity starts and when it ends. In order to determine when there is a start and end of dolphin sound activity, the reference noise level is computed from the total energy level at each spectrogram time slot.

The reference noise level is set to be the total energy level of the first spectrogram time slot prior to two consecutive time slots that have higher total energy levels. Therefore, function yields best results if the beginning of the dolphin sound signal is composed exclusively of noise and no signal of interest. To detect the start of dolphin sound activity at a spectrogram time slot, the total energy of that time slot needs to be higher than 2.5 times the reference noise level. To detect the end of dolphin sound activity at a spectrogram time slot, the total energy of that time slot need to be lower than 2.5 times the reference noise level.

The factor 2.5 was chosen experimentally because it yielded accurate detection of start and end of dolphin activity.

V. RESULTS

After processing of the signals from the database, the following results were obtained.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>BW(-3dB)</td>
<td>45-83KHz</td>
</tr>
<tr>
<td>2.</td>
<td>Fc(KHz)</td>
<td>90-120KHz</td>
</tr>
<tr>
<td>3.</td>
<td>Fp(KHz)</td>
<td>83KHz to 146KHz</td>
</tr>
</tbody>
</table>
1. Peak Power at each frequency

![Graph of Peak Power at each Frequency](image)

Figure 1: Peak Power obtained of Irrawaddy Dolphins at each Frequency

2. Spectrogram of the signal

![Spectrogram](image)

3. Detection of start and end of the clicks

![Detection of clicks](image)

REFERENCES


[3] Prof. Prafulla Kumar Mohanty, Dr. Sanjaya Narayan Otta, Orissa Review, June 2008, Dolphins of Chilika,


