Chapter 51
Automated Whale Blow Detection in Infrared Video

Varun Santhaseelan
Auviz Systems Inc., USA

Vijayan K. Asari
University of Dayton, USA

ABSTRACT

In this chapter, solutions to the problem of whale blow detection in infrared video are presented. The solutions are considered to be assistive technology that could help whale researchers to sift through hours or days of video without manual intervention. Video is captured from an elevated position along the shoreline using an infrared camera. The presence of whales is inferred from the presence of blows detected in the video. In this chapter, three solutions are proposed for this problem. The first algorithm makes use of a neural network (multi-layer perceptron) for classification, the second uses fractal features and the third solution is using convolutional neural networks. The central idea of all the algorithms is to attempt and model the spatio-temporal characteristics of a whale blow accurately using appropriate mathematical models. We provide a detailed description and analysis of the proposed solutions, the challenges and some possible directions for future research.

INTRODUCTION

Video sensor technology has taken off in a big way in recent times facilitating the collection of vast amounts of data for various purposes. Analysis of large amounts of data, be it for whatever purpose, requires automation. Automated image and video analysis algorithms mitigates the need for a human analyst to sift through millions of images or days of video data. Study of the migratory patterns of whales is one area where a lot of time is spent by researchers in going through hours of video data to detect the presence of whales in any part of the ocean. The presence of whales is indicated by the blows from whales and the timing between blows gives an approximate idea of the number of whales in any area.

DOI: 10.4018/978-1-7998-0414-7.ch051

Analyzing videos to find where the blows are is a mundane task and it would be of great help to the researchers if an automated system could provide the data by analyzing the video.

In this chapter, solutions to the problem of automated whale blow detection are proposed. The chapter delves into the details of multiple solutions designed so far, their advantages and disadvantages and the challenges that lie ahead. The goals of the solution are: (1) provide high accuracy in terms of detection, (2) reduce the number of false positives, and (3) provide a real-time solution. While the goals seem to be trivial, varying environmental factors make the task harder than expected. Therefore, a multi-stage approach is adopted to detect the presence of whale blows.

The central aim of the algorithm is to provide a suitable framework that could extract the characteristic shape variation of a whale blow from video. While complex shape extraction techniques may be used, the real-time constraint requires simpler pre-processing techniques to be adopted. In this chapter, three methods are discussed– (1) method based on neural networks (multi-layer perceptron) and simple thresholding techniques (Santhaseelan et al. (2012)), (2) method based on local relative variance and fractal features for shape description (Santhaseelan and Asari, 2013), and (3) method based on convolutional neural networks. In addition to whale blow detection, it would also be possible to roughly track whales based on the timing of blows (Rice et al (1984)). This is however an ill-defined problem and only an estimate would be available.

BACKGROUND

The use of infrared imagery to study the behavior of marine mammals was explored by Cuyler et al (1992). An extensive study of gray whale migratory behavior was done by Perryman et al (1999). The paper also explains in detail the different sea conditions that could affect the detection of whale blows and thus affecting the tracking procedure. An extensive study into the detection of whales from thermal imagery was done by Graber et al (2011) too. The research focused more on detection of whales depending on the shape characteristics of whales rather than the detection of whale blows. Another system for automated whale detection has been implemented by Zitterbart et al (2010, 2011). Their system was developed to detect the presence of whales in the vicinity of a ship.

Apart from the aforementioned research, not much work has been published in relation with whale detection. Other research has focused on horizon detection and object detection in sea. The problem is of interest because of the nature of ocean surface. The texture keeps varying according to environmental factors and any algorithm that is used to detect specific patterns in such a dynamic background has to account for these factors. This problem holds true for the case of whale blow detection as well.

The work presented in this chapter is new and therefore there are no comparisons to be made apart from the previous work of the authors. The rest of the chapter is organized as follows. Characteristics of whale blows in infrared video are listed in the next section. The section following that would present a neural network based methodology to detect whale blows. The section after explains in detail about how to use fractal features as a tool to represent dynamic shape variation. This is followed by another section on a solution using convolutional neural networks. The final section gives a summary of the work done so far along with some insight into possible avenues for future research.

Related Content