Individual Manta Ray Identification With Deep Convolutional Neural Networks

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Overview

Manta Rays have distinguishing spot patterns on their ventral area that can be used for individual identification, in a similar fashion to human finger prints. Marine biologists have been using these patterns to identify mantas and keep track of them. However, so far this has mainly required human effort and frequent dives. This project uses deep learning techniques to automate and speed up the process.

Aims and Objectives

- Show that deep Convolutional Neural Networks can be applied to individual manta ray identification,
- Eliminate the need for animal 'tagging' for the purposes of individual monitoring in the wild,
- Show how data augmentation techniques can improve the outcome of identification of marine animals and
- Provide a database of manta ray tracking for marine research and conservation.

Architecture

- An image as seen below is pre-processed and cropped to a bounding box so as to minimize lighting interference and distance
- Images used for training go through several augmentation techniques e.g. rotation, affine transform, perspective transform etc. An example of an affine transformed image can be found below
- The augmented images are fed into a currently simple CNN of 6 convolutional layers all followed by maz-pooling and ending in 2 fully connected layers.

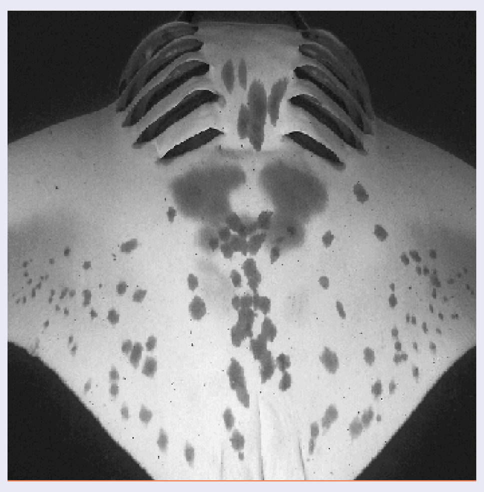

Figure: Example of an image pre-processed to its bounding box and in gray scale so as to eliminate color interference

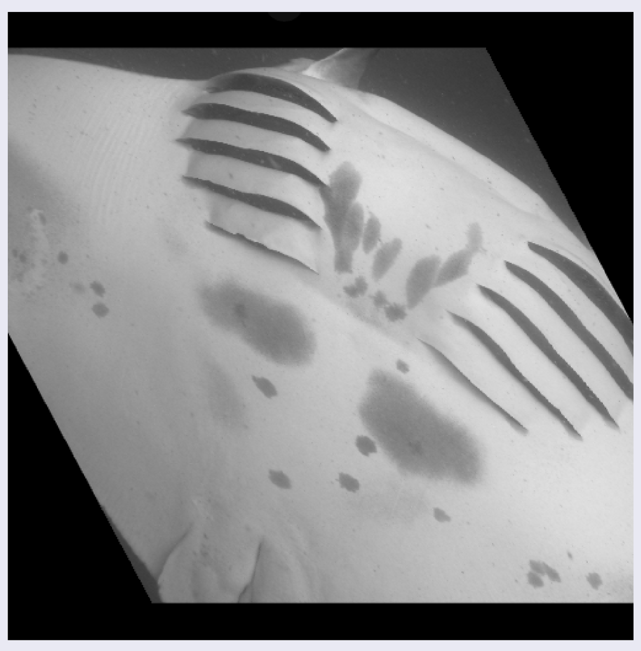

Figure: Example of an image with affine transformation applied

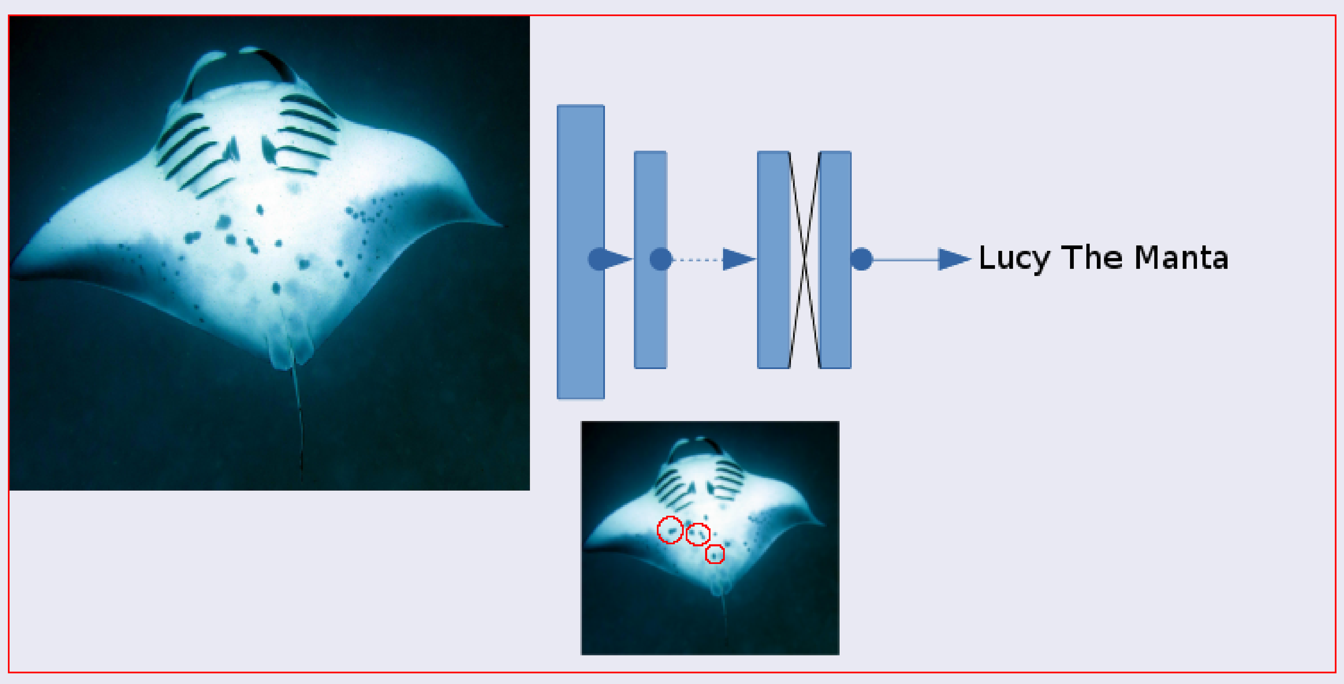

Figure: High level overview of the architecture

Challenges

- Creating a model that is invariant to the nature of marine photography i.e. lighting conditions, perspective, position and 'marine snow' interference,
- Creating a robust model from a relatively small dataset.

Project So Far

- Simple CNN implementation training on 100 individuals
- Implemented in Python using the Tensorflow library
- Investigating data augmentation techniques to significantly increase the dataset size
- Using the imgaug python library for image augmentation that It converts input images into a larger set of slightly altered images.

The work on the project so far mainly consists of augmentation techniques so as to account for situations such as seen in the figures below where the same manta ray may have images taken from significantly different angles and/or lighting conditions.

Figure: Image taken face on to identifying pattern of Manta X

Figure: Image taken at a perspective of Manta X

Further Work

- Improve robustness with further data augmentation
- Increase number of individuals to train on
- Improve network such that it can handle new classes i.e. individuals
- Deploy service in a web application

Acknowledgements

- Krizhevsky, A. Sutskever, I. Hinton, G. Imagenet classification with deep convolutional neural networks.
- Moskvyak, Olga, Maire, Frederic D. Learning geometric equivalence between patterns using embedding neural networks

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