AUTOMATING AERIAL IMAGE PROCESSING & ANALYSIS WITH MACHINE LEARNING

Duration: 36 months (May 2019 to May 2022)

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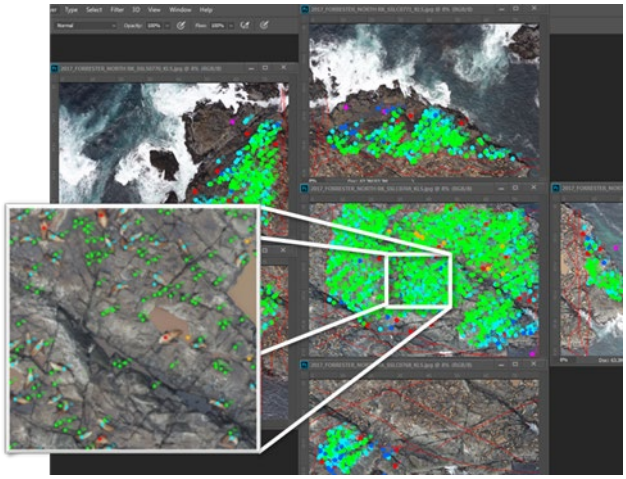

Steller sea lion aerial images arranged manually for a site and lines drawn to prevent double counting animals in overlapping images. Dots on images are placed on each animal for counting (different colors for different age-sex classes).

The Marine Mammal Laboratory (MML; NOAA Fisheries) is responsible for the stewardship of certain marine mammals and their habitat, protected under the Marine Mammal Protection Act (MMPA) and for listed species, the Endangered Species Act (ESA). Under the mission of NOAA Fisheries, MML conducts important population assessments to monitor protected species, and conducts research towards recovering depleted or endangered species and to help inform management decisions. Population studies are necessary to discover the underlying cause for declining populations. Specifically, regular abundance information is fundamental for monitoring populations and this information is used in the validation and enhancement of population models.

The western Steller sea lion stock is listed as Endangered under the ESA and is protected under the MMPA. This population has continued to significantly decline in a portion of its range in Alaska (in the western part of the Aleutian Islands) and is showing impacts from the increasingly prevalent warm water anomalies in the Gulf of Alaska, due to climate change. MML developed a UAS-based strategy to augment annual abundance surveys in 2014. Moving forward, this strategy has allowed MML to accomplish regular and consistent surveys of the most sensitive parts of the Steller sea lion population in Alaska.

Processing and analyzing these aerial images to collect sea lion counts is a time-consuming and costly process involving two, full-time MML personnel as independent counters. The first step involves manually puzzling together one to 100 images that comprise a site and drawing lines to exclude areas of overlap to avoid double counting sea lions. Individual sea lions are counted and identified as one of the five age-sex classes. Once counts are complete, the two independent counters reconcile their counts with each other to eliminate errors such as double counting or missing areas. In total, this process typically takes three to four months. These counts must be completed in a timely manner as they are eagerly anticipated by stakeholders, such as NOAA's Alaska Regional Office, industry, and environmental groups.

MML was awarded funding through the 2019 UAS Program Office RFP to work with experts in the field of artificial intelligence (AI) to develop a program to automate image processing and counts. Such a program is projected to significantly reduce the amount of time to produce final counts, requiring up to 75% fewer resources. MML contracted Kitware, developers of Video and Image Analytics for Marine Environments (VIAME; in cooperation with NOAA Fisheries) an open-source system for analysis of video and imagery and contains a number of different workflows for the generation of different object detectors, full frame classifiers, image mosaics, and methods for stereo measurement.

In the first year of this effort, MML has been working successfully with Kitware to convert previously counted images (with sea lions annotated with dots for each age-sex class) to box annotations. This is achieved by using a rudimentary sea lion detector and honing in on the sea lions with dots placed over each animal. With this first attempt at creating a training set of images, MML was able to go through and review the box annotations. Round one box annotations came out rather well but image annotation is a very important step for AI projects. The better the annotated images, the better the training set of data. This 'training set' of images is used to 'teach' the computer algorithm all the various shapes and forms sea lions can be.

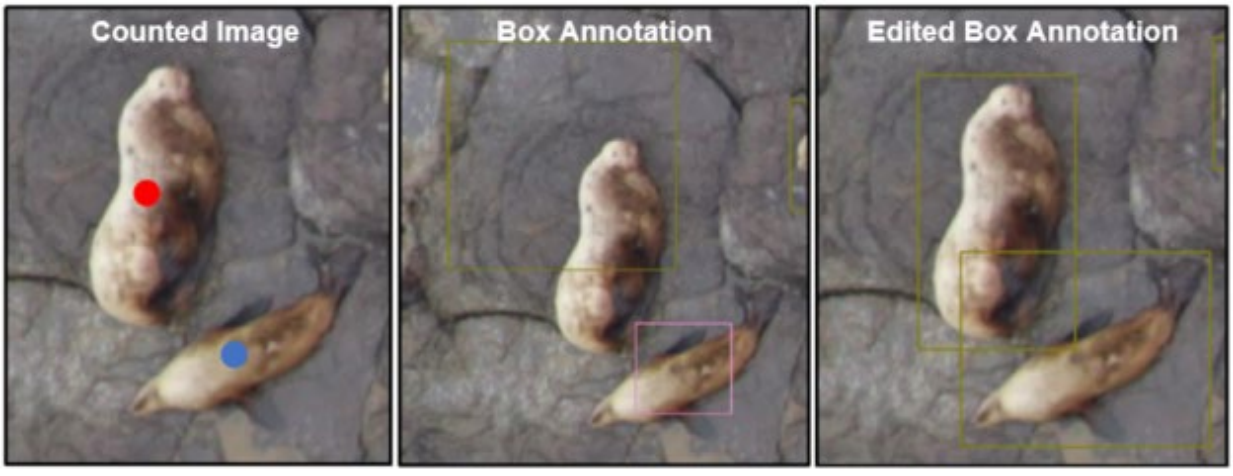

Image showing the counted image (left) and the resulting box annotation from round one of converting the dot to box annotations (middle). MML edited a subset of these images (right) which were used to improve upon creating box annotations from dots (all work for creating the 'training set' of images for eventual sea lion detector algorithm).

Using VIAME, MML staff edited a subset of images with box annotations from this first effort. The edited images were then considered ‘true’ box annotations and helped inform and improve upon the original model for creating box annotations from counted (dotted) images. The second round of images with box annotations are much tighter and precise around individual sea lions. MML will still go through these images (much faster this time as the boxes have improved greatly) to confirm and edit any necessary boxes that are not lined up correctly. All of this initial work will help to create a robust set of training images.

This training set of images will be used to create a robust sea lion detector. Once the sea lion detector is created, we can use a different set of images that are not counted or annotated to run through the detector. This set of images is called the ‘test set.’ We do in fact have count data for the images used in the ‘test set’ so we can compare the sea lion detector results with our known results. Additionally, MML and Kitware will be able to review the images and how well each individual sea lion was detected.

Over the course of year two of this project, MML and Kitware will work to improve the sea lion detector as much as possible, as well as develop an effective program interface for biologists to use to count sea lions. Stay tuned for more updates. MML is to have this automated count program ready to transition into regular operations for conducting annual counts from aerial images.