

Final Report: "Snow Leopard Identification Using Digital Image Processing"

CENTER FOR ENVIRONMENTAL JUSTICE AND SUSTAINABILITY (CEJS)

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1. Project Summary

Snow leopards (*Panthera uncia*) are listed as endangered on the International Union for the Conservation of Nature Red List of Threatened Species [1]. Their range of more than 2 million km² spans 12 countries in Central Asia. Snow leopards are very elusive and seldom seen by people. In 2003, scientists estimated that there are between 4,500 and 7,350 snow leopards in the wild, although this estimate may be too low because as population studies have expanded over the past decade, scientists are often finding more cats than expected [2]. Conservation activities include methods to better understand this species. Researchers use "camera traps" by placing cameras in remote areas inhabited by snow leopards. Such cameras capture photographs when a source of heat passes in front of them. These pictures are then used to recognize specific cats in order to track populations and movement patterns. Because each snow leopard has a unique coat, snow leopards are identified based on the characteristics of their spot patterns such as their size, shape, orientation, and coloration [3].

Files from camera traps are collected by conservation biologists who study the location and behavior of snow leopards. Their first task is to sort the images into sets with snow leopards and those with other animals. Currently, they have to do it manually, which takes up time that could be spent on more advanced data analysis. The work accomplished here is a first step in creating an autonomous method of sorting the camera trap images. Further research will analyze the sorted image sets to determine which images contain snow leopards.

2. Main Accomplishments

The main accomplishment of this project, under the support of the CEJS Fellowship, was the design and analysis of techniques to find areas of motion within sets of camera trap images. Images are grouped into sets and a common background image is computed for each set. The background and block-based features are then used to segment each image into objects that correspond to motion. The motion template images are then post-processed using morphological operations.

Fall 2014

To locate the areas of motion in each image, we use concepts from background subtraction. Traditional background subtraction methods used to separate background from foreground in video sequences perform well when the background is static, for example indoors where the source of illumination does not vary. In the outdoor environments of camera trap images,

changing weather (sun, rain, and wind) makes these methods very challenging to use. To account for the environment-related changes in the background, our first step is to sort all images from one location into *sets*. During the fall quarter, we worked on the method to create sets of images.

We determine which images should be grouped into a single set for background computation by comparing the conditions under which each photo was taken. We then group daytime images into sets according to the time when these images were taken. Initially, all day-time images that were taken within 90 seconds of each other belong to the same set. Following, we split daytime image sets using information about the ISO and exposure settings of the camera. We assume that a change in camera settings results in significantly different image that should be part of a different set. We group night- time images into sets based only on the camera settings. To reduce the run time of our background computation, no sets can have more than 30 images. The minimum number of images in a set is 3.

Winter 2015

For each set, we then compute a common background image. During winter quarter, we researched different methods to estimate the background from a set of images. It was concluded that the most successful method is to use median filtering which is known to be very robust compared to higher complexity methods.

Spring 2015

Following, we find the location of motion in each image. Background subtraction in which each image is subtracted from its corresponding background is a typical approach to obtain the foreground mask. However, for snow leopard camera trap images, such approach proves to be inadequate and leads to very noisy results where large sections of motion are missing. Instead, we use thresholding of image features.

To find motion in camera trap images, we first compute block-based Mean of Differences (MoD) and Difference of Means (DoM) features for each image. Then, for each block, motion decision is made according to the values of MoD and DoM. If one or both of these features are greater than their corresponding threshold, the block is classified as a motion block. If both features are lower than their respective thresholds, block is classified as a background. The thresholds are found empirically for each given camera trap data set. During spring quarter, we worked on the design and refinement of these motion estimation algorithms.

Summer 2015

During the summer quarter, I analyzed the performance of the methods described above on a large set of images. To improve the results from our classification algorithms, I developed techniques that use morphological operations to fill all holes smaller than the size of five blocks and remove all binary objects smaller than the size of five blocks.

3. Summary

The methods described are reasonably successful in finding motion in images from camera traps set to capture snow leopards. In the future, I will work on improving the proposed techniques to produce results that are robust with respect to changes in illumination due to weather and time of day. This research will open the door to image classification based on type of animal sighted, and eventually to individual snow leopard recognition.

4. Dissemination

Conference paper submitted to the IEEE International Conference on Image Processing:

Agnieszka Miguel, Sara Beery, Erica Flores, Loren Klemesrud, Rana Bayrakkismith, “Finding Areas of Motion in Camera Trap Images”, submitted to the 2016 IEEE International Conference on Image Processing.

5. References

- [1] International Union for the Conservation of Nature, “The IUCN red list of threatened species. Version 2015-14.,” <http://www.iucnredlist.org>, Accessed: 2016-01-08.
- [2] Thomas McCarthy and Guillaume Chapron, “Snow leopard survival strategy,” Seattle, USA: ISLT and SLN, 2003.
- [3] R. M. Jackson, J. D. Roe, R. Wangchuk, and D. O. Hunter, “Estimating snow leopard population abundance using photography and capture-recapture techniques,” *Wildlife Society Bulletin*, vol. 34, no. 3, pp. 772–781, 2006.