CEJS Mid-Year Report: Identifying snow leopards based on their individual spot pattern

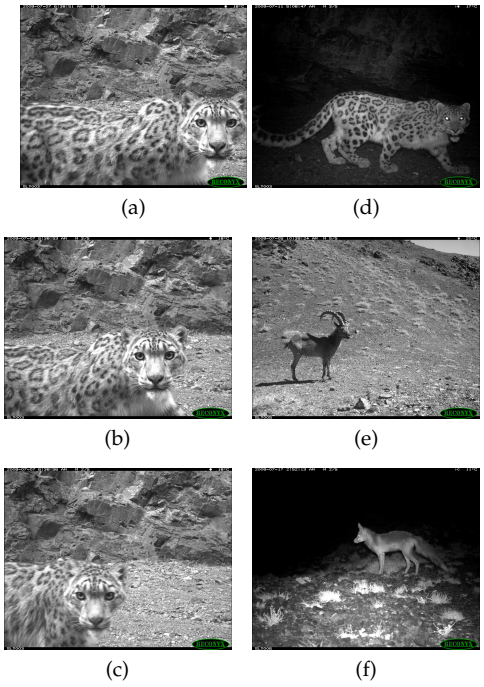
Sara Beery

February 23, 2016

Camera trapping is used by conservation biologists to study snow leopards, and images are sorted manually in order to separate snow leopard photos from photos of other animals (examples seen in fig. 1) and then to individually identify leopards. In this research, we are developing techniques to automate the sorting and identification process.

Paper Submission

So far this year, my research advisor Dr. Miguel and I have been working hard to push the project forward, while also taking the time to document our results. We worked together, in conjunction with several other students, in order to write a paper titled *Finding areas of motion in camera-trap images* describing our previously-developed novel method for locating areas of motion from our images. We honed the method, added several new features to improve the accuracy, and submitted a paper to the International Conference in Image Processing in February 2016. This is our first submitted paper for this research project, which has been ongoing since my freshman year, so it was very exciting to finally submit our preliminary results. The paper describes the first step of our multi-step process, automatic image segmentation to create a mask that represents an animal's location in the image, as can be seen in fig. 2.



(a) (d) (b) (e) (c) (f)

Figure 1: Examples of images used in our research. (a)-(c) Snow leopard images that are part of a sequence of 10 images. (d) Snow leopard in a night picture. (e) Ibex. (f) Fox in a night picture.

(a) Original image (b) Motion location

Figure 2: Example of motion location results.

Animal Species Classification

The next step, animal species classification, is currently in progress. We have developed methods to recognize which animals are snow leopards or not based on a trained spot recognition algorithm, which we developed based on the Viola-Jones feature recognition algorithm and a support vector machine (SVM) learning structure. This method gave promising initial results, recognizing snow leopards around 70% of the time. We are working to improve the features we input in to the SVM, and along that train of thought I have been conducting an extensive literature review in order to recognize what methods have been previously developed. We currently plan to utilize promising methods discussed by Yang, et. al.[1] in conjunction with our previously developed classifier to improve our results.

[1] Jianchao Yang, Kai Yu, Yihong Gong, and Tingwen Huang. Linear spatial pyramid matching using sparse coding for image classification. In *Computer Vision and Pattern Recognition, 2009. CVPR 2009. IEEE Conference on*, pages 1794–1801. IEEE, 2009

Individual Leopard Identification

I am also looking towards the future, to our third step: classifying the leopards individually based on spot pattern. I have spent time communicating with the creators of WildBook, a widely-used animal recognition software that is based on annotation and human-overseen classification. I have been working to adapt their methods to our hands-off approach, which has required me to work towards the development of a MATLAB implementation of the Groth Algorithm [2]. This algorithm was originally created in order to recognize constellations from various angles and scales in the night sky, and it uses relationships between every possible triangle that can occur within a set of coordinate points to match stellar constellations, seen in fig. 3.

The Groth algorithm is now being adapted as a method of matching individual spot patterns on whalesharks, fish, frogs, and other species. [3] However, since snow leopards have fewer spots, and spots of irregular shape, I have developed a method of recognizing a particular type of curve based on analysis of the change in curvature over the parametrized curve fit of the skeletonization of the spot. Instead of recognizing curves individually, I found it was more versatile to instead recognize families of curves as a "type" to compare to at a later date. This, plus analysis of the spot pattern match based on the results from the Groth algorithm, I hypothesize will be a valid method for classification of individual leopards.

[2] E.J. Groth. A pattern-matching algorithm for two-dimensional coordinate lists. *Astronomical Journal*, 91:1244–1248, 1986

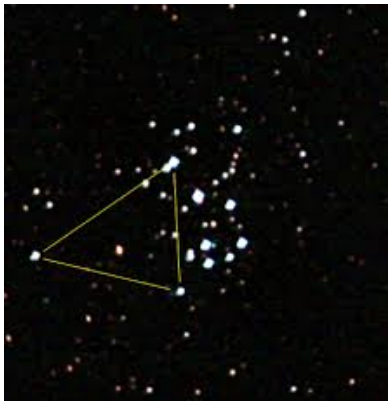


Figure 3: The Groth algorithm, demonstrated on star patterns.

[3] Z. Arzoumanian, J. Holmberg, and B. Norman. An astronomical pattern-matching algorithm for computer-aided identification of whale sharks rhincodon typus. *Journal of Applied Ecology*, 42(6):999–1011, 2005