Name: Alberto Candela Garza Report rcvd. 8.24.20
Program: Lewis and Clark Field Fund for Exploration and Field Research in Astrobiology
Date of Award: 2018
Project Title: Automated Detection of Biosignatures in the Atacama Desert, Chile

Project Report

My name is Alberto Candela Garza, and I am a doctoral student at Carnegie Mellon University. My research focuses on developing artificial intelligence methods for assisting scientific investigations in remote environments. I am also part of the SETI NASA Astrobiology Team. We are developing new strategies for planetary exploration that will change the way we search for life beyond Earth. This will help prepare future Mars rover missions, such as Mars 2020 and ExoMars, to look for traces of ancient biosignatures.

In 2018, our team visited a number of Mars analog sites in the driest place on Earth: the Atacama Desert, which is located in the Chilean Altiplano. We specifically conducted research at three sites: Salar de Pajonales, El Tatio (near San Pedro de Atacama), and Lejía Lake. Our campaign started on October 27 and finished on November 20, spanning three weeks approximately. The city of Antofagasta was our destination for both arrival and departure.

Figure 1: We conducted research at three sites: Salar de Pajonales, El Tatio, and Lejía Lake. The city of Antofagasta was our destination for both arrival and departure.

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Figure 2: High-quality aerial images of the three sites.

As part of this project, we provided support to the science team by using a number of computer vision algorithms to help them find high-potential locations in terms of biosignature presence. In order to achieve this, we collected high-quality imagery using a commercial DJI drone.

First, we used structure from motion (SfM) to construct millimeter-resolution orthomosaics and elevation models of locations of interest.

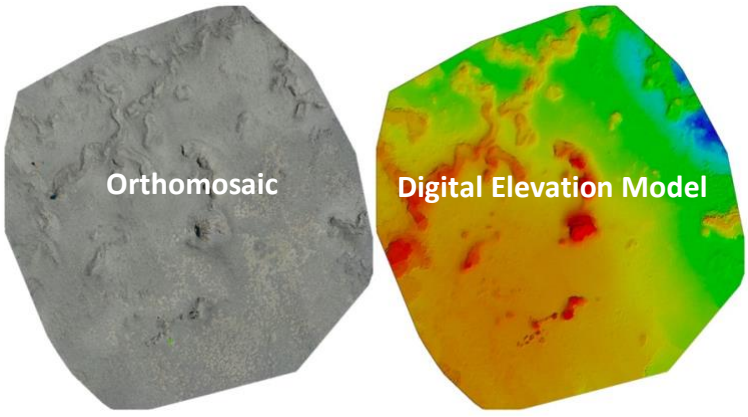

Figure 3: Millimeter-resolution orthomosaic and elevation model of a site of interest at Pajonales

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At Salar de Pajonales, a lake that dried out millions of years ago, we found that the local microgeology is strongly correlated to the presence of bacteria. We identified three different geologic classes and called them “mounds”, “sand”, and “polygons.” We estimated the chances of finding bacteria for each of these classes, which are 85%, 50%, and 0%; respectively. We then developed a computer vision algorithm for the automated mapping of this microgeology in millimeter-resolution images. The algorithm is based on a state-of-the-art deep learning model for image segmentation [1]. Our algorithm achieved an accuracy over 90% with respect to images that were hand-labeled by our science team. In some cases, we found that our algorithm generalized so well that it was able to compensate for labeling errors. One such examples is shown next.

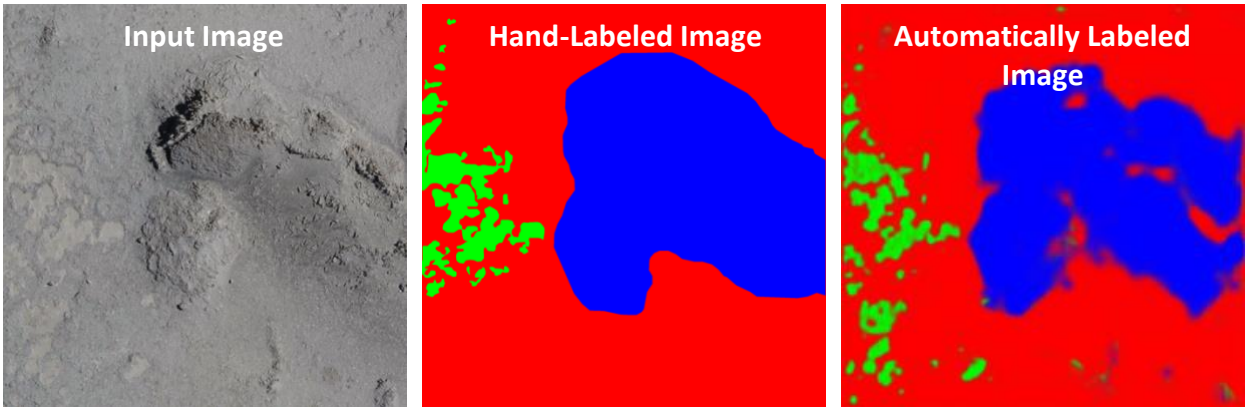

Figure 4: Automatic microgeology mapping from drone imagery. Biosignature presence is strongly correlated to these geologic classes: mounds (blue), sand (red), and polygons (green).

References

J. Long, E. Shelhamer, and T. Darrell. “Fully Convolutional Networks for Semantic Segmentation.” *Proceeding of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR).* 2015.