Summer 2022 RAVEN Fieldwork: Dreki & Holuhraun

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22 August 2022

1 Introduction

The following is a description of the conditions, experience, and scientific gains of the RAVEN fieldwork in Summer of 2022, as it pertains to a Computer Science PhD student. It is intended to show that computer science research need not occur only in a typical indoor, office-based environment, but can be cross-disciplinary and even relevant in Icelandic highland environments that are principally of interest to geologists. It also aims to show that the RAVEN fieldwork – while difficult – can present a good opportunity for students in general to broaden their research horizons and to network with other, leading researchers.

The Rover-Aerial Vehicle Exploration Network (RAVEN) is a project to evaluate the scientific gains made by combining rover and drone teams for Mars exploration, instead of using each vehicle by itself. It is a US-based Planetary Science and Technology from Analog Research (PSTAR) program, that uses Iceland's rough terrain – particularly Iceland's highlands and lava flows – as its analog research environment. It is headed by Christopher Hamilton and Joanna Voigt from the University of Arizona, and also has collaboration from Reykjavik University, the University of Tennessee, the University of Western Ontario, Honeybee Robotics, the Canadian Space Agency, and NASA. It is a great opportunity for students from Reykjavik University to collaborate with such researchers.

2 Conditions & Experience

2.1 Camp Infrastructure

Dreki (shown in Figure 1) is a small collection of buildings, forming a semi-rugged campsite about 5 km east of Lake Askja. It has 2 full cabins with rooms and bathrooms, 1 A-shaped cabin with a loft (no bathroom), 1 public bathroom, a reception, a building for the wardens and emergency workers, and a large open area for tent camping. We were not planning to stay in the cabins, as they are quite expensive. So, the entire RAVEN team set up in the tent area, with a set of large tents forming designated common spaces. The personal tents were centered around "Electric Avenue" – a designated place where our fiber optic cable ran, in order to provide a private internet connection for the team. This connection was primarily for data transfer from the field to offsite workers in Pasadena, but was otherwise freely usable by all of us. The solar array in Figure 2 provided charge to 2 batteries in the shipping container, which in turn provided US wall power (120 V) to the camp. We used the public bathroom building for bathrooms, showering, and faucets for running water which came from the nearby stream.

2.2 Weather

The weather at Dreki is not to be underestimated, and indeed proved multiple times to be a challenge. On a normal day, the temperature ranged from about 8°C = 46°F to 12°C = 54°F, with occasional extremes of freezing or up to 15°C = 59°F. It also rained at least half of the days (maybe more), sometimes for prolonged periods. Windstorms with gusts well over 25 m/s destroyed some larger tents, deformed

Figure 1: Panorama of Dreki, centered east.

Figure 2: The tent area, with (left to right) our shipping container, solar panel array, 4 common tents, and kitchen tent. The personal tents are in the background.

Figure 3: The tent city of the early group sent to prepare camp, taken on top of the future Electric Avenue.

(a) Inside of my personal tent. This held my 3 bags, 2 air mattresses (for thermal insulation against the cold ground), and 2 pillows.

(b) The kitchen tent, replete with tons of fruit, vegetables, tea, coffee, candy, etc. This was the domain of our wonderful chef Guðrún.

smaller tents, and ultimately forced most of the tent inhabitants to move into one of the cabins. The 4-person Mountain Hardware tents, among others, handled the wind the best. It is *necessary* to bring the proper clothing and equipment (such as in the following non-exhaustive list), and to not underestimate the weather:

- **Wool or synthetic base layers**
  (top and bottom)
- **Wool socks**
  I wore cotton ankle socks (as liners to keep the wool socks cleaner for longer) inside wool, full-length, waterproof socks (SealSkin).
- **Waterproof external layers**
  It is good to have GoreTex shells as external pants and jackets.
- **Waterproof gloves**
  Gloves are necessary, and with the amount of rain it is much more comfortable to have waterproof ones.
- **Cold-weather sleeping bag**
  Rated for temperatures significantly below freezing.
- **Sleeping bag liner**
  To keep the sleeping bag clean and increase its heat retention.
- **A *small*, cold-weather tent**
  Larger tents cannot handle the wind and may be destroyed. This is not an exaggeration. It actually happened. A "blackout room" can help with sleeping in the never-ending summer brightness.
- **Sand screws**
  Normal, straight tent stakes do not work in this terrain. It is better to use something that cannot be removed from the soft, rocky ground by pulling it up vertically. Sand screws should be installed such that its guideline pulls at roughly a 90° angle from its axis.

It may snow in the summer at Dreki, and indeed did snow during the fieldwork in 2022, as shown in Figure 5.

(a) Dreki with snow.

(b) Space station tent with snow.

(c) Personal tent with snow.

Figure 5: Sudden, non-negligible summer snow event.

3 RAVEN Work

The 2022 fieldwork involved 2 separate teams conducting parallel missions – one for the rover side and one for the drone side. In subsequent fieldwork sessions, the teams will run a joint mission. The missions are organized in a set of simulated "sols" – a word designating a day in the context of some particular planet, abstracting from the 24-hour period implied by an Earth day. The goal of the 3-week fieldwork is to carry out approximately 10 sols, under the assumption that about 40% of the days will be rained out and that people will need some days off (during which they typically head out to Myvatn). Multiple sols can be simulated in a single day.

Each team in the fieldwork is divided into 3 groups:

- **Implementation:** these are the people who physically carry out data collection, drive the rover, fly the drones, collect hyperspectral data, collect Laser Induced Breakdown Spectroscopy (LIBS) data, take samples of rock/sand, and – perhaps most importantly – *document* everything that happens.
- **Operations:** these are the people who give orders to the implementation team, telling them where to take samples, and giving them mission goals, e.g. "take a survey from this coordinate A to coordinate B." The operations team also receives and analyzes data from the field (and forward it to offsite team members) in order to inform subsequent missions. They are not allowed to go to the implementation site, nor to read/ask about it. It should appear as a black box to them, as would the Martian surface site.
- **Offsite:** these are not in the field but participate in data analysis and determination of high-level mission goals.

3.1 Heli

The thin Martian atmosphere means that it is inefficient to use typical multirotor drones for Martian exploration. Helicopters' large, slow-moving rotors create thrust create thrust more efficiently in a scenario where energy is a precious resource. However, in the recent past, much more earth-based research effort into UAS (uncrewed aerial systems) has gone into multirotor drones. Multirotor drones have fewer moving physical parts, and are simpler products for consumers and industry to use. For this simulation, where the goal is to test the mission operations themselves, the details are not as important, and the large helicopters are therefore replaced by easier-to-use multirotor drones.

A typical drone mission will include a flight, survey, and data collection with one or more operations after landing (possibly on a different sol, to simulate the time required for recharging). Such operations can include drilling, picking things up with a claw, analyzing chemical composition of the ground beneath the drone, and taking pictures of the landing site.

3.2 Rover

RAVEN has a replica of a Mars rover from the Canadian Space Agency, called MESR.

(a) A DJI matrice flying above Holuhraun.

(b) A drill site on the lava flow.

Figure 6: Some heli implementation