An inexpensive and open survey infrastructure for archeology and ecology

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Introduction

The goal: Create an Inexpensive automated solution for mapping and surveying archaeological and ecological sites.

Our research provides an open platform of system integration. It combines the output of a multi-modal sensor system mounted to an UAS. The sensors various outputs are run through a workflow of algorithms for photo manipulation, photogrammetry, and machine learning model. The processed data is then transferred into a geographical information system suitable for end user application.

Hardware

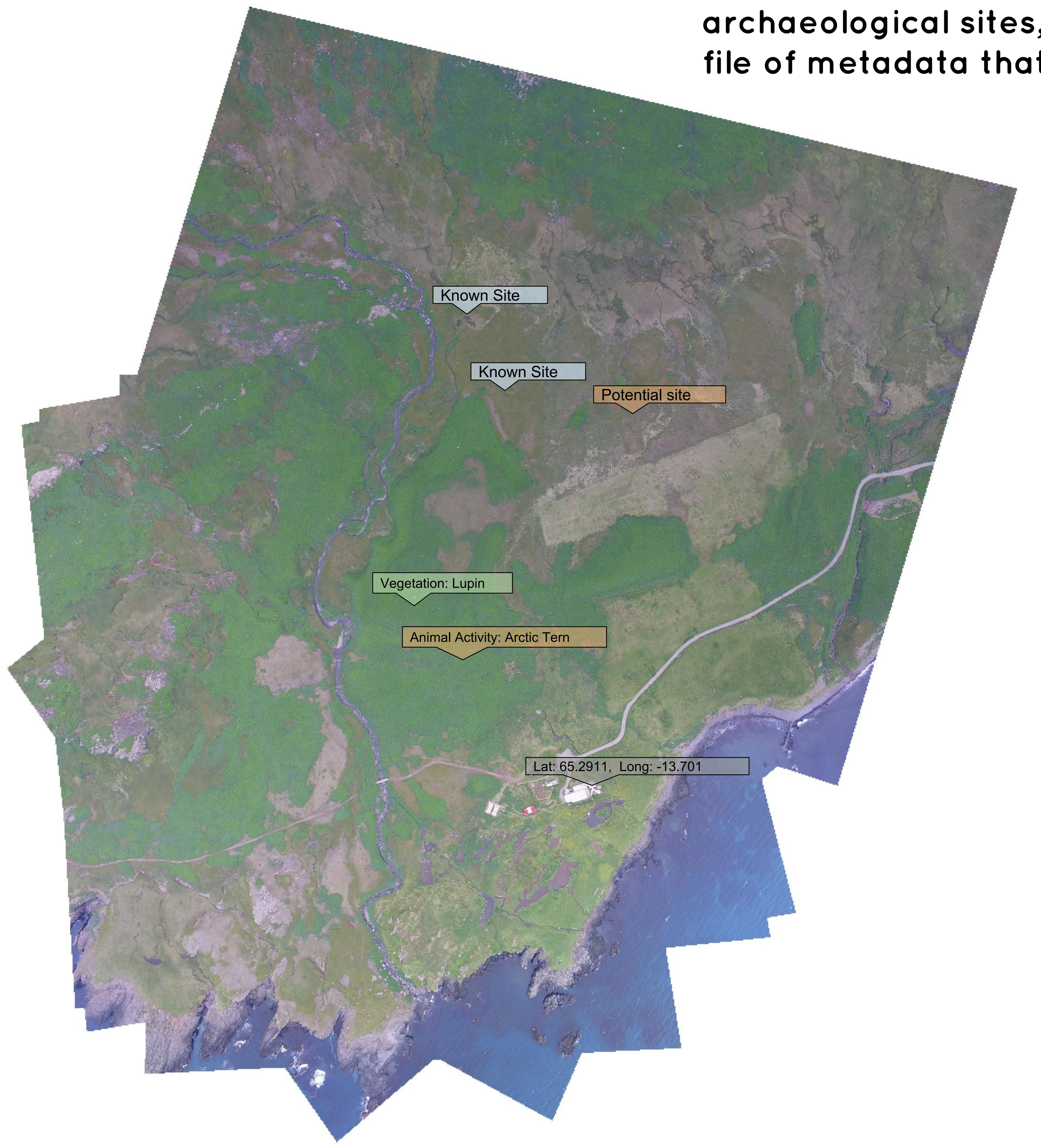
The DJI Phantom3 Advanced UAV platform is equipped with a f/2.8 12megapixel camera. The UAV provides GPS location allowing photos to be geo-tagged and tracked flights. Flight can be sustained for ~20 minutes.

LiDAR is used to collect a dense point cloud of 2mm resolution for a rendering of ground topography. Our scanner has a 360 degree field-of-view and sample rate of 2000 points-per-second.

Implementation

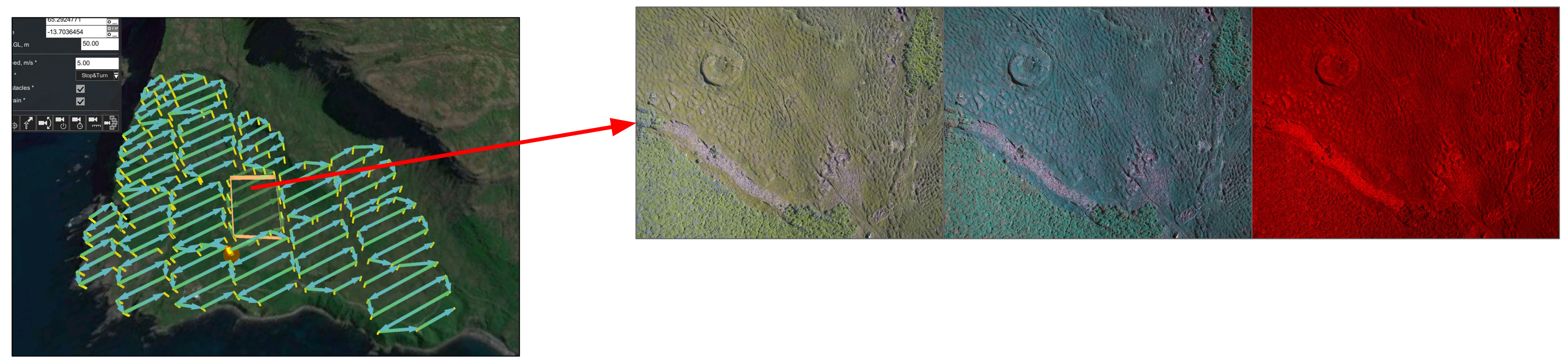
Surveys are flown at an initial height of 100 meters above ground. After this first flight, a second pass is done at 50 meters. Images are taken in a raw digital negative format (DNG). DNG formats allow for 4096-16384 shades per color channel.
An operator is monitoring the flight at all times to accommodate for any errors that may occur.

LiDAR is carried separately on a gimbal system. Flights are done at a height of ~10 meters. The scans are collected through a combination of mobile computer and our mobile app, Field Day. It is translated and filtered to add GPS coordinates to the point cloud.



Software WorkFlow

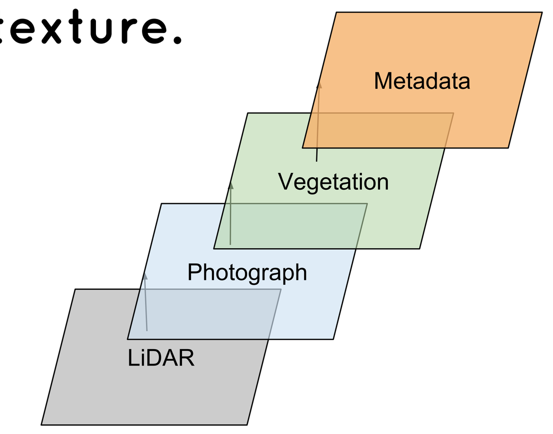
Ground Control software is used to map and schedule automated flights. Images are taken at set intervals making sure the full survey area is covered. After the images are captured we automate the post processing and convert the original DNG file into compressed lossless images. Photographs are processed and colored to aid in object detection.



After images have been processed the photographs are merged together to create a single high-resolution image that is used as the base layer of the data infrastructure. Photogrammetry is applied to specific features such as buildings and known archaeological sites to create a layer of 3D models.

Machine learning algorithms are used to search through images to identify potential archaeological sites, assess vegetation, and animal activity. The algorithm returns a file of metadata that is added into the final data infrastructure.

The infrastructure is compiled using a geographical information system that takes the processed sensor data and presents it in an interactive visual model. Photographs make up the base of each layer with machine learning algorithm providing a layer of metadata labels. GPS coordinates are present to geo-reference locations. The LiDAR point cloud is used to generate elevation and ground texture.



Our Tests and Future Work

The data collection methods have been applied at the Skalanes field research center in the eastern fjords of Iceland. We chose Skalanes for it's known areas of archeological importance and variety of plants and wildlife. In a way, it makes the perfect scientific control and it has a high potential for the discovery of more sites.

Future works include implementing real time infrastructure creation through the use of cloud based cluster computing. The infrastructures has the potential to be useful for many fields beyond just archeology and ecology. We are working towards measuring glacial melt, search and rescue, and simulation.

OpenCV

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