An inexpensive, open terrestrial surveying system for archaeology and sustainability

Yanzhi Li, Roger Lu, Porter Libby, Lillian Gray, Jordan Christian, Charles Peck, Emmett Smith

The intersection of Computer Science with other natural sciences has greatly expanded in recent years. The use of unmanned aerial vehicles (UAV) is just one example of these intersections with archaeology and sustainability. Our project uses low-cost equipment and open source software tools to produce 2 and 3 dimensional renderings with visible light imagery, and with a wide-spectrum lens we capture near infrared images used for normalized differential vegetative index analysis. We have applied these tools and techniques working with ecologists, archeologists, and glaciologists in Iceland.

Methods

Desk

Site selection

Working with domain specialists we identify study areas, typically on the order of between a few and 20 hectares.

Flight Plan generations

Google Earth is used to generate a map file (KML) with a polygon representing the survey area. This is then decorcated with elevation, image frequency, front and rear overlap, and related parameters and becomes a flight plan.

Flight plans are transferred via the Field Science virtual machine to tablets running Major Tom, our flight control software.

Field

Site preparation

Ground control points are placed in a North pointing line spread across survey area. Each sampling mode (visible, near-infrared) can “see” these enabling us to georeference multiple image layers together for unified analysis.

Flights

The drone operates under the control of Major Tom and the flight plan, typically flying iin a zigzag pattern. Battery changes and charging are handled by the humans.

Visible light images are captured, and then the camera gimbel is swapped and near infrared images are captured.

After each flight the images are copied from the SD card to a directory structure on the Field Science virtual machine for analysis.

Computational

Structure from Motion (SfM)

Using the open source SMVS software we produce 3D images from structured 2D imagery taken by the UAVs. These can be used to create digital elevation maps of the site.

Open Drone Map (ODM)

Creates both 3D and 2D meshes of geographical data from structured 2D images. It is installed as a container through Docker on the Field Science VM. We create 2D stitched images of our NIR data and 3D meshes of our VLI data.

QGIS

An open source GIS package with an expansive tool set that allows us to merge several data streams by their location in the world.

MeshLab

Open source suite that allows interaction with the variety of specialized file types that we generate and work with.

DataViz

An online mapping tool built using Python/Flask and OpenStreetMap to easily view elevation data.

Results

Visible Light

Structure from motion

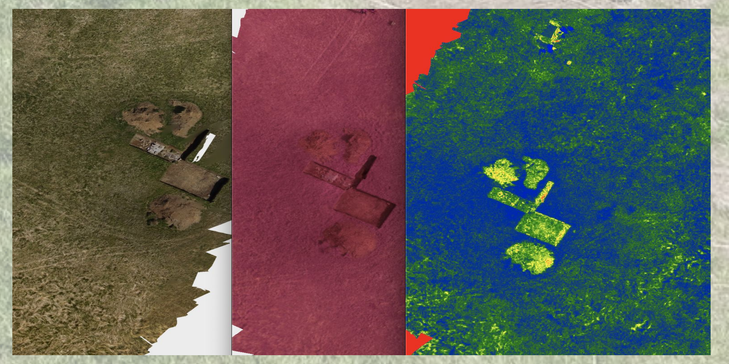
Structure from motion image of the house at Stod

2D Orthographic

Composite image of the dig site at Stod, built from ~600 discrete images takes at 50m elevation.

Visible Light and Near Infrared

VLI **NIR** **Normalized differential vegetative index**



We apply a series of algorithms to the VLI & NIR orthographics to generate false-color images like these which are used by archaeologists to identify likely areas for further excavation.

Future Plans

There are a number of additional image processing algorithms to develop, e.g. contrast enhancement and histogram balance, and a tool for practitioners to view multi-modal images of a single location easily.

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