The Painted Hills

Exploration of 3D visualization and hologram generation as tools for conservation and ecological analysis

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Can virtual landscapes aid in species conservation?

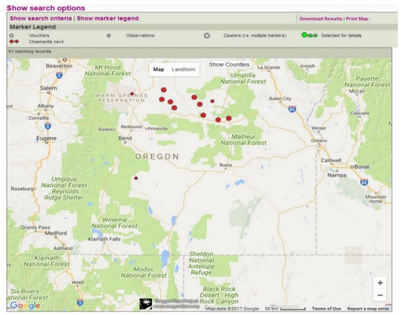
One of the Painted Hills from the employed UAV

1 - INTRODUCTION

The Painted Hills areas of Oregon area home to several endemics species. The landscapes themselves are geologically ephemeral and erode away over the course of 100s of years and some may erode at rates up to several cm a year. In the process, new painted hill zones are exposed potentially providing habitat to the local endemic species.

The hills are derived from volcanic ash and become striated by the redox reactions of minerals in the ash layers which have now become paleosols or ancient soils. The hills support a set of seven plant association and the greater areas support prominently western juniper/sagebrush communities.

Mapping these associations, understanding why these associations may be related to specific topographic positions on the landscape, and identifying specific niche habitat of the endemic species are current and future goals of the project.



Global distribution of *Chaenactis nevii*

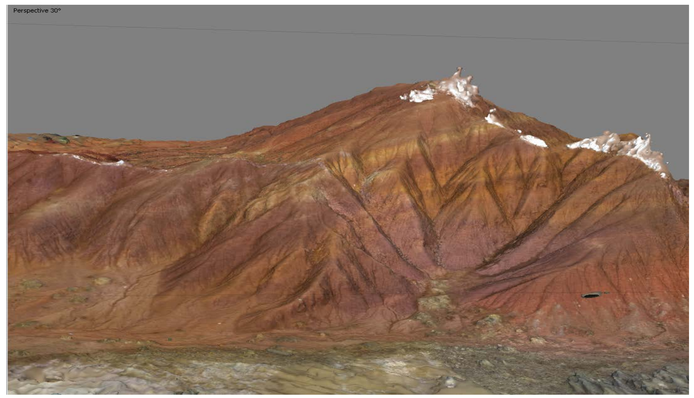
Part B - PLANT ASSOCIATIONS

- Greasewood / Great Basin wildrye
- Shadscale saltbush / Sandberg's bluegrass
- Big sagebrush /Bluebunch wheatgrass-Sandberg's wheatgrass
- Western juniper / Big sagebrush / Bluebunch wheatgrass
- Scabland sagebrush / Sandberg's wheatgrass
- Riparian vegetation
- Mountain brush vegetation

PART C - LIST OF ENDEMIC & RARE PLANTS

- *Astragalus diaphnaus* - endemic
- *Asclepias crytpocerus* ssp *davisii* - uncommon
- *Castilleja xanthotricha* - endemic
- *Chaenactis nevii* - endemic
- *Penstemon eriantherus* var. *argillosus* - endemic
- *Pontentilla glandulosa* var. *campanulata* - endemic

Recreated
Painted Hills QuadCopter Flight Path



Textured mesh output from Agisoft Photoscan

Part D - 3D HOLOGRAMS & AUGMENTED REALITY

Technology limitations have created a world of 2-dimensional maps when the world is really 3-Dimensional. 3D relief maps exist as physical objects but are challenging to store and share.

New virtual reality (VR) and augmented reality (AR) tools now make it possible to easily share purely digital 3D representations of topographical space. These virtual 3D spaces allow for greater understanding of the distributions of plants and the movement of animals.

Using a quadcopter and camera system, I collected ~1,000 images of the one of the Painted Hills' slopes. Then using a process called Structure-from-Motion or Photo-alignment, a subset of the images were mosaicked together to form a single 3D landscape of the area flown. Finally, processing the 3D image via the Unity Graphics engine and Microsoft VisualStudio, I successfully ported the image into Microsoft Hololens where the landscape can be visualized as a 3D hologram.

2 - METHODS

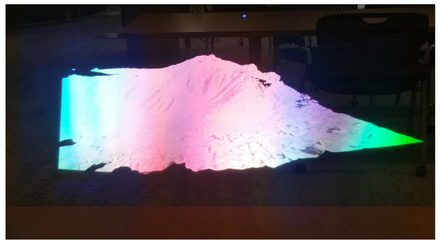
A UAV drone carrying a GoPro Hero 3 camera was flown for ~20 minutes over the zone in question. The camera was set to take one 12-Megapixel image every three seconds during the flight. Additional photographs of the slope were taken on foot by the author with a DSLR camera.

After the flight, all images were downloaded to a laptop for model building. Approximately every 5th image was selected for processing with Agisoft Photoscan software. Over several days, the image set was processed to create a dense point cloud and finally a 3D mesh of approximately 5 million faces/facets. Also using Photoscan, image texture was draped over the mesh giving it the appearance of the original landscape.

At the time it was not known how well the Microsoft Hololens system could handle a 5-million-face mesh so the mesh was simplified using Rhino5 CAD software. After several iterations the landscape was reduced to a 20k facet mesh. Dropping the mesh down to 10,000 faces created a landscape that became blocky and resembled 1990s video game landscape. Therefore, a 20k facet mesh was used for the remainder of the project.

I then opened the 20K facet mesh in the Unity Graphics Engine (Unity for Hololens build 5.4.0f3-HTP). In Unity the object was resized to a viewable room-sized object and the camera viewing angle set such that the viewer is looking directly at the object from a point 2-meters above the base of the object. The object was then saved as a VisualStudio solution file, opened in VisualStudio 2017, and ported via a cable to the Hololens system as a 3D viewable hologram.

Operating the Hololens with hand gestures



The Painted Hills hologram as seen through the Hololens. The color is due to refraction when taking the picture and is not related to the model.

3 - CONCLUSION

I successfully deployed a UAV derived landscape model to the Microsoft Hololens system, but I cannot yet state whether there are any advantages to this technique over 2D systems until more research is complete.

In projects studying the 3D movements of organisms in space, many have shown advantages to mapping organisms in 3D space to better understand their ecology (Ousterhout et al 2015, Laplanche, 2015, & Udyawer, 2015).

4 - FUTURE WORK

1. Add the associated visual texture of the landscape onto the Hololens hologram model.
2. Geographically set place markers on the 3D mesh model so that it can be placed into a GIS system such as ArcMap.
3. Work on associating topographical and environmental features to plant associations and niche habitats of endemic species with a goal of better understanding how these features drive species distribution.

5 - BIBLIOGRAPHY

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6 - ACKNOWLEDGMENTS

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