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Using Small Unmanned Aircraft Systems for Remote Sensing and Data Collection: Aerospace Education and Service Learning

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Using Small Unmanned Aircraft Systems for Remote Sensing and Data Collection: Aerospace Education and Service Learning

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Agenda

- Location and Background
- Cultural Heritage Site Data Collection
- Urban Boundary Layer Data Collection
- Service Learning and Lessons Learned
- Questions

Location and Background

Introduction

- Cultural Heritage Site Documentation
- Air Data Collection in Urban Areas for modeling

Partners on the Table

Service Learning Study Abroad

- **23 students in the Balkan country, the Republic of Kosovo, during June and July 2019.**
- **From Colleges of Aviation and Engineering**
- **Using small unmanned aircraft systems (sUAS), as platforms for remote sensing, students gathered imagery of historical cultural heritage locations and collected atmospheric data in the urban boundary layer (UBL).**

Service Learning Study Abroad

- **Funded, in part by the U.S. Embassy in Kosovo, the reinforced core learning concepts through practical problem solving in field applications.**
- **Furthermore, participants benefit from enhanced collaboration, cultural exposure and civic engagement.**

Service Learning

- *Service learning* is the term used to describe educational experiences that provide students with learning opportunities that are set in the real-world and occur through collaboration with community engagement

UAS Flight Operations and Photogrammetry

➤ Equipment

- DJI Phantom 4 Pro v2
- DJI S1000
- DJI Mavic 2 Pro
- eBee

➤ Software

- Pix4Dmapper Pro
- Pix4Dcapture
- DJI GO
- Blue Marble Global Mapper

BLUE MARBLE
GEOGRAPHICS
MIND THE GAP BETWEEN WORLD AND MAP

Operational Summary

Metric	Quantity
Flight Hours	29.5
Sorties	140
Data Generated	405 GB
Photos Collected	8,247
4K Video	59 min 14 sec

A Day in Kosovo – Roman City Ulpiana

Cultural Heritage Site Data Collection

Embry-Riddle Aeronautical University in Kosovo

- UAS Flight Operations and Photogrammetry
- Pedagogy of an effective program
- Partnering
 - Application to Meet Needs
 - Cultural Heritage Site Documentation

Cultural Heritage Flight Ops

Service Learning

➤ Purpose:

- Gather imagery
- **Develop three dimensional (3D) virtual objects and two dimensional (2D) orthomosaic maps**
- Aid with inspecting, documenting and chronicling locations

➤ Why:

- Assist with cultural heritage preservation in Kosovo
- Bring STEM Education to Kosovo
 - Effort funded, in part, by U.S. Embassy Kosovo

UAS Flight Operations and Photogrammetry

The basic premise of photogrammetry is the art and science of obtaining useful information from the environment by processing imagery and then applying exacting measures that can provide 3D characteristics.

Flight path for aerial photography with end overlap to provide parallaxic perspective of pixels to be recognized as a keypoint.

UAS Flight Operations and Photogrammetry

Jensen, 2009

Flight path for aerial photography with side overlap to provide parallax perspective of pixels to be recognized as a keypoint.

Cultural Heritage Site Documentation

- Accurate 3D perspectives can help clearly identify change regardless of the causes of change (i.e., caused by human and/or nature).
- High resolution imagery is essential for detection, interpretation and measurement of small features often associated with cultural heritage preservation work.
- Correctly scaled 2D imagery and properly render 3D virtual objects enable examination in detail and from numerous perspectives.

Case Example –Dranoc Kulla*

- Built with 2-3 floors with exterior stairs, mostly square in plan
- Built of stone and/or brick one meter thick at the bottom
- Interior floors constructed of tree trunks and upper ceilings with wooden planks

*

fortified house

Dranoc

Dranoc

Photo

Virtual Object

Dranoc Virtual Village

Dranoc Orthomosaic

Urban Boundary Layer Data Collection

- UBL research during the summer of 2019 included investigating vertical profiles of wind, flow acceleration in urban canyons, and turbulence generation in the shear zones found at rooftop levels.

- Students developed and built an instrumentation suite hosted on a S-1000 UAS during the fall and spring semesters of the 2018-2019 academic year.
- The platform measures thermodynamic and kinematic (i.e. three-dimensional wind components) and atmospheric parameters.

Atmospheric Measurements

➤ Investigation

- Instrumented DJI S-1000 octocopter
- Flown around buildings and within urban canyons
 - Prishtina Kosovo

- Measurement
 - Temperature
 - Pressure
 - Humidity
 - 3D wind components

Atmospheric Measurements

➤ Motivation

- The lowest layer of the atmosphere is termed the Atmospheric Boundary Layer
- Very dynamic because of the influence of the Earth
 - Especially in the urban boundary layer (UBL) environment
- Poorly understood

Atmospheric Measurements

- Improved understanding important for weather, climate, urban planning, and burgeoning UAS operations such as:
 - Urban Air Mobility
 - Package Delivery
 - Infrastructure Inspection
 - Intelligence, Surveillance and Reconnaissance (ISR)

Service Learning and Lessons Learned

Pedagogy

- Experiential learning theory (ELT) (Kolb, 1984)
 - Educational theory, a process through which students develop knowledge, skills, and abilities from direct experiences.
- Service Learning
 - Addresses a need in the community (campus, local, regional, global)
 - Meets one or more course objectives
 - Demonstrates a clear connection between the service activity and the course content
 - Involves reciprocity between course and community that results in students' increased civic awareness and engagement
 - Involves structured student reflection
 - Involves collaboration with an appropriate agency representative

Pedagogy

- MSA 533, Unmanned Aerospace Systems -3hr
- AS 390, Application of UAS Technology -3hr
- AS 399, UAS Photogrammetry for Site Survey -3hr
- GCS 304, Political Violence and Terrorism -3hr
(upper-level social sciences elective)

Service Learning and Lessons Learned

- Direct Application of Learned Material
- Role Reinforcement and Collaboration
- Objective-Oriented Learning
- Cultural Exposure with Other Ancillary Learning

Future Possibilities

Future Possibilities

In the Kosovo, and the Balkan region in general, the need for remotely sensed sUAS collected data is nearly limitless. Capturing images and collecting UBL data provided opportunities for service learning that meets real world needs. Each trip to the region enables the identification and discovery of new projects that meet local needs and provide students with meaningful learning opportunities while simultaneously helping to expand knowledge.

A satellite map of the Earth from space, showing the Americas. A red dot is placed on the northeastern coast of Florida, marking the location of Daytona Beach. The text "Daytona Beach" is written in white serif font below the dot. The background is a deep blue space filled with stars.

Daytona Beach

Questions

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Case Study for Service Learning

Cultural Heritage without Borders (CHwB) Kosovo

- Cultural Heritage without Borders was founded in 1995 as an independent Swedish non-governmental organization to work in the spirit of the 1954 Hague Convention for the protection of cultural property in the event of armed conflicts, natural catastrophes, neglect, poverty or political and social conflicts.

Cultural Heritage without Borders (CHwB) Kosovo

- ❑ **CHwB VISION** is that everyone has the right to enjoy, have access to and participate in cultural heritage.
- ❑ **CHwB MISSION** is to promote cultural heritage as both a right in itself and a resource. CHwB works with civil society and institutions at all levels to strengthen peace building, sustainable socio-economic and democratic development and the realization of human rights.

USE OF 3D PHOTOGRAMMETRY IN THE REGENERATION OF A HISTORIC ROAD

THE REGENERATION OF THE HISTORIC ROAD

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