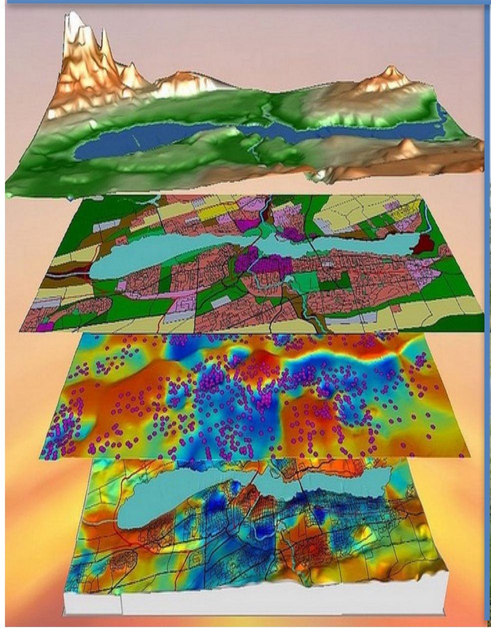
UAS Activities at the Conrad Blucher Institute at TAMUCC

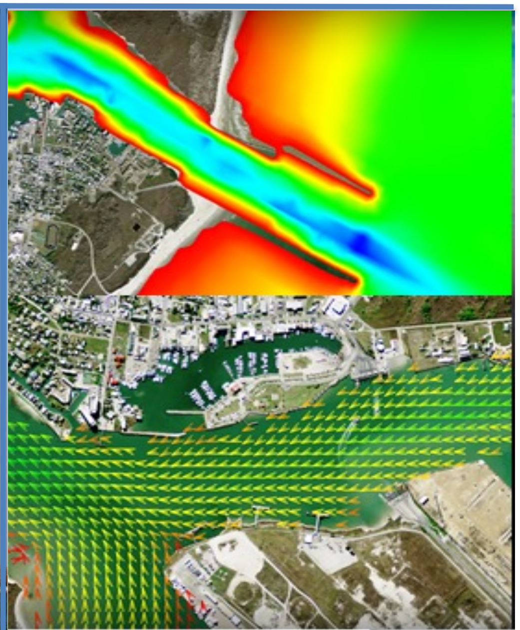
An update:
Scientific Committee for Oceanographic Aircraft Research
November 2, 2023

Michael J. Starek
Professor of Geospatial Systems Engineering
Chair of Remote Sensing & Autonomous Systems at CBI

Conrad Blucher Institute for Surveying & Science

- Dedicated May 1987 - Blucher Family: surveyors of South Texas (1882-1954)
- Support of academic programs (BS – MS – PhD)
- Research in geomatics, UAS, GIS, coastal observation & modeling, coastal AI
- Work supports coastal management, navigation, emergency response…

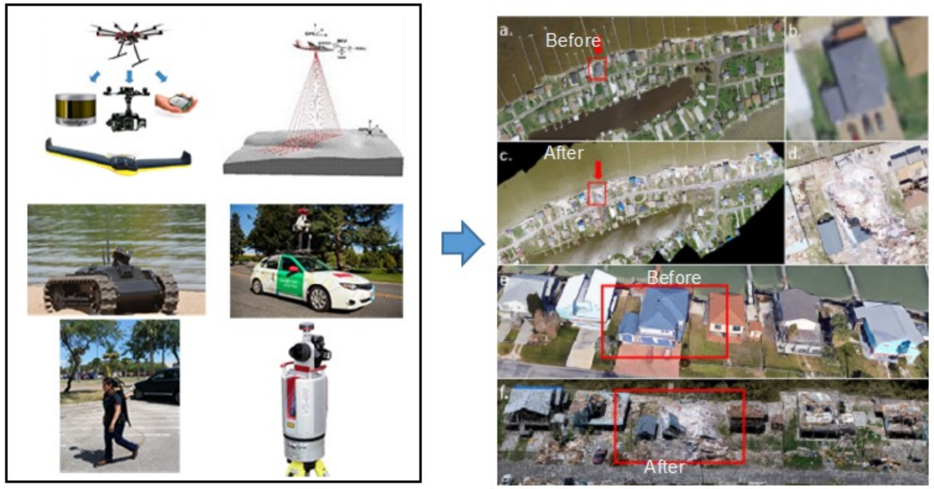




MANTIS

MEASUREMENT ANALYTICS

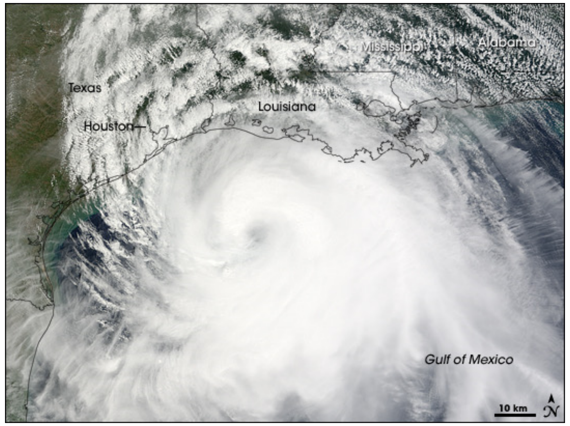
TEXAS A&M UNIVERSITY CORPUS CHRISTI | CONRAD BLUCHER INSTITUTE FOR SURVEYING AND SCIENCE

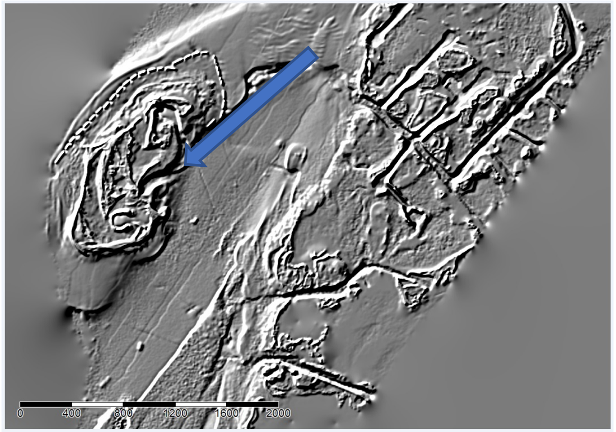


MANTIS explores the merging of geomatics, remote sensing, and geospatial computing to aid science and engineering decision-making through improved measurement and analytics.

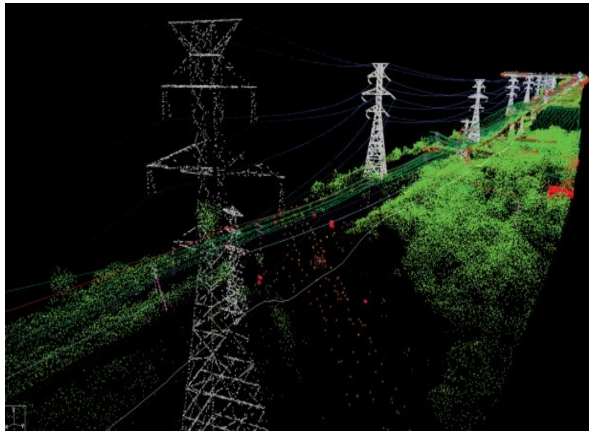
Applications

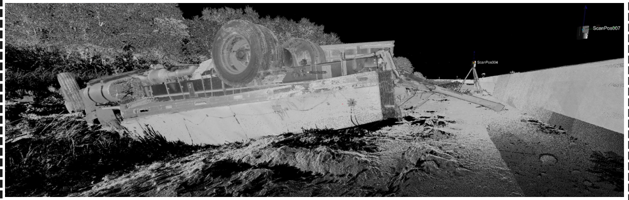
Coastal Zone Monitoring and Resiliency



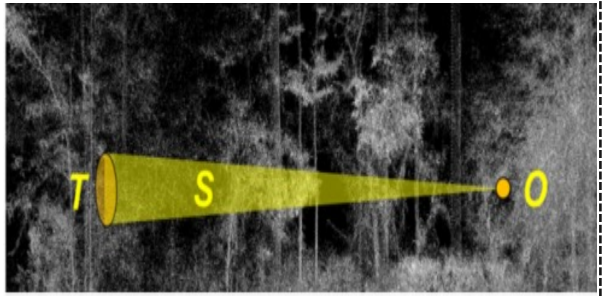


Infrastructure and Transportation

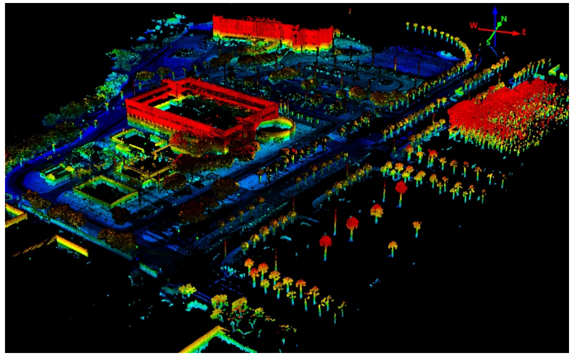




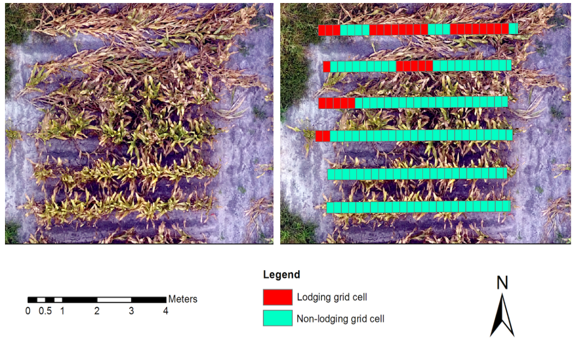
Geospatial Intelligence/Military



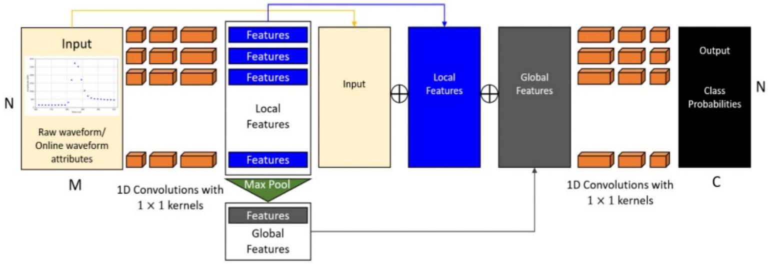
3D Scanning & Mapping



Agriculture



Geospatial AI

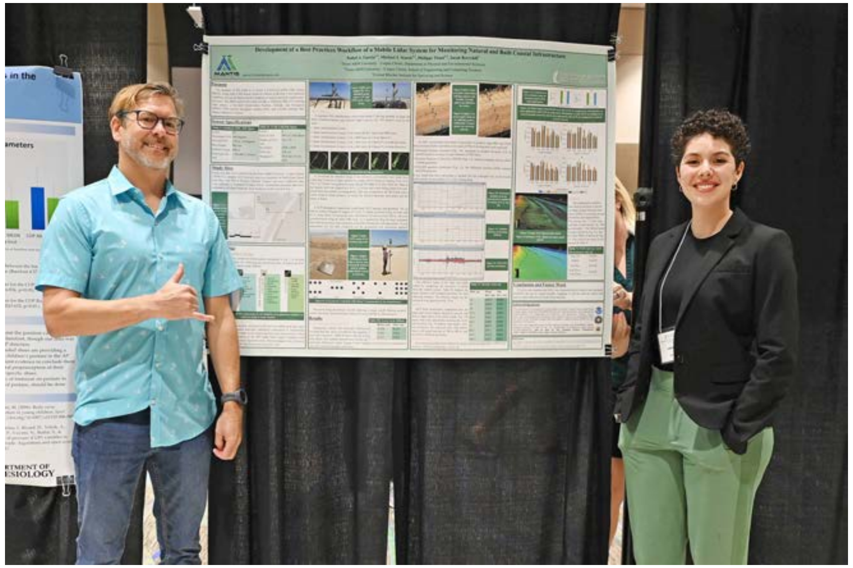


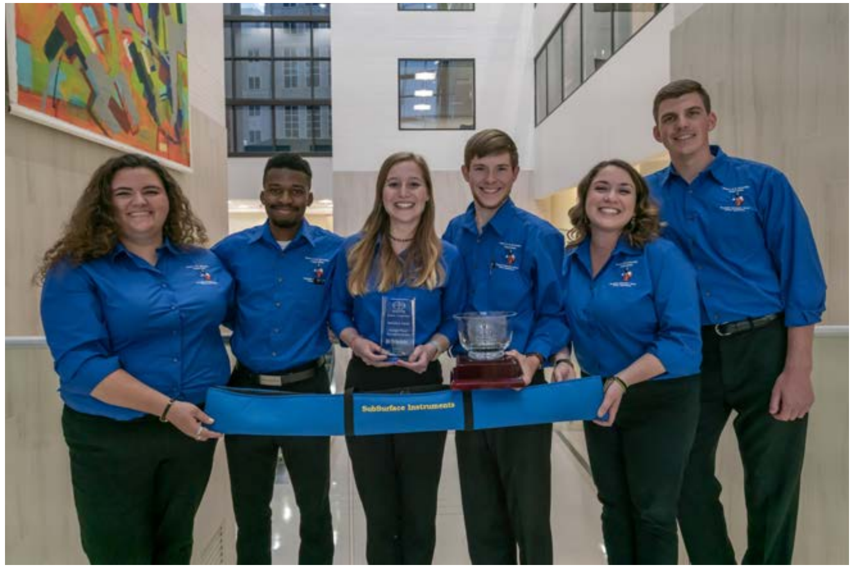
Expertise

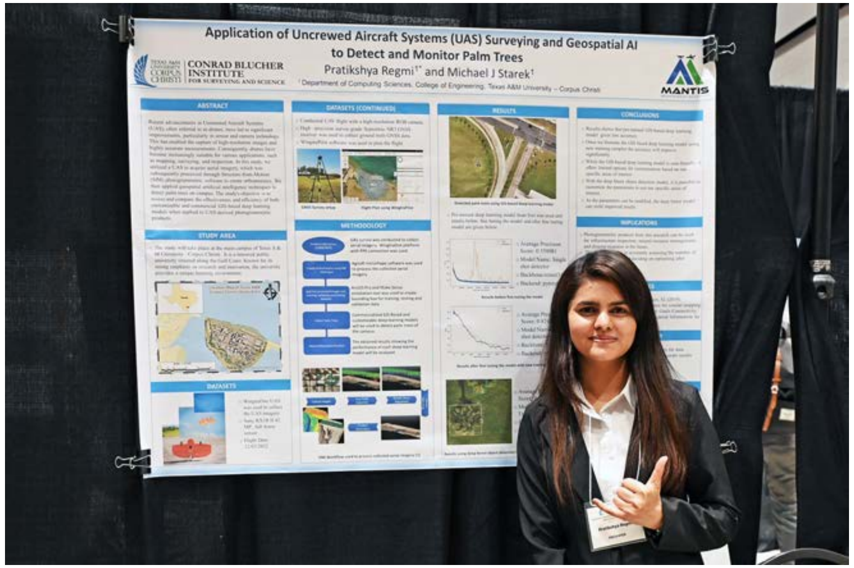
- LiDAR
- Photogrammetry
- Computer Vision
- InSAR
- AI and GIS

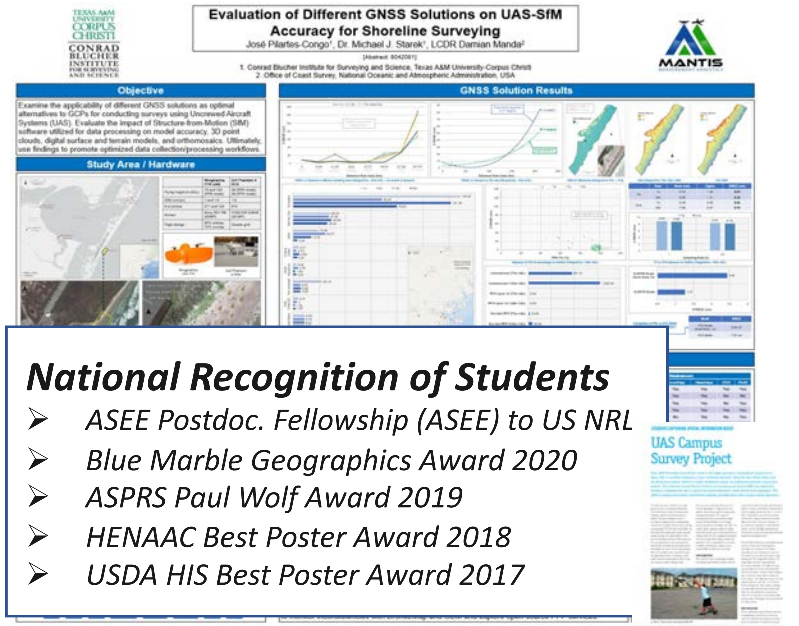
Instruments

Students on the Go!









National Recognition of Students

- *ASEE Postdoc. Fellowship (ASEE) to US NRL*
- *Blue Marble Geographics Award 2020*
- *ASPRS Paul Wolf Award 2019*
- *HENAAC Best Poster Award 2018*
- *USDA HIS Best Poster Award 2017*

UAS-LiDAR Sensor Evaluation (Example Results)

Data Collection Equipment: UAS-LiDAR

RIEGL VUX-1 LR

7 lb

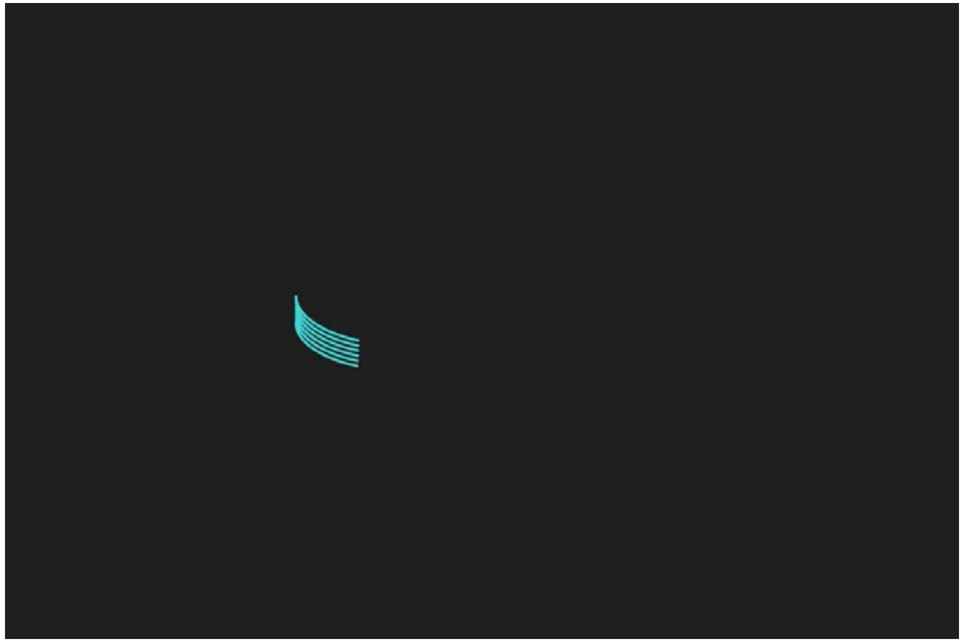
- NIR wavelength (1550 nm)
- Max Pulse Rate = 820 kHz
- Max Effective Range = 1540 m @ 80% albedo
- Ranging Accuracy = 1 cm
- Max Number of Returns = 12
- Rotating scanner, FOV = 360°
- **Rotating mirror scanner**

Livox Avia

1 lb

- NIR wavelength (905 nm), **MEMS IMU**
- Max Pulse Rate = 240 kHz (single returns)
- Max Effective Range = 320 m @ 80% albedo
- Ranging Accuracy = 2 cm
- Max Number of Returns = 3
- Line scanner (2 modes), FOV = 70.4°,
- **Risley prism beam steerer**

Livox Avia LiDAR Sensor

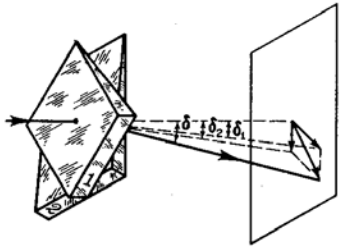


Non-repetitive Circular Scanning

In the non-repetitive scanning mode, as more time it provided for the system to scan the area, the coverage area ratio increases, thus improving the detection of objects and details within the FOV.

Repetitive Line Scanning

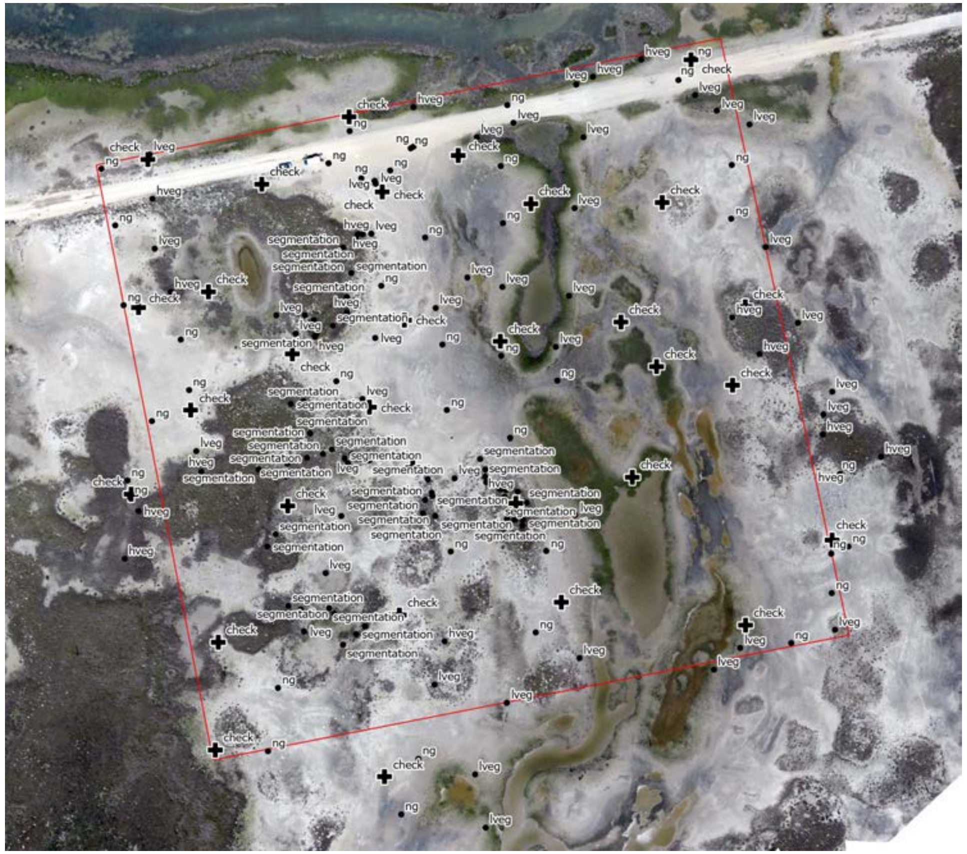
The repetitive scanning mode enables the Livox Avia to operate more efficiently in mapping scenarios that require high precision and point cloud distribution, such as the mapping of agricultural fields, forests and hill slopes, as well as the inspection of construction sites.



Data Collect: Mustang Island (MUI) Wetland Site

Date: 04/01/2023

Purpose: elevation accuracy, impact of altitude & density, SfM versus LiDAR



10 acre historical study area

Flights Completed

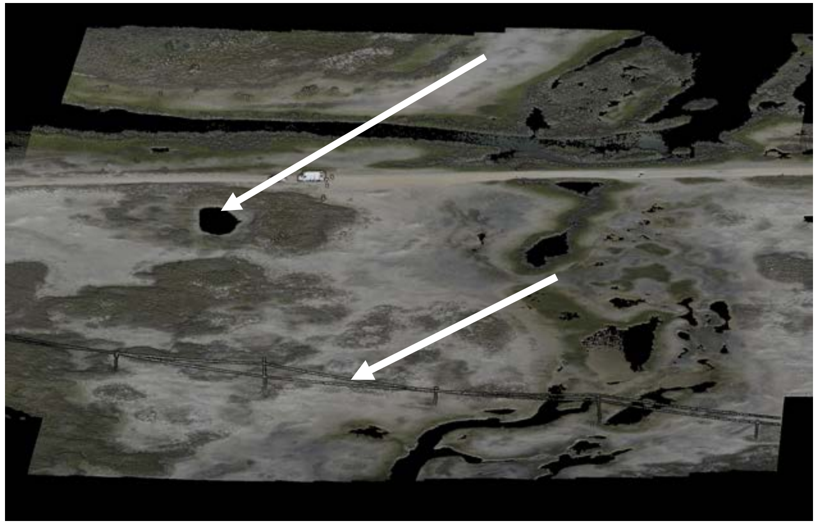
UAS-LiDAR

- REIGL VUX-1 LR @ 600kHz @ 120 m AGL
  - 163 points per meter square average
- REIGL VUX-1 LR @ 600 kHz @ 90 m AGL
  - 409 points per meter square average

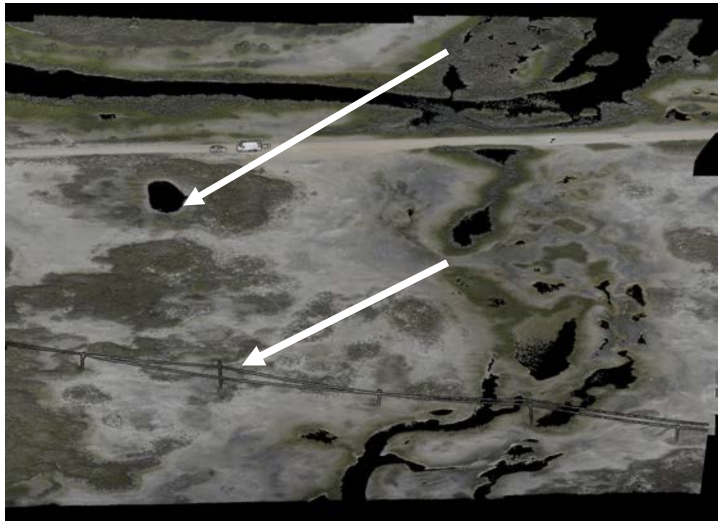
UAS-SfM (Photogrammetry)

- WingtraOne Gen II @ 120 m AGL
  - 1.6 cm/pixel GSD
  - North-South, East-West
- WingtraOne Gen II @ 60 m AGL
  - 0.8 cm/pixel GSD
  - North-South, East-West

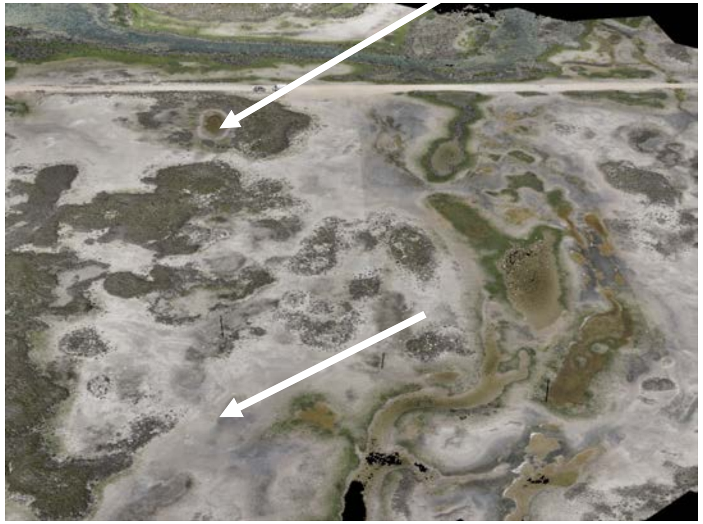
Colorized Point Cloud Examples



VUX-1 LR @ 120 m AGL (LiDAR)



VUX-1 LR @ 90 m (LiDAR)



WingtraOne @ 60 m (SfM)

Inertial Explorer®

NovAtel Inertial Explorer®

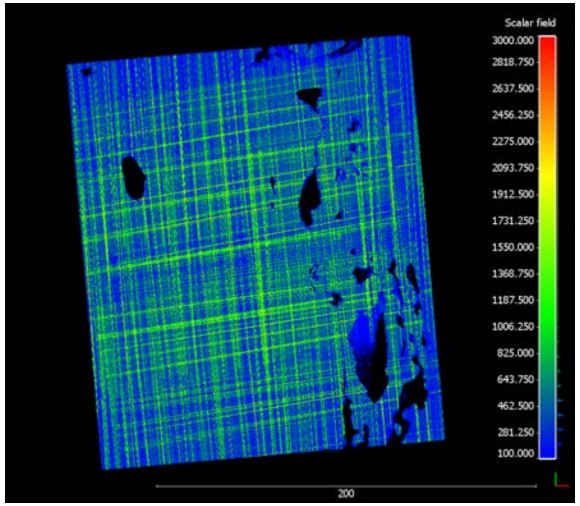
SE

PHOENIX SPATIAL EXPLORER

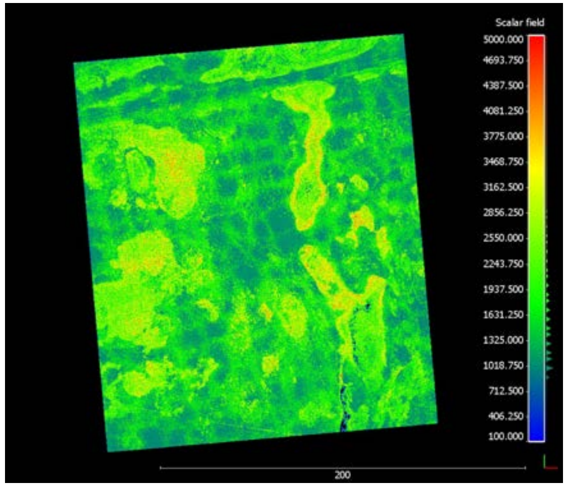
Results @ MUI

Point Cloud Density & Accuracy

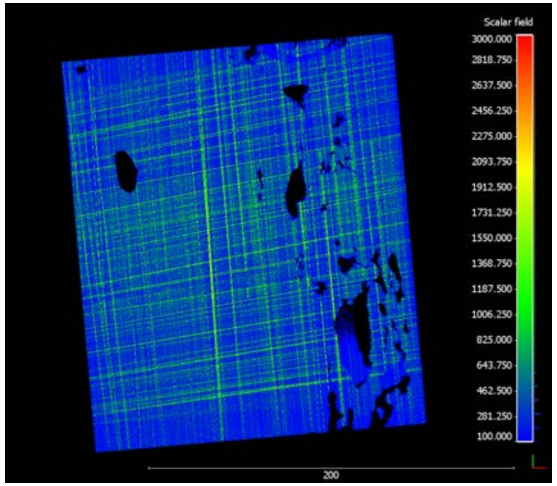
VUX LiDAR (90m)



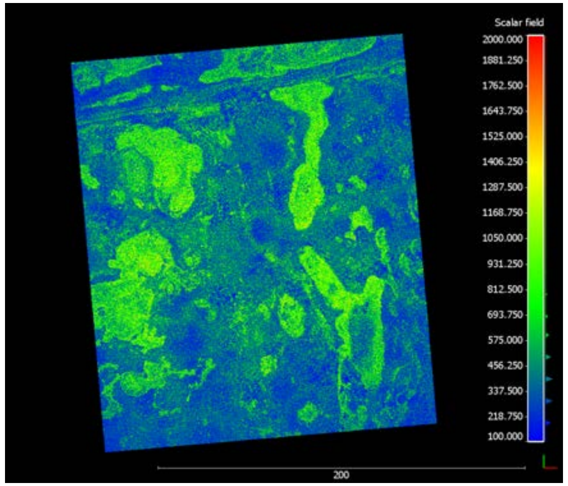
Wingtra SfM Merged (60m)

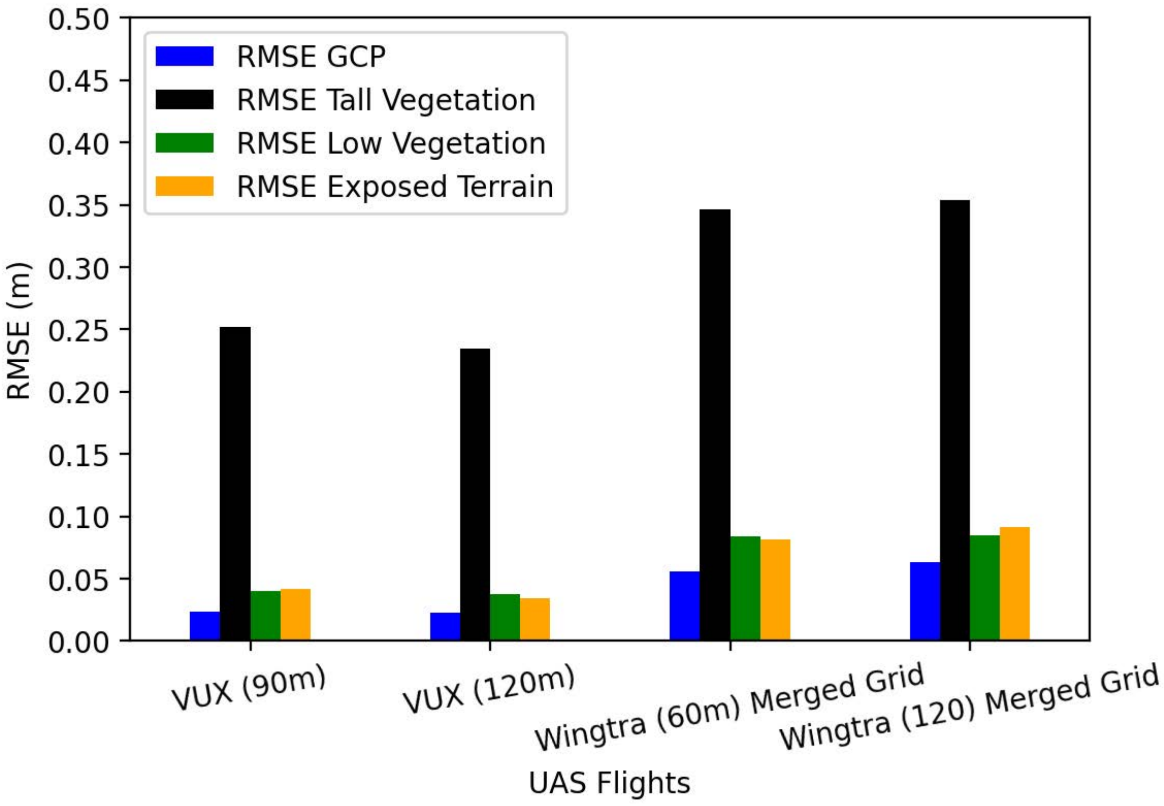


VUX LiDAR (120m)



Wingtra SfM Merged (120m)

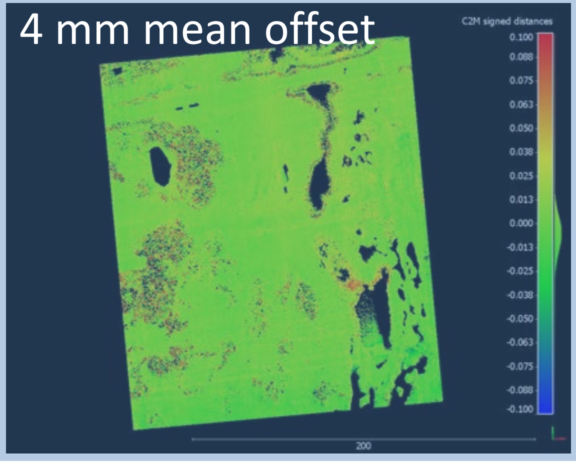




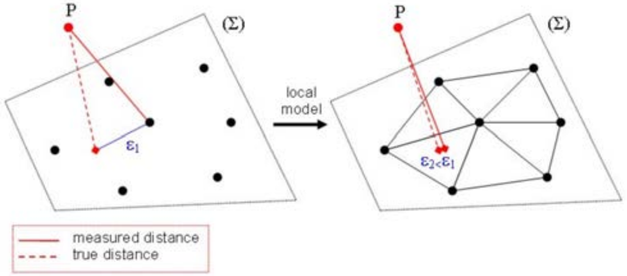
Research supported by TxDOT Project 0-7157

Cloud2Model Distance

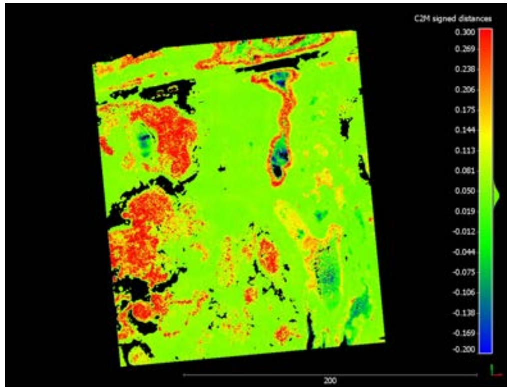
VUX (90m)-VUX (120m)



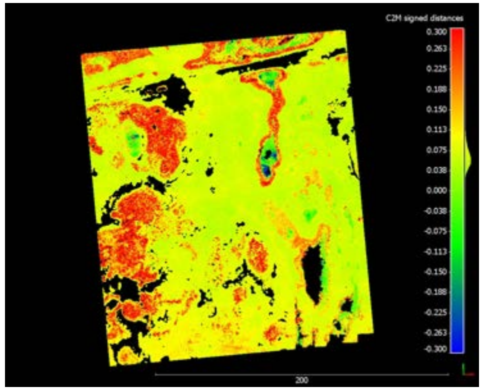
TIN created for **classified terrain points from VUX LiDAR (90m). Terrain** points from different flights are compared with the TIN to calculate the offset distances.



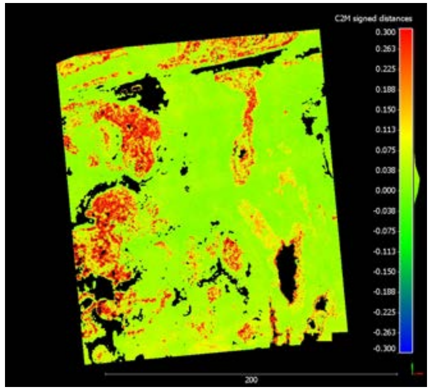
VUX (90m)-Wingtra (60)-East-West



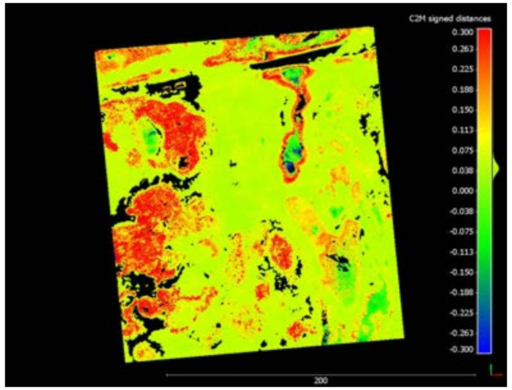
VUX (90m)-Wingtra (120)-East-West



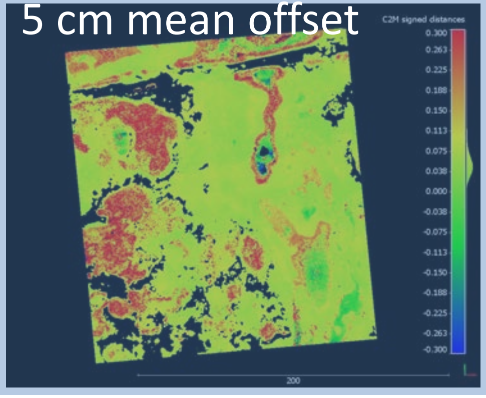
Wingtra (60)-Wingtra (120) -East-West



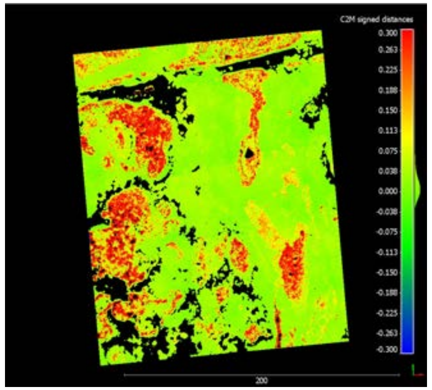
VUX (90m)-Wingtra (60)-Merged



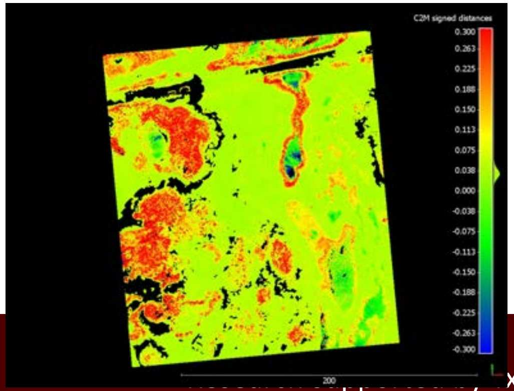
VUX (90m)-Wingtra (120)-Merged



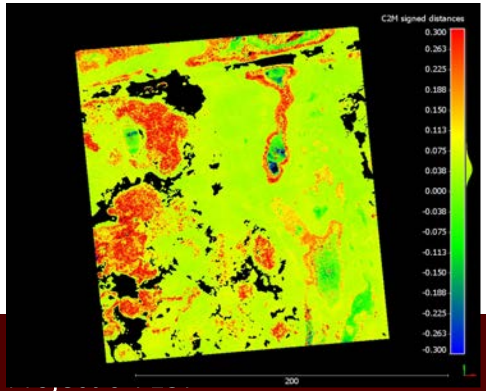
Wingtra (60)-Wingtra (120) -Merged



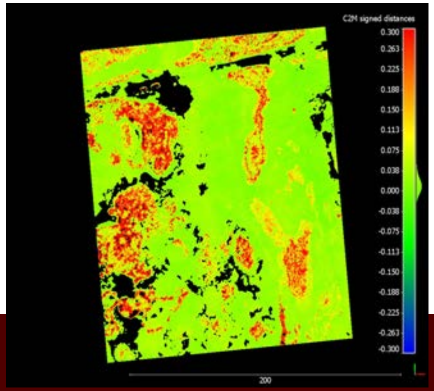
VUX (90m)-Wingtra (60)-North-South



VUX (90m)-Wingtra (120)-North-South



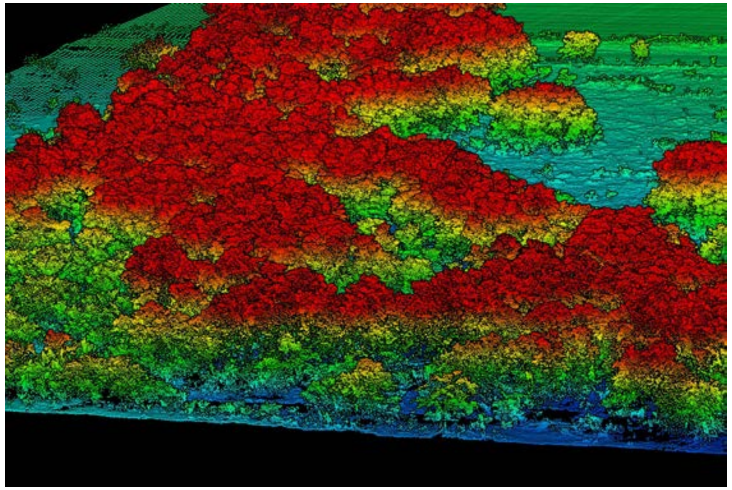
Wingtra (60)-Wingtra (120) -North-South

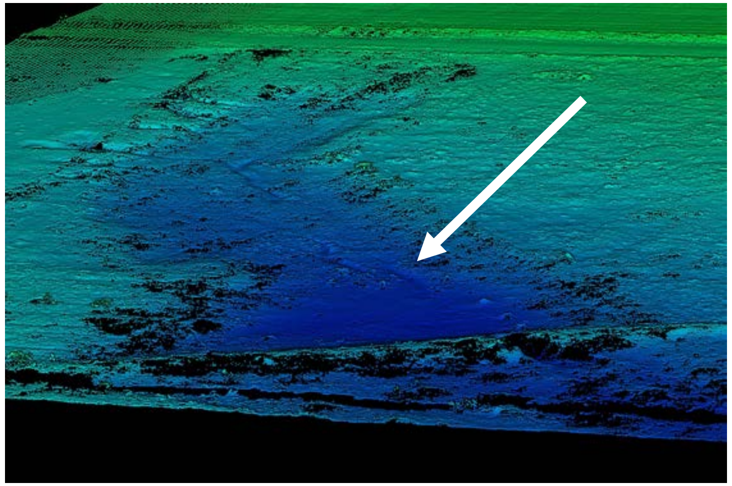


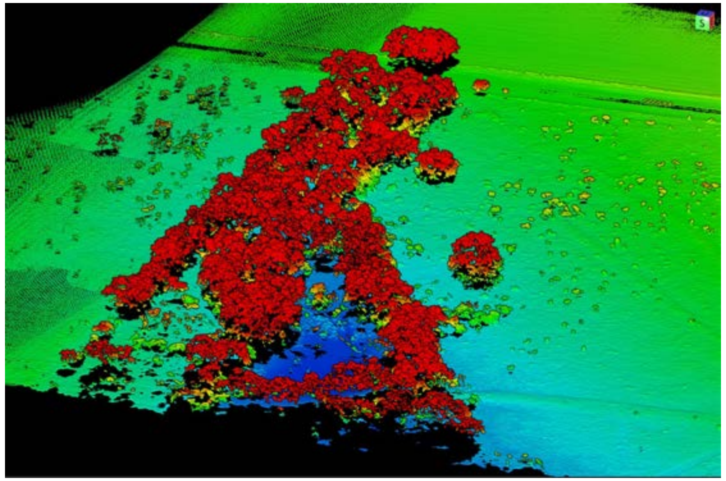
Data Collect: Goliad Greenfield Site

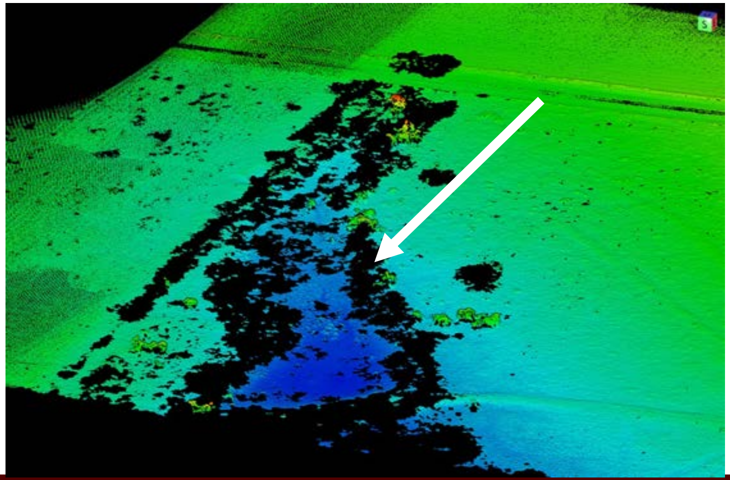
Date: 04/13/2023

Purpose: LiDAR sensor evaluation









Flights Completed

UAS-LiDAR

- Avia Livox @ 120 m AGL
- REIGL VUX-1 LR @ 600 kHz @ 120 m AGL

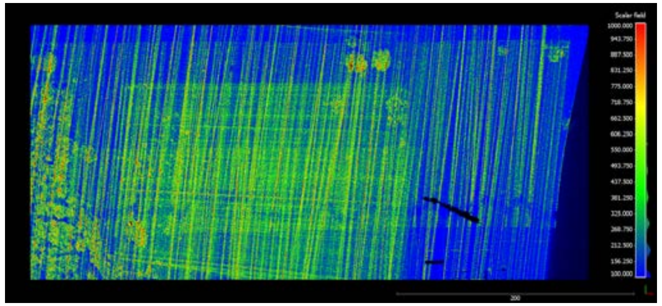
UAS-SfM

- WingtraOne Gen II @ 120 m AGL

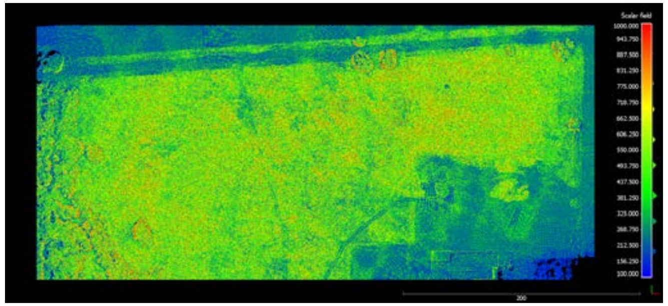
Preliminary Results @ Goliad

Point Cloud Density and Accuracy

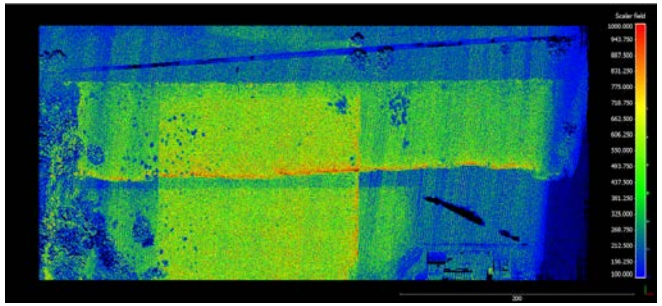
VUX

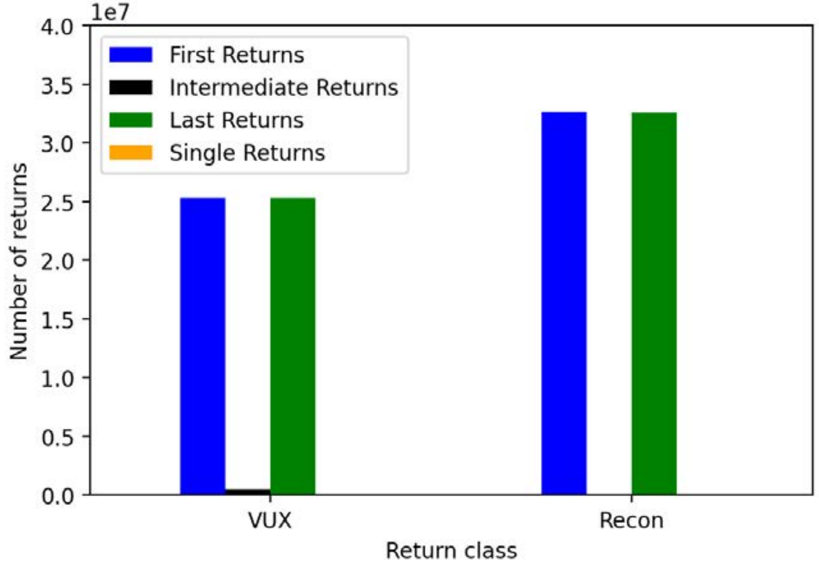


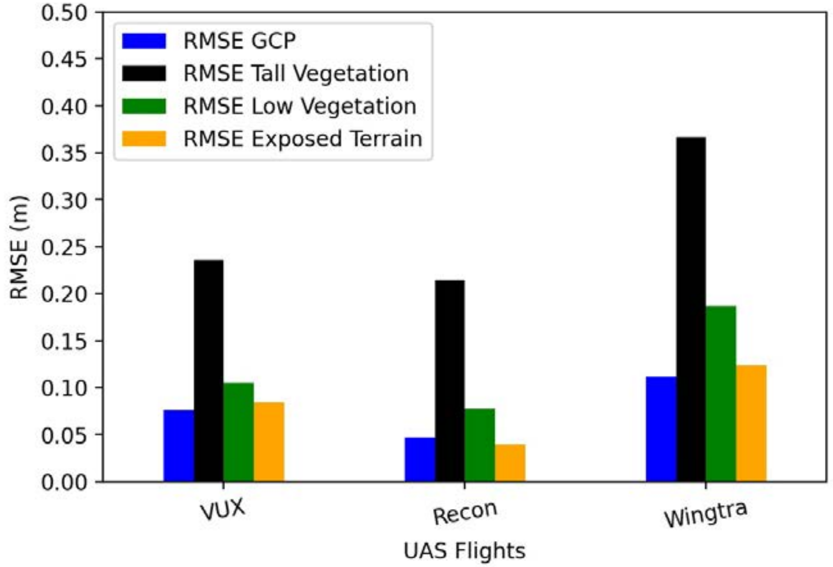
Wingtra



Recon







*Direct georeferencing/no GCPs

Research supported by TxDOT Project 0-7157

Data Collect: RELLIS TAMU Test Site

Date: 04/27/2023 – 04/30/2023

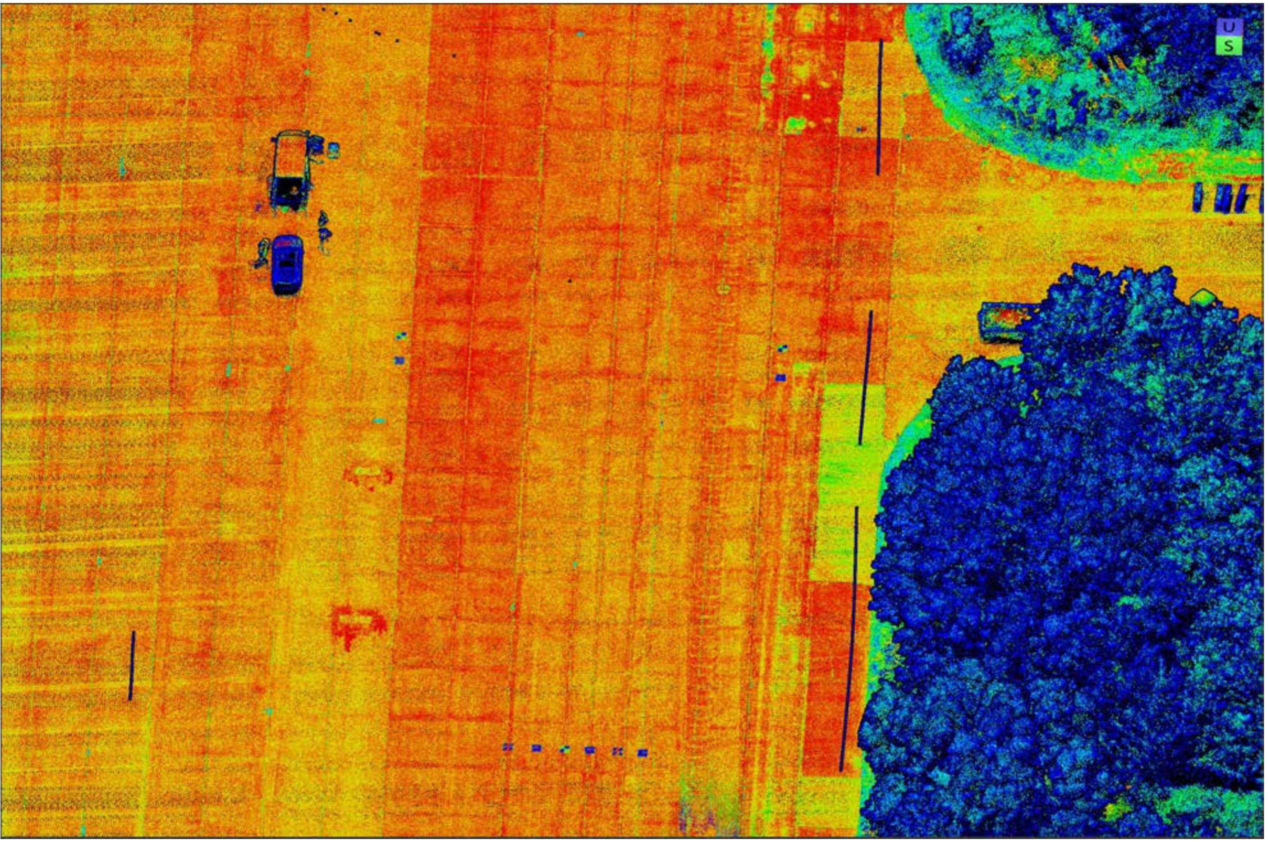
Purpose: Multi-day field experiment to assess repeatability, influence of control, and surface change detection error

Flights Completed

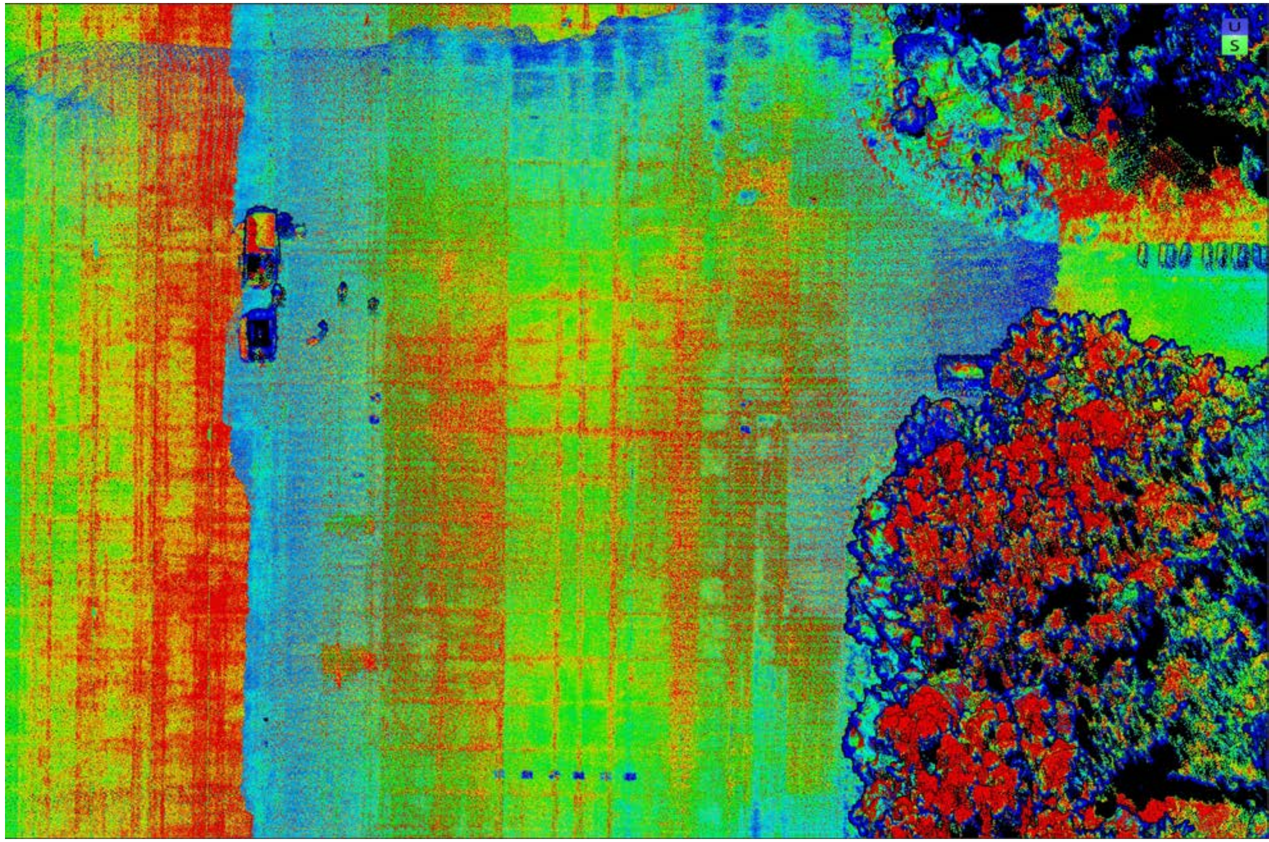
UAS-LiDAR

- 2 days x Avia Livox @ 60 m AGL,
  - 1300 points per square meter average
- 2 days x REIGL VUX @ 820 kHz @ 80 m AGL
  - 630 points per square meter average

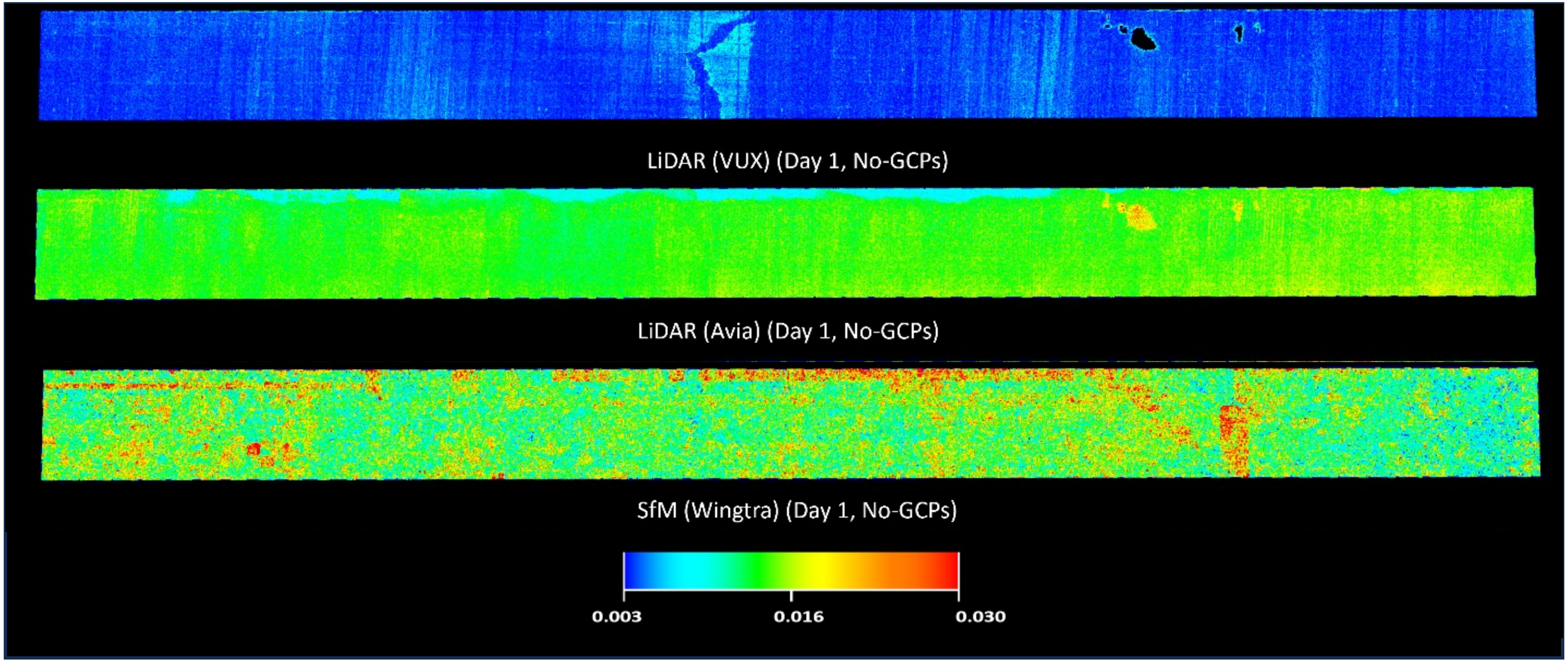
Point Cloud Examples



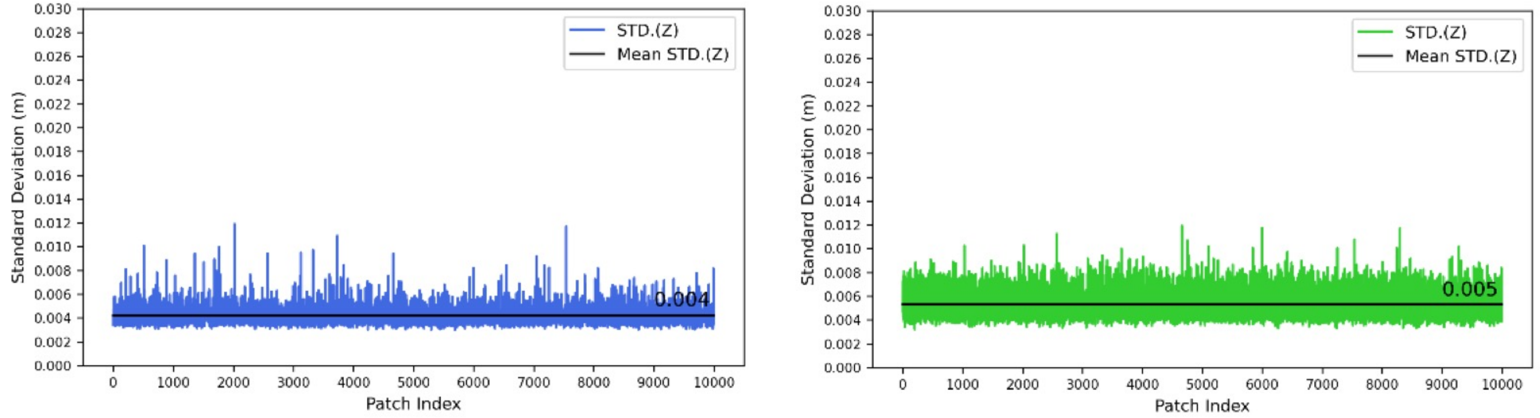
REIGL VUX-1 LR colored by intensity



Livox Avia colored by intensity

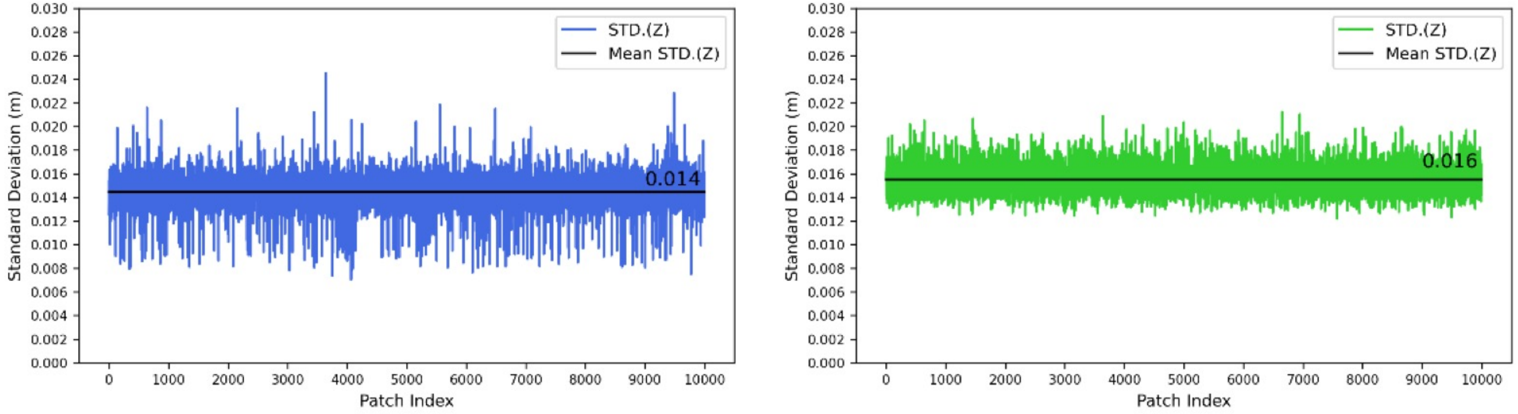


30 cm grided surface roughness map (measures std. z-value/precision)



Day 1 Day 2

Surface Roughness of Runway Surface - VUX LiDAR.



Day 1 Day 2

Surface Roughness of Runway Surface - Avia LiDAR.

Research supported by TxDOT Project 0-7157

AI for Coastal Mapping

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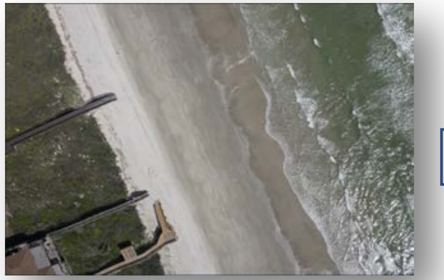
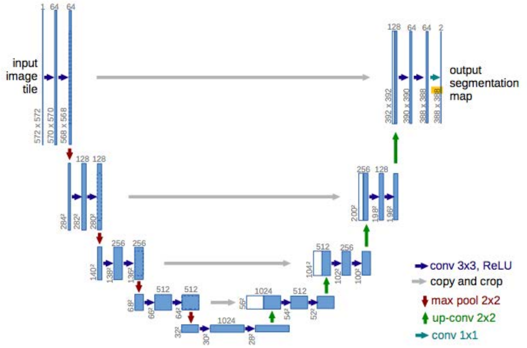
Current Research

AI Image Segmentation within UAS-SfM Workflow





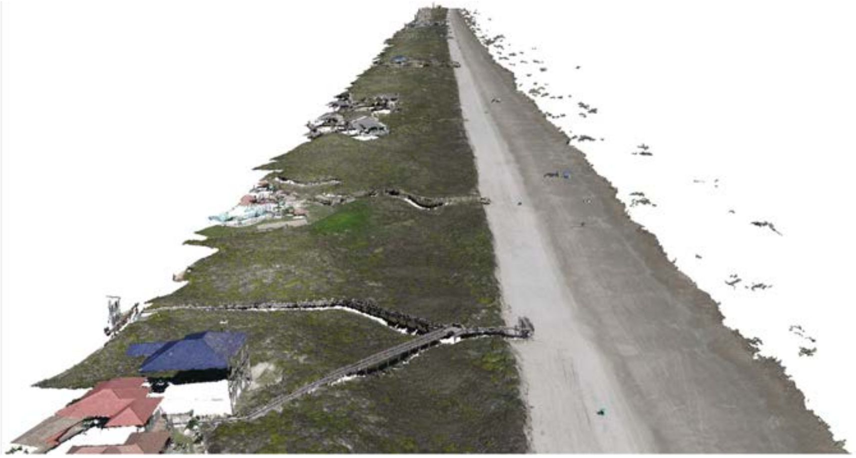
Structure-from-Motion Photogrammetry

Segmented 3D Scene

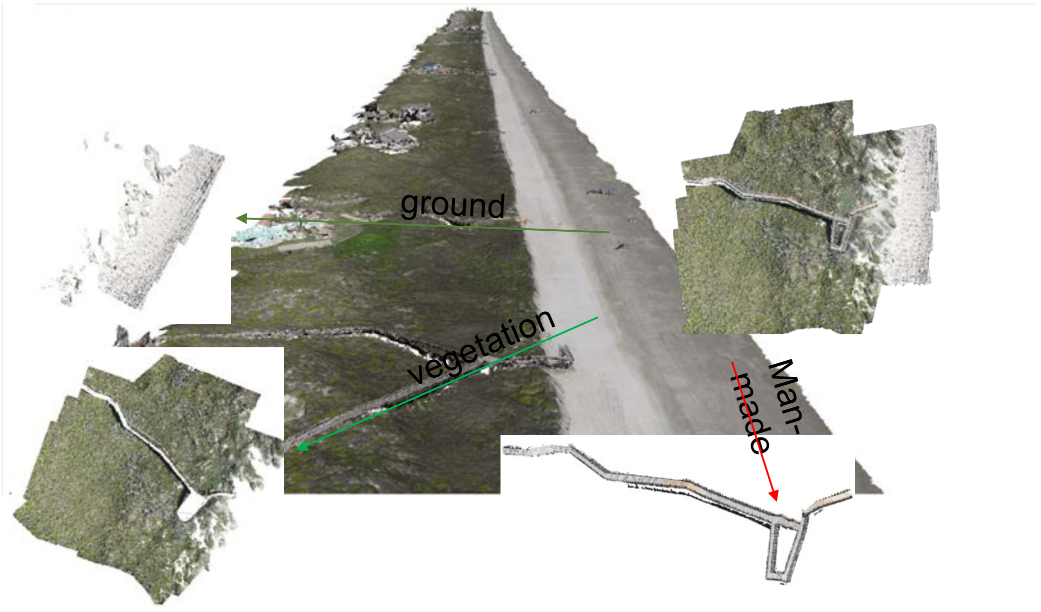
Metashape

- **Traditional approach** classifies point cloud **after reconstruction**
- **This approach** segments image **before reconstruction**
  - reconstruct targets of interest

Before Water Removal



After Water Image Masking



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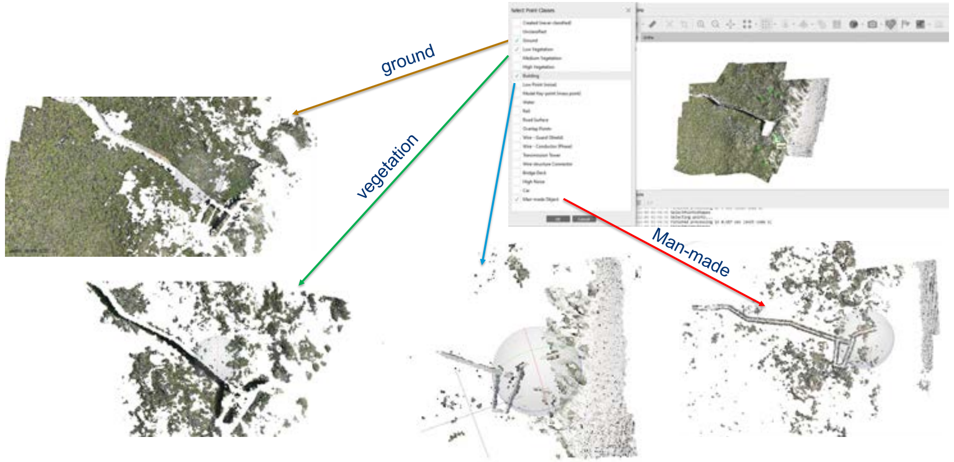
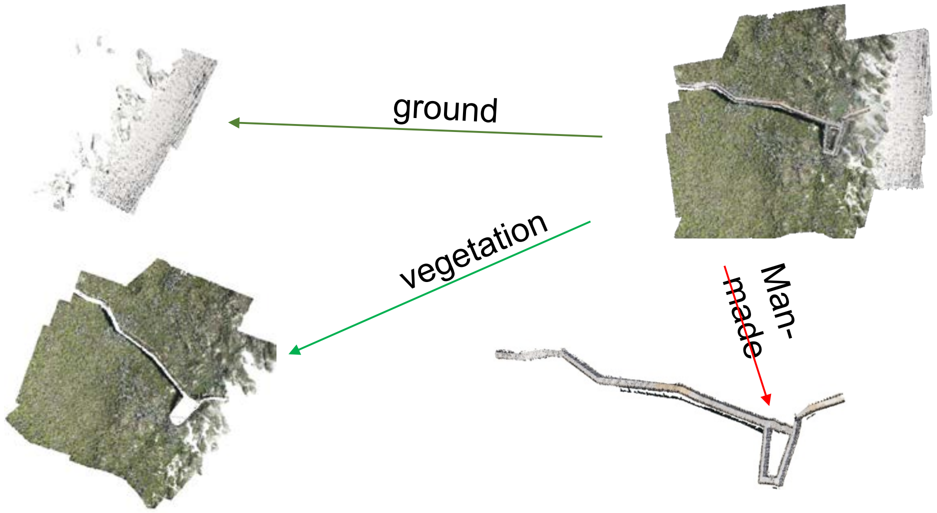
Point Cloud Classification by Software

After Cloud Generation (noisy)



Direct Reconstruction of Target of Interest

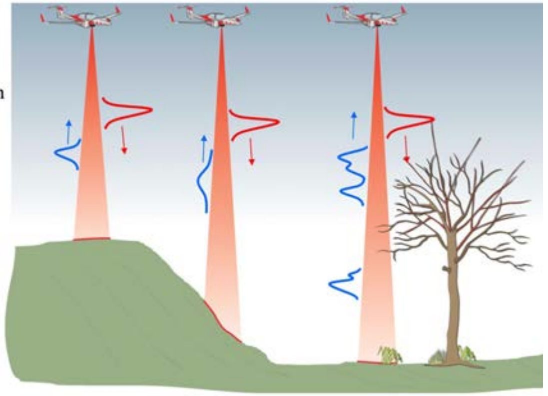
Based on AI image segmentation (less noisy)

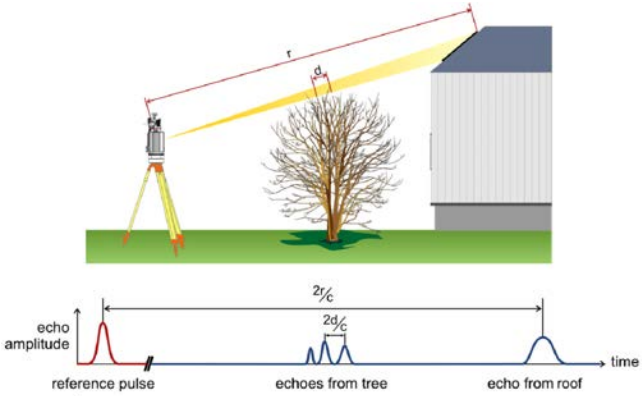


Current Research

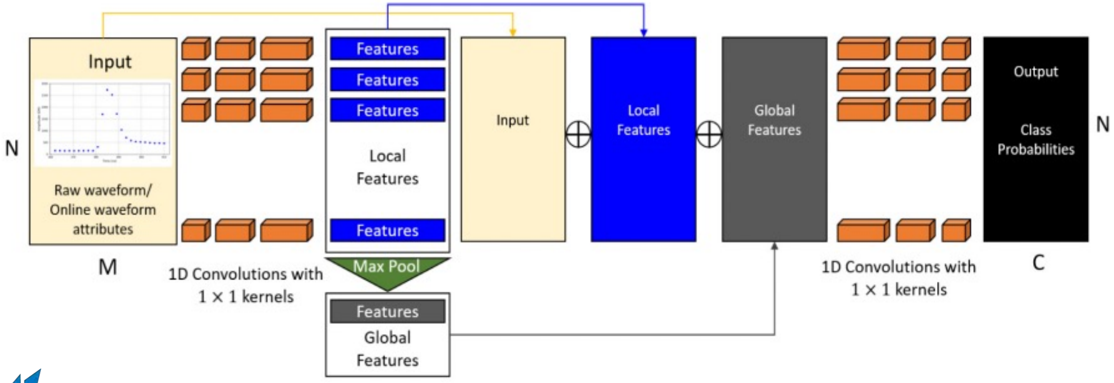
Deep Learning for Direct Classification of FW LiDAR

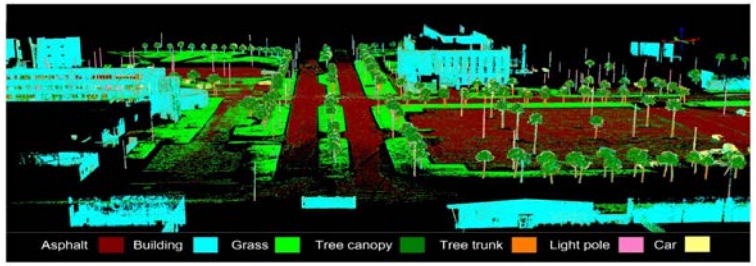
Full Waveform (FW) Lidar



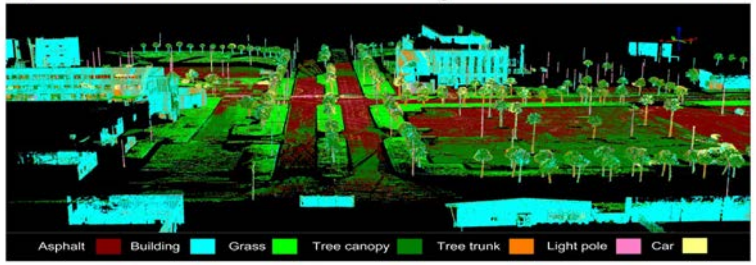


Source: Riegl

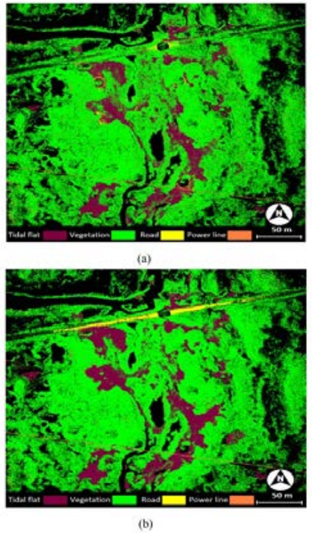


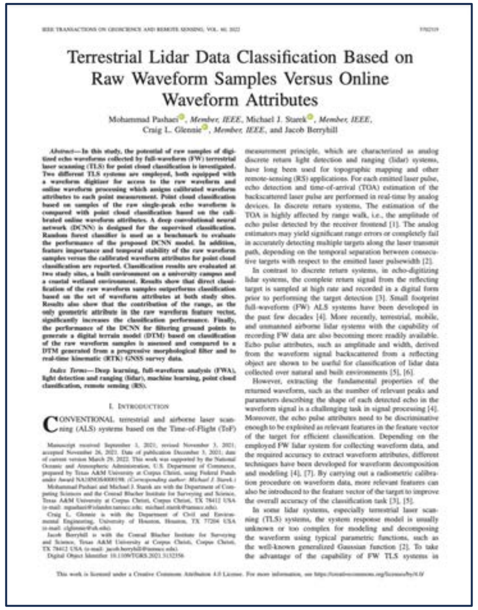


a) Classification result on feature vectors containing the calibrated waveform attributes



b) Classification result on feature vectors containing samples of digitized echo waveform.




Terrestrial Lidar Data Classification Based on Raw Waveform Samples Versus Online Waveform Attributes

Mohammad Pashaei, Member, IEEE, Michael J. Starek, Member, IEEE, Craig L. Glennie, Member, IEEE, and Jacob Berryhill

I. Introduction

CONVENTIONAL terrestrial and airborne laser scanning (ALS) systems based on the Time-of-Flight (ToF)


Classification of Terrestrial Lidar Data Directly From Digitized Echo Waveforms

Mohammad Pashaei, Member, IEEE, Michael J. Starek, Member, IEEE, Craig L. Glennie, Member, IEEE, and Jacob Berryhill

I. Introduction

TERRESTRIAL laser scanning (TLS) systems are increasingly being used for topographic and land cover mapping

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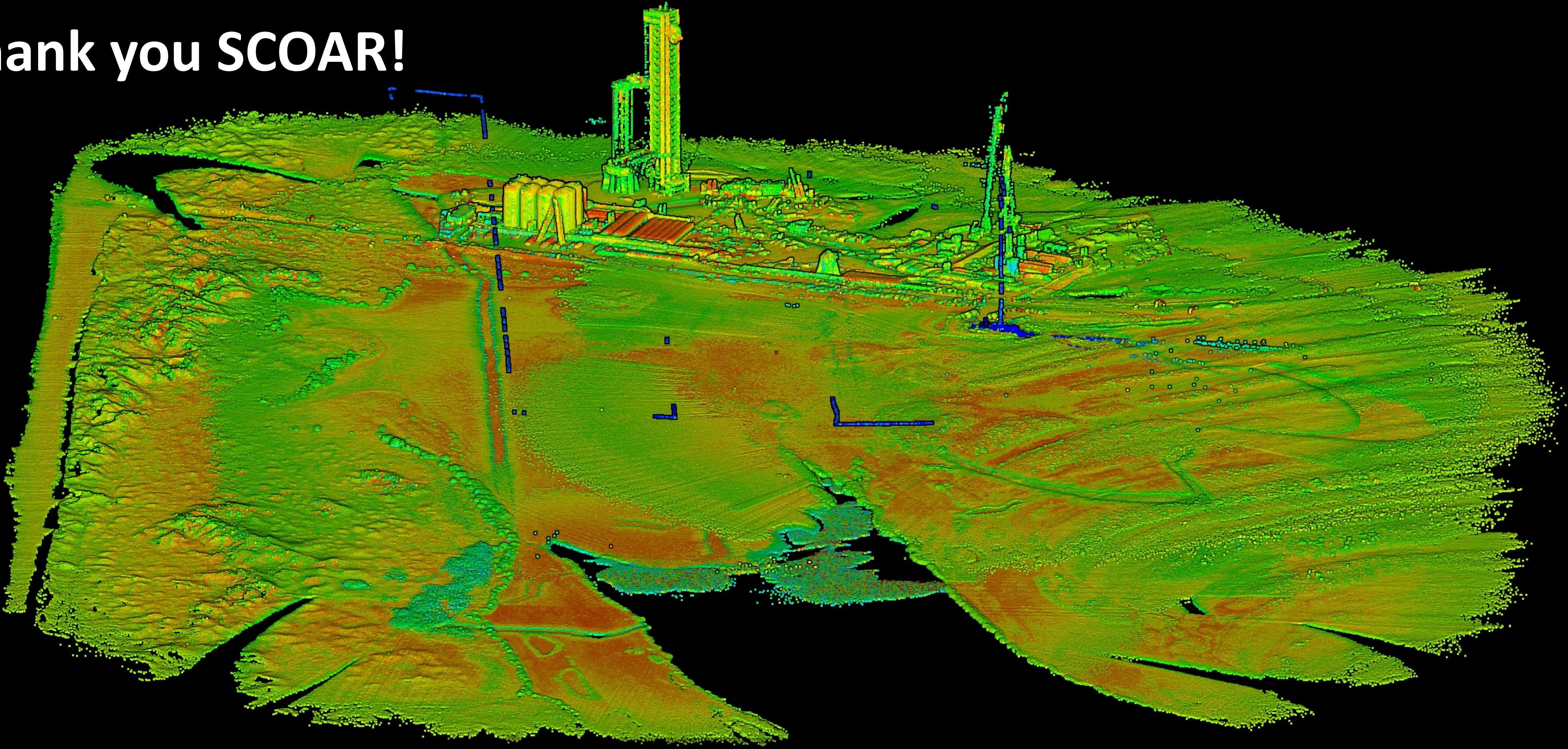
Ocean Wave Energy Study

- **UAS surveys** conducted in September 2023, of Inishmaan and Tory Island, Ireland.
- Map boulder sizes and locations relative to sea level to examine energy transport of massive ocean waves

Basemap: (C) Sentinel-2 cloudless by EOX IT Services GmbH (C) Mapzen

Thank you SCOAR!



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