CEC Continuing Education Center

DesignNews

Using Drone-Based LiDar

DAY 5 : Demonstration

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- Submit questions for the lecturer using the Q&A widget. They will follow-up after the lecture portion concludes.

Louis W. Giokas

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Course Overview

During this program, attendees will learn how to convert data collected from a LiDAR mission into a point cloud comprised of over 6 million points, which will be used to create highly accurate digital surface models and contours. Watch the entire process and learn how you can start saving time and money by adding drone-based LiDAR to your workflow. In particular you will learn the components of UAV LiDAR; how to save time and money with drone-based LiDAR as part of workflows; evaluate the benefits of drone-based LiDAR; how to create a 3D point cloud with a visual data demonstration.

Class Overview

In this class we will look at an example, of how to use LiDar and UAVs to create accurate digital surface maps. Using simulated data we will take a project from start to final image.

Agenda

- Overview
- Selection of Area to be Mapped
- Selection of Equipment
- Selection of Software
- Flying the Mission
- Point Cloud Processing

Overview

- The goal of today's class is to give an example of the processes we have been reviewing and to take that process from start to the generation of the point cloud.
- This is just an example. Each project will have its own parameters and goals. Using what we have learned will allow you to make these decisions in light of the specific projects you might be working on.
- As such, you may want to take this as a cookbook approach, with the steps herein acting as a guide.

Overview

- In the previous class, we looked at a typical project flow. This assumed that many of the considerations we will consider today have already been settled.
- If using a service, the service provider will have done much of this work previously. They will generally have picked equipment and software, integrated it and will have experience with it. It still pays to have these decisions explained and to question their approach, with an eye toward ensuring that your specific project goals are met.

Overview

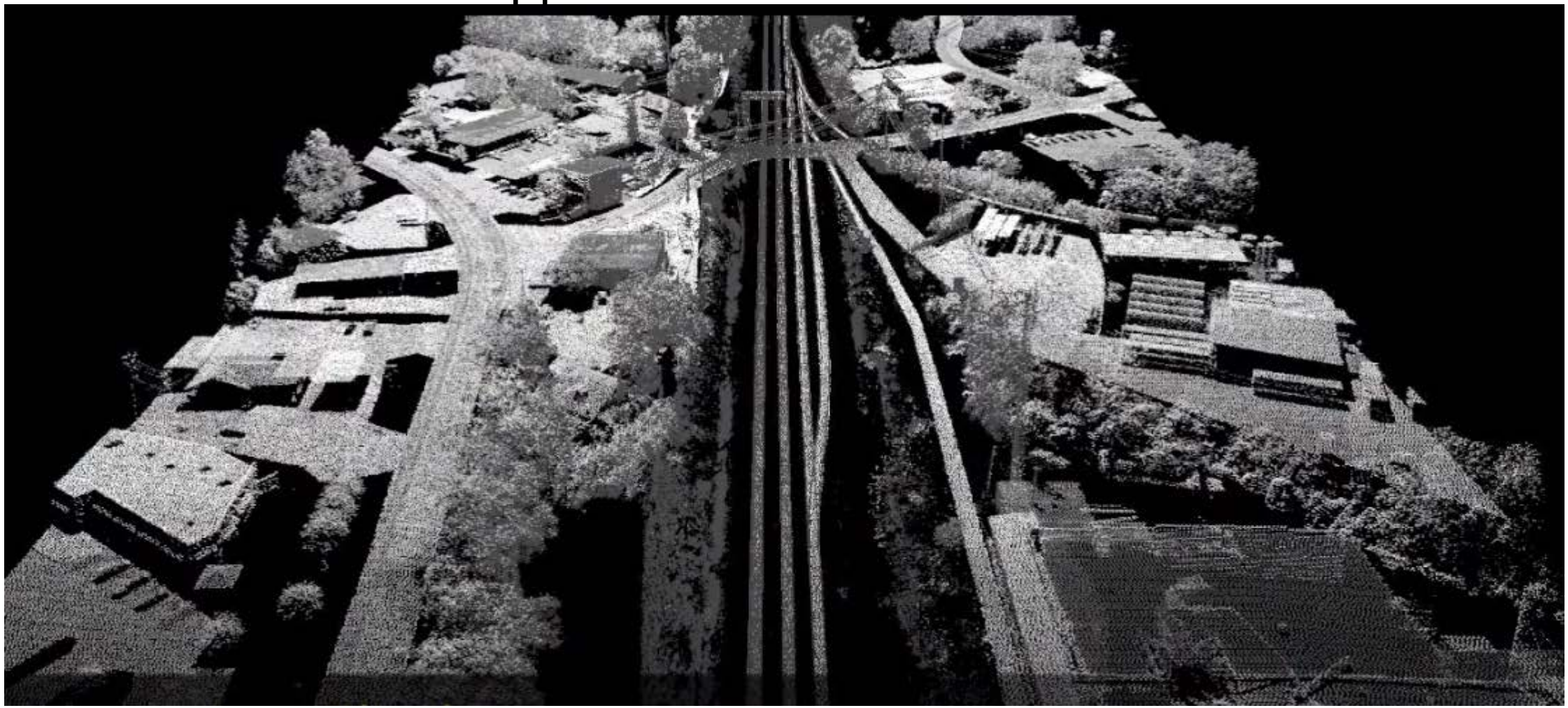
- As one can see from the Agenda, there are basically two phases to a project.
  - Selection
  - Operation
- Once the equipment selection phase is completed, the operation phase will be driven by those equipment selections.
- At that point, the approach taken to project execution in the previous class will be useful.

Selection of Area to be Mapped

- This selection will be driven by your customer's requirements.
- It may be a general mapping exercise, or may have a goal of measuring details such as we have mentioned before:
  - Vegetation
  - Agricultural conditions
  - Road or building conditions
  - Geological features
- You may need to consider obstacles and restrictions.

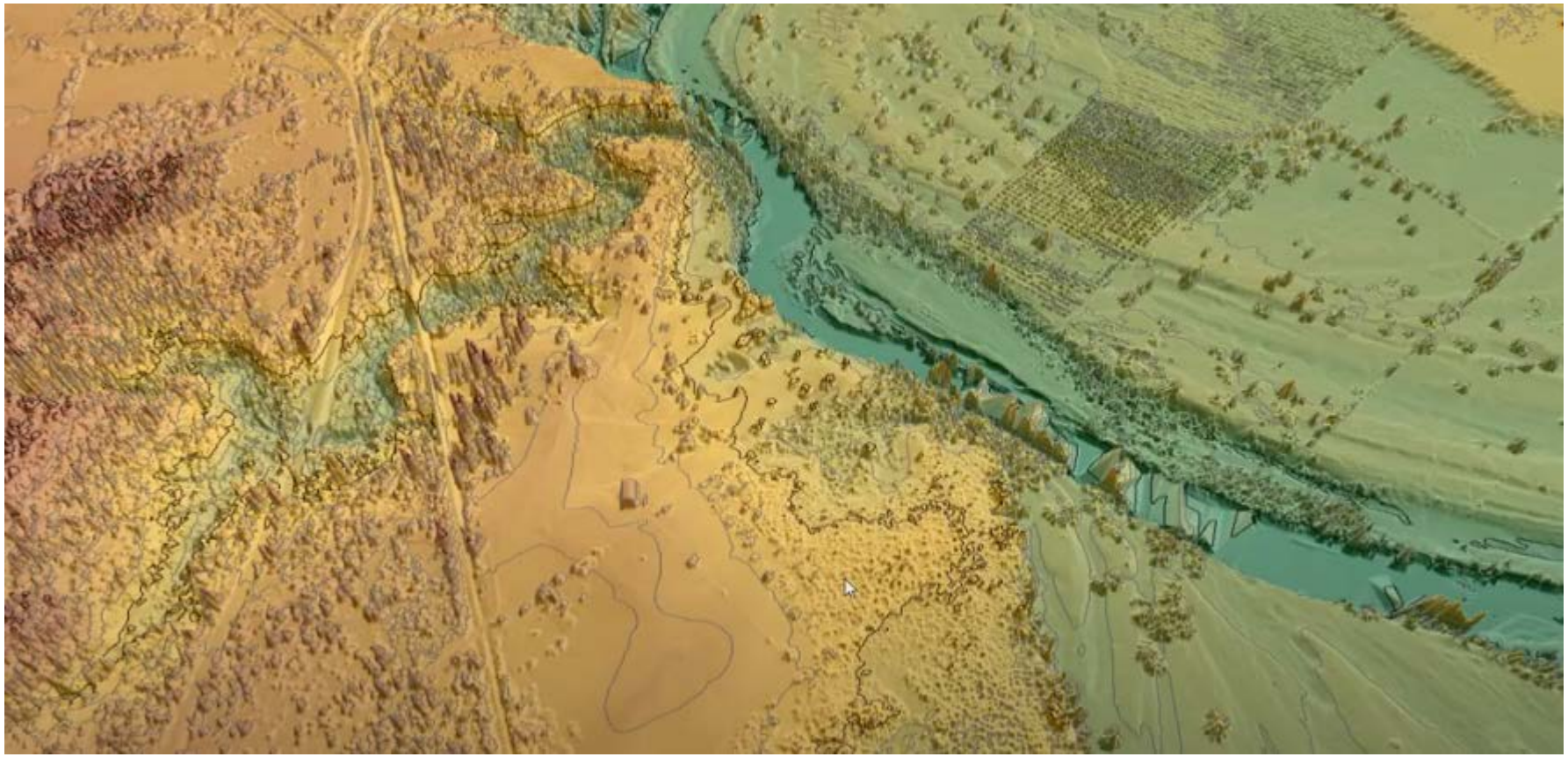
Selection of Area to be Mapped

Built up area



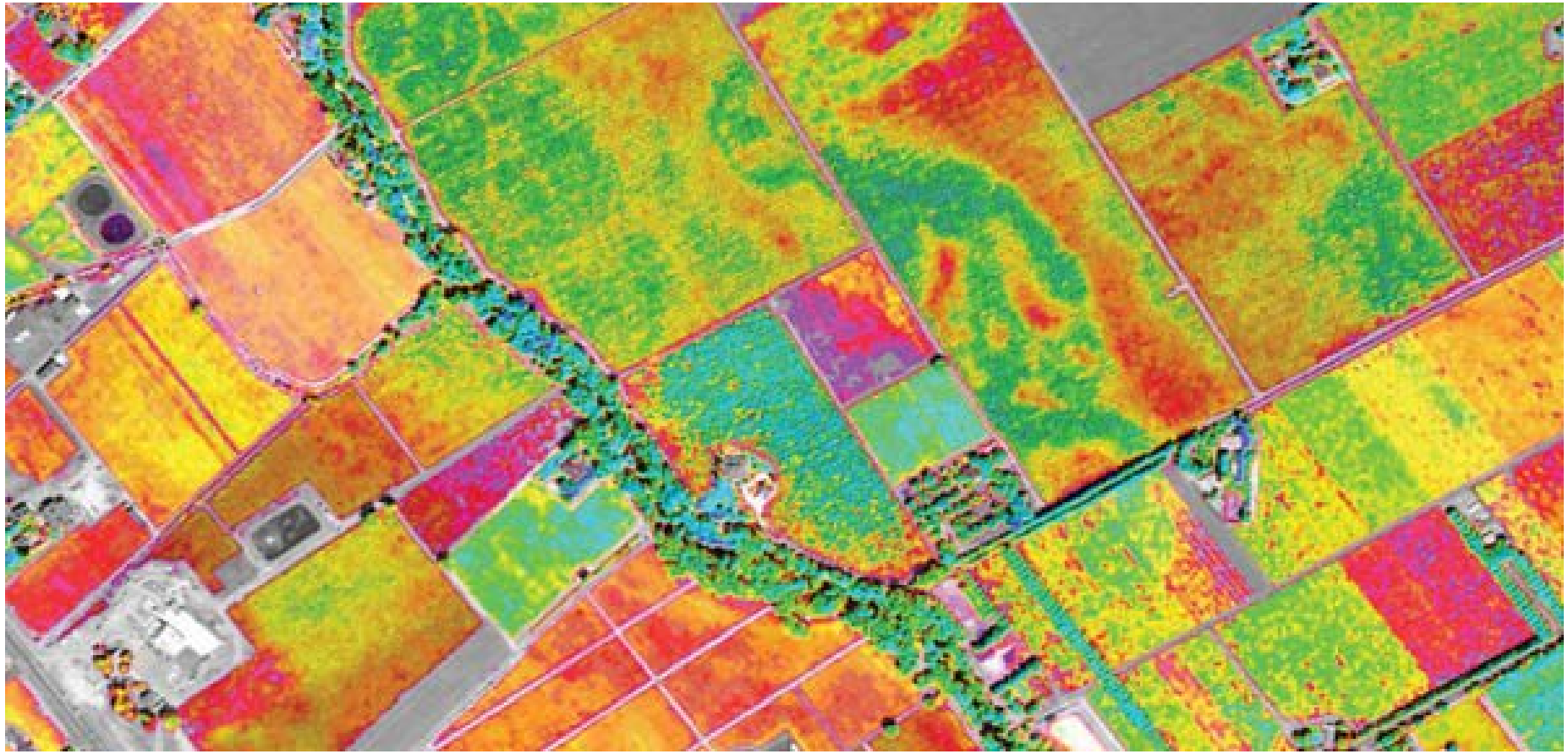
Selection of Area to be Mapped

Open terrain. This is a surveying application.



Selection of Area to be Mapped

Agricultural Area



Selection of Equipment

- There are two main pieces of equipment to be selected.
  - Sensor
  - UAV
- In each of these, there are many options available.
- We will start with the sensor.
  - Weight and power requirements will be a driver for the selection of the UAV
- Other components of the system, such as software and processing environment will be discussed in those sections.

Selection of Equipment

- LiDAR sensors have varying characteristics.
  - Wavelength of the laser.
  - Sensor capabilities.
  - Speed of sensing.
  - Laser steering method.
    - Mechanical, MEMs mirrors, etc.
  - Cost of the sensor.
  - Ensure that sensor can collect the information you need.

Selection of Equipment

- UAVs come is many sizes and capabilities.
- Those used for remote sensing tend to be larger in order to give the necessary range and duration while carrying the LiDAR device.
- Position measuring equipment, such as the GPS receiver and IMU are also considerations.
  - Are these already integrated into the UAV, or are they add-ons.
  - The weight and power requirements of these items must also be taken into account.

Selection of Equipment

- Control systems for the UAV.
  - As we have seen, the flight path we follow can be complex, depending on the terrain and goal of the mission.
  - These may be integrated with the UAV from the vendor or may need to integrated by the user.
  - Ensure that the system meets the need of the mission.
    - Constant height operation.
    - Terrain following.

Selection of Equipment - UAVs

- DJI M600 Pro lidar quadcopter
- Draganflyer Commander
- Riegl RiCopter Lidar UAV
- Harris H4 Hybrid HE UAV
- VulcanUAV Harrier Industrial
- VelosUAV helicopter
- Robota Eclipse fixed wing drone
- DJI Matrice 200 Series quadcopter
- OnyxStar Xena drone lidar
- OnyxStar Fox-C8 HD quadcopter
- GeoDrone X4L lidar quadcopter
- Tron F9 VTOL fixed wing lidar
- Boreal long range fixed wing drone
- Vapor 55 UAV helicopter

Selection of Equipment – LiDAR Sensors

- LeddarTech Vu8
- LeddarOne Lidar Sensor
- Velodyne
  - HDL-32E Lidar Sensor
  - Puck VLP-16 Lidar Sensor
  - Puck Lite Lidar Sensor For UAVs
  - Puck Hi-Res Lidar Sensor Features
- Riegl VUX-1UAV

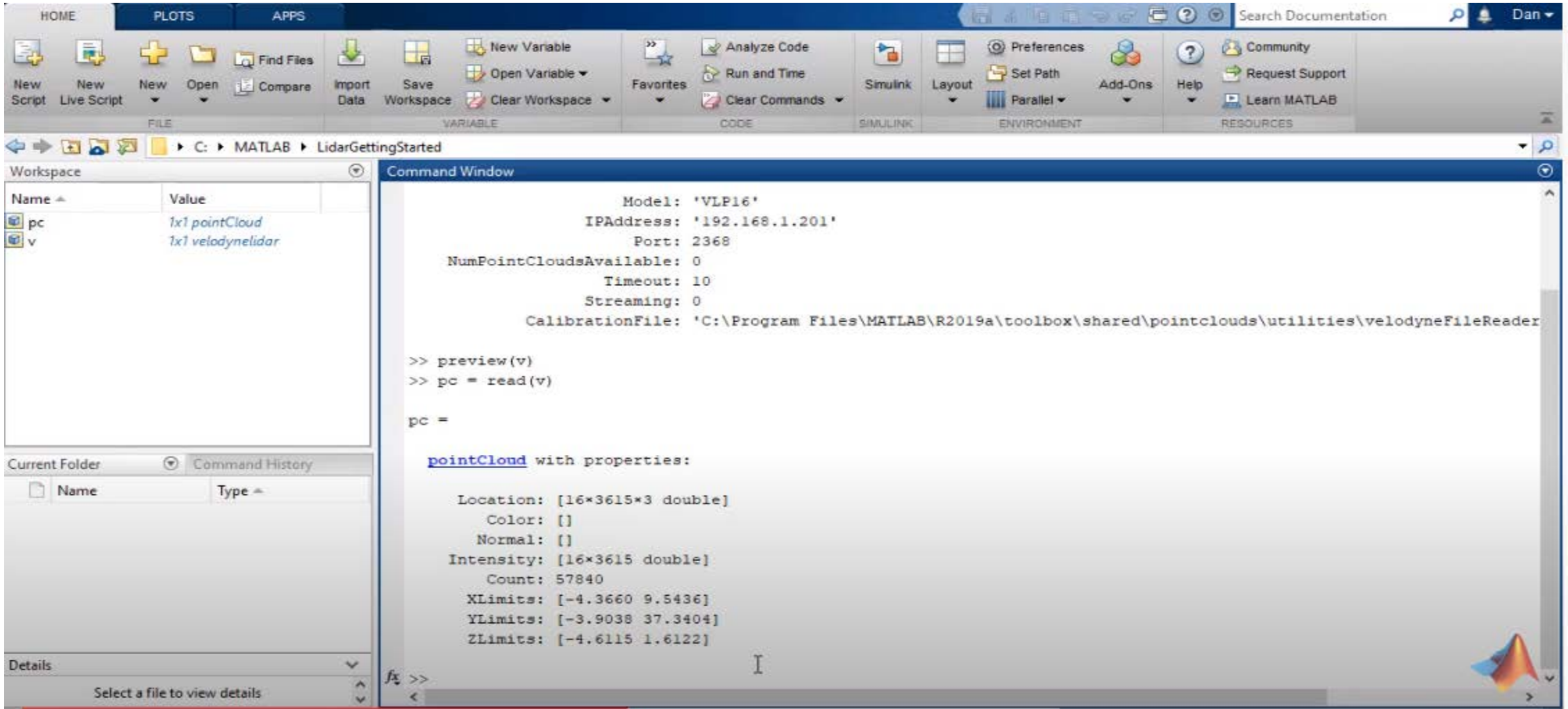
Selection of Software

- The next item we need to select is the software we will use to process the raw data.
- Our first step is to clean up the raw point cloud data.
  - If we are overlapping scans, we need to register the points in common.
  - Calibrate the data.
- The cleaned-up point cloud will be the input to further processing, which is application dependent.

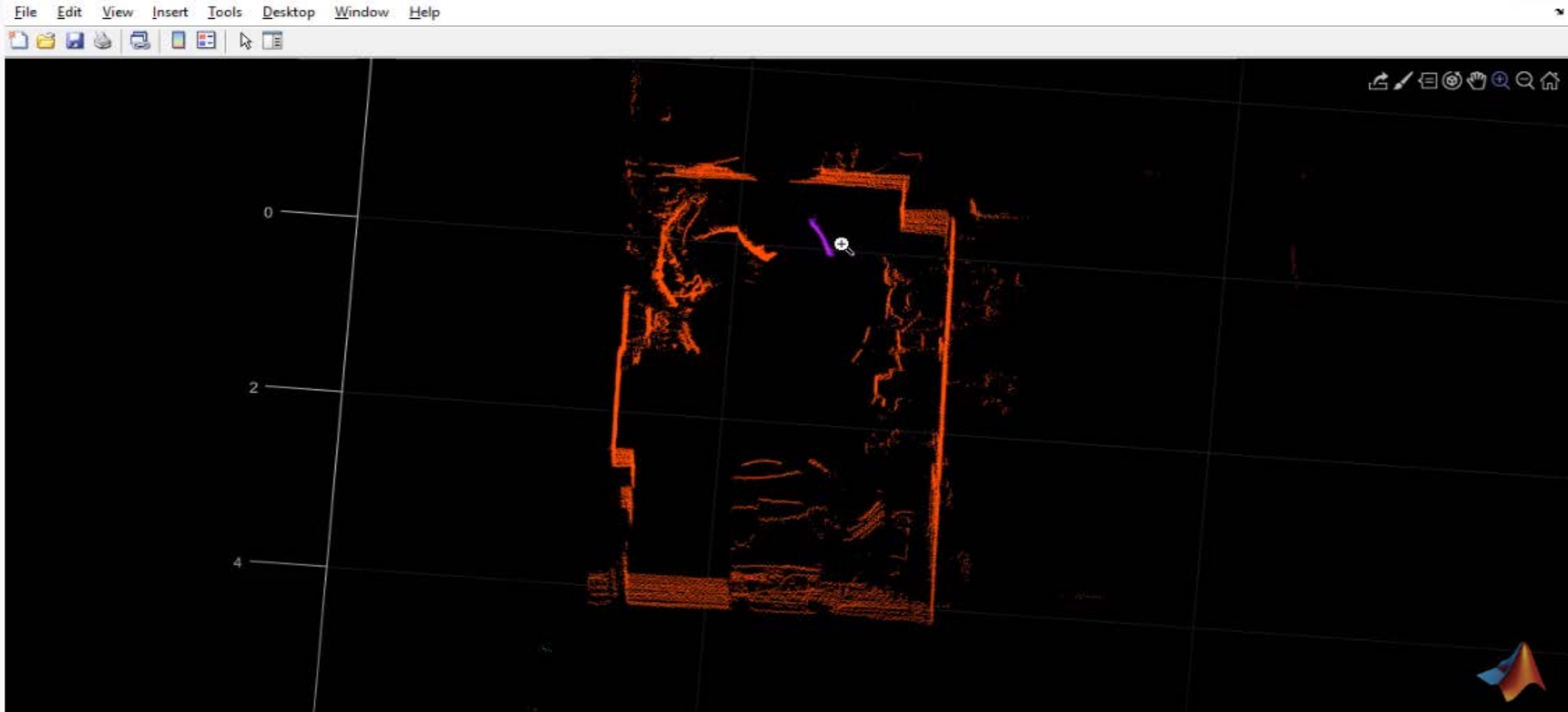
Selection of Software

- Some vendors we might consider:
  - Vercator: a dedicated point cloud processing solution hosted in the cloud
  - MATLAB: process the point cloud in a well-known tool.
  - ESRI tools: ARCMap, ARCScene, ARCGIS, etc.
  - Virtual Surveyor: Converts point clouds to terrain.

Selection of Software



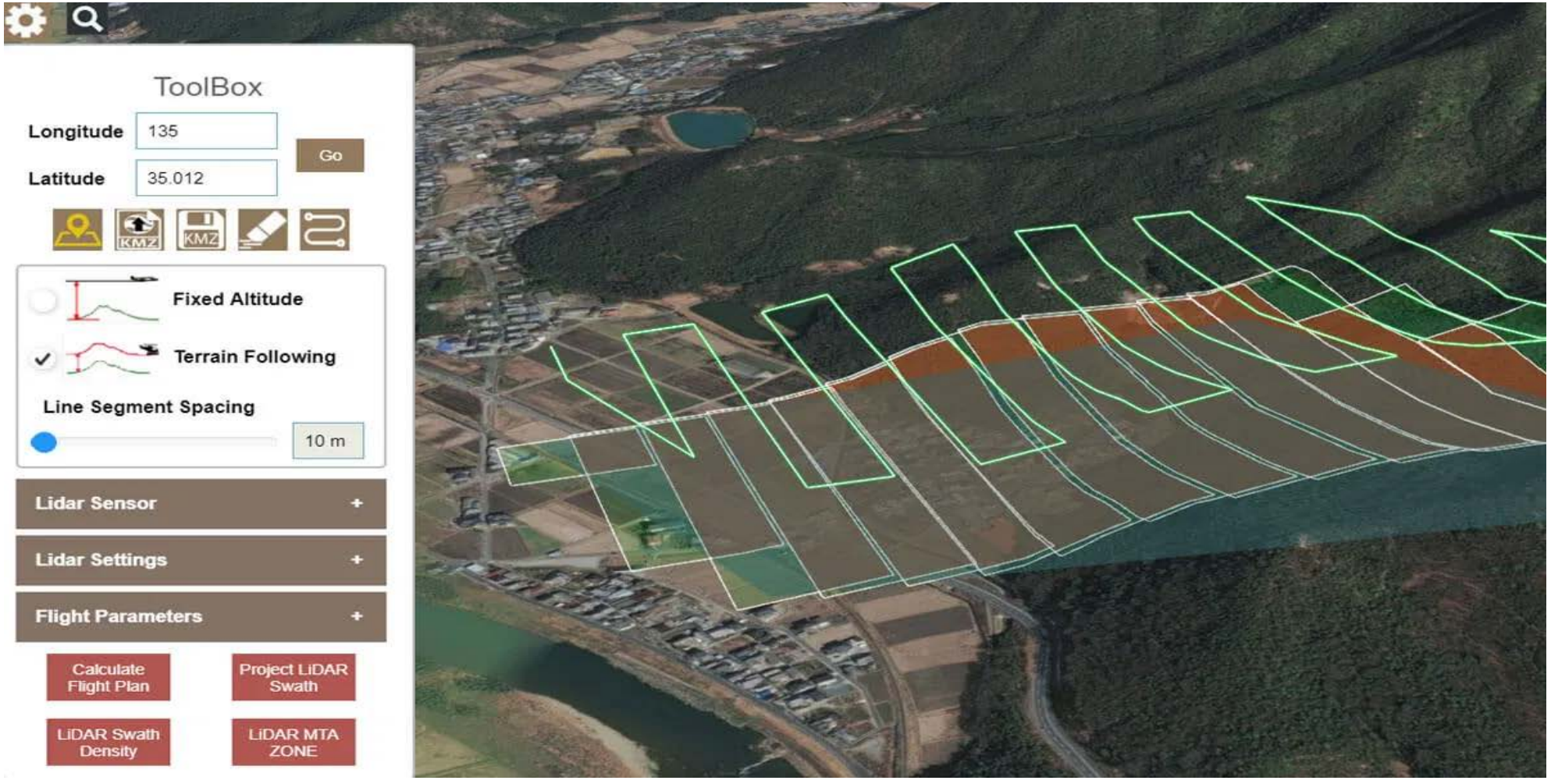
Selection of Software



Flying the Mission

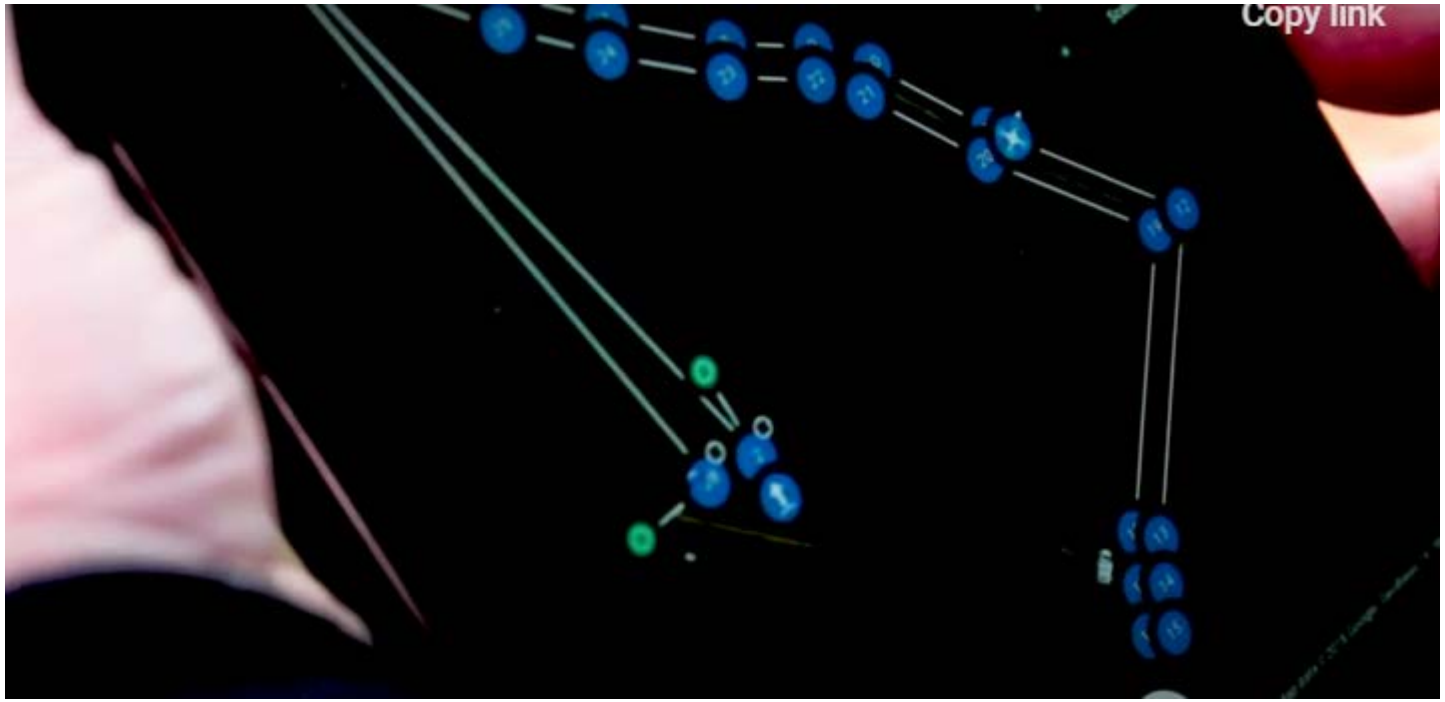
- Now we have the components we need to fly the mission.
- Look at yesterday's class to understand the parameters we need.
- The UAV will be assembled on site, with the sensor attached, and the programming transferred to the UAV in preparation for flight.
- The process may have to be repeated is problems are found with the data later on.
  - The ability to take samples during operation can help.
- The application may require that the same flight plan is repeated over time.

Flying the Mission



Flying the Mission

Flying the Mission



Point Cloud Processing

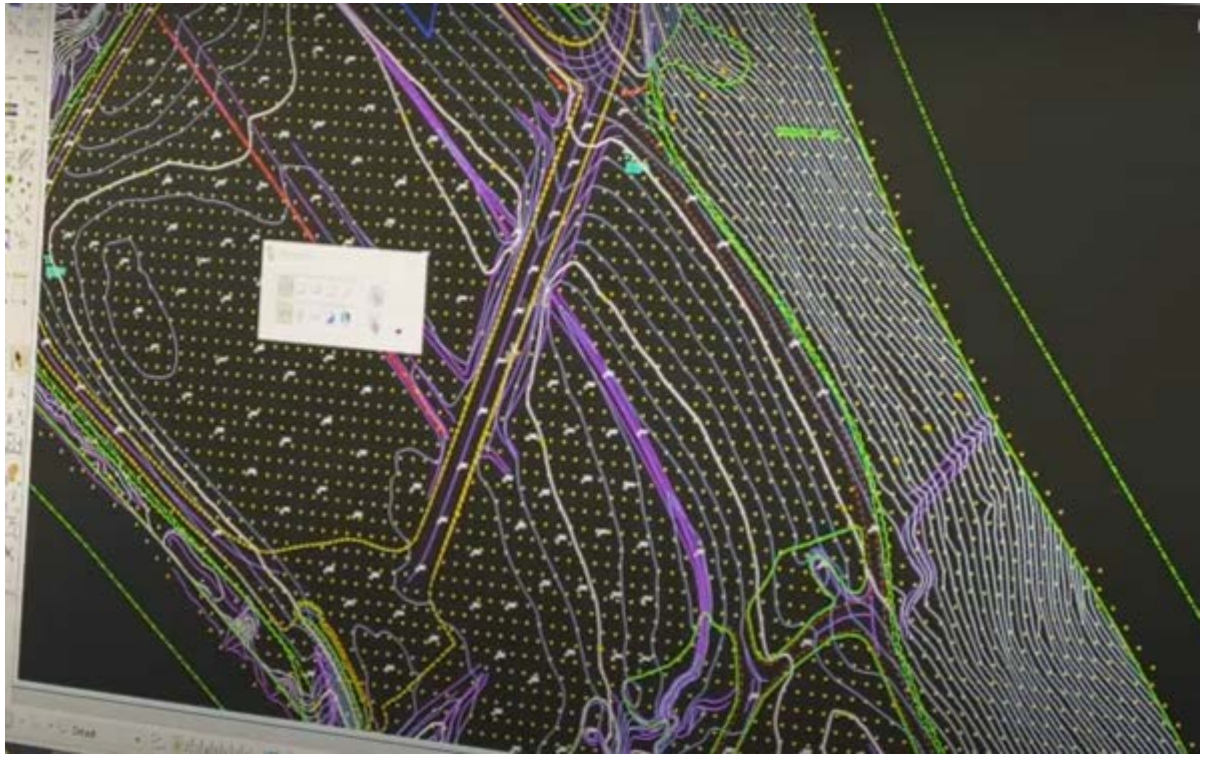
- As mentioned above, once we have the raw data, it needs to be processed into a clean point cloud.
  - Calibration of both the point measurements and the positioning data.
- This generally requires significant computing power, primarily because of the size of the datasets.
- One should consider cloud-based solutions, since these can be sized to application at hand dynamically.
  - Not only for storage, but to take advantage of parallel computing capabilities.

Point Cloud Processing

- In many cases we take imagery data along with the point cloud data from the LiDAR.
  - This improves the fidelity of the point cloud.
  - The image gives good information on color.
  - The LiDAR data gives precise location and elevation data, as well as penetrating many types of vegetation.
  - LiDAR waveform data is also critical to many applications.

Point Cloud Processing

Point Cloud Processing



Thank you for attending

Please consider the resources below:

- Books
  - LiDAR Remote Sensing and Applications, By Pinliang Dong, Qi Chen
  - Topographic Laser Ranging and Scanning: Principles and Processing, Second Ed., edited by Jie Shan, Charles K. Toth
  - Lidar: Range-Resolved Optical Remote Sensing of the Atmosphere, edited by Claus Weitkamp

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