CEC Continuing Education Center

DesignNews

Using Drone-Based LiDar

DAY 3 : Platforms for Processing

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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

Processing of the raw data to convert it into accurate surface models and contours can be done using a number of different platforms. We will look at some of the platforms available and how our choice of technologies drives the selection of a platform. We will also consider the data storage issues for such large data sets including standard compression schemes.

Agenda

- Processing Overview
- File Formats
- Processing Flows
- Data Storage

Processing Overview

- Collection of point cloud data results in a large dataset of points in space. Our goal is to take that data and render it into a 3D model of the real world.
- We also will generally want to extract information from the measurements that is at a higher level than the just a rendering.
- Combining point cloud data with other information can enhance the process and give a more detailed picture of the volume being measured.

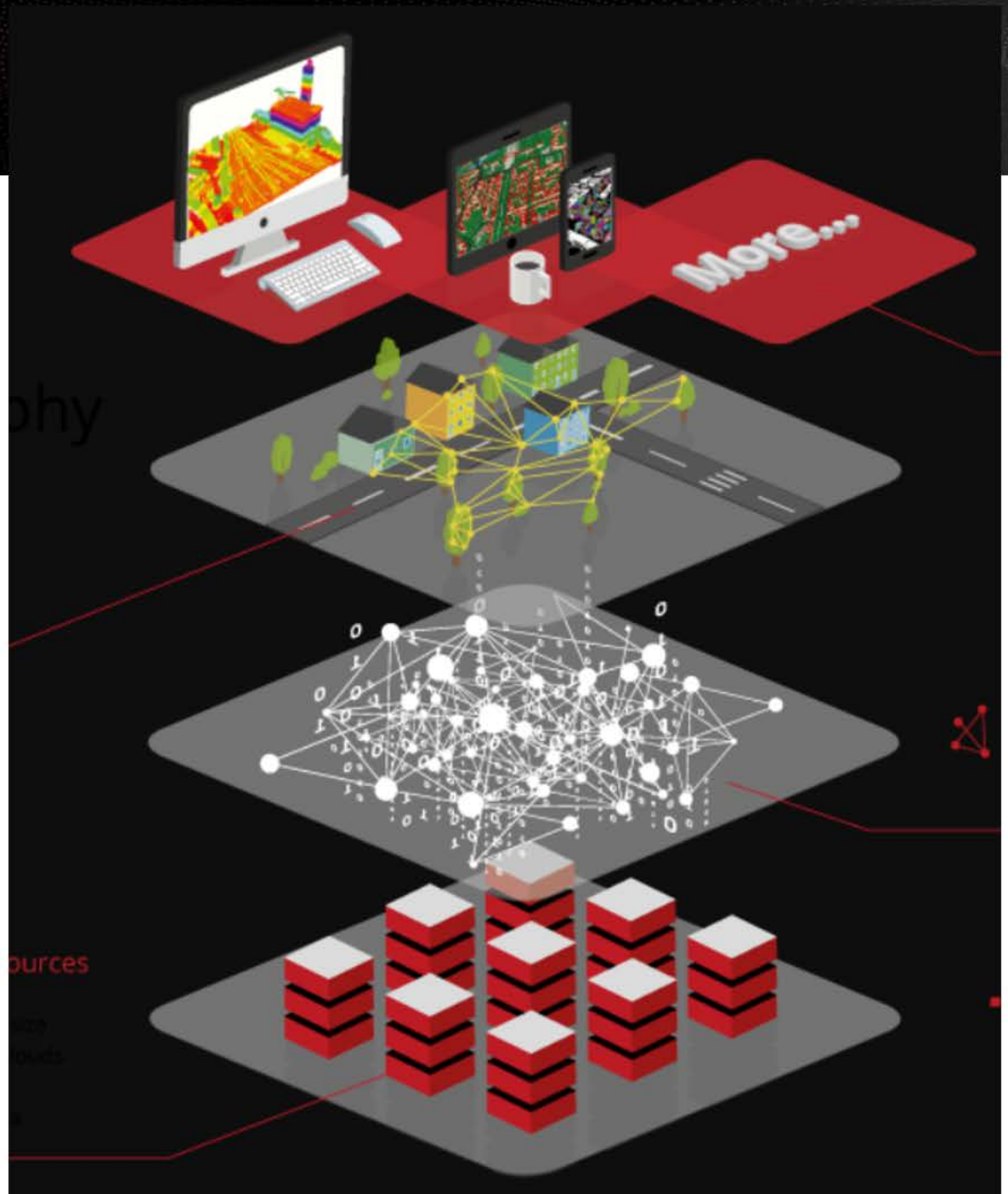
Processing Overview

- Point clouds have their origin in surveying and mapping, and this is the type of application we will look at in this course.
- This is the class of applications that typically require a UAV and LiDAR approach.
- Other applications of point clouds are useful and interesting and many of the techniques are applicable.
- Processing techniques are driven by the application and the software used.

Processing Overview

- We often connect point cloud data collected by the UAV and LiDAR system to external data such as GIS information.
- Data elements in the point cloud, such as waveform data, gives more detail of the actual scene.
- Each scan we do can be combined with previous scans to detect differences in the environment.
  - Some examples may be agricultural data, allowing for the tracking of the development of crops and the use and effectiveness of fertilizers and pesticides

Processing Overview



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Point Cloud

File Formats

- The standard format for point cloud data is the .LAS/.LAZ format
- This datasets have four basic components
    - Header - Required
    - Variable Length Records (VLRs) - Optional
    - Point Data Records - Required
    - Extended Variable Length Records (EVLRs) - Optional

File Formats

Typical Point Data Format

x
y
z
Intensity
Return Number
Number of returns
Scan direction flag
Edge of flight line
Classification
Scan angle rank
User data
Point source ID
GPS time
Red
Green
Blue
Wave packet descriptor index
Byte offset to waveform data
Waveform packet size in bytes
Return point waveform location
$x(t)$
$y(t)$
$z(t)$

File Formats

Classification Value	Meaning
0	Created, never classified
1	Unclassified
2	Ground
3	Low vegetation
4	Medium vegetation
5	High vegetation
6	Building
7	Low point (noise)
8	Reserved
9	Water
10	Rail
11	Road surface
12	Reserved
13	Wire—guard (Shield)
14	Wire—conductor (Phase)
15	Transmission tower
16	Wire—structure connector (e.g., Insulator)
17	Bridge deck
18	Nigh noise
19–63	Reserved
64–255	User definable

This slide is a placeholder for a participant question.

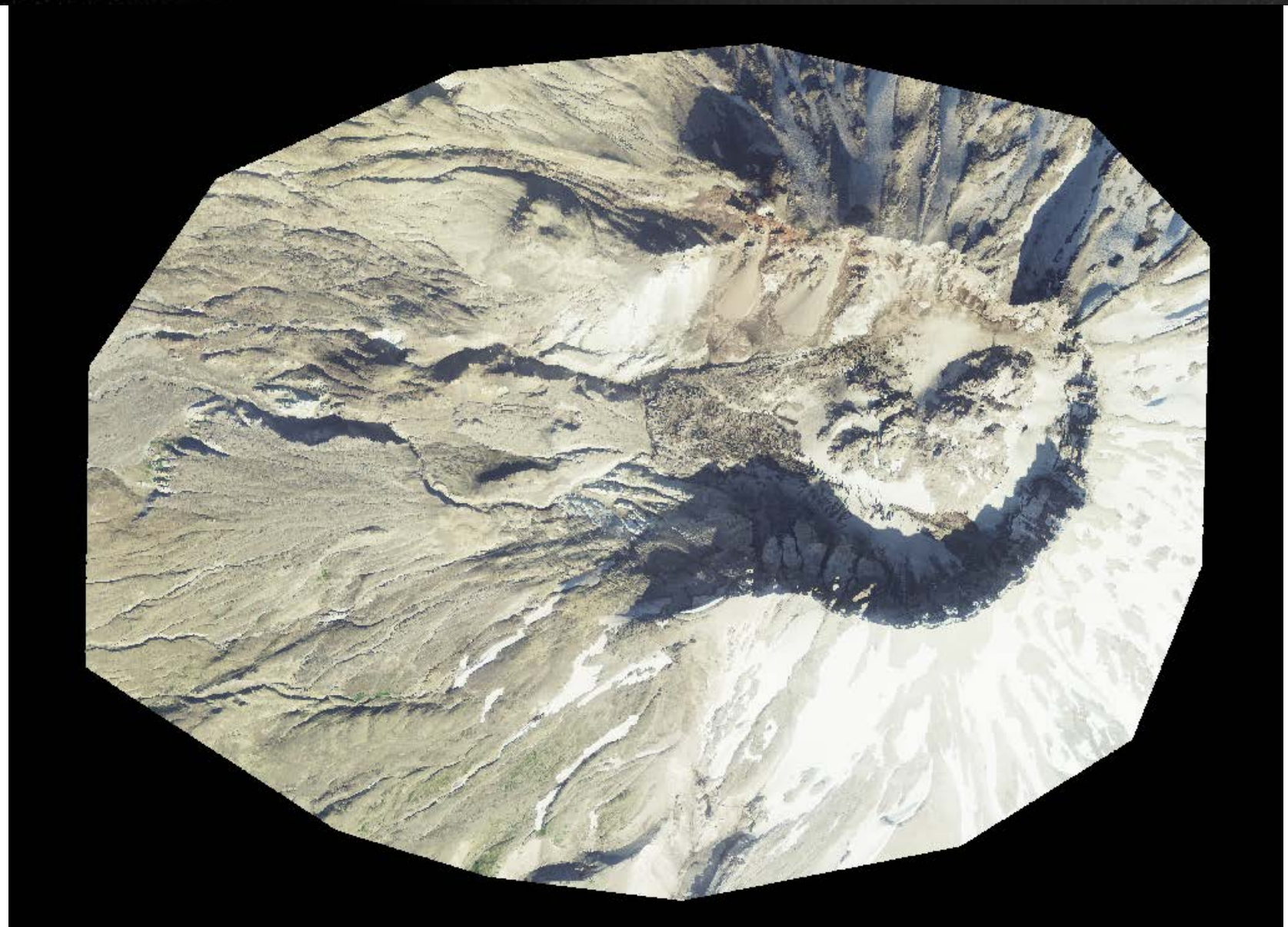
Please use it in each position you would like a participant question included. It will be hidden in the live presentation and replaced with the interactive question you submit.

File Formats

- Output data sets vary in format, driven by the tools that will be used to view and further process the information.
- As we are often using the point cloud to develop a view of the real world, we can render it with different levels of detail, and dynamically change the rendered information.
- In the following, a view of Mount St. Helens is utilized, provided by the NSF using a viewer called Plas.io
  - It has over 12M points with 34 bytes per point

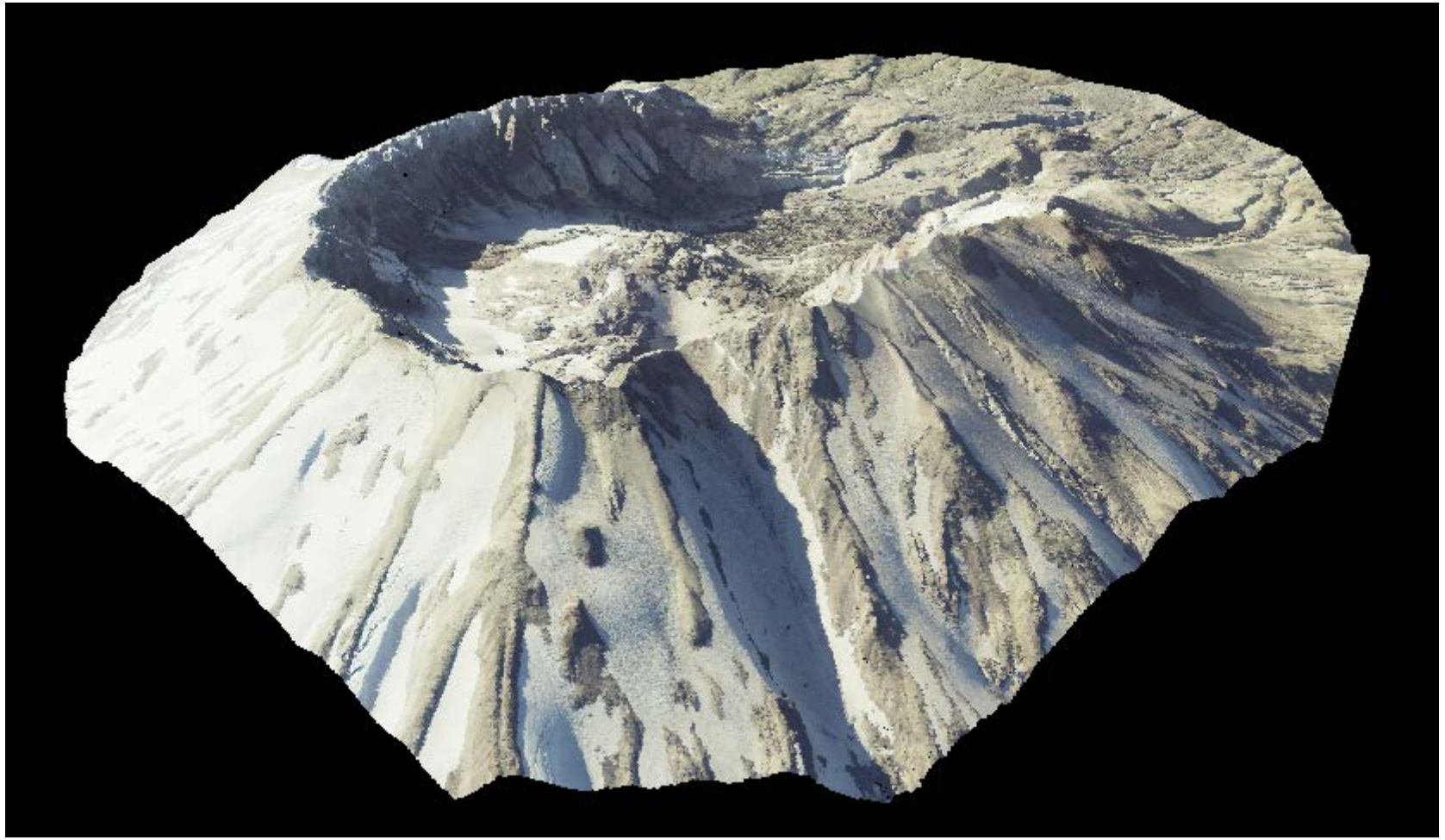
File Formats

Top View



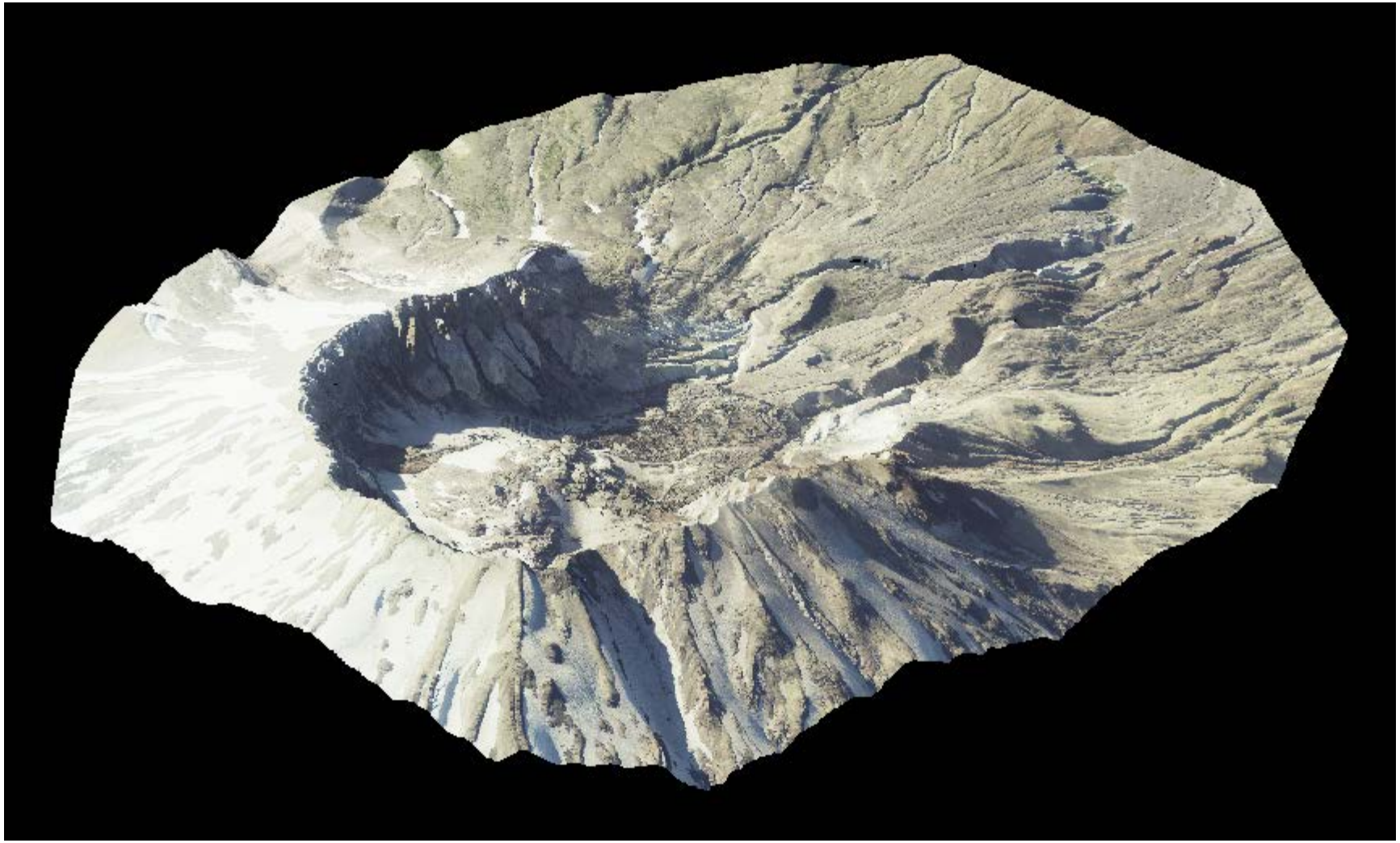
File Formats

Perspective View



File Formats

Orthographic View



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Processing Flows

- For simple visualization, packages such as OpenGL can be used.
  - This allows one to manipulated to image, panning and zooming at will
- For use in analysis and more detailed processing, such as inclusion in 3D CAD packages, more detailed processing is required.
  - This often includes the use of Neural Network technology to extract objects from the point cloud.
- The integration of metadata is often required to locate specific features, such as map references.

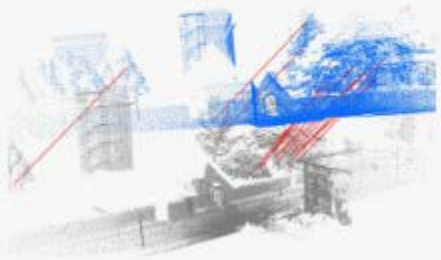
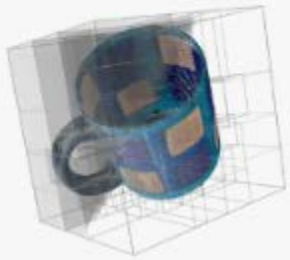
Processing Flows

- The details of any processing are very dependent on the package chosen and the use to which that data will be put.
- The point cloud will often be processed in several different ways, each having its own use.
- We will look at some of these using an open source package called pcl (point cloud library).
  - Various outputs can be created, and each has a specific purpose.

Processing Flows

- One of the first steps is registration.
  - Point clouds have data that often overlaps (recall the process of data collection from the previous lecture, where various types of route planning are used).
  - Registration identifies points of overlap and lines these up to produce a clean point cloud dataset.
  - This process uses estimation of errors and processes such as SVD to iteratively improve the image.

Processing Flows

registration	kdtree	octree
		

We process the data from raw input to various representations that allow the image to be refined for eventual visualization. Various graphics representations are used, which will allow rendering of the objects in the scene.

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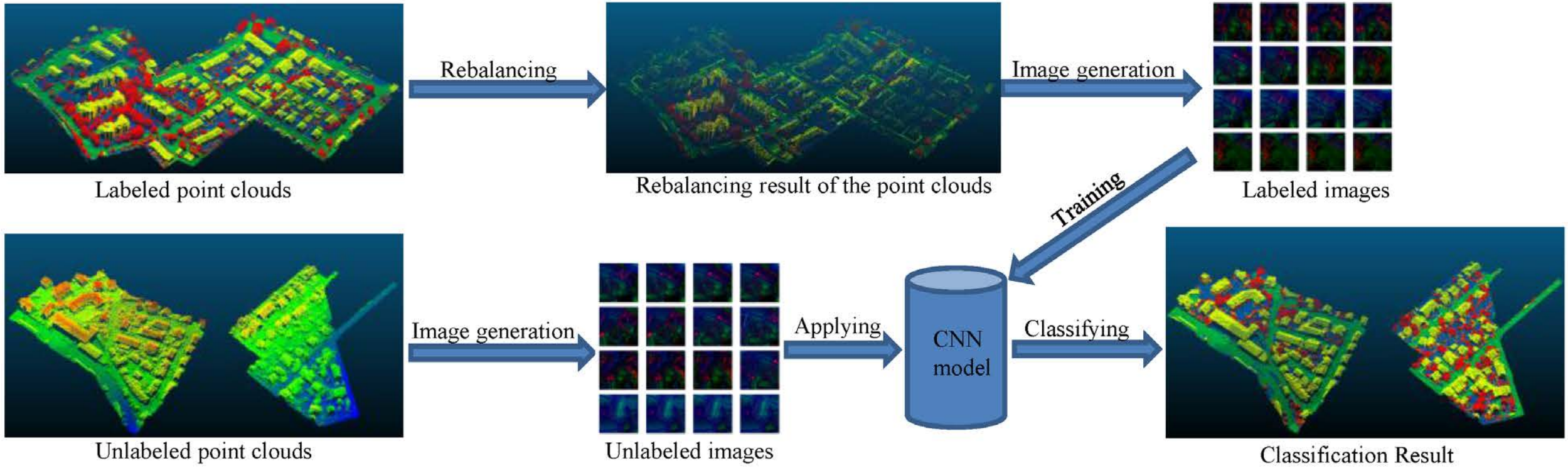
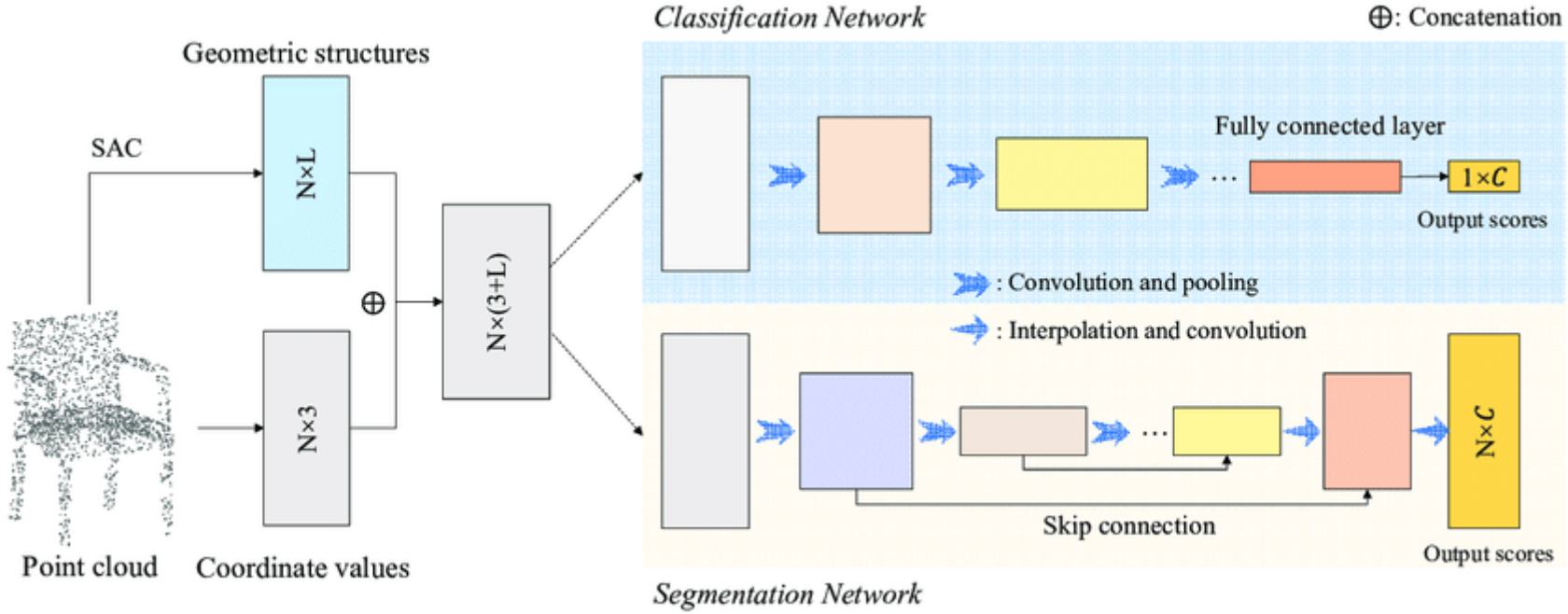
Processing Flows



Processing Flows



Processing Flows

- As can be seen, the size of the point clouds and the amount of information contained therein makes processing quite intensive.
- Many platforms can be used to process the point cloud data, from powerful workstations to cloud computing platforms.
  - These later are finding more application as point clouds grow in size and complexity.
  - This is also more efficient and can use the parallel nature of cloud computing to enhance processing.

Processing Flows

- For mapping purposes, packages such as those provided by ESRI are very useful.
  - These include ArcMap, ArcScene and ArcGIS Pro and Global Mapper.
- Using these packages, point cloud data can be visualized and integrated with existing datasets.
  - These include GIS data and CAD data

Data Storage

- Point cloud data, as we have seen is quite large.
  - Out example had over 16M points
- We typically store the data in compressed form.
  - Any standard compression can be used.
- The for LAS is the uncompressed form.
- LAZ is the compressed form of the same data, and this is what will usually be used once the data has been collected.

Data Storage

- Different compression techniques can be used/
  - PKZip is a common compression technique.
  - It is typically used because of availability.
  - Specific applications may want to use more advanced algorithms, but then these must be maintained by the user and converted to the standard format used by many packages.

Data Storage

- If large numbers of point cloud data are being stored, cloud storage is the best choice.
- There are many cloud providers, such as AWS, Microsoft Azure and Google.
- Local storage should only be used for particular images that are being processed.
  - Then the point cloud data should be returned to cloud storage until it is required again.

Thank you for attending

- Today we discussed the processing and data storage aspects of point clouds.
- Tomorrow we will look at project planning and flows and the technologies we will need to implement the project.

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