CEC Continuing Education Center

DesignNews

Using Drone-Based LiDar

DAY 1 : Primer on Point Clouds

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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

Point clouds have many uses. Simply put they are a set of points in space. This allows 3-D imaging of all manner of objects, including manufactured parts and the external environment. In this class we take a look at the general concept of point clouds

Agenda

- Basic Concept
- Methods of Capture
- Processing of Inputs
- Uses of Point Clouds

Basic Concept

- Point clouds are 3D models. They are generally considered the simplest form of 3D model.
- They consist of a collection of points in space (3D space).
- These points are always of the external surface of the object.
- Each point that is measured has the usual coordinates of (x,y,z) and can also have other information associated with it, including:
  - Color (r,g,b)
  - Luminescence

Basic Concept

- Depending on the size of the object, or area, scanned, this produces a large amount of data
  - This requires a data base, and there are several technologies
- Storage and processing this data can be a computationally intensive task
- Software methods in the past have been highly user intensive, with the need for extensive editing of the raw data using software packages
- More recent methods have been developed using AI that cut the time to process significantly

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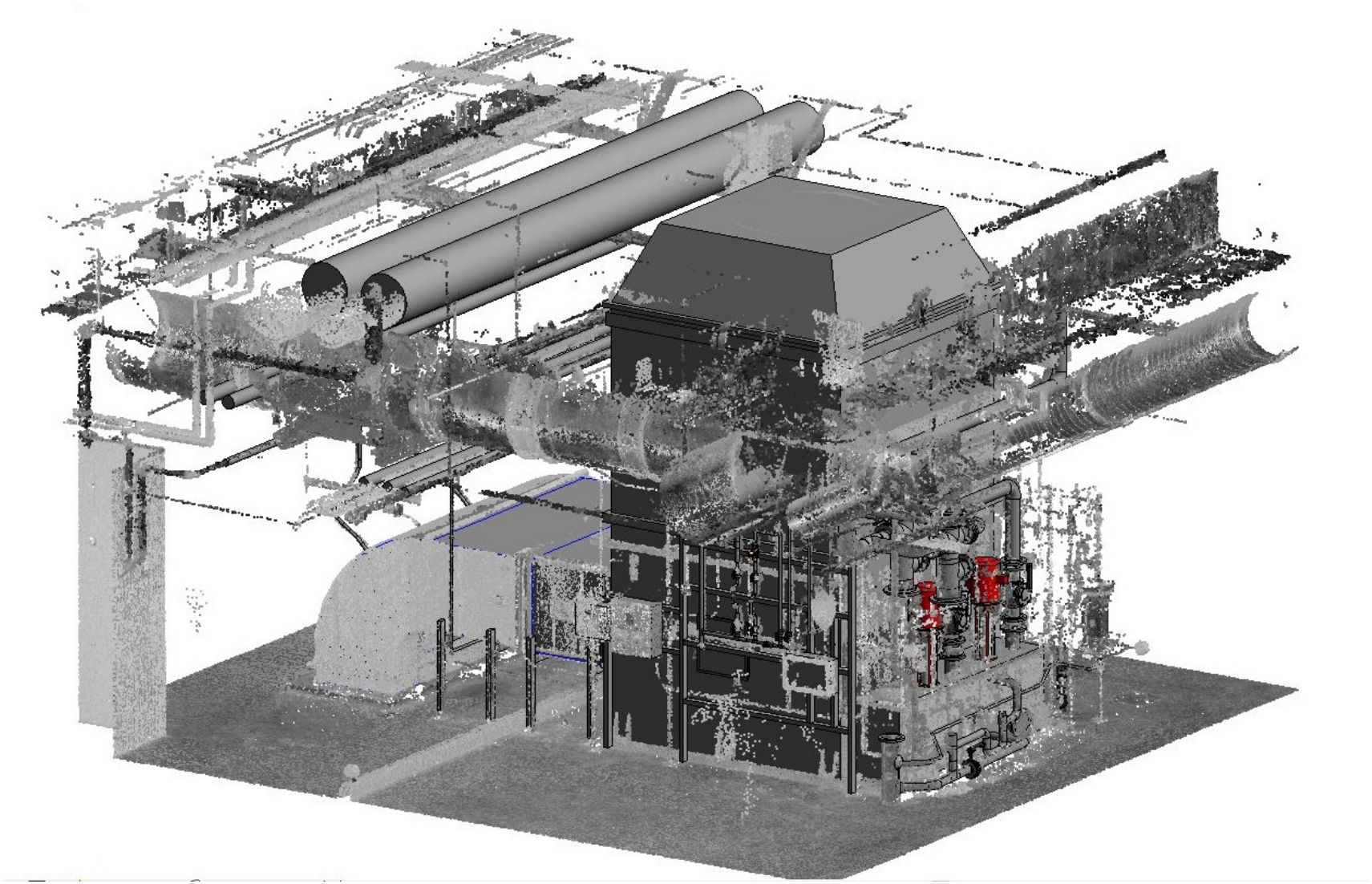
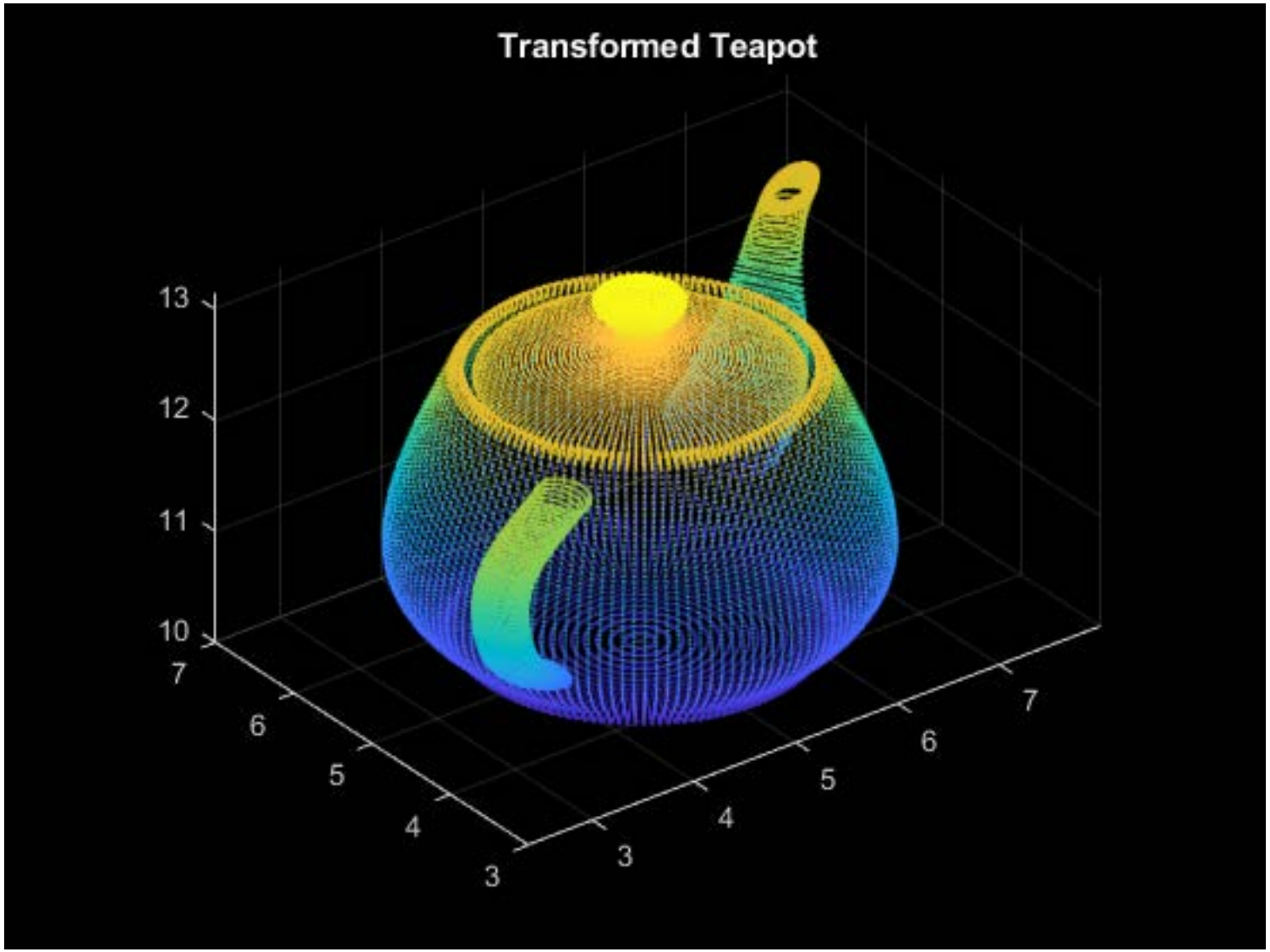
Basic Concept

Basic Concept

Basic Concept



Basic Concept



Basic Concept

Methods of Capture

- Point clouds can be generated in two main ways:
  - Photogrammetry
    - Taking a number of overlapping photos of an object or site of interest
  - Lasers
    - Either stationary or mounted in a vehicle, such as a plane or more likely a drone

Methods of Capture

- In photogrammetry, many images are taken, then processed
- There must be significant image overlap for processing to be done properly
- Typically these images are high resolution digital images, requiring significant storage
- The main issue is finding common elements in the images and associating them (registration). This is the main time-consuming part of the process.

Methods of Capture

- Another method is to use lasers to collect the data.
- These can be ground-based stationary lasers, or airborne lasers.
- The technique is based on LiDAR, which is the main topic of this class.
- In ground-based systems, the laser device is set up, and then scans the area to captured.
- In airborne systems the vehicle flies a predetermined route mapping the area of interest.

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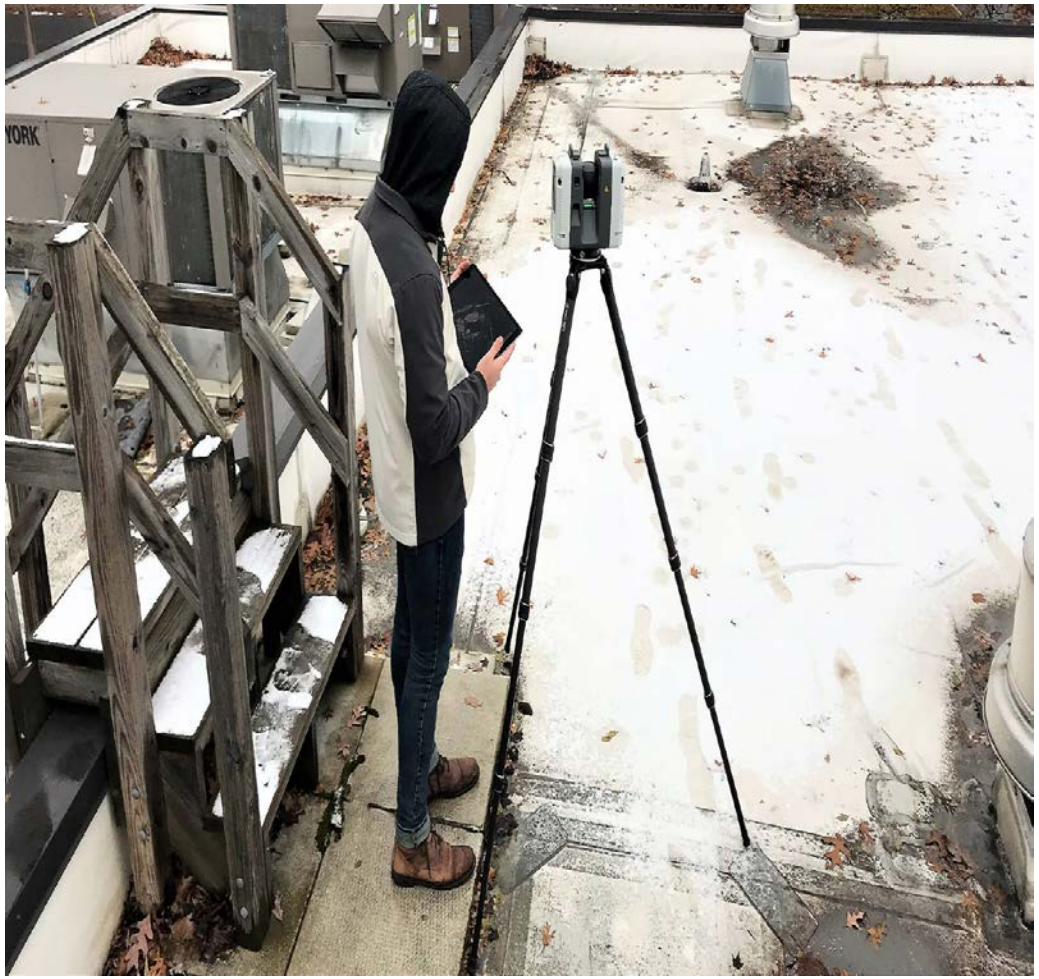
Methods of Capture



Methods of Capture

Processing of Inputs

- Since point clouds consist of very large datasets, there are many considerations concerning storage and access to the data.
  - Efficient methods for storage and access are required.
  - Memory requirements during processing are also important
- Fortunately, there are many packages for these tasks. We will outline just a few.
- Processing advances, using machine learning, are decreasing processing time dramatically.

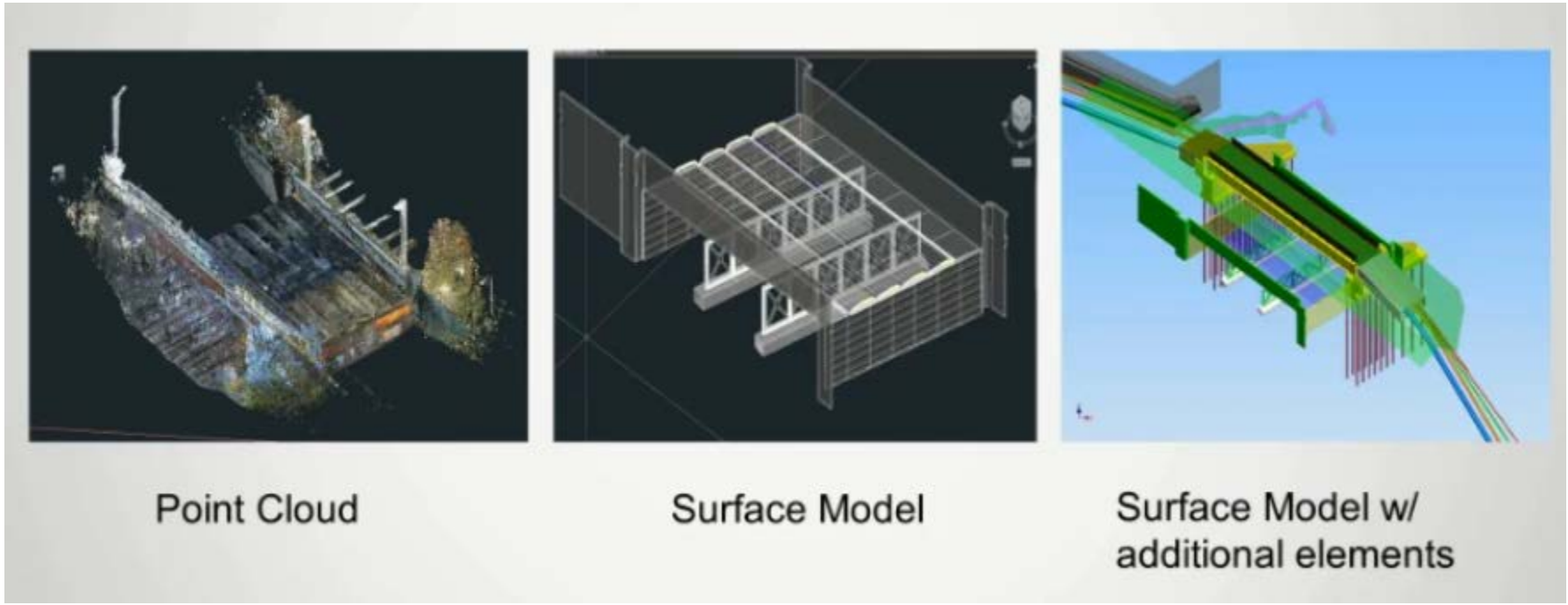
Processing of Inputs

- The processed 3D models can have several formats.
  - Generally driven by the package in use
  - Polygon Mesh
  - Triangle Mesh
  - NURBS Surface Models (Non-Uniform Rational Basis Spline)

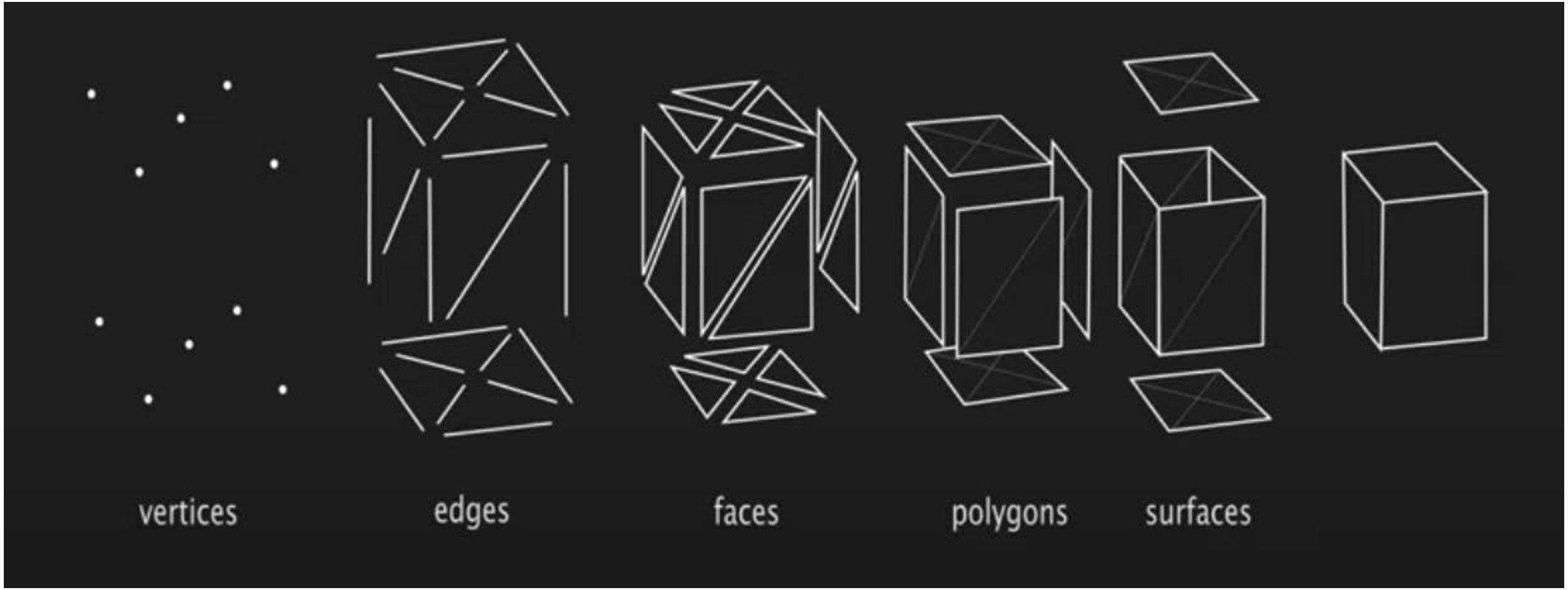
Processing of Inputs

- The general goal of using a point cloud is to generate a 3D model.
- These models may feed into various downstream processes and systems
  - CAD
  - Visualization
  - Virtual Reality (VR)
  - Inspection systems
- Each may have its own type of representation requiring converting the point cloud.

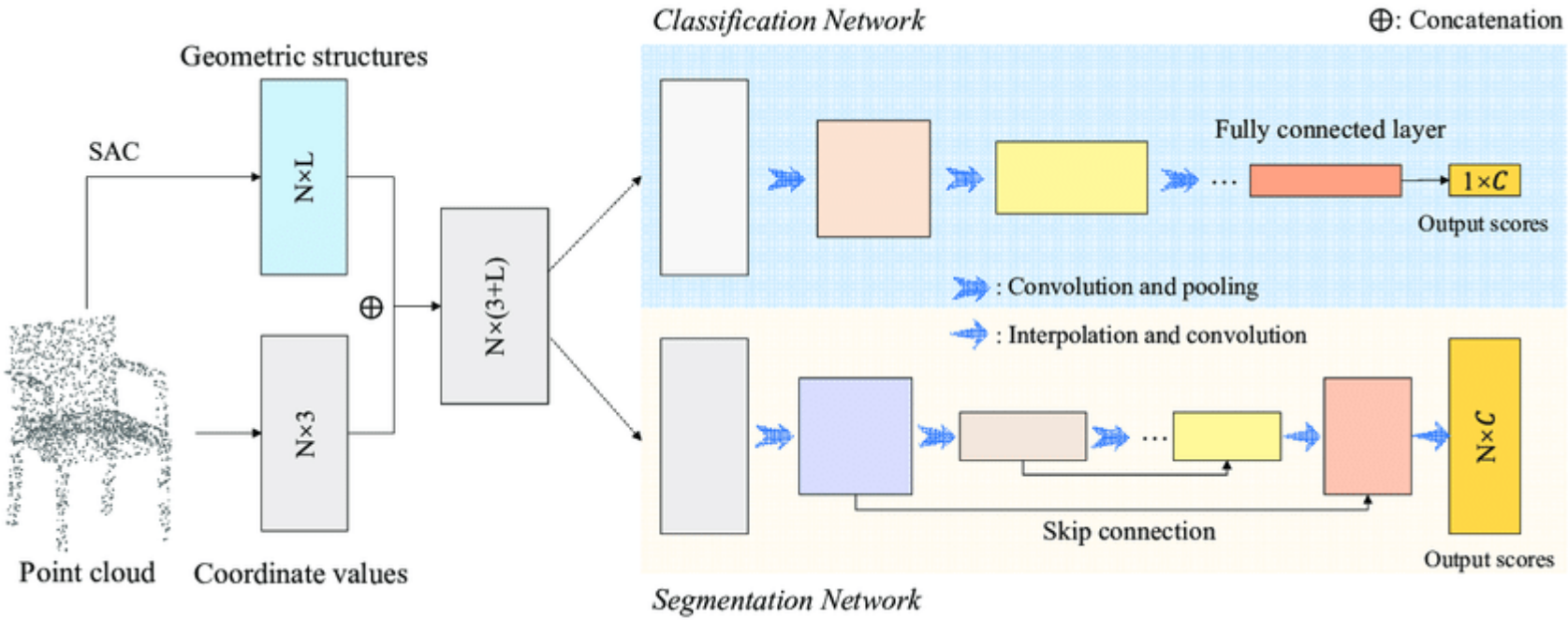
Processing of Inputs



Processing on Inputs



Processing of Inputs



Processing of Inputs

- Of the many packages available for point cloud processing, many are open source
  - PCL: Point Cloud Library
  - CloudCompare
  - MeshLab
  - OpenDroneMap
- These packages allow the processing of the point cloud into shapes and models
- They generally also provide statistics on the image that can be used for analysis

Processing of Inputs

- Many commercial packages are also available, vendors include
  - Vergator (Correvate)
  - 123D Catch (Autodesk)
  - 3DF Zephyr (3DFlow)
  - Pix4Dmapper (Pix4D)
  - MATLAB
- Various output formats are available

Uses of Point Clouds

- Point clouds applications are many and varied.
- The same basic technologies are used, but outputs and uses drive the project shape and scope.
- Some early applications seem to have started in the surveying field.
- As technologies became more sophisticated, both for collection and processing, use has soared.
- As we have seen, this is a powerful technology for all sorts of visualization.

Uses of Point Clouds

- Surveying and infrastructure analysis
  - Allows for efficient data capture and fine detail
  - Much faster than manual techniques
  - Advances in processing cut project time
  - Can map infrastructure, such as roads and bridges, and gives visual, processable information of the state of that infrastructure.

Uses of Point Clouds

- A related area is architecture and construction
  - As projects progress, frequent point cloud images can be taken and then compared to 3D CAD models of the design.
  - Point cloud models of existing structures can be used as input to CAD systems, aiding in the design process for modifying, adding to or replacing structures
  - This technology is applied to both interiors and exteriors.
  - Aids in site planning.
  - Provides much more useful information than traditional methods.

Uses of Point Clouds

- Virtual Reality (VR)
  - The point cloud is processed and used in the VR system
  - Applications
    - Demos (say of a building)
    - Medical
    - Design
    - Crime Scenes

Uses of Point Clouds

- Agriculture and Land Use
  - Efficient planning for agriculture
  - Can take often to monitor progress of crops and identify issues
  - Used to drive automated machinery at high precision
- Manufacturing
  - Take and existing part into a CAD/CAE/CAM system
- Metrology

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Thank you for attending

- This class has been an overview of the point cloud technology.
- In this class we introduced the basic concept of point clouds.
- We looked at the methods of capture.
- We the provided an overview of the processing methods and outputs.
- Finally, we went over some of the uses of this technology.
- Tomorrow we will go over the two main technologies of interest in this course, LiDAR and UAVs.

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