

<http://gmv.cast.uark.edu> A Method Store for Advanced Survey and Modeling Technologies Mon, 01 Apr 2013 03:29:18 +0000 en-US hourly 1 <http://wordpress.org/?v=3.5.1>  
<http://gmv.cast.uark.edu/scanning/hardware/konica-minolta-vivid-9i/checklist-konica-minolta-vivid-9i/konica-minolta-vivid-9i-setup/> <http://gmv.cast.uark.edu/scanning/hardware/konica-minolta-vivid-9i/checklist-konica-minolta-vivid-9i/konica-minolta-vivid-9i-setup/#comments> Wed, 20 Mar 2013 16:28:40 +0000 caitlin 5 meters]]> <http://gmv.cast.uark.edu/?p=13209>

**This document will guide you through setting up the Konica-Minolta for use with a turntable.**

*Hint: You can click on any image to see a larger version.*

## TRIPOD & MOUNT

1. Setup the scanner tripod. The tripod doesn't have to be completely level but you want it to be stable so some degree of leveling is required.
2. Prep the scanner mount by pulling the black lever out, pushing up the gold pin, and then releasing the lever. This widens the slot where the scanner mount rests.



When done correctly, the lever will continue to stick out.



## **CONNECT SCANNER**

3. Place the scanner on the tripod until it locks into place (you will hear a 'click' sound when the mount has locked). Once the scanner has been mounted, ensure that your setup is stable.
4. Remove the power cable and gray SCSI cable with the PCMCIA card adapter from the small black case. Plug the scanner power cable in and connect the SCSI cable. **DO NOT TURN THE SCANNER ON.**



5. Remove the card insert from the PCMCIA slot on the laptop and plug the PCMCIA card into the laptop.



## SETUP TURNTABLE

6. Remove the turntable, black power box, and all cables from the black case. Set the two, black and white calibration charts to the side for now. Place the turntable approximately 1 meter (or slightly less) from the scanner with the corded end facing towards the front i.e. towards the scanner. The suggested

scan range for the tele and mid lenses is .6 to 1 meter. When you begin scanning, the distance parameter will be displayed in the scan window. We generally suggest to keep the distance in the range of 700-800 mm to avoid data loss that can occur when an object is either too close or too far from the scanner.

7. Plug the gray cable from turntable into the black power box; also plug the power cable into the black power box. Next, take the blue serial cable and plug the green end (with 4 prongs) into the COM1 port on the black box. NOTE: The prongs on the green end are directional and will face down.



## CONNECT LAPTOP

8. Next, take the other end of the serial cable and plug it into the serial connection on the laptop. To work with a laptop, you will probably have to remove the black case around the plug end using a small screwdriver.





## POWER UP SCANNER

9. Once everything has been plugged in and you have the desired lens in place (see the **Changing Lenses** section in the final slides of this post if you need to change the scanner lens). Next power on the scanner. It will take a minute to load, when it is complete, it will display the following message on screen "Please open laser barrier and press any key."



10. Next, pull the large round cap off of the front of the scanner (bottom) and remove the lens cap (top), and then press any button on the back of the scanner to continue.



## OPEN POLYWORKS

11. Next power on the laptop and log on. **Note: It is important to power the scanner first and then the laptop so the connection is established.**

12. Once everything has been turned on, open Polyworks on the laptop. Once the Polyworks Workspace Manager opens, open the IMAAlign Module. Next, go to Scanners menu, and select Minolta – VIVID 9i. In the window that comes up, you should see a live camera view from the scanner (connection successful – hooray.) You are now ready to continue to the [Konica-Minolta Vivid 9i – Scan Settings](#) post.



## VIVID 9i LENSES

### Changing the Lenses on the VIVID 9i

The VIVID 9i comes with a set of three interchangeable lenses: tele, middle, and wide. The scanner's camera array is fixed 640X480 pixels. Each lens offers a different field of view with the tele being the smallest. The FOV for each lens is provided below.

Lens	FOV (in mm)
Tele	93 x 69 x 26
Mid	165 x 124 x 42
Wide	299 x 224 x 66

Fixed 640 x 480 array

The tele lens offers the best resolution and is ideal for scanning objects smaller than a baseball or larger objects with a higher resolution. The mid lens works well for objects that are basketball size and was the lens predominantly used for scanning pottery vessels in the [Virtual Hampson Museum](#) project. CAST researchers generally do not recommend use of the wide angle lens.

## CHANGING LENSES I



- A. To change the lens on the VIVID 9i, first make sure the scanner is turned off.
- B. Next remove the lens that you wish to use from the lens box and its plastic bag.



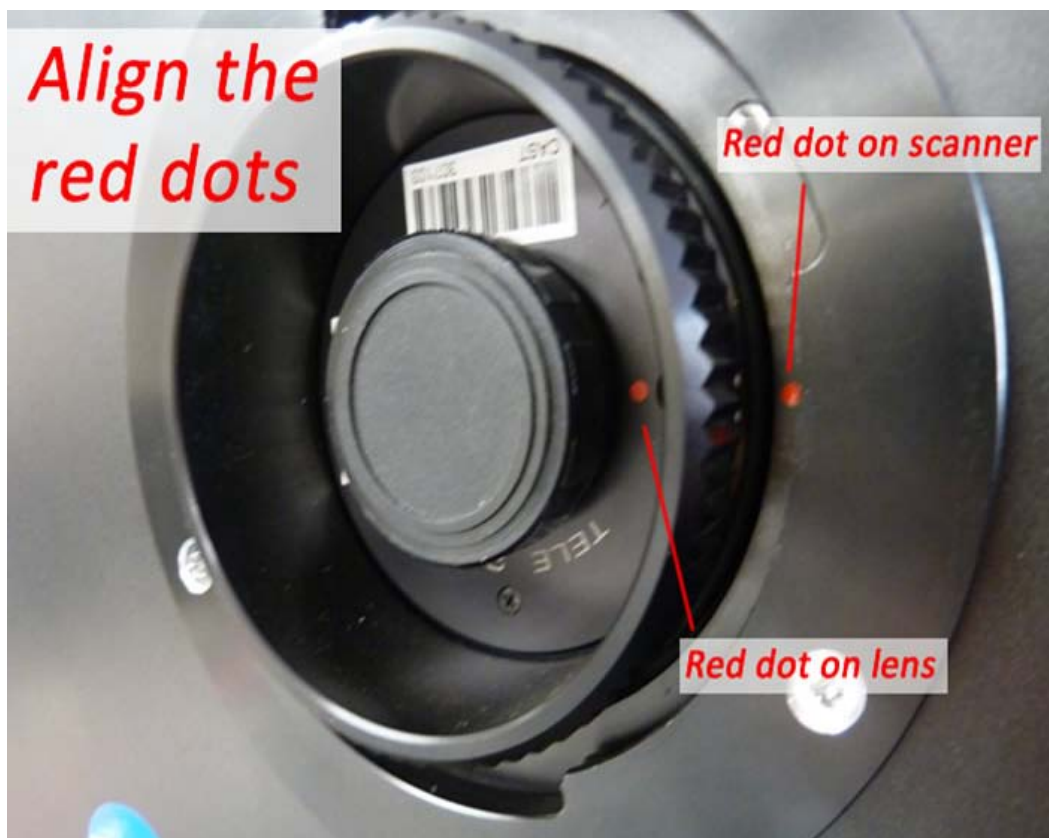
- C. Next remove the lens protector and unscrew the lens that is currently on the scanner. IMMEDIATELY place the lens cap (located on the lens box) on the back of the lens.

*NOTE:* Every lens should always have 2 lens caps (one of the front and back of the lens) when the lens is not in use or is being stored.



## CHANGING LENSES II

D. Remove the back lens cap from the desired lens and screw the new lens into the scanner by first lining up the red dots found on both the lens and the scanner.



E. Replace the black lens protector on the scanner. Replace both lens caps on the newly removed lens, place in a plastic bag, and store in the lens box.

F. You are ready to begin scanning. Power on the scanner and continue with Step 9 on the 'Power up Scanner' Slide above.

## CONTINUE TO...

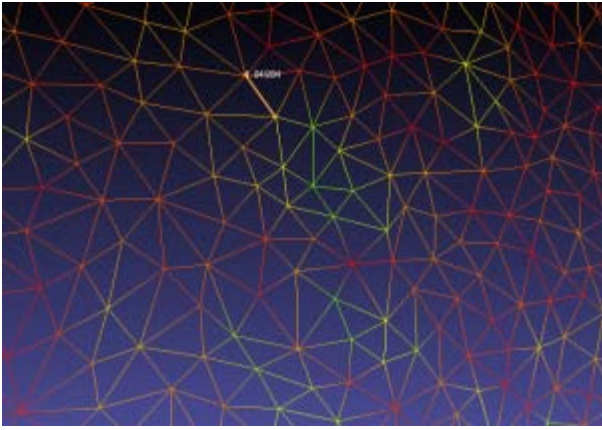
Continue to [Konica-Minolta Vivid 9i – Scan Settings](#).

]]> <http://gmvcast.uark.edu/scanning/hardware/konica-minolta-vivid-9i/checklist-konica-minolta-vivid-9i/konica-minolta-vivid-9i-setup/feed/0> <http://gmvcast.uark.edu/scanning/hardware/leica-c10/assessing-your-3d-model-effective-resolution/> <http://gmvcast.uark.edu/scanning/hardware/leica-c10/assessing-your-3d-model-effective-resolution/#comments> Fri, 22 Feb 2013 14:17:08 +0000 Rachel <http://gmvcast.uark.edu/?p=12077>

## Why effective resolution?

For many archaeologists and architects, the minimum size of the features which can be recognized in a 3D model is as important as the reported resolution of the instrument. Normally, the resolution reported for a laser scanner or a photogrammetric project is the point spacing (sometimes referred to as ground spacing distance in aerial photogrammetry). But clearly a point spacing of 5mm does not mean that features 5mm in width will be legible. So it is important that we understand at what resolution features of interest are

recognizable, and at what resolution random and instrument noise begin to dominate the model.



Mesh vertex spacing circa 1cm.

## Cloud Compare



The open source software [Cloud Compare](#), developed by Daniel Girardeau-Montaut, can be used to perform this kind of assessment. The assessment method described here is based on the application of a series of perceptual metrics to 3D models. In this example we compare two 3D models of the same object, one derived from a C10 scanner and one from from a photogrammetric model developed using Agisoft Photoscan.

## Selecting Test Features

Shallow but broad cuttings decorating stones are common features of interest in archaeology. The features here are on the centimetric scale across (in the xy-plane) and on the millimetric scale in depth (z-plane). In this example we assess the resolution at which a characteristic spiral and circles pattern, in this case from the 'calendar stone' at Knowth, Ireland is legible, as recorded by a C10 scanner at a nominal 0.5cm point spacing, and by a photogrammetric model built using Agisoft's photoscan from 16 images.



## Perceptual and Saliency Metrics

Models from scanning data of photogrammetry can be both large and complex. Even as models grow in size and complexity, people studying them continue to mentally, subconsciously simplify the model by identifying and extracting the important features.

There are a number of measurements of saliency, or visual attractiveness, of a region of a mesh. These metrics generally incorporate both geometric factors and models of low-level human visual attention.



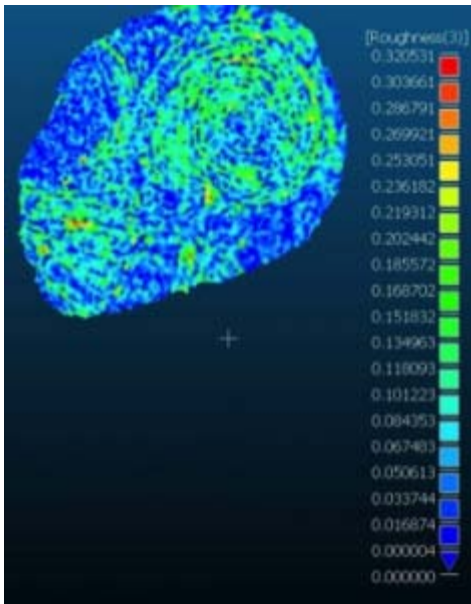
Local roughness mapped on a subsection of the calendar stone at Knowth.

Roughness is a good example of a relatively simple metric which is an important indicator for mesh saliency. Rough areas are often areas with detail, and areas of concentrated high roughness values are often important areas of the mesh in terms of the recognizability of the essential characteristic features. In the image above you can see roughness values mapped onto the decorative carving, with higher roughness values following the edges of carved areas.

## Distribution of Roughness Values

The presence of roughness isn't enough. The spatial distribution, or the spatial autocorrelation of the values, is also very important. Randomly distributed small areas with high roughness values usually indicate noise in the mesh. Concentrated, or spatially autocorrelated, areas of high and low roughness in a mesh can indicate a clean model with areas of greater detail.

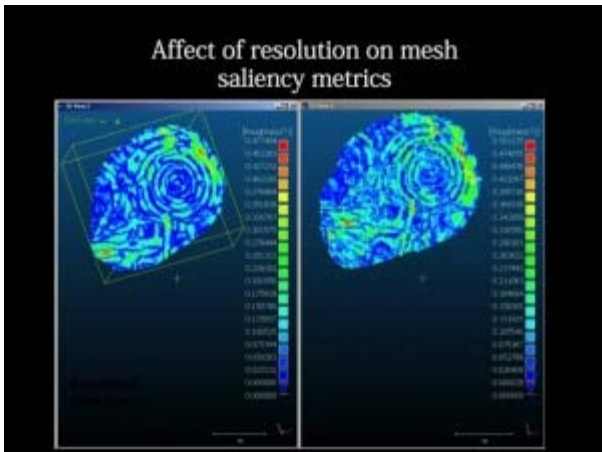




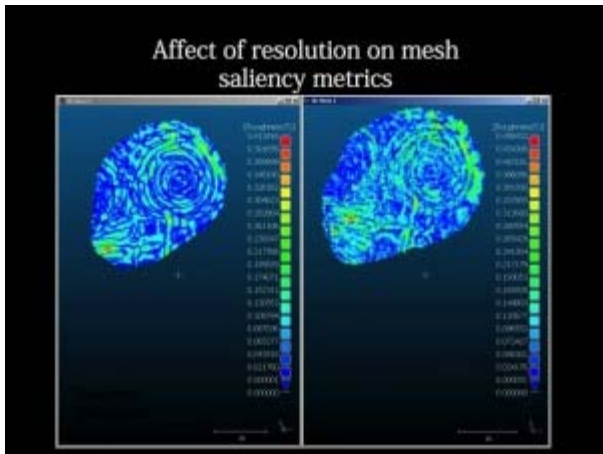
High roughness values combined with low spatial autocorrelation of these values indicates noise in the model.

## Picking Relevant Kernel Sizes

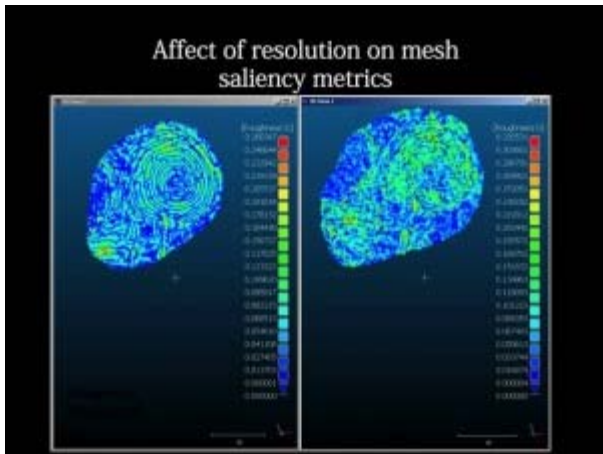
To use the local roughness values and their distribution to understand the scale at which features are recognizable, we run the metric over our mesh at different, relevant, kernel sizes. In this example, the data in the C10 was recorded at a nominal resolution of 5mm. We run the metric with the kernel at 7mm, 5mm, and 3mm.



Local roughness value calculated at kernel size: 7mm.



Local roughness value calculated at kernel size: 5mm.



Local roughness value calculated at kernel size: 3mm.

Visually we can see that the distribution of roughness values becomes more random as we move past the effective resolution of the C10 data: 5mm. At 7mm the feature of interest -the characteristic spiral- is clearly visible. At 5mm it is still recognizable, but a little noisy. At 3mm, the picture is dominated by instrument noise.

]]> <http://gmvc.cast.uark.edu/scanning/hardware/leica-c10/assessing-your-3d-model-effective-resolution/feed/> <http://gmvc.cast.uark.edu/scanning/software/polyworks/workflow-polyworks/polyworks-pifedit-cleaning-point-cloud-data/> <http://gmvc.cast.uark.edu/scanning/software/polyworks/workflow-polyworks/polyworks-pifedit-cleaning-point-cloud-data/#comments> Mon, 11 Feb 2013 23:25:30 +0000 caitlin <http://gmvc.cast.uark.edu/?p=12311>

**This page will show you how to view and 'clean' the data in Polyworks PIFEdit.**  
*Hint: You can click on any image to see a larger version.*

## POLYWORKS PIFEDIT

### Introducing Polyworks PIFEdit:

PIFEdit is a data viewing and editing software available in the PolyWorks suite. It is used to clean scan data of unwanted data/points before importing the data into IMAAlign.

\* **Note:** You have to have a full license of Polyworks (w/dongle) to be able to edit and save data out of PIFEdit (otherwise it functions only as a viewer).

## Basic Navigation:

Upon opening the PIF file in PIF Edit, view the scan using the appropriate mouse buttons:

**Left Button:** Rotates the scan

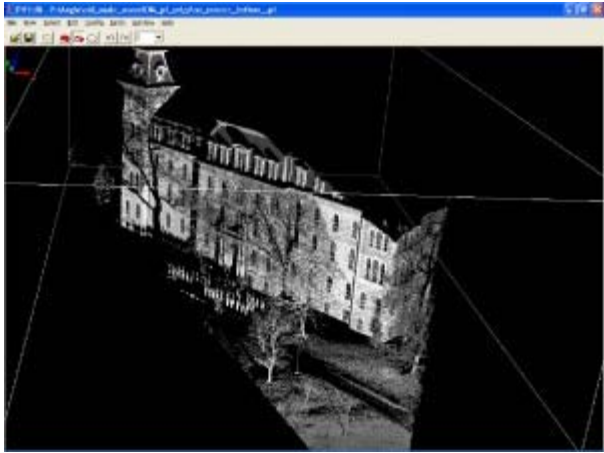
**Middle Button:** Translates the scan

**Right Button:** Zooms in and out on the scan

Get accustomed to the use and “feel” of these buttons because they are used in all of the PolyWorks modules.

## VIEW DATA

View the data from every angle to identify which data you want to keep and which data can be removed.



In this “un-cleaned” data the trees and people, in this case ROTC soldiers, are seen

In the image above, a group of ROTC soldiers were included in the scan. Since the focus of the scan is the building, the scan data of the soldiers, the trees, and the ground in front of the building will all be removed.

Notice how the trees and the soldiers (objects in the forefront) cause shadows or holes in the scan data of the structure (object in the rear). This can be remedied by simply acquiring another scan of the same area from another location if access and time permit another scan.

## SELECT UNWANTED DATA

To remove the unwanted scan data, press the **space bar**. This activates the Selection dialog box.

Hold down the **Shift and Ctrl keys and use the middle mouse button** to make your selection.

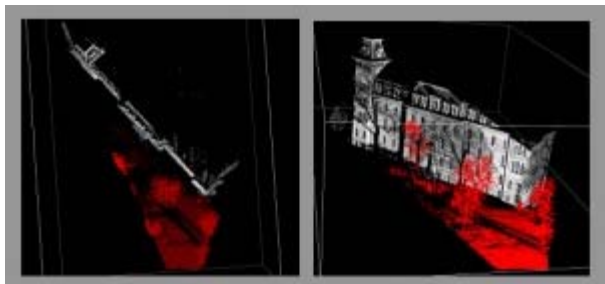
**Shift:** Enables Volumetric Selection – otherwise it is in Surface Selection mode which is only useful with polygon meshes

**Ctrl:** Enables Polygonal Selection – otherwise in Freeform Selection mode

## CONFIRM SELECTION & DELETE DATA

Because you have to perform a volumetric selection in PIFedit (aka it selects everything in the selection window), it is always good to **double check** the integrity of your selection before you delete any data.

Once you have done so you can go ahead and delete the unwanted data points from the scan. Repeat this operation as many times as needed.



The red indicates data that has been selected. On the left we view the data from above, on the right we view the same selected data in a perspective view

When finished, go to **File – Save As – save as name\_cln.pf**.

Note: Our naming convention is to tack a 'cln' onto the scan name or to put the cleaned data into a 'clean' subfolder. **As a rule of thumb – never overwrite the original data.**

## CONTINUE TO...

For further processing in the Polyworks Suite, continue on to [Importing Data into IMAlign](#).

]]> <http://gmvcast.uark.edu/scanning/software/polyworks/workflow-polyworks/polyworks-pifedit-cleaning-point-cloud-data/feed/> 0 <http://gmvcast.uark.edu/scanning/hardware/optech-ilris-3d/checklist-optech-ilris-3d/optech-ilris-parser-pre-processing-scan-data/> <http://gmvcast.uark.edu/scanning/hardware/optech-ilris-3d/checklist-optech-ilris-3d/optech-ilris-parser-pre-processing-scan-data/#comments> Mon, 11 Feb 2013 22:46:11 +0000 caitlin <http://gmvcast.uark.edu/?p=12280> [Continue reading →](#)]]>

**This page will show you how to process raw scan data from the Optech ILRIS in ILRIS Parser and how to view and 'clean' the data in Polyworks PIFedit.**

*Hint: You can click on any image to see a larger version.*

## THE OPTECH PARSER

### Introducing the Optech ILRIS-3D Parser:

The Parser program processes raw scanner data in a variety of output formats recognized by PolyWorks, GIS softwares, and other 3D modeling suites.

### Using ILRIS Parser



Open the Parser program by double-clicking on the icon on your desktop. The Parser window displays as follows:



The Optech Parser window

## ADD DATA

### Add your data

Add your **.i3d** file by clicking the “Add” button.

Browse to the scan file location and select the desired scan.



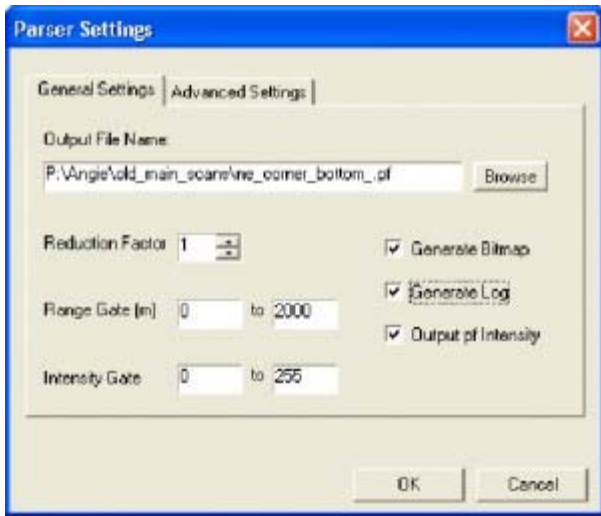
Adding data in Optech Parser

The **.i3d** file is added to the file window in the Parser. A photograph of the scanned area acquired by the laser scanner is also viewable in the Parser window.

## OUTPUT FILES & GENERAL SETTINGS

Next, specify your desired output file type. For more information on output file types and their respective settings, please refer to the ILRIS-3D Operation Manual (Section 9). The PIF file type is the default output file type and is a PolyWorks specific format for use in the Polyworks Suite. The PIF output options are discussed in the following slides.

Click on the “Settings” button.



General settings in Optech Parser

**In the Output File Name** textbox, specify the name and location for the output PIF file.

**The Reduction option** allows you to subsample your data (recommended subsampling: 1).

**Filtering** – You also have the option to “filter” your data by specifying a Range Gate and/or an Intensity gate.

**The Range Gate** option specifies a desired data range based on distance from the scanner (in meters)

**The Intensity Gate** option specifies a desired data range based on the intensity readings returned from the scanner. While it is good practice to range grade your data to remove outliers etc..., it is not required because the data can also be edited in the PIFedit software.

## MORE GENERAL & ADVANCED SETTINGS

### General Settings:

It is recommended to leave the Generate Bitmap, Generate Log, and Output of Intensity options checked.

Generate Bitmap creates a separate .bmp file of the scan photograph

Generate Log creates a report containing the scan statistics

Output of Intensity adds the intensity values returned from the scanner to the PIF file.

### General Details and Advanced Settings:

For more on these options and those available in the Advanced Settings tab, please refer to the ILRIS-3D Operation Manual (Section 9).

## PARSE DATA

When the desired options have been selected in the “Settings” menus, click “Ok,” and “Parse” the data. A progress report is displayed to show the steps and completion of the parsing process

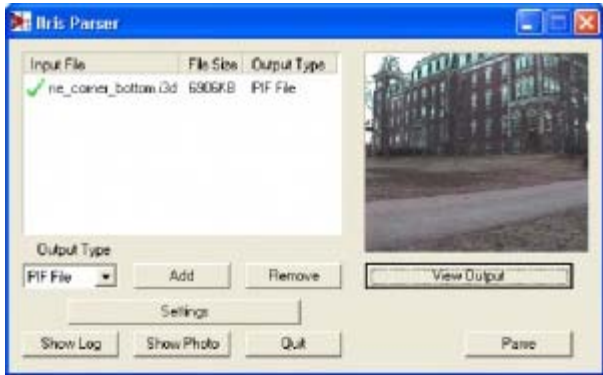


The progress window shows as the data is being parsed

## CONFIRM PARSING IS SUCCESSFUL

Note that a green check appears beside the file name in the file window indicating that that the file has been parsed.

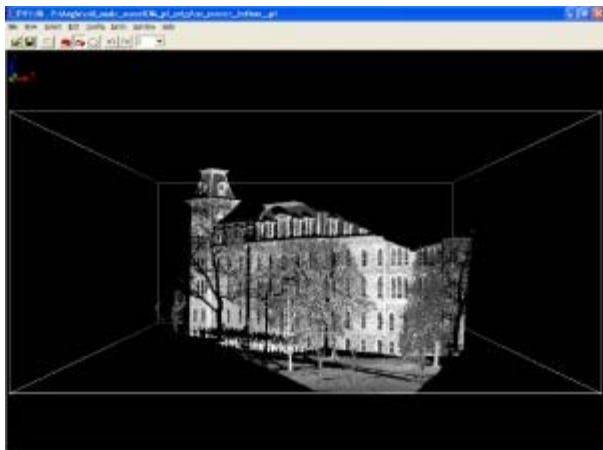
To view the resulting PIF file, click the "View output" button.



Confirm parsing was successful and view output file

## VIEW PARSED DATA

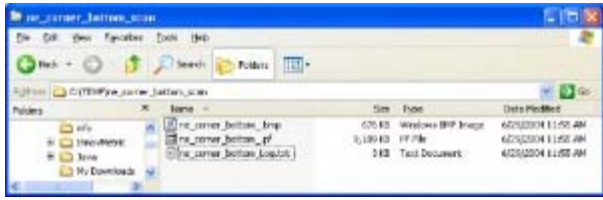
Once you click 'View Output' in ILRIS Parser, the PIF file is opened in the PIFEdit viewing window



The parsed file can now be viewed in PIFedit

## FILES CREATED IN PARSING

Note that a PIF file (.pf), a report log (.txt) and a bitmap of the scan photo (.bmp) are created in the parsing process.



The files created in the parsing process

## CONTINUE TO...

Continue to [Polyworks PIFEdit: Cleaning Point Cloud Data](http://gmvcast.uark.edu/scanning/hardware/optech-ilris-3d/checklist-optech-ilris-3d/optech-ilris-parser-pre-processing-scan-data/feed/)

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```

These are basic set-up and operation instructions for operating the Optech ILRIS 3D with a laptop. See the Optech Manual that accompanies the scanner for more detailed information.

1. Set up the tripod as levelly as possible
2. Attach scanner to tripod, be sure to tighten screw securely
3. Turn on laptop and connect it to scanner using either the cable or wireless network. Depending on the desired configuration, please set up accordingly:

### **Ethernet/Wired Connection**

- In Control Panel > Network Connections > Select Internet Protocol (TCP/IP)
- Use the following IP address: 192.9.202.1 and Subnet Mask: 255.255.255.0
- In I3dNet Software > Go to tools > Prefs > Communication > Enter 192.9.202.248
- Polyworks dongle

### **Wireless Connection**

- In Internet Protocol (TCP/IP), enter the following IP address: 192.168.0.6 and Subnet Mask: 255.255.255.0
- In I3dNet Software > Enter IP address 192.168.0.5
- Note that to reset the IP address you can log onto the internet > In Control Panel > Network Connections > (TCP/IP) > Specify 'Obtain IP Address Automatically'

4. Connect batteries to I-Bar in a T-shape. This is the only way that they will provide power to scanner
5. Connect batteries to scanner using battery cable
6. Start the I3DNet Program



7. Go to the Communication Menu > Click 'Connect'
8. Click icon with red outline to place scanning area on screen and re-size red box to define the scan area
9. Click 'Acquire' button to obtain the distance to the object to be scanned
10. Set the parameters of the scan – **First** will return readings from the first object/surface that is encountered while **Last** will return readings from the last object/surface that is encountered. Use Last to scan 'through' objects such as trees, fences, etc.
11. Set point spacing of laser (resolution)
12. Press the apply button
13. Start scan and save the file in the desired location
14. Parse scan to check data quality
15. Continue to [Optech ILRIS Parser: Pre-Processing Scan Data](#)

]]> <http://gmvcast.uark.edu/scanning/hardware/optech-ilris-3d/setup-operations-optech-ilris-3d/optech-ilris-3d-set-up-and-basic-operation/feed/> 0 <http://gmvcast.uark.edu/uncategorized/optech-ilris-3d-equipment-checklist/> <http://gmvcast.uark.edu/uncategorized/optech-ilris-3d-equipment-checklist/#comments> Wed, 06 Feb 2013 23:44:19 +0000 caitlin <http://gmvcast.uark.edu/?p=12194>  
[Continue reading →](#)]]>

## Equipment Checklist – Confirm before leaving the lab!!

- 1. Tripod – DO NOT FORGET!!!
- 2. ILRIS 3D Scanner
- 3. Scanner Batteries – fully charged (4 total)
- 4. I-Bar/Battery Holder
- 5. Gray Battery Cable
- 6. Copy of Operation Manual
- 7. Operating Options :
- - **Laptop Option (Recommended) Requires:**
  - - Laptop with I3DNet, PIF Edit, and Parser software installed
  - - External lithium battery – fully charged (2 options)
  - - Modified Ethernet cable to connect to scanner OR two wireless cards (PCM 352 and LCM 352)
  - - Polworks software (optional)
  - - Polyworks dongle
  - 
  - 
  - **Palm Option Requires:**

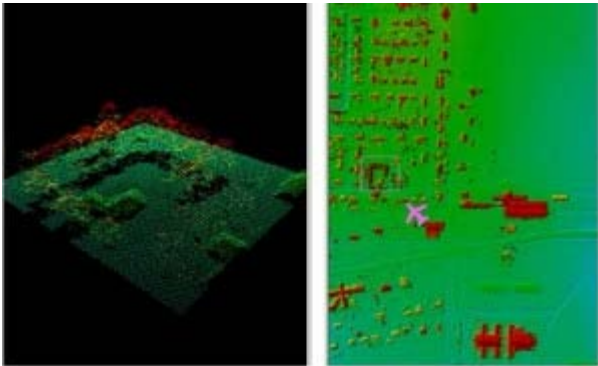
- - Handheld Palm Unit – fully charged with ILRIS 3D Palm software installed (different than I3DNet)
- - Serial data cable to connect to scanner
- - Flash card, flash card holder (to store data)

- **8. Optional Equipment:**

- - Extra scanner batteries
- - Extra external laptop batteries
- - Battery charger(s) for scanner batteries, laptop batteries, etc...
- - AC/DC Car Charger
- - Scan targets (optional)
- - Digital Camera
- - Metal rods (triangular) used for stabilizing tripod on hard surfaces

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<http://gmvcast.uark.edu/scanning/airborne-laser-scanning/als-processing-assessing-data-quality/>  
<http://gmvcast.uark.edu/scanning/airborne-laser-scanning/als-processing-assessing-data-quality/#comments> Fri, 18 Jan 2013 13:30:40 +0000 Rachel <http://gmvcast.uark.edu/?p=11987>

## LAS files

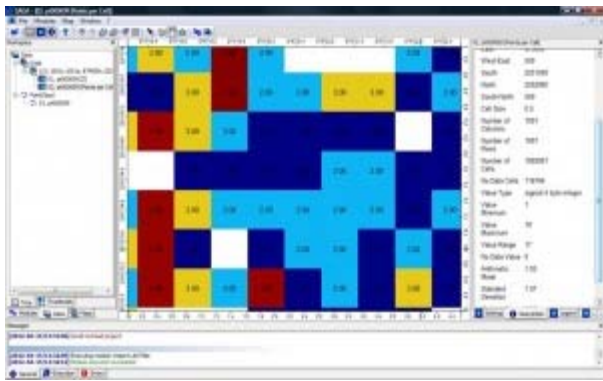


ALS data is now usually delivered in the LAS format. The LAS format specification is maintained by the [The American Society for Photogrammetry & Remote Sensing \(ASPRS\)](http://www.asprs.org/). The current version of the specification is [1.4](#). These files may be delivered as per-flightstrip or, more commonly from commercial vendors, as a collection of tiles.

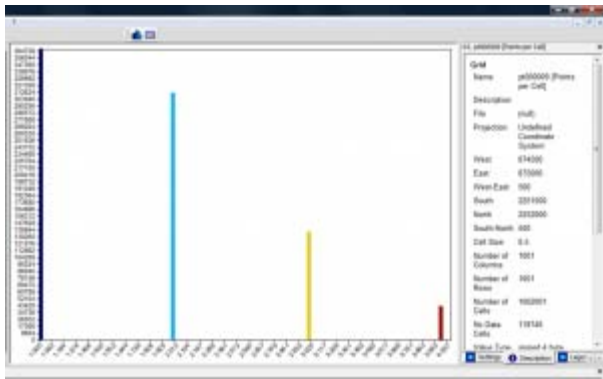
## Metadata and Headers.



software package, to plot per grid cell density and visualize how the densities vary across your dataset.



Points per grid cell visualized in SAGA.



Histogram of points per grid cell, visualized in SAGA.

## Sources of ALS Errors.

The total error for a lidar system is the sum of the errors from the laser rangefinder, the GPS and the IMU. These sources of error and the calculation of error budgets have been discussed extensively in the literature, including good summaries by Baltsavias (1999) and Habib et al. (2008). For ALS surveys conducted from fixed-wing aircraft platforms, these often total somewhere between 20 and 30cm.

The main sources of error are:

- Platform navigational errors
- GPS/IMU navigational errors
- Laser sensor calibration errors (range measurement and scan angle)
- Timing resolution
- Boresight misalignment
- Terrain and near-terrain object characteristics

Errors may be vertical (along the Z axis) or planimetric (shifts on the XY plane). The errors are obviously related, but they are usually quantified separately in accuracy reports. In commercial applications accuracy analyses usually focus on vertical accuracy, while planimetric accuracy (XY) is secondary.

## Types of Errors.

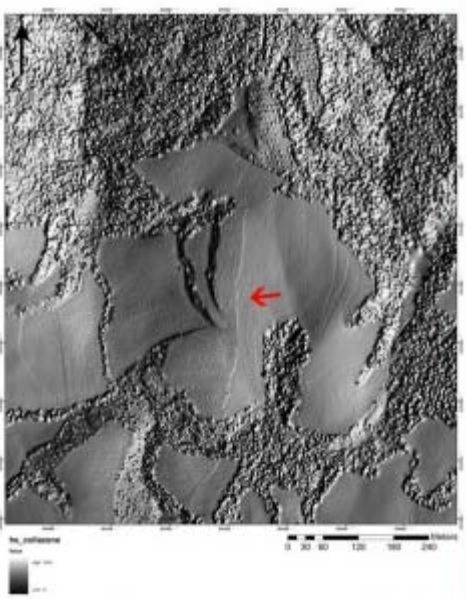
Both horizontal and vertical errors may be described as random, systematic or terrain dependent. The main



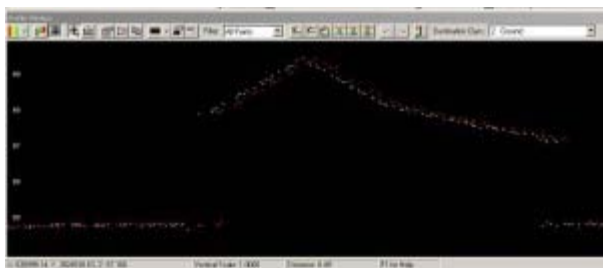
source of random error is position noise from the GPS/IMU system, which will produce noise in the final point cloud. These coordinate errors are independent of the flying height, scan angle and terrain.

Systematic errors include errors in range measurement, boresight misalignment, lever arm offset and mirror angle, and some errors from the GPS/IMU system (e.g. INS initialization and misalignment errors and multi-path returns). These errors will appear throughout the dataset. Terrain dependent errors derive from the interaction of the laser pulse with the objects it strikes. In steeply sloping terrain or areas with off-terrain objects, and at higher scan angles, beam divergence may be increased and result in vertical errors due to horizontal positional shift.

Errors are most visually apparent in areas of strip overlap. A characteristic sawtooth pattern seen in hillshaded DTMs and clear misalignments of planar roof patches seen in the profile are typical of misalignment between adjacent strips.



Strip overlap errors seen in a hillshaded DTM.

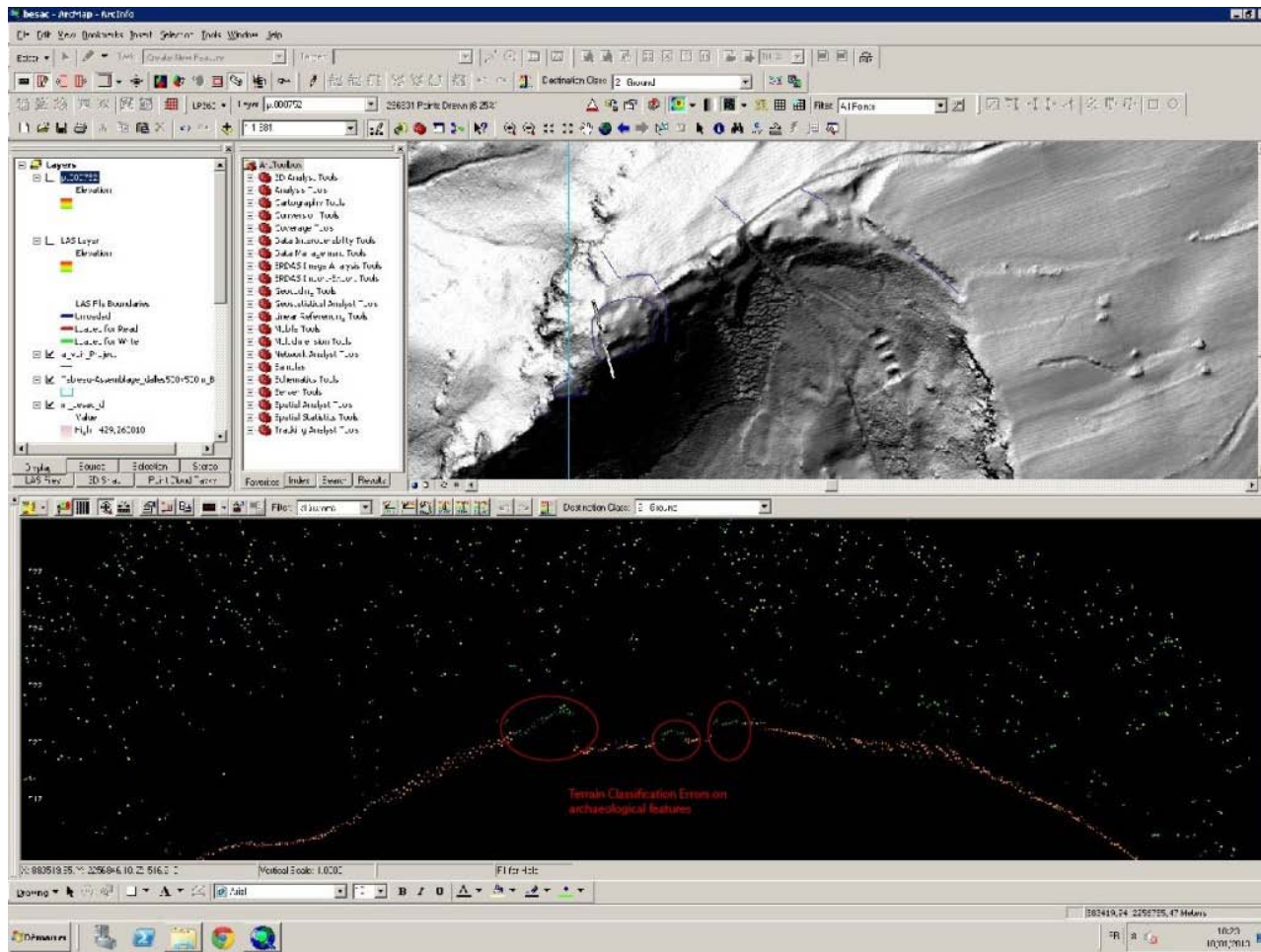


Two scans of the same roofline in two overlapping strips are slightly offset, indicating a slight error. Points coloured by flightstrip.

## Classification Errors.

Lidar data is typically gathered across large areas of the landscape, which may include woodland, urban and arable areas. One of the advantages of lidar over other remote sensing technologies is its ability to 'see through' the vegetation canopy, as some returns will pass through gaps in the canopy, reaching and

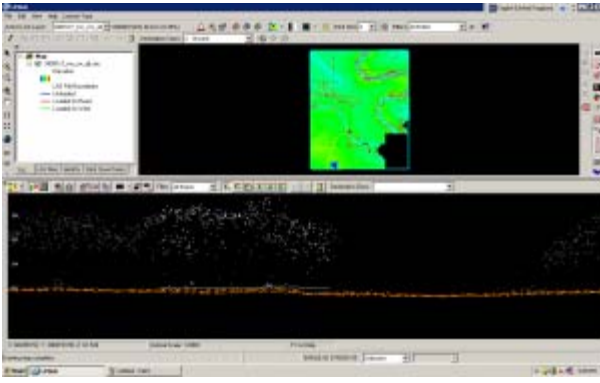
returning from the ground- allowing the creation of a bare earth DEM. To accomplish this data must be classified (or filtered) to separate returns from terrain and off-terrain objects.



Points incorrectly classified as low vegetation (dark green) which should be terrain (orange).

There are a number of algorithms in use for classifying a point cloud. Regardless of the algorithm used, some errors will be committed. Two types of classification errors occur when performing a classification: the removal of points that should be retained (type 1) and the inclusion of points that should be removed (type 2). Overly aggressive algorithms or parameter settings have a tendency to remove small peaks and ridges in the terrain and to smooth or flatten the ground surface. Conversely, insufficiently aggressive parameters will induce the inclusion of clumps of low vegetation returns in the ground class, and can result in false 'features'

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ALS data from the Bayou Meto undergoing processing

CAST researchers and student assistants developed a hydro-enforced DTM (Digital Terrain Model) covering the Bayou Meto watershed, in collaboration with the NCRS and Arkansas Natural Resources Commission. The classification of the raw ALS data, interpolation to basic bare-earth terrain models, the creation of breaklines and streamlines for hydro-enforcement, and the refinement of final hydro-enforced models were carried out at CAST.

Data for this project was collected by Aeroquest in 2009 and 2010 for two areas within the Bayou Meto, at a nominal resolution of 10 pts/m<sup>2</sup>. The [TIFFS](#) and [LP360](#) software packages were used to process the discrete return ALS data and to assist in breakline production.

For more information, see the [main project webpage](#).

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## DTMs

ALS data can be used to create a number of products based on elevation data. The most common ALS product created is the bare earth DTM. The bare earth DTM provides the basis for analyses in hydrology, flood risk mapping, landslides, and numerous other fields.

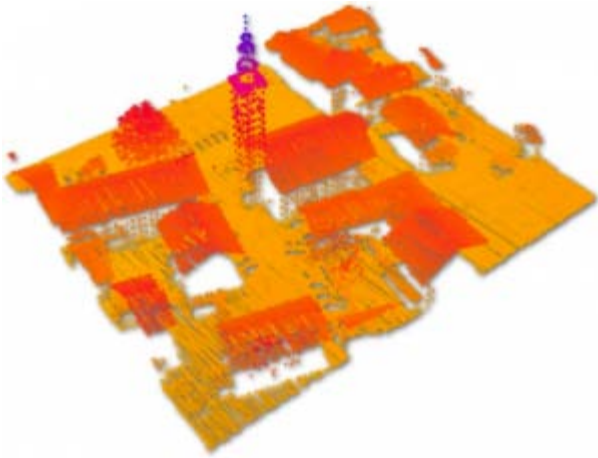
Hydro-enforced DTMs include breaklines, importantly stream centerlines and edges, and breaklines delimiting standing water bodies such as ponds. While auto-extraction of breaklines is improving, the creation of hydro-enforcing features is still by and large a manual task.



Deliverables include hydro-DTMs.

## DSMs

Digital Surface Models (DSMs) can include only returns from the terrain, buildings and specific classes of off-terrain objects like bridges, or can also incorporate returns from vegetation. DSMs are commonly used in urban environment analyses such as noise pollution modeling and inter-visibility analyses to assess the impact of new building.

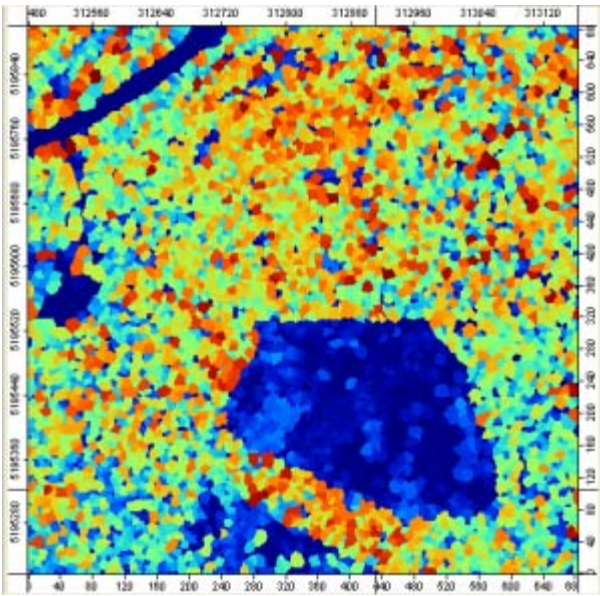


DSMs are often used for modeling in urban areas.

## CHM

Canopy height models, and per-stand or individual tree metrics are important ALS-based products for forestry applications. These models often include returns separated into low- mid- and high- vegetation classes, and are sometimes normalized based on local terrain heights to facilitate comparisons between different forest areas.

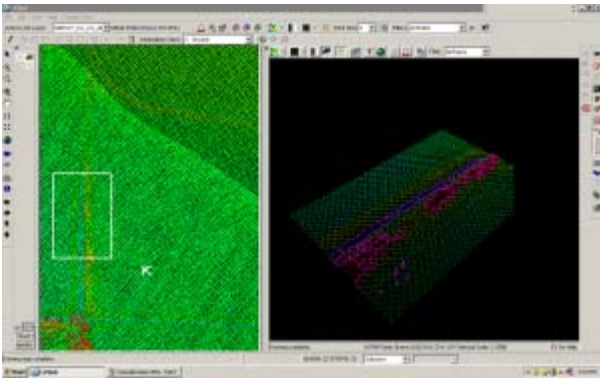




Canopy height model generated using SAGA GIS.

## Contours

Contour maps at standard intervals, e.g. 1m, 5m, or 20m contours, can be generated from bare earth DTMs. Contour maps can be generated with or without breaklines.



Contours developed based on the terrain model.

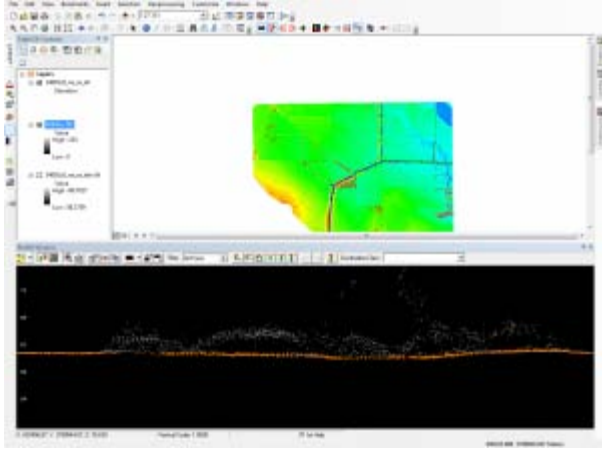
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## Initial Automatic Classification

In most ALS projects, in the first instance, the data is automatically classified. No automatic classification is perfect, and therefore visual assessment and the manual re-classification of some returns are important steps in the creation of a high quality hydro-enforced terrain model, and the development of other derivatives of ALS point clouds. The Bayou Meto terrain model developed at CAST was processed using



[TIFFS](#), a software program which implements a morphological filter. Other good low cost or open source software for automatic classification includes [LASTools](#) and [MCC-Lidar](#).



Automatically classified Point Cloud seen in profile. Terrain points (class 2) are orange, and off-terrain points are grey.

## Create DTMs and Hillshades

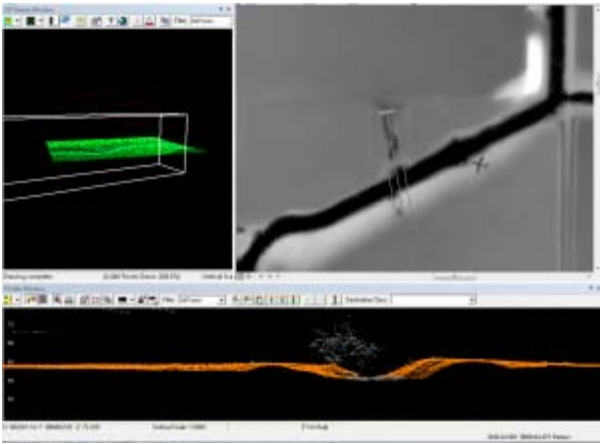
To facilitate visually identifying incorrectly classified returns, it's useful to interpolate the automatically classified ground points into a DTM, and to create basic hillshades. Many classification errors will be readily apparent in the hillshaded models. The DTMs for the Bayou Meto project were created using [LP360 for ArcGIS](#).



Bare earth DTM created before manual re-classification.

## Linked Viewers

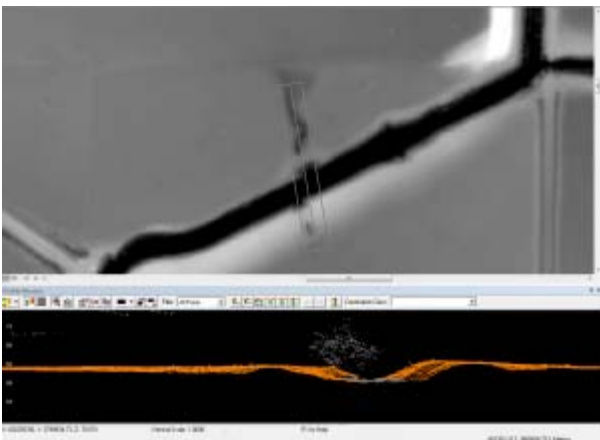
Viewing the point cloud simultaneously with the hillshaded terrain model, you can navigate quickly to 'problem areas' to re-classify any incorrect points in the ALS point cloud.



Linked viewers allow simultaneous viewing as a 3d point cloud, in profile, and at a shaded DTM.

## Drawing Profiles

Draw a profile across an area of the terrain model where potential mis-classifications have been identified. Depending on how regular the terrain surface is, set the depth of the profile. Areas where the elevation of the terrain varies greatly generally require narrower profiles to clearly visualize the separation between the ground surface and low vegetation.



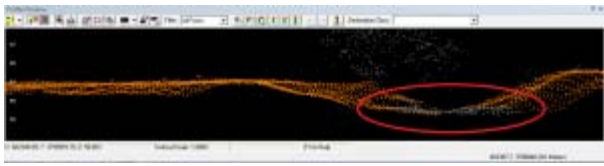
Drawing the profile on the DTM.

## Editing classifications

When editing the classification of the points it's best to set the point cloud coloring style to 'by class' rather than by elevation or by return, as it's then easier to see which points should be re-classified. In LP360 you can change the classification of points by selecting them in the profile view using a 'brush' or 'lasso' tool and then typing the number of the class they should be and hitting enter.

## Typical problem areas

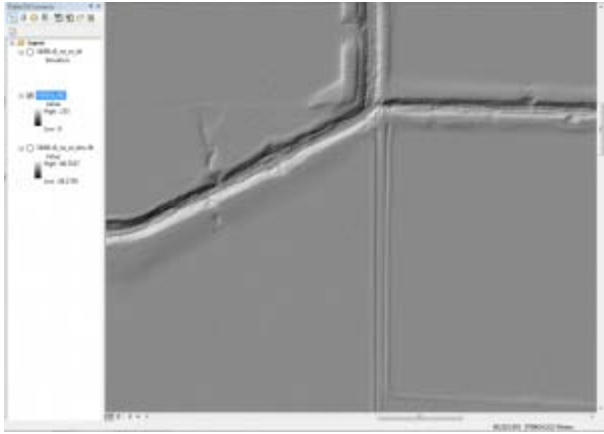
Work across the dataset systematically, until all problem areas have been improved. Note that areas with dense, low vegetation, large numbers of small buildings, and mixed steep slopes and vegetation are the most likely to contain mis-classified returns, and will require more effort. In the Bayou Meto dataset, the edges of streams proved typical problem areas, combining sloping terrain and low, dense vegetation.



Typical problem area circled in red, located under vegetation at the base of the slope.

## Re-creating the terrain models

After re-classifying the ALS returns, it is necessary to re-create the terrain models and any other derivatives. These new models are the basis for further processing and analysis.



Hillshades and other derivatives are created from the cleaned point clouds.

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