Lidargrammetry

Direct Exploitation of Stereo Imagery Generated from Lidar Data

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Technologies

Outline

- ☐ Motivation
- ☐ Concept of Inferred Stereo Pairs (ISP)
- ☐ Lidar Imagery
- ☐ Workflow Comparisons
- ☐ Quantitative Observations
- ☐ Further Investigations

Motivation

- ☐ Directly integrate proven (accepted) photogrammetric workflow with the accurate terrain information available lidar.

- ☐ Enable the deployment of lidar while still exploiting an organizations:
  - ▪ Existing environment (infrastructure).
  - ▪ Current skill sets (people).
  - ▪ Client satisfaction with proven and accepted processes (reputation).

Motivation

- ☐ Directly [...accepted) photogra[...]w accurate[...]n a lidar.

- ☐ Enable t[...]dar while still[...]ons:
  - [...]ure)
  - skill sets (people).
  - [...]atisfaction with prov[...]ed [...]es (reputation).

Motivation

- ☐ Investigate improvements to overall workflow efficiencies.

- ☐ Determine if an end-to-end 'lidar-only' workflow for creating established mapping products is practical.

- ☐ Quantify any cost reductions.

Inferred Stereo Pairs (ISP)

- ☐ By creating a second image from a orthorectified source image and an elevation model, a traditional stereo pair can be inferred.

- ☐ With lidar data, the readily available elevation values and additional information such as intensity, make this concept relatively easy to implement in software.

ISP Generation

- ☐ ISP generation requires a single orthorectified image and an underlying terrain model as input.

- ☐ Introduce parallax (displacement of the image pixels in the X direction) in a second inferred image.

- ☐ The parallax is proportional to the difference of the actual elevation value for a pixel from a fixed elevation value (average).

ISP Exploitation

- ☐ Images can be viewed as a stereo model in standard photogrammetric software (with the appropriate math model).

- ☐ Production technicians can use established viewing, measurement and compilation techniques.

- ☐ In practice, parallax is split between two new inferred images.

Lidar Imagery

- ☐ Extremely rapid timeline from sensor to exploiter (hours).
- ☐ Independent of lighting conditions.
  - ▪ Acquire at night and/or under clouds.
- ☐ Orthographically correct.
- ☐ Exploit with existing image display hardware and software infrastructure.
- ☐ Iterative refinement scheme allows selective improvement of specific Areas of Interest.

Lidar Imagery

- Extre... r to explo...
- Inde...
  - ...der
- Ortho...
- Explo... hardware and s...
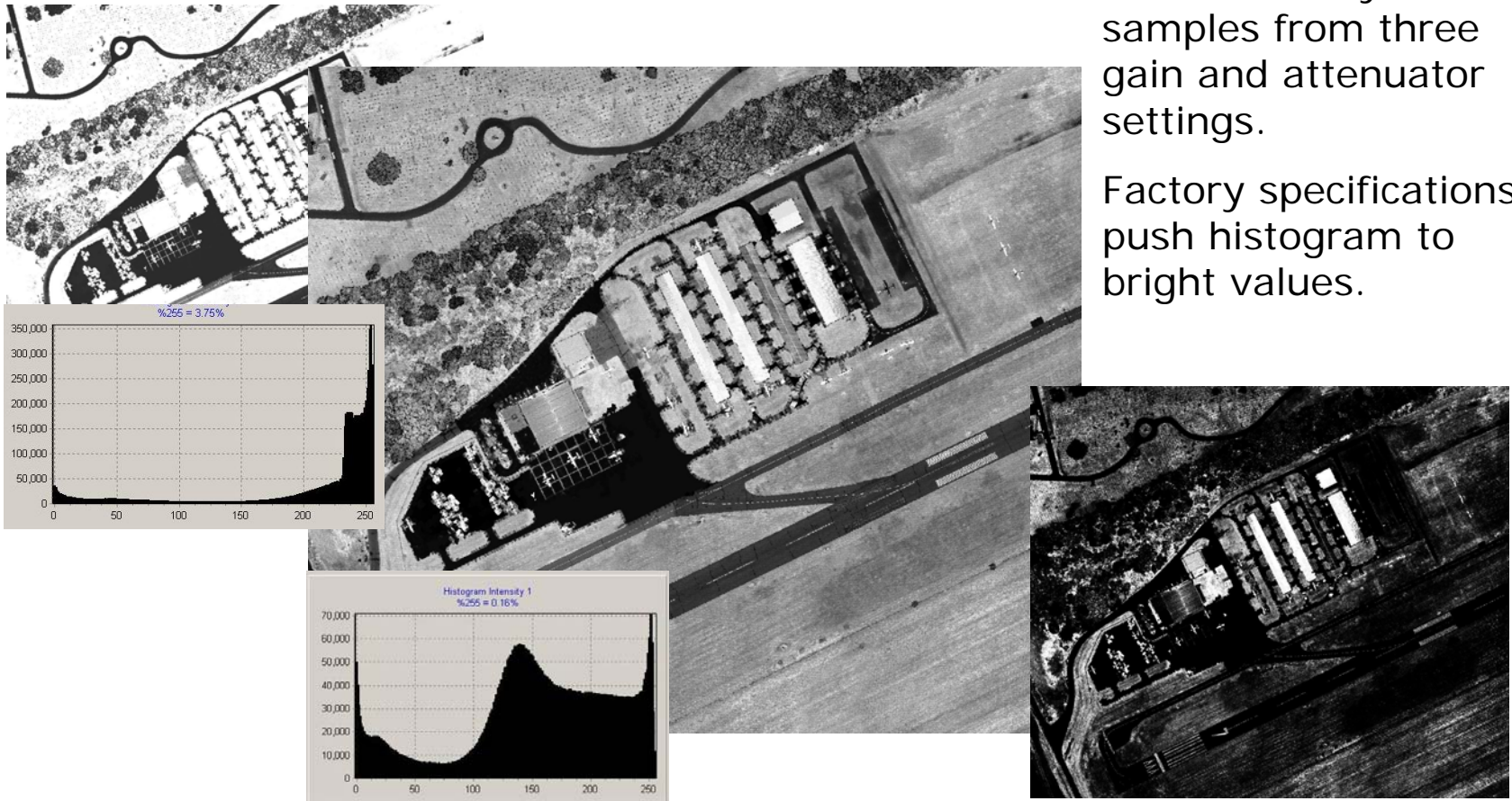- Itera... selective impro... erest.

Lidar Stereo Imagery

- ☐ Provides for enhanced interpretability of features in a 3D viewing environment.

- ☐ Stereo images provide much faster manual extraction environment for a production operator versus point display.

- ☐ Exploit with existing stereo workstation hardware and software infrastructure.

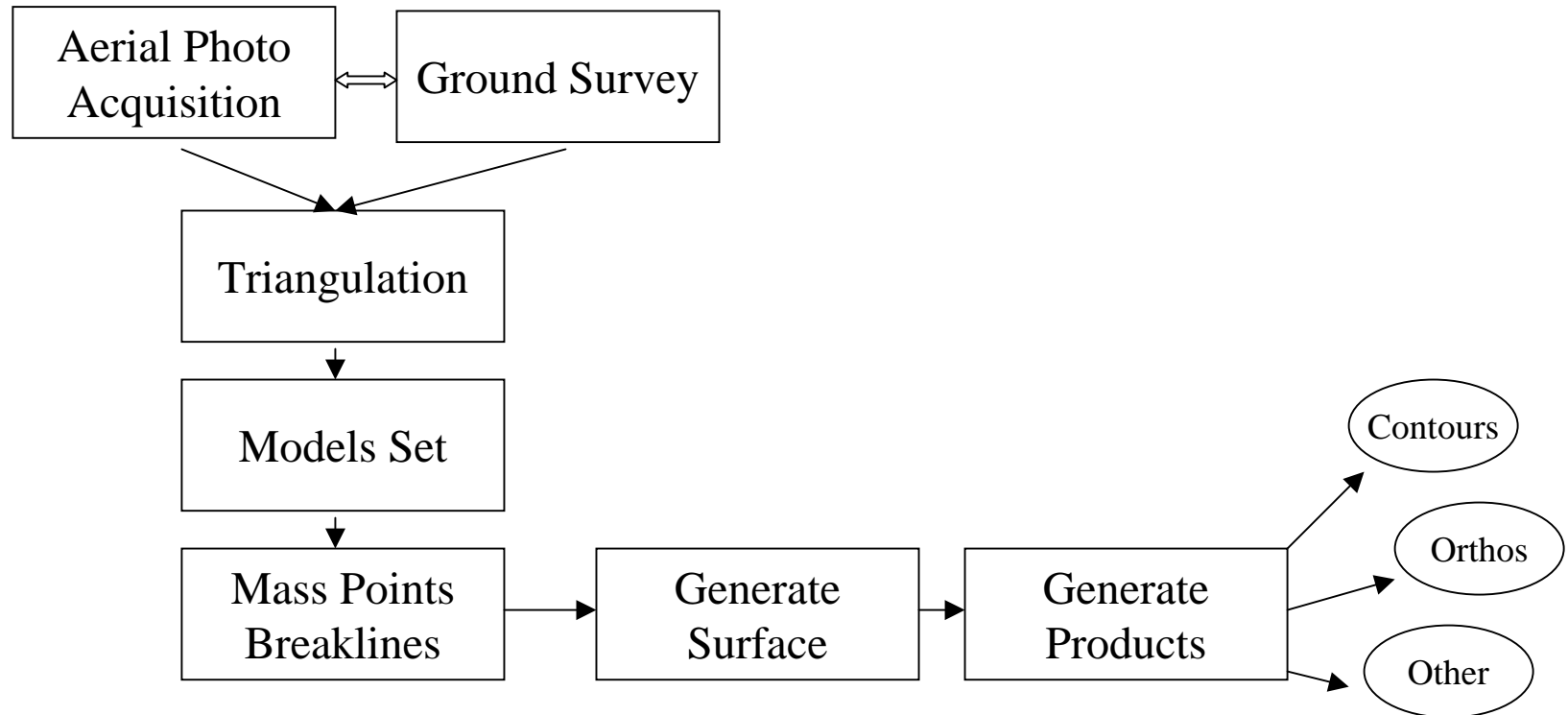- ☐ Extracted features are 3-Dimensionally correct at time of collection.

In-Flight Parameters Effect Lidar Imagery

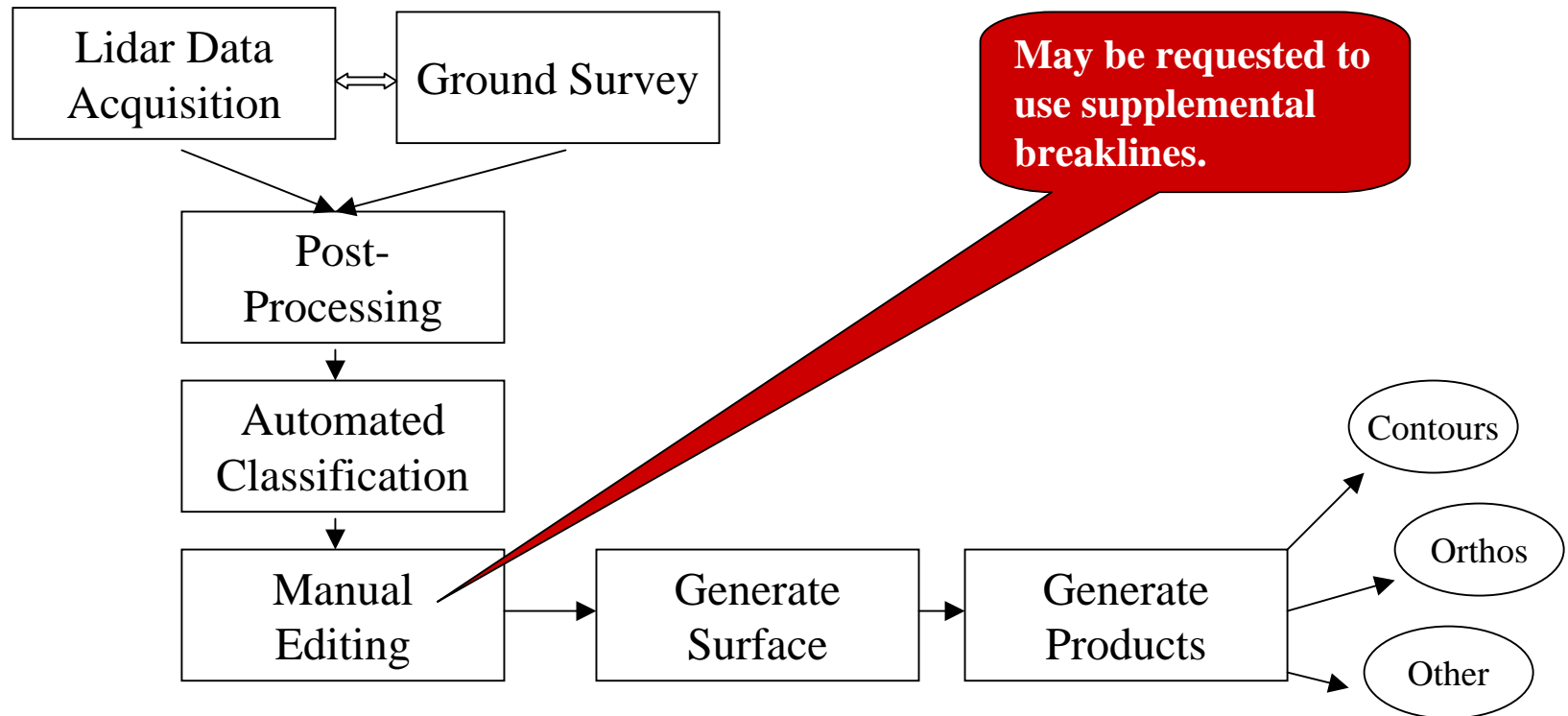Lidar Intensity samples from three gain and attenuator settings.
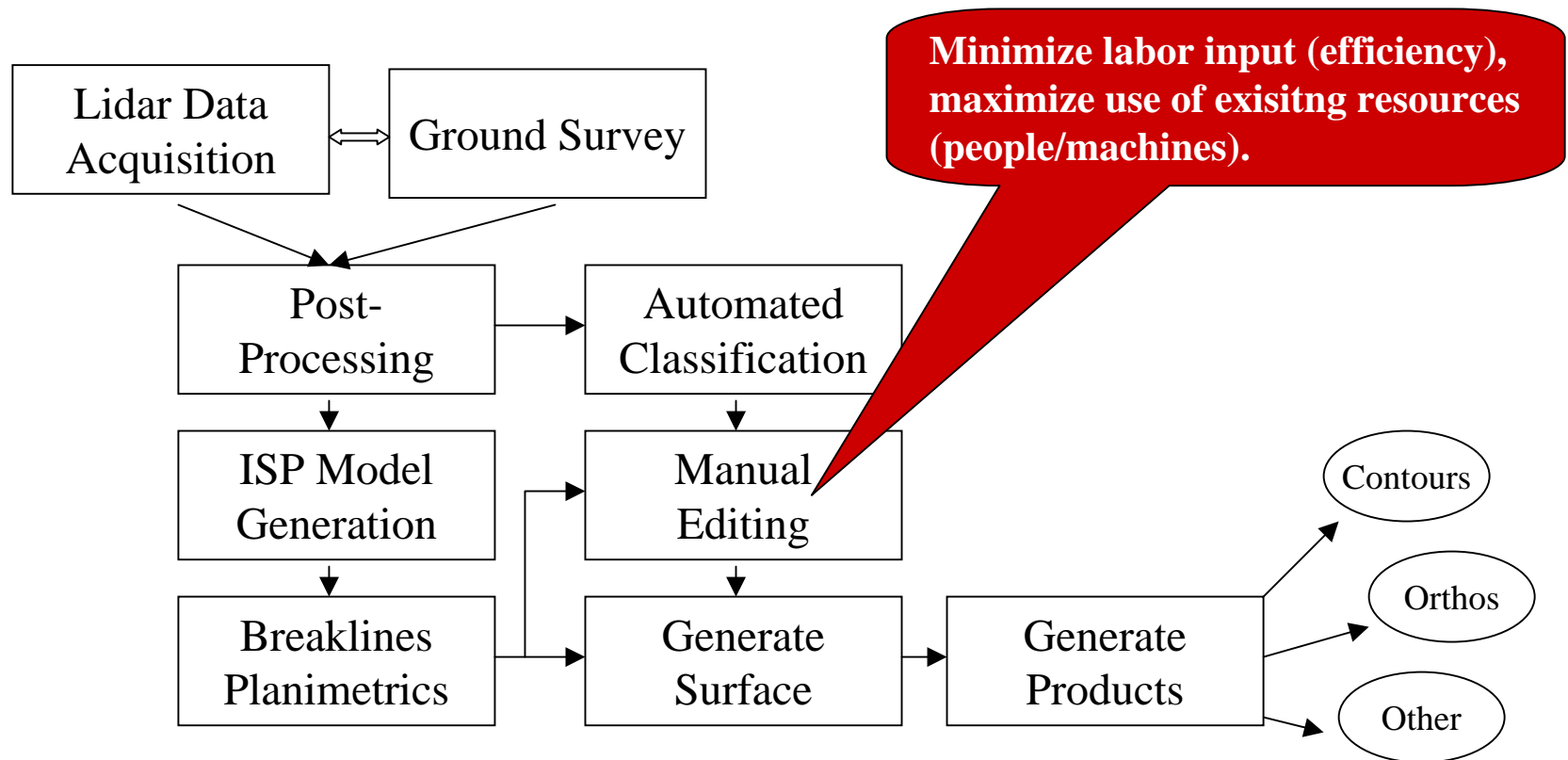
Factory specifications push histogram to bright values.

# Photogrammetric Workflow

Lidar Workflow

'Lidargrammetric' Workflow


```
Lidar Data
Acquisition   <-->   Ground Survey


Post-                Automated
Processing    -->    Classification


ISP Model            Manual
Generation           Editing


Breaklines           Generate        Generate       Contours
Planimetrics  -->    Surface    -->   Products       Orthos
                                                     Other
```

**Minimize labor input (efficiency), maximize use of exisitng resources (people/machines).**

ISP Workflow (GeoCue)

☐ After tiling and segmentation of lidar data.

☐ Define Stereo models (recommend 5000x5000 point spacing).

☐ Assign image generation parameters.
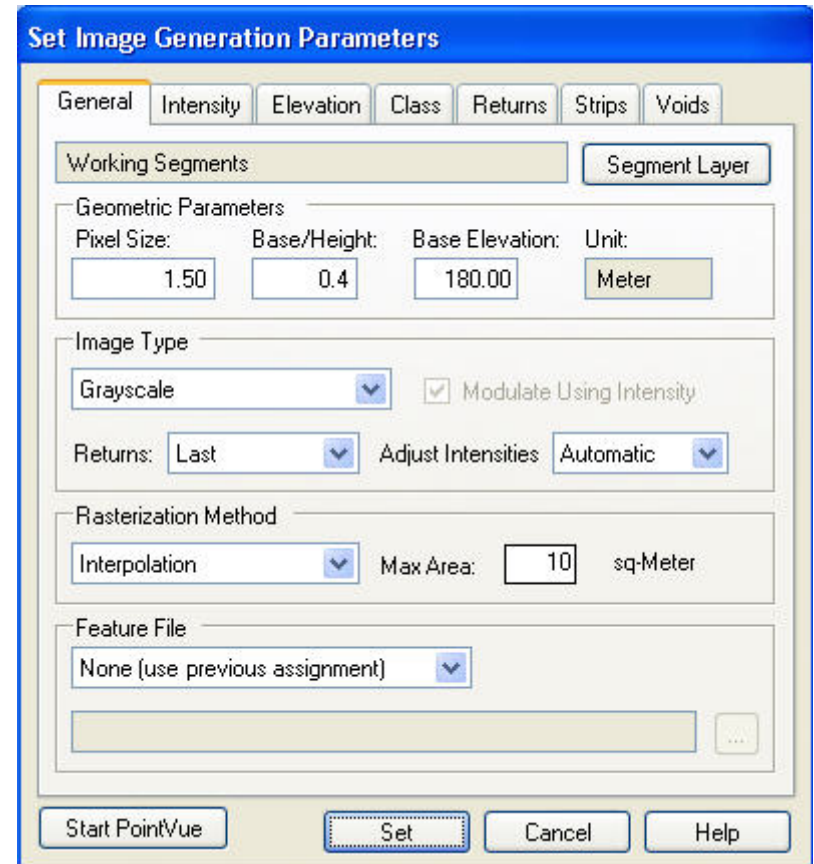
ISP Workflow (GeoCue)

- ☐ Generate test stereo pair.
- ☐ View and qualify usability.
- ☐ Make adjustments & repeat as necessary.
  - ▪ Base to height ratio.
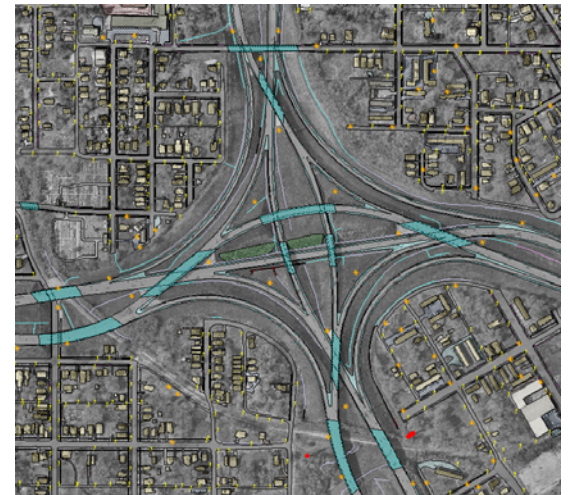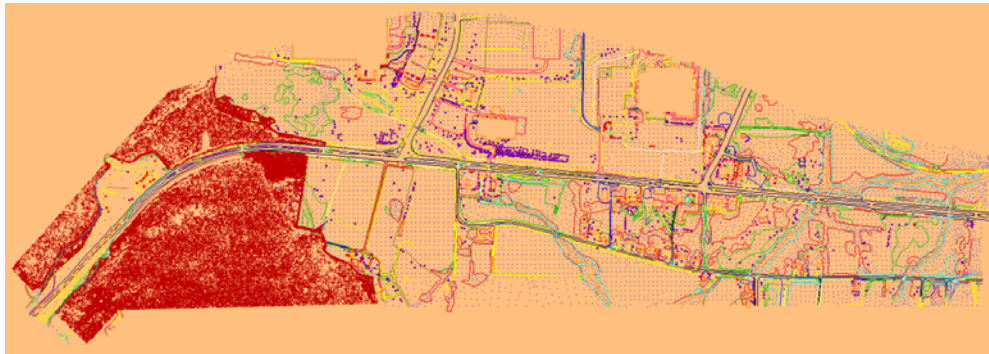 - ▪ Adjust intensity values.
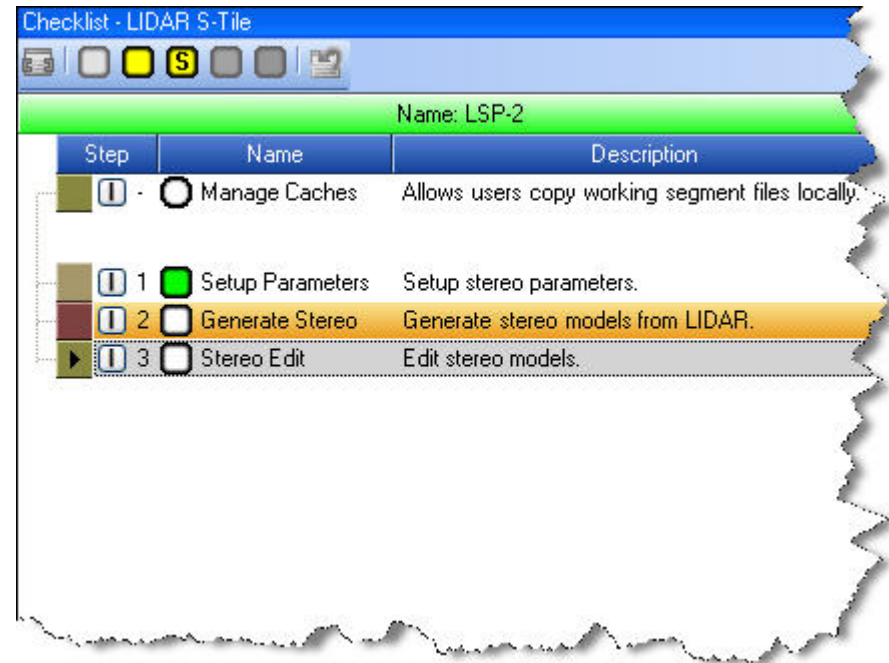
ISP Workflow (GeoCue)

☐ Assign parameters to remaining stereo models.

☐ Generate stereo models for entire project.

Current Applications in Production

- ☐ Breakline delineation for terrain modeling (improved contours).
- ☐ Planimetric feature capture.
- ☐ Classification QA/QC.

Qualitative Observations

- ☐ Requires a dense data set for accurate image creation.
- ☐ Collection parameters critical to intensity image quality.
- ☐ Breaklines collected from 2 meter posting lidar data is equivalent to 1"=200' scale imagery (horizontally).
- ☐ Low vegetation causes some problems in stereo models.

Qualitative Observations

☐ Collection area (coverage per ISP) can be larger than traditional imagery so less setups need per project.

☐ No need of importing point data to find anomalies.

Too easily?

☐ Resulting vector set is very light and easily 'roamable'.

☐ Regeneration of 'problem' areas or areas of interest with greater stereo exaggeration is very easily accomplished.

Qualitative Observations

☐ Shorelines not obscured by vegetation.

☐ Actual horizontal positioning of a water body is more accurate than from corresponding imagery.

☐ Can measure more accurate water level.

☐ Hydro breakline locations and flow direction very easy to determine.

Further Investigations

- ☐ Work with increased resolution lidar imagery.

- ☐ Examine 'class-based' stereo images.

- ☐ Use color images created by blending intensity/elevation or intensity/classification.
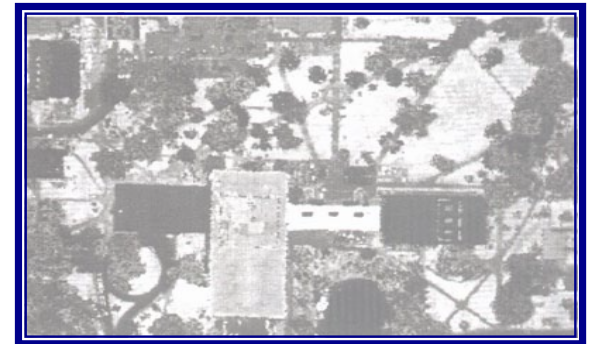
Further Investigations

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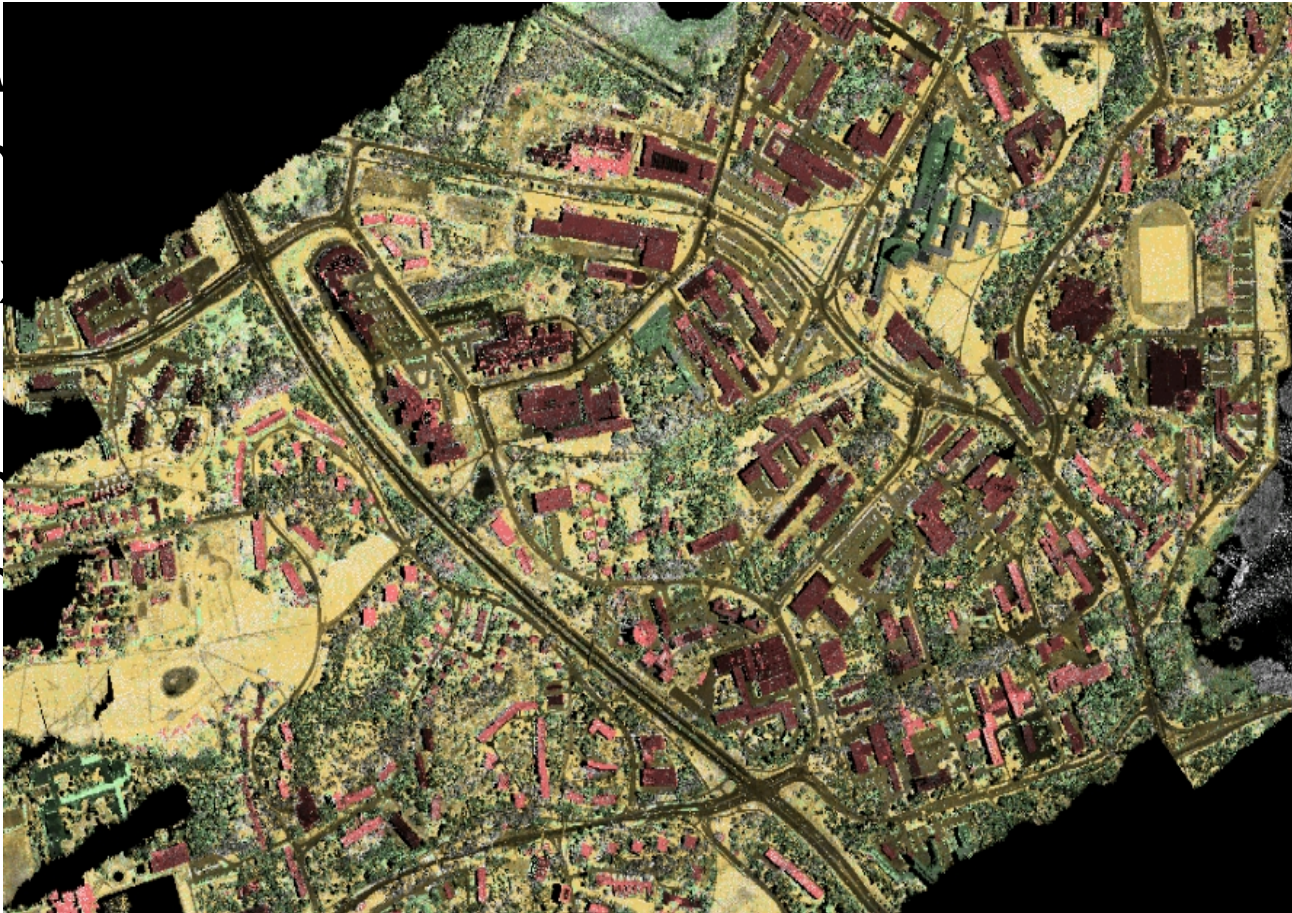
Further Investigations

- ☐ Fusion of lidar imagery with other imagery in stereo.

- ☐ Advantages as supplement to automated feature extraction.

- ☐ Work with legacy/historical data sets.

Further Investigations

- ☐ Enable manual re-classification in stereo workstation:
  - ▪ Bounding polygons, similar intensities, etc
  - ▪ Hooks between TerraSolid, GeoCue and stereo viewing software.

- ☐ 'Automated' 3D Feature Extraction
  - ▪ Similar features, colors and elevations

Eliminates the difference between 'lidar editors' and 'stereo compilers'.

Discussion

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