Field Notes

Forest Application: Plot-level Forest Mensuration

Optech Incorporated was contacted by Otterburn Geographic (located near Kingston, Ontario) in order to evaluate Optech's ILRIS-3D laser scanner for plot-level forest mensuration data extraction. Two 35 x 35 metre plots were investigated: a red pine conifer plantation (plot C), and a mixed deciduous stand dominated by sugar maples (plot D), both located north of Toronto, Canada. Five ILRIS-3D point cloud scans were centred on each plot, and were subsequently analysed with the Innovmetric Polyworks® software suite. Ground truth data was manually collected using differential GPS over several days during the same period, for subsequent comparison. There were more than 130 trees in both plots. The ultimate purpose of the project was multi-fold, and the following parameters were measured from the ILRIS-3D point cloud data:

1. Stem location
2. Tree height
3. Stem diameter at breast height (DBH)
4. Stem density - derived
5. Timber volume (gross and usable) - derived

ILRIS-3D Data Collection

Five scans of data were collected for each plot, plus two more scans along an adjacent pathway to facilitate accurate alignment of the ILRIS-3D data for both plots. Each tree was identified with a unique ID tree tag, and intensive ground truth data collection (tree position, height and DBH) was carried out for the purpose of validating ILRIS-3D derived forest information. Five control marker locations were subsequently surveyed using DGPS to geo-register the ILRIS-3D point cloud data (a minimum of three are required for this task).

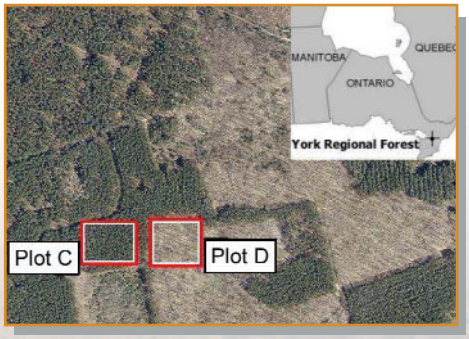
Alignment and geo-registration of the raw ILRIS-3D scans were carried out using the IMAlign© module within the Innovmetric Polyworks© software suite. The entire scanning process for the two plots including set-up time took less than a day.

Data Extraction

After slicing the ILRIS-3D point cloud data to leave behind a tree stem layer, the manually surveyed tree location map was visually overlaid onto the sliced point cloud layer to assess which trees were visible. Individual trees were extracted from the point cloud and written to separate files which were numbered according to the tree tag identifiers placed on each tree in the field. For the coniferous plot, the 77 trees extracted from the ILRIS-3D data equaled 95% of the 81 trees actually hand counted within the plot. This corresponded to the proportional ILRIS-3D scan coverage within the plot; the stem density estimate of 661 stems/ha for the plot was identical using both techniques. For the other plot, all 57 trees were identified within the ILRIS data despite scan coverage of approximately 97%. Within the scan area, there were no errors of tree omission or addition.

Tree DBH

In order to determine diameter at breast height (DBH), each individual tree point cloud file was imported into IMInspect© so that tree metrics could be extracted from the point cloud. Tree height was estimated by fitting a vector primitive to the



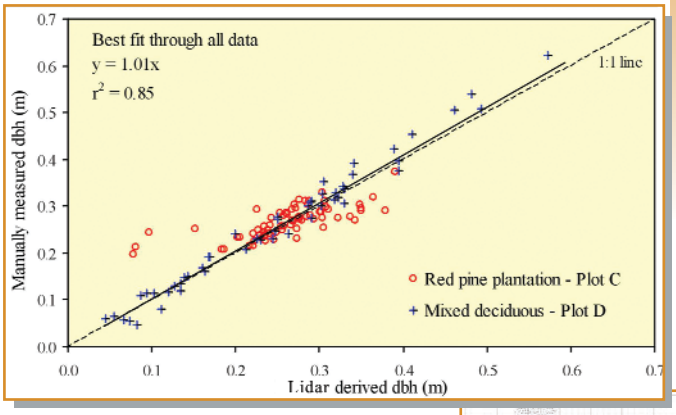
Survey Scene. Images courtesy of Otterburn Geographic.

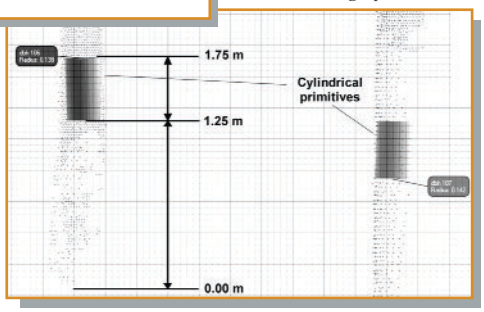
data corresponding with the visible height of the tree. The tree stem diameter for the individual tree point cloud files was estimated by selecting all ILRIS-3D point data that lay between 1.25 m and 1.75 m vertically above the lowest point in the file, and then fitting a cylinder "primitive" to the data. By using a least squares method of averaging the DBH was easily extracted.

An excellent correlation between plot level estimates of tree height and DBH was achieved between the manual and ILRIS-3D measurement techniques. For DBH, there was no tendency for ILRIS-3D to under- or overestimate the ground-truth value. Also, when graphed the data illustrated that ILRIS-3D is indeed a useful technique for estimating the heights of trees within both coniferous and deciduous plantations. Similarly, diameter at breast height (DBH) showed a good linear relationship between ILRIS-3D and manual measurements (see images).

Tree Volume Estimation

Forest mensuration equations using the height, DBH and plot area estimates above were used to determine plot-level estimates of tree volume. All ILRIS-3D derived estimates of volume were within 7% of those calculated from manual ground-truth measurements. For the coniferous plot, the ILRIS-3D data lead to a slight underestimation of both gross and merchantable volume and this is attributable to slight underestimations of both DBH and tree height. For the deciduous plot the ILRIS-3D data slightly over-estimates gross and merchantable volume, due to a slight overestimate of stem density. Therefore, there is no systematic tendency for ILRIS-3D data to either over- or underestimate tree volumes.





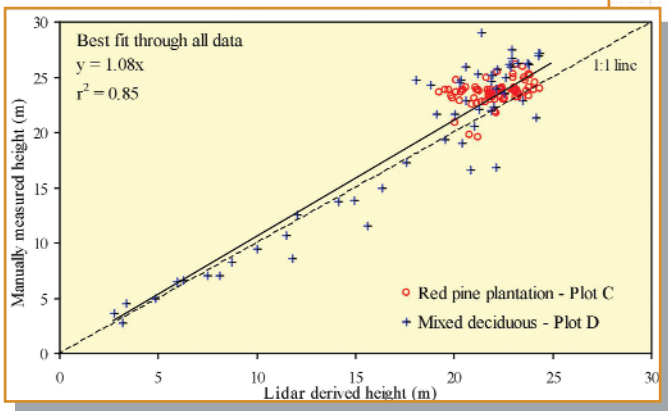
Images: DBH regression plot (left); stem DBH (below).

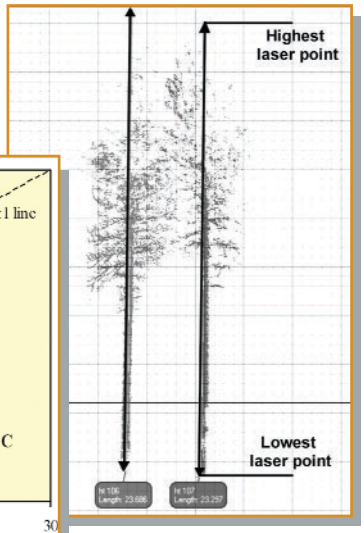
All images courtesy of Otterburn Geographic.

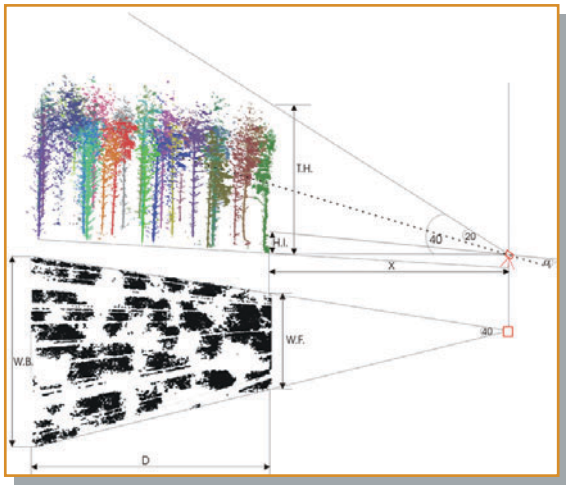
Conclusions

It was found that all parameters could be measured or derived using the ILRIS-3D intelligent laser scanner. Timber volume estimates of both plots were within 7% of manually derived estimates. Each parameter evaluated can be measured or derived with little manual intervention.

Overall, Optech Incorporated's ILRIS-3D provided a more objective and consistent methodology for forest metric assessments than traditional manual techniques.







Images (left to right): Stem height regression plot, stem height and plot D single scan.

All images courtesy of Otterburn Geographic.

ILRIS-3D provides greater speed and objectivity of data collection and feature extraction.

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