Technical Report

Terrestrial Laser Scanner Optech ILRIS 3D

Experiment on the angle of incidence and recorded intensity

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**Experiment on angle of incidence and recorded intensity**

Two targets were placed in a distance of approximately 7m from the scanner. The targets were diffusely reflecting surfaces (A4 size) mounted onto wooden boxes. The boxes were places next to each other (distance of about 5cm), directly facing the scanner. Then, following the first scan, during the following 21 scans, one target was rotated to change the angle of incidence of the laser beam on the target surface. On each target roughly 8000 points were measured.

The image below shows the recorded scene with the two target areas highlighted. Selection of the points of the right target was, due to the target's immobility, automated, whereas final selection of the points from the left target was performed manually.
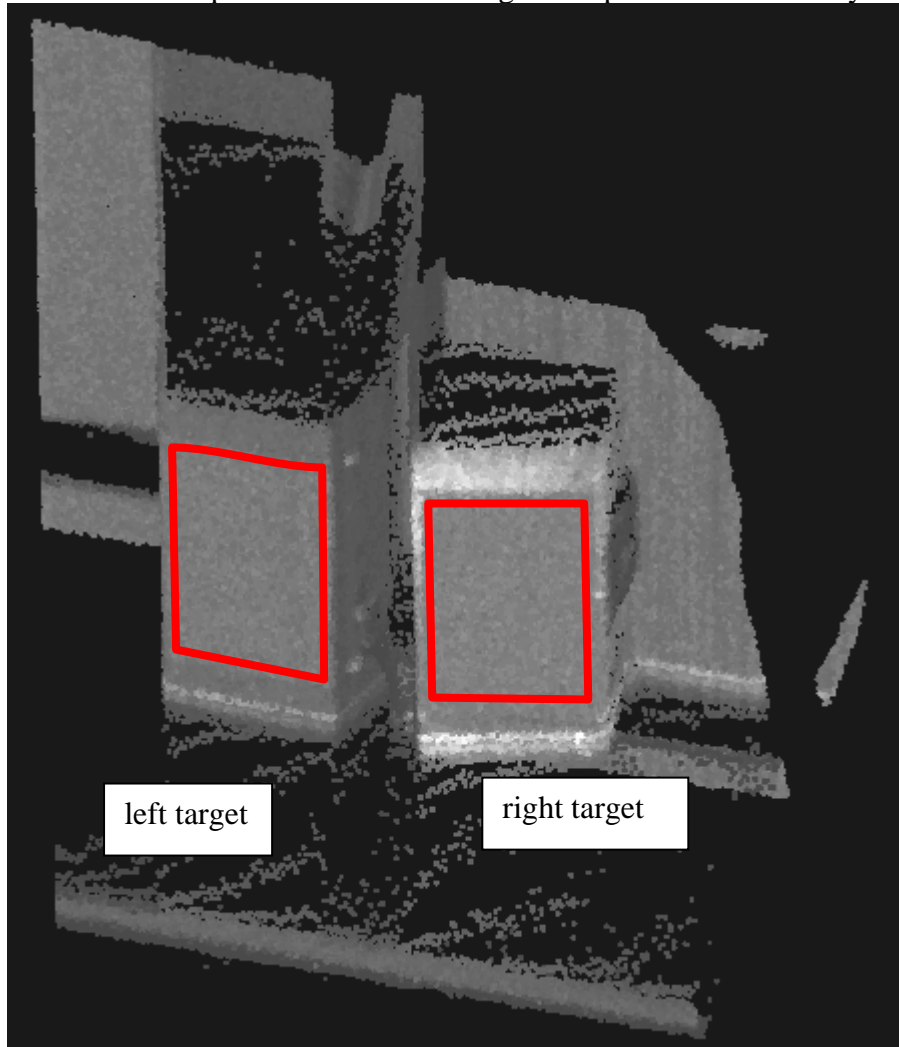
Angle of incidence

A value of 90° indicates, that the laser light hits the target orthogonally
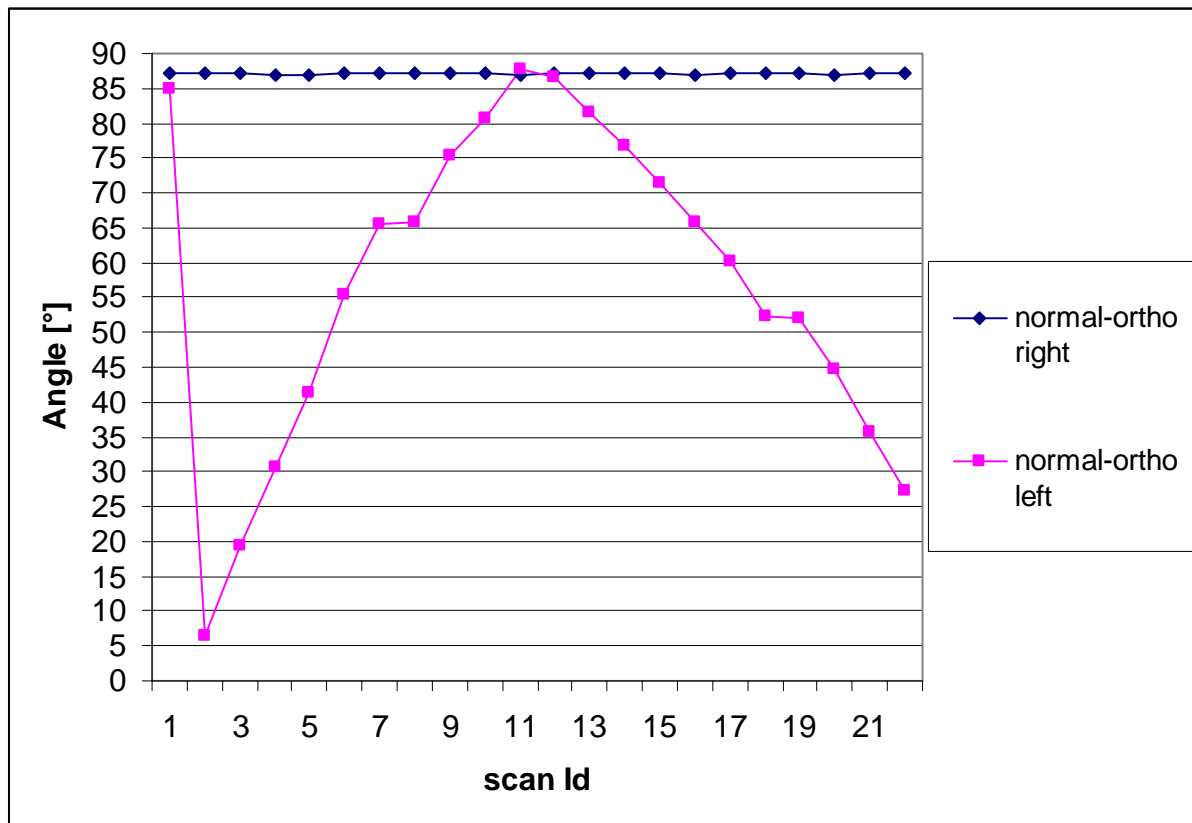
Plane fitting accuracy

The target points were used for fitting a plane by minimizing orthogonal distances. The r.m.s. of the residuals is plotted below. The effect that for small angles of incidence (above definition) the r.m.s.e. also drops is not fully understood. There may be a connection to the number of points measured.
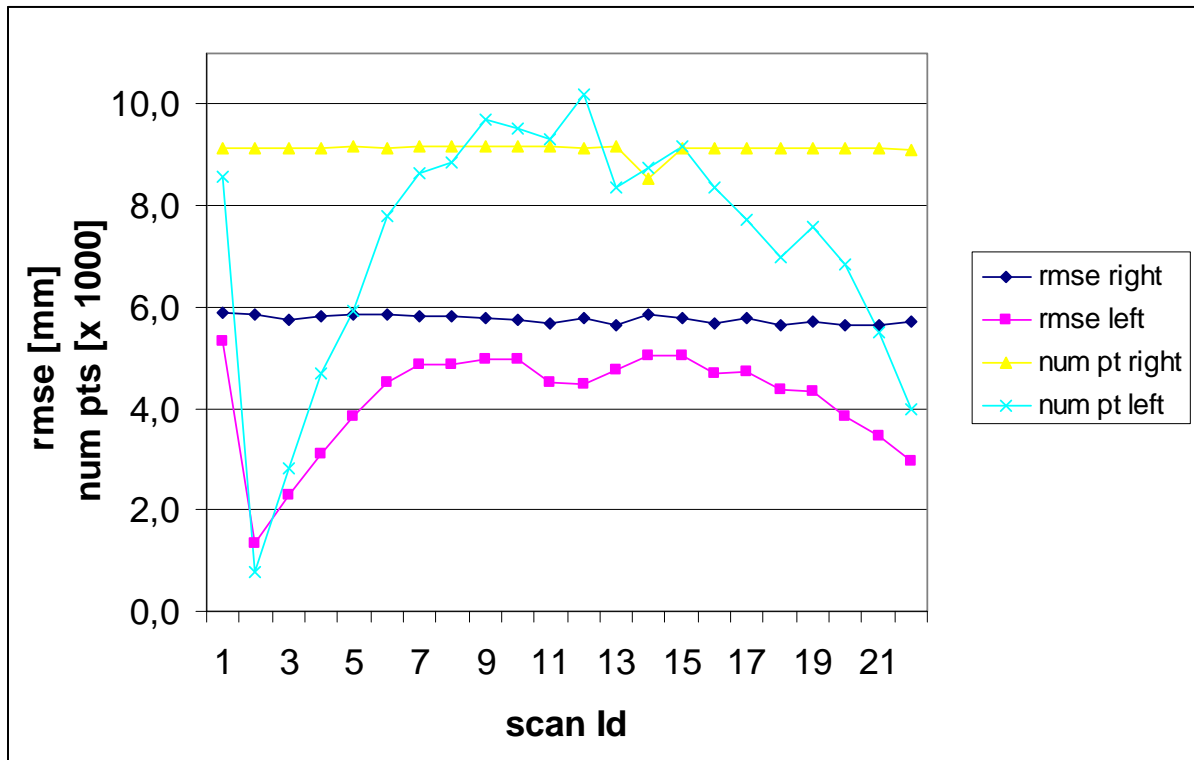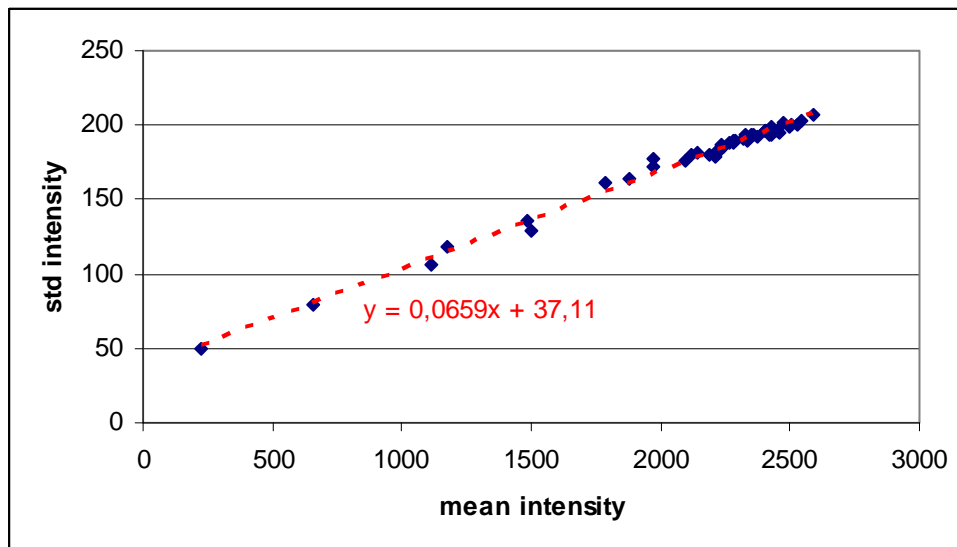
Observed intensities

The mean intensities observed in the target points and their standard deviations are shown.
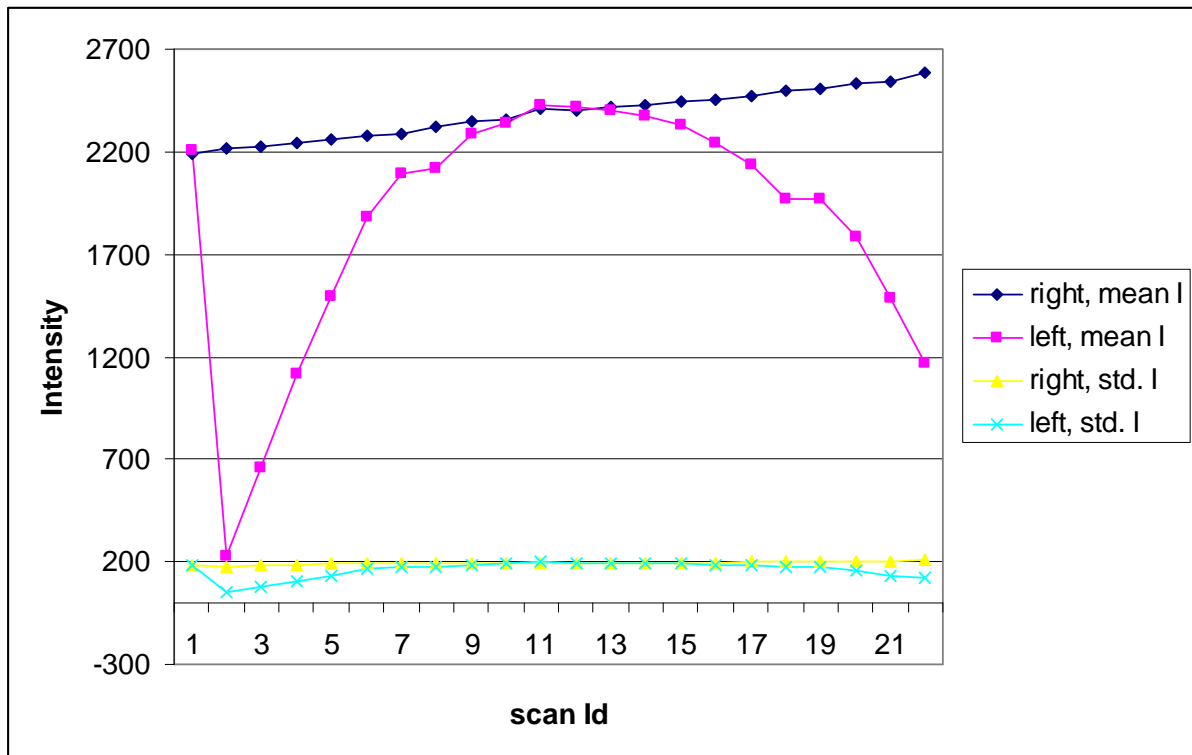

Apparently, the standard deviation grows with the mean of the intensity. This is verified in the scatter plot showing mean intensity of the target vs. standard deviation of the intensities.

The trend line shows that the standard deviation of the intensities (values larger than 500, plus possibly other, experiment typical limitations) relates to the standard deviation by the formula: 7% of the intensity value plus 35.

Furthermore, the intensities are apparently growing with increasing scan Id, which corresponds to time lapse. A closer look relates the mean intensity to the time the directory containing the data was stored on the memory stick in the scanner. As it can be seen, after the first ten scans there was a break of about 10 minutes, and before the last 4 scans there was a break of about one hour. Batteries were changed during this period. It is currently not clear, if the intensity grows with the time the scanner is switched on or with the number of laser shots emitted (which heats up the instrument).
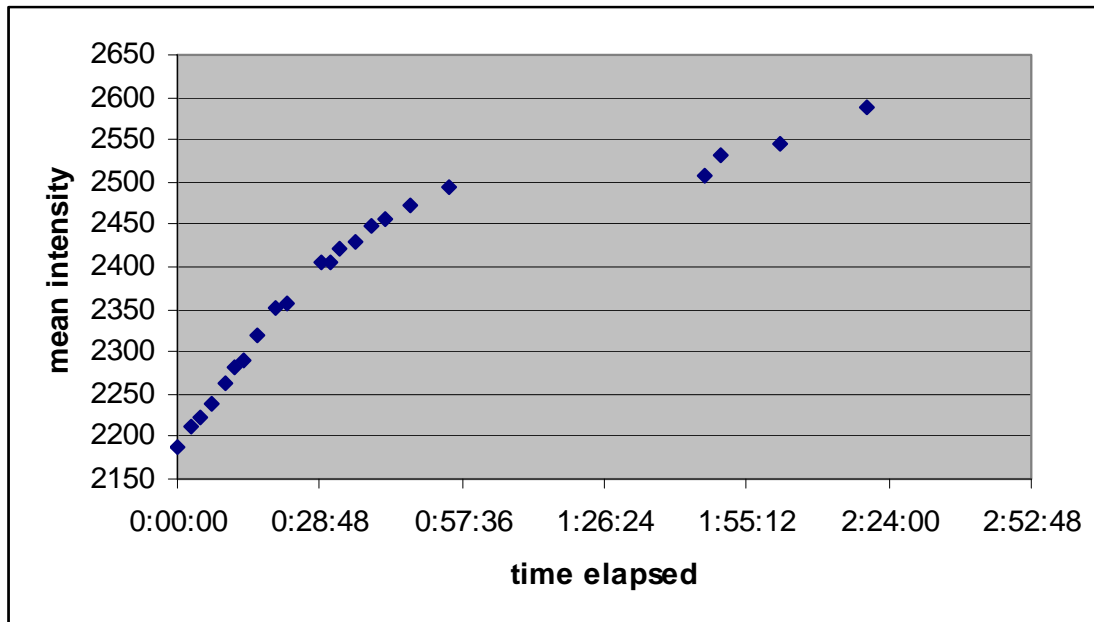
Intensity correction

The diagram shows the mean intensity values from the left and the right target corrected by different methods. Correction has been performed on range (taken from the mean point of each target point cloud), on the angle of incidence (Lambert's cosine law), and using both. As the range differences are very small only, no notable improve is obtained from correcting by the range alone. Correcting by the angle alone brings the two signals close together.

Applying both corrections still maintains a small distance between the corrected intensities, although a larger deviation than the theoretically poorer angle correction alone. One possible, though not very plausible explanation is a reflectivity difference in the left and the right target which is exactly counterweighted by the correction term of the range correction. However, a more likely explanation is that the intensities are corrected for the range already when exported by the measurement device. Also the last line of the log file generated by the conversion (parsinglog.txt) supports this hypothesis. There it reads: "Range-dynamically scales intensity: Yes"

For angles smaller than 20° the intensity difference is not fully compensated for. However, for angles larger than 27° (rightmost value) the error, applying both corrections, is less than 100, which is half of the standard deviation of the signal itself. For angles smaller than 20° the error has roughly the same size as the standard deviation. The term error refers to the not compensated part of the difference in the reconstructed reflectivity of the material.