Section 2 - Terrestrial laser scanning

1. Scan resolution

Terrestrial laser scanners suitable for applying to most earth science problems offer the potential to record large volumes of point data, and this potential will increase as technology advances and new models are introduced. The newest sensors are starting to reach similar acquisition rates as airborne systems, with tens of thousands of points per second being possible. Some consideration of the optimal scan resolution to use is therefore important, so as not to be overwhelmed by point data, even on the most up to date computing hardware. The goal of the project determines the scale of the features/surfaces that are to be surveyed, and the resolution of the scans can be chosen to ensure that the smallest required details are visible. Some further resolution considerations are listed here:

- Regions of overlap between scans are often large, which may result in much higher point spacing when point clouds are merged.

- The denser the point cloud, the more noticeable will be the random noise, especially when overlapping data are combined (Buckley and Mitchell, 2004).

- If a triangular mesh (digital elevation model) is required to be fitted to the point data, such as for texture mapping visualisation, the number of triangles will be equivalent to approximately double the number of input points. This will limit the amount of data that can be processed, loaded and displayed.

- Instrument manufacturers sometimes quote the maximum point spacing (or angular resolution) as being higher than the width of the laser beam itself. Choosing too high an angular spacing can therefore result in "blurring" of the data caused by oversampling the terrain surface (e.g. Lichti and Jamtsho, 2006).

- It is best to ensure that the resolution of the collected data is the same in the horizontal and vertical direction (most instruments record a 2D grid of points based on horizontal and vertical deflection of the laser beam). Unless there is a good reason for having different values for each axis, this can complicate processing, and even result in lower data quality if resampling is required.

There is an argument for recording the highest resolution possible, even if it is not required by the project, in the case that a future user may revisit the data with increased hardware capabilities, or with a different purpose in mind for the data. However, it is clear that at current rates of progress, scanner resolution will continue to stay well ahead of hardware capabilities, requiring more advanced software solutions to handle more data rather than just increased processor speeds. In the end the best advice is to gain some experience to choose a suitable scan resolution which meets the different project goals.

References:

Buckley, S.J. and Mitchell, H.L., 2004. Simultaneous integration, validation and point spacing optimisation of digital elevation models, *The Photogrammetric Record*, 19(108): 277-295.

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Lichti, D.D. & Jamtsho, S. 2006. Angular resolution of terrestrial laser scanners, *The Photogrammetric Record*, 21(114): 141–160.