Point Density and the Challenge in Processing Multi-source Lidar Data

Over the past few years, Lidar systems have become established as a leading technology for rapid collection of high density 3D point cloud. The advent of these systems has reduced the cost and increased the availability of accurate 3D data for diverse applications such as terrain mapping, environmental monitoring, transportation planning, emergency response, 3D city modelling, heritage documentation and forest mapping. In order to meet the needs of these applications, collected point cloud should be processed to extract useful information. Point density, which is an indication of the inter-point spacing, is one of the key data characteristics that should be considered during the various processing activities (e.g., neighbourhood definition, classification, segmentation, feature extraction and object recognition). The overwhelming majority of existing data processing techniques assumes that the collected point cloud has a uniform point density. However, one should expect that the collected data might exhibit significant variation in the point density due to perturbations in the acquisition system trajectory, variation in the reflective properties of the mapped surface, number of overlapping strips and/or incorporation of terrestrial laser scanning systems. Therefore, data processing techniques should consider the possible variations in the point density within the dataset in question. This ability will ensure the flexibility of the developed processing techniques in dealing with datasets captured by different platforms and/or from different sources. However, effective consideration of variations in the inter-point spacing is contingent on having standard measures for evaluating the local point density.

To date, only a few attempts have been made to evaluate the local point density in laser scan data. Moreover, current point density measures only consider the 2D distribution of the point cloud. Therefore, the resulting measures are only valid when dealing with point cloud acquired by an airborne system over flat horizontal terrain. Moreover, the implication of considering the varying point density in the data processing stage has not been investigated. The need to establish standards for the evaluation of local point density is more pronounced when attempting a national coverage using heterogeneous point cloud from multiple sources and/or captured by different platforms. Therefore, the Lidar community is in need of having access to standardised measures for defining the local point density while considering the 3D distribution of the point cloud as well as the nature of the surface enclosing the individual points where the local point density will be evaluated. Such measures will have a positive impact on increasing the flexibility of current data processing techniques in handling data captured by airborne and terrestrial scanner systems. Moreover, the measures will act as a quality-control criterion to determine whether or not the desired point density has been achieved.