**Title**

UAV LiDAR Point Cloud Acquisition and Quality Assessment

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**Abstract**

The TU Delft has acquired a UAV LiDAR system and can be used to acquire an 3D point cloud of the terrain below the system. It is of interest how such a flight mission would be best performed and what the corresponding quality would be. Current free software provided limited data quality estimation and mission planning support for the DJI Matrice 300 RTK and Yellowscan Mapper+ UAV LiDAR system. For these reasons an open source flight planner tool has been created. This tool does require the DJI Pilot 2 application and can for this reason only be used with DJI UAVs. It is optimized for the Yellowscan Mapper+ LiDAR module.  
  
To analyze the quality of the data, two types of point cloud quality methods have been performed: comparison of targets in the point cloud to GNSS measurements, referred to the target analysis, and based on comparisons to itself for different acquisition times on the same location, referred to as the overlap analysis. For the target analysis an automatic, LiDAR intensity based method was developed, for determining target coordinates. Furthermore, target coordinates where detected manually based on image projected RGB data in the point cloud. By comparing these target coordinates to the reference GNSS target measurements, the combined GNSS and point cloud error can be estimated separate from the target fitting errors. It was found that the combined point cloud and GNSS error is likely larger than the fitting errors in up direction up to 70m flying height. This might allow for study of the point cloud error in up direction, with this method.  
  
The presented overlap method can be used when no other reference data is available. This method divides the data in horizontal grid cells. The data in each grid cell is divided in time groups. For each time group a PCA plane is fitted and used to estimate the height in the horizontal center of the grid cell. By comparing heights between different time groups in the same grid cell, the height precision can be studied. With this method two types of overlaps are found. Within flight strips and between flight strips. The overlaps within flight strips seem to have a strong relation with the considered time difference length. This is likely caused by a combination of IMU and scan geometry errors. The overlaps between flight strips do not seem to have such a relation. This is likely caused by a combination of strip adjustment errors and possible GNSS errors. The found estimated standard deviations, up to a flying height of 70m, are generally below 17mm. It was found that flights above 70m seemed to perform significantly worse. Furthermore, grass resulted in larger estimated standard deviations than expected for low flights. This is likely caused by the ability of the scanner to measure the 3D shape of the grass leaves for lower flying heights and not for larger flying heights.