ABSTRACT

Title: A Comprehensive Framework for Quality Control and Enhancing Interpretation Capability of Point Cloud Data
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Emerging mobile mapping systems include a wide range of platforms, for instance, manned aircraft, unmanned aerial vehicles (UAV), terrestrial systems like trucks, tractors, robots, and backpacks, that can carry multiple sensors including LiDAR scanners, cameras, and georeferencing units. Such systems can maneuver in the field to quickly collect high-resolution data, capturing detailed information over an area of interest. With the increased volume and distinct characteristics of the data collected, practical quality control procedures that assess the agreement within/among datasets acquired by various sensors/systems at different times are crucial for accurate, robust interpretation. Moreover, the ability to derive semantic information from acquired data is the key to leveraging the complementary information captured by mobile mapping systems for diverse applications. This dissertation addresses these challenges for different systems (airborne and terrestrial), environments (urban and rural), and applications (agriculture, archaeology, hydraulics/hydrology, and transportation).

In this dissertation, quality control procedures that utilize features automatically identified and extracted from acquired data are developed to evaluate the relative accuracy between multiple datasets. The proposed procedures do not rely on manually deployed ground control points or targets and can handle challenging environments such as coastal areas or agricultural fields. Moreover, considering the varying characteristics of acquired data, this dissertation improves several data processing/analysis techniques essential for meeting the needs of various applications.

An existing ground filtering algorithm is modified to deal with variation in point density; digital surface model (DSM) smoothing and seamline control techniques are proposed for improving the orthophoto quality in agricultural fields. Finally, this dissertation derives semantic information for diverse applications, including 1) shoreline retreat quantification, 2) automated row/alley detection for plant phenotyping, 3) enhancement of orthophoto quality for tassel/panicle detection, and 4) point cloud semantic segmentation for mapping transportation corridors. The proposed approaches are tested using multiple datasets from UAV and wheel-based mobile mapping systems. Experimental results verify that the proposed approaches can effectively assess the data quality and provide reliable interpretation. This dissertation highlights the potential of modern mobile mapping systems to map challenging environments for a variety of applications.