ABSTRACT

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The vast potential of digital representation of objects by large collections of 3D points is being recognized on a global scale and has given rise to the popularity of point cloud data (PCD). 3D imaging sensors provide a means for quickly capturing dense and accurate geospatial information that representing the 3D geometry of objects, in a digital environment. Due to spatial and temporal constraints, it is quite common that two or more sets of PCD are obtained to provide full 3D analysis. It is therefore quite essential that all the PCD are referenced to a homogeneous coordinate frame of reference.

This homogeneity in coordinates is achieved through a point cloud registration task and it involves determining a set of transformation parameters and applying those parameters to transform one dataset into another reference frame or to a global reference frame. The registration task typically involves the use of targets or other geometric features that are recognizable in the different sets of PCD The recognition of these features usually involves the use of imagery, either intensity images or true-color images or both. In this dissertation, cloud-to-cloud registration, which is also called surface matching or surface registration is investigated as an alternative registration method, which has potential for improved automation and accuracy.

The challenge in cloud-to-cloud registration lies in the fact that PCD are usually unstructured and possess little semantics. Two novel techniques were developed in this dissertation, one for the pairwise registration of PCD and the other for the global registration of PCD. The developed algorithms were evaluated by comparing with popular approaches and improvements in registration accuracy up to four fold were obtained. The improvement obtained can be attributed to some of the novel considerations introduced in this dissertation. The main novel consideration being the simultaneous consideration of the stochastic properties of a pair of scans via the commutative correspondence.