Abstract

Digital Elevation Model: Registration and Quantification
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Digital Elevation Models, DEMs, characterize the bare earth surface in terms of horizontal coordinates and elevation. DEMs of an area can vary in bulk, can be obtained using varied sensors, or multi-temporal, or multi-modal, or captured from different viewpoints, or have different resolution and sizes. These variations give rise to the need to establish a generic platform to aggregate such vide information to be presented as a single usable entity.

DEM registration is the process of establishing mapping between two or more data files and aligning them with respect to a single coordinate system so as to have a coherent structure of the information present. Registration falls under the class of ill-posed problems.

Apart from the lack of a generic platform for aggregating DEM information into a single entity, other problems that plague the DEM registration domain include lack of multiple candidate DEM registrations, lack of symmetric and inverse-consistency, robustness of mapping function to DEM errors and data holes, and lack of study in quantification of DEMs. In Chapter 2, 3 and 4 we have introduced new methods to handle DEM registration for the multitudinal types of DEMs and have addressed various issues related to the knowledge gap found for registration. We have proposed a new Window-Based Method (WBM) and its extension SVDWBM for multi-temporal DEM registration. In these works, matrix windows of various sizes were treated for feature forming and later matching. Another approach, WTCC based on morphological operations and usage of Watershed-Transform and Chain Coding for successful segmentation and classification was also designed for multi-modal DEM registrations. The next approach, Cognitive Mapping and Contextual Pyramid (CMCP) based method was demonstrated for Multi-view and Multi-resolution DEM registration. This method exhibit the adaptation of the concepts of spatial cognition for understanding landmarks. The formation of landmarks and their correspondence has been shown using contextual pyramid concepts. CMCP based registration has shown agreeable results for the vast set of test cases used for its demonstration. Next, Diffeomorphism-based Symmetric and Inverse-Consistent Non-Rigid (DSICNR) method, for registration of Multi-view and Multi-resolution DEMs has been introduced. In many instances, it is found that registering only on a pair-wise basis is not sufficient, but a group of candidate DEMs may need to be registered. Accordingly, registration process has been extended successfully to include multiple registrations having overlapping area common to various candidate DEM data files.

DEM quantification has also been taken up to have measures of content associated with each individual DEMs, measures of similarity in the pairs of DEMs involved and have a measure of registration improvement involving all the three, namely reference, candidate and registered DEMs together. Based on their assessment of DEMs quantification, with respect to certain information theoretic measures, important inferences follow and classification of DEMs based on their topology provide a ground. This has been discussed in Chapter-5. Application of information-theoretic measures on DEMs allowed their analysis in terms of quantization and, in some cases, their classification too.