Geomatics methodologies for acquisition, processing and manipulation of 3-D data

Prof. Massimo Fabris

Objectives:
The goal of the Course is to provide theoretical, practical and mathematical tools for spatial data management: methodologies for acquisition, processing and manipulation of 3-D data, generation, management, accuracy, analysis and applications of DTMs.

Schedule:

Introduction in Geomatics (principles of Topography, Cartography and GNSS).

Acquisition of 3-D data
Photogrammetry: terrestrial, aerial and satellite acquisitions. Mathematical relationships between image and object space. Direct and inverse problems of projective and similarity coordinate transformations. Conditions of collinearity and coplanarity. Orientation procedures (Interior, Exterior, Relative and Absolute). Measurement and correction of image coordinates. Image matching, structure from motion, aerial triangulation. Stereo-model generation and error analysis. Various mathematical models strip and block adjustments. Project planning;
LiDAR: working principles. TLS (Terrestrial Laser Scanning) and ALS (Airborne Laser Scanning). Time Of Flight versus based on phase measuring systems. Data management, full waveform data Interpretation. Characteristics of instruments and sensors. UAV systems.
Co-registration of 3-D data in Local or Global reference systems. Georeferencing.

Surface representation
Digital Terrain Modelling (DTM, DEM, DSM, DTMM) concepts and their implementation and applications in geomatics engineering and other disciplines. Emphasis will be on mathematical techniques used in the acquisition (e.g. photogrammetric data capture, digitized cartographic data sources capturing, other methods: InSAR, and LiDAR) processing, storage and manipulation of DTM. Models of DTM (Grids, Contours, and TINS), interpolation and extrapolation. Surface representation from point data using moving averages, linear projection, and Kriging techniques. Grid resampling methods and search algorithms used in gridding and interpolation.

Geo-statistical methods
Introduction to Geo-statistics. Statistics, estimators and their properties: least squares estimation and best linear estimator. Random processes and second order description of random processes. Variograms. Kriging and IDW (Inverse Distance Weighing) methods. Regularization methods.

Applications
DTM derivatives (slope maps, aspect maps, viewsheds and watershed). Filtering algorithms for feature, edge, contour extraction. Applications of DTM in volume computation and drainage networks. Multi-temporal and multi-resolution DTM, DEM, DSM, DTMM: integration, interpolation and co-registration for monitoring applications.
Geomorphological operations and classification. Image rectification and orthophotos generation. Monitoring of buildings and infrastructure damaged. Monitoring of landslides, volcanic areas, subsidence, coastal erosion and evaluation of hydro-geological risks with geomatics data.
Applications of thermal cameras and data processing. Multi-temporal and multi-resolution spatial representation and analysis.