UNIVERSITÀ DI PAVIA

Anno Accademico 2016/2017

PHOTOGRAMMETRY, LIDAR AND GIS

Enrollment year	2016/2017
Academic year	2016/2017
Regulations	DM270
Academic discipline	ICAR/06 (TOPOGRAPHY AND CARTOGRAPHY)
Department	DEPARTMENT OF CIVIL ENGINEERING AND ARCHITECTURE
Course	ENVIRONMENTAL ENGINEERING
Curriculum	Impiantistico
Year of study	1°
Period	2nd semester (01/03/2017 - 09/06/2017)
ECTS	6
Lesson hours	52 lesson hours
Language	Italian
Activity type	WRITTEN AND ORAL TEST
Teacher	CASELLA VITTORIO (titolare) - 6 ECTS
Prerequisites	Surveying, differential calculus, linear algebra, analytical geometry.
Learning outcomes	Main learning objectives Concerning the technologies/methodologies. giving the essentials of aerial digital photogrammetry and aerial Lidar, that is, the two main methods for the 3D survey of the territory of medium/large size. As for the "products": to make students experts in digital cartography and topographic databases (DTDB, digital topographic database), digital terrain models (DTM) and orthophotos. Regarding the tools: give students a basic training on the QGIS program and the photogrammetric program Photomod of Racurs. Main learning results To know the main analytical elements and the most important quality parameters of aerial photogrammetry and aerial lidar. Being able to view, edit and integrate a modern DTDB; be able to create

a DTM managing the main options in an appropriate way.
Knowing how to create and manage small GIS and photogrammetry projects.

Course contents

GISs
- The main data types handled in a GIS: vector digital maps, raster maps, orthorectified images, digital elevation models having grid and TIN structure
- Management of datums and map projections;
- Use of the vector cartography: logic colorization, alphanumeric and spatial queries, selections, calculated fields, editing and creation of new entities and layers;
- Use of raster maps and digital orthorectified images: colour, transparency, world file;
- Calculation of a DEM: implementation of the first and second interpolation with the methods TIN, IDW and bilinear;
- DEM analysis: slope and aspects maps, calculation of profiles, raster algebra;
- Integrated use of spatial data;
- Realization of a GIS project by each student.

The coordinate transformations
- Usefulness of coordinates transformations in surveying, photogrammetry and geomatics in general;
- Elementary transformations in the plane: translation, scaling and rotation;
- The composite transformations: congruence, conformal, special affinity, affinity.
- Generalization to the space of the elementary transformations and in particular of the rotations, the rotation matrix in the space;
- The Helmert transformation with 7 parameters;
- Conventional aspects: chirality, order of the elementary transformations, changes, order of rotations, direction of the rotations; the matrix of rotations for photogrammetry and geodesy.

Digital images for the representation of the territory
- The colour representation in digital devices;
- The nature and characteristics of a digital image, spatial and radiometric discretization, ground resolution;
- Production of digital images using digital cameras or scanners;
- The manipulation of digital images and the necessity of interpolation, the bilinear interpolation method;
- Georeferencing of digital images, the GeoTIFF format and the world file.

Digital photogrammetry
- Geometrical principles of the photogrammetric take and restitution;
- The concepts pf photogram, strips and blocks; block configuration, including overlaps, flying height, focal length, base to height ratio;
- Collinearity equations;
- Calculation of the exterior orientation for a single image, a stereoscopic pair and a block;
- The photogrammetric measurement principle and stereoplotting;
- Hints on automation, aerial digital cameras, the use of GNSS / IMU sensors for aerial photogrammetry;

	- What you can produce with Photogrammetry: measurement of distinct points, individual measures, vector maps, digital terrain models, orthophotos; - Realization of a simple photogrammetric project by the students, divided into small groups. Laser scanning - The principle of operation and the equations of the aerial laser scanning; - the available sensors and their main characteristics; - Data filtering; - The products obtainable from the aerial laser scanning and their use for environmental purposes; - Hints on terrestrial laser scanning. Modern tools for the representation of spatial data: digital maps, vector and raster, DEMs and orthophotos - The vector digital cartography: the main properties, similarities / differences with the paper maps, the main qualitative parameters, how it is produced and who produces it in Italy; - Raster digital maps: the main properties, similarities / differences with the vector ones, main quality parameters; - Digital elevation models: definitions and main concepts. distinction between DEM, DTM and DSM, examples; - TIN and grid structure, the first and second interpolation, bilinear interpolation methods, TIN, IDW; - Visualization and analysis of DEM: wireframe and mesh display, contours; calculation of slope and aspect maps, grid algebra; - Orthophotos: why a photograph is not a map, main concepts on how to make a photograph similar to a map, that is, how to calculate an orthophoto.
Teaching methods	Lectures and practice sessions which will be guided by the teacher sometimes and simply assisted by him and by the support team in other occasions.
Reccomended or required readings	Lecture notes, available on KIRO.
Assessment methods	There are two compulsory tests and one optional. 1 - compulsory oral test, evaluated up to 24 points 2 - compulsory project activity, valued at up to 3 points 3 - optional oral exam, valued at up to 3 points, 5 in exceptional cases. Those who had at least 18 in the written test and carried out the project activities, can record the sum of the votes of the two mandatory activities. In the oral examination, the votes earned in the compulsory tests are maintained, usually. Unless the oral contradicts them in striking way. Who does not carry out the project activity is obligated to do the oral examination, which will be valued up to six points and which will focus on the usual topics of the oral and also on the project’s ones.

Further information

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