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國立東華大學

教學計劃表　Syllabus

課程名稱(中文) Course Name in Chinese	應用3D雷射掃描儀於地表調查專題			學年/學期 Academic Year/Semester	114/1
課程名稱(英文) Course Name in English	Seminar on the Application of 3D Laser Scanner to Earth Surface Surveys				
科目代碼 Course Code	ES__51600	系級 Department & Year	碩士	開課單位 Course-Offering Department	自然資源與環境學系
修別 Type	選修 Elective	學分數/時間 Credit(s)/Hour(s)	3.0/3.0		
授課教師 Instructor	/張有和				
先修課程 Prerequisite					

課程描述　Course Description

利用陸地三維雷射掃描技術進行地表資訊收集，本課程除了讓學生學習最新之技術也讓學生實際進行環境學院建築之掃描與後處理工作，使學生能由資料收集與資料處理過程中學習建立3D模型之方式

Introduction to terrestrial LIDAR techniques. this course will focus on collecting and analysing earth surface data collecting from using ground based Lidar. Following by data processing lab. in order to create 3D virtual reality models.

課程目標　Course Objectives

近年來利用陸地三維雷射掃描儀記錄地表變遷已成為最常使用的方法之一，掃描的對象包含（一）考古與文化遺址：例如金字塔、神廟等（二）建築物：包含歷史建築、古蹟與一般建築（三）工廠（四）城市街道與建築物（五）土木工程：公路、橋樑、水庫與隧道等（六）地形：海岸地形、崩塌地、淹水潛?與河階等（七）森林資源（八）自然景觀：冰川移動、峽谷地形、火山、惡地地形之掃描記錄。掃描範圍與精確度則視投資設備經費多寡而定,目前本課程使用奧地利製Riegl LMS Z360i三維雷射掃描儀（http://www.riegl.com/terrestrial_scanners/lms-z360i_/360i_all.htm），掃描範圍約200公尺精確度為5mm（1 sigma)。本課程預訂利用2至3週時間讓選課同學熟悉儀器操作與部分原理，然後利用2週時間選定預掃描對象、範圍與工作流程。其它時間讓每一位修課同學（不超過十人）進行野外實際調查、資料收集與處理，最後完成不超過5000字報告，報告內容包含研究主題、方法步驟、流程設計、資料處理與結果。課程進行一個月後依序讓修課學生進行實地掃描時，每週以一名學生進行掃描工作其它學生協助進行。

	系專業能力 Basic Learning Outcomes	課程目標與系專業能力相關性 Correlation between Course Objectives and Dept.'s Education Objectives
A	能覺知多元的自然科學與社會科學理論並具備研究能力To have knowledge of natural and social science theories	●
B	具備自然資源與人類社會議題之調查分析、規劃與經營之能力To be able to investigate, analyze, plan, and manage both natural resource and human social issues	●
C	具備將環境倫理與生態思想落實於永續性生活型態的能力To implement sustainable lifestyles based on environmental ethics and ecological principles	●
D	能以整全式的觀點來解析環境問題，並具備發展系統性解決方案的能力To resolve environmental issues and develop systematic solutions with a global perspective	●
E	具備系統分析、未來思考、溝通協調與團隊合作的能力The ability to analyze, plan, communicate, and coordinate with others (teamwork)	●
F	具備終身學習、國際視野與外語溝通的能力To instill the values of lifelong learning, an international perspective, and the ability to communicate in a foreign language	

圖示說明Illustration ：● 高度相關 Highly correlated ○中度相關 Moderately correlated

授 課 進 度 表 Teaching Schedule & Content		
週次Week	內容 Subject/Topics	備註Remarks
1	課程簡介: Introduction to terrestrial LIDAR techniques: Laser Scanning: Evolution of the Discipline , Chapter 8 Laser Scanning. In Photogrammetry: Geometry from images and laser scans (2004) 2nd edition by Karl Kraus。 . 三維雷射掃瞄理論：Chapter 8 Laser Scanning: Evolution of the Discipline . In Photogrammetry: Geometry from images and laser scans (2004) 2nd edition by Karl Kraus。 Basic of surveying using total station (測量學：測距、測角度與全測站簡介): Introduction to Nikon DTM A10 and Topcon GPT 3003LN Long distance and Non-Prism Total Station (遠距雷射免稜鏡全站儀)	Introduction to Terrestrial Laser Scanning Topcon Lase total station
2	Introduction to Riegl LMS Z360I 3D laser scanner (陸地光達系統簡介)：http://www.riegl.com/terrestrial_scanners/lms-z360i_/360i_all.htm。 Point clouds post-processing software: Riscan Pro and MeshLab (點雲後處理軟體簡介Riscan Pro and MeshLab)	Time Of Fly (TOF) and Triangulation/Trilateration
3	3D model from photos: Introduction of Photogrammetry and Visual SFM (Visual Structure from Motion System) Assignment 1: Build a 3D color point cloud using Visual SFM(作業一:利用Visual SFM與照片建立3D點雲)!	VisualSFM : A Visual Structure from Motion System (http://ccwu.me/vsfm/index.html)
4	3D model of small status (10-50 cm) using triangulation 3D laser scanner: David laser scanner (Now HP laser scanner) Coordinate Transformation(座標轉換：利用兩已知點藉由Backsighting方法進行大地座標之建立、高程測量)：Introduction to Leveling and height measurement using Sokkia SDL 30 Digital Level (水準測量原理與Sokkia SDL 30電子水準儀簡介)	
5	Davidlaser handheld laser scan practicing Lab A222! 3D laser scanning and camera calibration (三維雷射掃描與相機校正)： Triangulation Lases Scanner: Davidlaser camera calibration TOF Laser Scanner: Riegl LMS Z360I and Nikon D100/20mm fixed lens (使用Riegl LMS Z360I與Nikon D100 /20 mm定焦鏡頭)。	作業一繳交
6	Davidlaser II scan practicing Lab A222! Point clouds: object within 10 m(三維雷射掃描（一）十公尺內目標三維點雲掃瞄)：How to 3D scan a small object? 計劃包括解析度、準確度評估、掃瞄對象與控制點擺放與測量大地座標等規劃 Revopoint pop 2 eGNSS介紹 Assignment 2: Build a 3D color point cloud using Davidlaser II (作業二:利用Davidlaser II建立3D點雲)!	https://www.revopoint3d.com/pop-3d-scanner-2/ 作業二
7	Revopoint pop 2 scan practicing Lab A222! Point clouds within 10 m(三維雷射掃描（一）十公尺內目標三維點雲掃瞄)：Lab. of 3D laser scanning within 10 m (實際現地掃瞄與攝影)。（環境學院前雕塑：掃瞄距離6-8公尺、6個掃瞄位置） Assignment 3: Build a 3D color point cloud using Revopoint pop 2 (作業三:利用Revopoint pop 2建立3D點雲)!	作業二
8	Introduction of Solid State Lidar: Introduction to Livox Mid-40/ Mid-70 lidar Point clouds within 10 m(三維雷射掃描（一）十公尺內目標三維點雲掃瞄)：indoor 3D scan Lab. of 3D laser scanning within 10 m Point cloud process and 3d model reconstruction 1 (實際現地掃瞄與攝影之資料後處理一：座標轉換、雜訊去除、點雲連結與上色、誤差評估與資料輸出。) Assignment 4: Build a 3D color point cloud using Livox solid state scanner (作業三:利用Livox solid state scanner建立3D點雲)!	https://www.livoxtech.com/mid-40-and-mid-100 https://www.livoxtech.com/mid-70 作業二繳交 作業四

9	Introduction of Solid State Lidar: Introduction to Livox Mid-40/ Mid-70 lidar Point clouds within 10 m(三維雷射掃描（一）十公尺內目標三維點雲掃瞄)：indoor 3D scan Point clouds within 10 m(三維雷射掃描（一）十公尺內目標三維點雲掃瞄)：Lab. of 3D laser scanning within 10 m Point cloud process and 3d model reconstruction 2（實際現地掃瞄與攝影之資料後處理二：3D建模)。	作業三繳交
10	Introduction of Solid State Lidar: Introduction to Livox Mid-40/ Mid-70 lidar Point clouds within 10 m(三維雷射掃描（一）十公尺內目標三維點雲掃瞄)：indoor 3D scan Point clouds within 10 m(三維雷射掃描（一）十公尺內目標三維點雲掃瞄)：Lab. of 3D laser scanning within 10 m Point cloud process and 3d model reconstruction 2（實際現地掃瞄與攝影之資料後處理二：3D建模)。 Point clouds: scanning distance between 10 m and 50m, 3D reconstruction of Environment College building 1-scanning（三維雷射掃描（二）10-50公尺內目標三維點雲掃瞄：計劃、掃瞄與建立3D模型。）（環院建築）	
11	Introduction to Structure Core Lidar Point clouds: scanning distance between 10 m and 50m, 3D reconstruction of Environment College building 2- scanning（三維雷射掃描（二）10-50公尺內目標三維點雲掃瞄：計劃、掃瞄與建立3D模型。）（環院建築	作業四繳交 https://www.youtube.com/watch?v=nlzP9BP3168&t=5s
12	Introduction to Mechanical 3D Scanner: Riegl LMS Z360i Point clouds: scanning distance between 10 m and 50m, 3D reconstruction of Environment College building 3- scanning(三維雷射掃描（二）10-50公尺內目標三維點雲掃瞄：計劃、掃瞄與建立3D模型。）（環院建築）	
13	Point clouds: scanning distance between 10 m and 50m, 3D reconstruction of Environment College building 4- point cloud processing(三維雷射掃描（二）10-50公尺內目標三維點雲掃瞄：計劃、掃瞄與建立3D模型。)（環院建築）	
14	Point clouds: scanning distance between 10 m and 50m, 3D reconstruction of Environment College building 5- point cloud processing(三維雷射掃描（二）10-50公尺內目標三維點雲掃瞄：計劃、掃瞄與建立3D模型。)（環院建築）	
15	Point clouds: scanning from 50m to 200 m and airborne LIDAR-1(三維雷射掃描（三）50-200公尺內目標三維點雲掃瞄：計劃、掃瞄與建立3D模型。)(地形)	
16	Point clouds: scanning from 50m to 200 m and airborne LIDAR-2(三維雷射掃描（三）50-200公尺內目標三維點雲掃瞄：計劃、掃瞄與建立3D模型。)(地形)	
17	Point clouds: scanning from 50m to 200 m and airborne LIDAR-3(三維雷射掃描（三）50-200公尺內目標三維點雲掃瞄：計劃、掃瞄與建立3D模型。)(地形)	
18	Point clouds: scanning from 50m to 200 m and airborne LIDAR-4(三維雷射掃描（三）50-200公尺內目標三維點雲掃瞄：計劃、掃瞄與建立3D模型。)(地形)	

教 學 策 略 Teaching Strategies

☑ 課堂講授 Lecture ☑ 分組討論Group Discussion ☐ 參觀實習 Field Trip

☑ 其他Miscellaneous: 野外測量工作

教 學 創 新 自 評 Teaching Self-Evaluation

創新教學(Innovative Teaching)

☐ 問題導向學習(PBL) ☐ 團體合作學習(TBL) ☐ 解決導向學習(SBL)

☐ 翻轉教室 Flipped Classroom ☐ 磨課師 Moocs

社會責任(Social Responsibility)

☐ 在地實踐Community Practice ☐ 產學合作 Industy-Academia Cooperation

跨域合作(Transdisciplinary Projects)

☐ 跨界教學Transdisciplinary Teaching ☐ 跨院系教學Inter-collegiate Teaching

☐ 業師合授 Courses Co-taught with Industry Practitioners

其它 other:

學期成績計算及多元評量方式 Grading & Assessments									
配分項目 Items	配分比例 Percentage	多元評量方式 Assessments							
		測驗 會考	實作 觀察	口頭 發表	專題 研究	創作 展演	卷宗 評量	證照 檢定	其他
平時成績 General Performance	20%								
期中考成績 Midterm Exam									
期末考成績 Final Exam									
作業成績 Homework and/or Assignments	80%								
其他 Miscellaneous (_____)									

評量方式補充說明 Grading & Assessments Supplemental instructions

教科書與參考書目（書名、作者、書局、代理商、說明）
Textbook & Other References (Title, Author, Publisher, Agents, Remarks, etc.)

第一、二週 (1)Kraus, K. (2004)Chapter 8 Laser Scanning. In Photogrammetry: Geometry from images and laser scans (2004) 2nd edition by Karl Kraus。(2)曾義星與史天元(2003)三維雷射掃瞄技術及其在工程測量上之應用，http://web1.nsc.gov.tw/public/Data/popsc/2003_222/9205-02.pdf。(3) http://www.oocities.com/adaptive_geoservices/MPES2000_ISITE.pdf。(4) http://www.fig.net/pub/bratislava/papers/ts_02/ts_02_stanek.pdf。(5) Airborne Laser Scanning: Basic Relations and Formulas, ISPRS Journal of Photogrammetry & Remote Sensing, 54: pp. 199-214. Baltsavias, E.P., 1999 (http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.42.1900&rep=rep1&type=pdf)
第三、五週 Riegl （http://www.riegl.com/）與Rapidform（http://www.rapidform.com/）網站、Elementary surveying: An introduction to geomatics by Wolf, P. R and Ghilani, C. D. (2006), 11th edition, Pearson Prentice Hall, London。Chapter 4-5, p.72-125 and chapter 8, p.187-226。
第六、八週 (1) http://www.menci.com/services/camera-calibration.html。
(2) Riegl tutorial video and manual: http://www.riegl.com/downloads/ http://www.riegl.com/download/?nav=browse&category=TRAINING
(3) Rapidform：http://www.rapidform.com/portal/Iframe/evaluation。
papers
(1) http://www.tu-dresden.de/ipf/photo/publikationen/2006/Bienert_Maas_Scheller_ForestryVienna2006.pdf
(2) http://www.photogrammetry.ethz.ch/general/persons/henri/EISE_649.pdf (topography)
(3) Sternberg, H., Kersten, Th., Jahn, I., and Kinzel, R.(2004) Terrestrial 3D laser scanning - data acquisition and object modeling for industrial as-built documentation and architectural applications. International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 35 (B7), 942-947.
(4) Gruen, A., and Akca, D., 2005. Least squares 3D surface and curve matching. ISPRS Journal of Photogrammetry & Remote Sensing, 59(3), 151-174.
(5) https://www.fig.net/commission6/baden_2006/PDF/LS2/Sternberg.pdf （building）
(6) http://www.rieglusa.com/applications/geology/index.shtml
Geology
TLS in the national park Saxon Switzerland - T. Martienben, K.H. Lobel
Landslide Monitoring Visualization and Quantification of Material Movement - Multiple Authors
Glacier Monitoring Sulzbachkees, Alps. Austria Monitoring Campaign 2008 using LPM-321 - Multiple Authors
Glacier Monitoring Sulzbachkees, Alps, Austria - Multiple Authors
Geology Outcrop Modelling and Interpretation Using Ground Based Hyperspectral and Laser Scanning Data Fusion - T. Kurz, S. Buckley, J. Howell, D. Schneider
Building Pit Surveying - Austria - Multiple Authors

Buildings and Architecture
Please click on the link below each project to view the project PDF:
Melk Monastery
Keola Condo Tower

課程教材網址(含線上教學資訊,教師個人網址請列位於本校內之網址)
Teaching Aids & Teacher's Website(Including online teaching information. Personal website can be listed here.)

ftp site: 134.208.103.43

login name: user

password: 8227106

/study/3d_laser_scan

只能在校內下載

其他補充說明 (Supplemental instructions)