Geosensing Systems Engineering and Sciences
Department of Civil & Environmental Engineering
UNIVERSITY OF HOUSTON

CIVE 6374: Optical Imaging Metrology **Spring 2023**

Instructor: Craig Glennie
Office: Technology Bridge Bldg 4, Room 212
E-mail: clglennie@uh.edu
Phone: (832)-842-8861
Office Hours: M/W 1130-1230, or by appointment

Prerequisites: Permission of Instructor

Course Description: Optics and Sensors, image measurements and optical distortion, interior, exterior and absolute image orientation. Collinearity, resection and intersection equations and aero-triangulation. Principles of direct georeferencing. Bundle adjustments, datum definitions and image self-calibration. Structure from motion and semi-global matching.

Suggested Texts: (1) Luhmann, T., Robson, S., Kyle, S. and Boehm, J., 2013. Close Range Photogrammetry: Principles, Techniques and Applications. Whittles Publishing, Caithness. 683 pages. (LU)
(2) Wolf, P.R., Dewitt, B.A., Wilkenson, B.E., 2014, Elements of Photogrammetry, 4th edition, McGraw Hill: Boston, 676 pages. (WD)

Lectures: Twice a week (M/W 1000-1130) – TB4 110

Topics	**Reading Assignment**
Introduction	(LU) Ch. 1, (WD) Ch. 1
Optics and Sensors	(LU) 3.2, 3.3 (WD) 2, 3.2
Image Measurements and Interior Orientation	(LU) 2.1, 2.2 (WD) 4, 11.9
Transformations/Relative Orientation	(LU) 2.2, 4.5 (WD) 10, 11.5, 11.10
Absolute Orientation/Aero-triangulation	(LU) 4.2 (WD) 11.11
Collinearity, Resection, Intersection & Backprojection	(LU) 4.2-4.4 (WD) 11.4, 11.7
Direct Georeferencing	(LU) 7.2 (WD) 11.2
Bundle Adjustments/Methods	(LU) Ch. 2 & 4 Ref. Below
Datum Definitions	Ref. Below
Image Distortion/Self Calibration	Ref. Below
Structure from Motion/Semi-Global Matching	Ref. Below

Suggested Reading List

Bundle adjustment methods

Cooper, M. A. R. and S. Robson, 1996. Theory of close range photogrammetry. In. K. B. Atkinson (Ed.): Close Range Photogrammetry and Machine Vision. Whittles Publishing, Caithness. Pages 9-51.
Förstner, W. 1985. The Reliability of Block Triangulation. Photogrammetric Engineering and Remote Sensing. 51 (6), 1137-1149.
Förstner, W, 1987. Reliability analysis of parameter estimation in linear models with applications to mensuration problems in computer vision. Computer Vision, Graphics, and Image Processing 40 (3), 273-310
Granshaw, S. I., 1980. Bundle adjustment methods in engineering photogrammetry. Photogrammetric Record, 10 (56): 181-207.

Photogrammetric datum definition

Fraser, C. S., 1982. Optimization of precision in close-range photogrammetry. Photogrammetric Engineering and Remote Sensing, 48 (4): 561-570.
Fraser, C. S., 1984. Network design considerations for non-topographic photogrammetry. Photogrammetric Engineering and Remote Sensing, 50 (8): 1115-1126.

Imaging distortion models and self-calibration

Fraser, C. S., 1997. Digital camera self-calibration. ISPRS Journal of Photogrammetry and Remote Sensing, 52 (4): 149-159.
Fraser, C.S., 2013. Automated camera calibration in close-range photogrammetry. Photogrammetric Engineering and Remote Sensing, 79 (4): 381-388.
Fryer, J. G., 1996. Camera calibration. In. K. B. Atkinson (Ed.): Close Range Photogrammetry and Machine Vision. Whittles Publishing, Caithness. Pages 156-179.
Kenefick, J. F., 1971. Ultra-Precise Analytics, Photogammetric Engineering, 37(11):1167-1187.
Kenefick, J. F., M. S. Gyer and B. F. Harp, 1972. Analytical self-calibration. Photogrammetric Engineering, 38 (11): 1117-1126.

Structure from Motion and Semi-Global Matching

Gehrke, S., Morin, K., Downey, M., Boehrer, N., Fuchs, T., 2011. Semi-Global Matching: An Alternative to Lidar for DSM Generation? Proceedings of the 2010 Canadian Geomatics Conference and Symposium of Commission I. Vol. 2. 2010.
Hirschmüller, H., 2008. Stereo Processing by Semiglobal Matching and Mutual Information. IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 30, No. 2.
Snavely, N., Seitz, S.M., Szeliski, R., 2008. Modeling the World from Internet Photo Collections. *International Journal of Computer Vision*, 80, pp. 189-210.
Küng, O., Strecha, C., Fua, P., Gurdan, D., Achtelik, M., Doth, K.-M., Stumpf, J., 2011. Simplified building models extraction from ultra-light uav imagery. *ISPRS – Int. Arch. Photogramm. Remote*

Sens. Spatial Inform. Sci., XXXVIII-1/C22 (2011), pp. 217-222.
Gini, R., Pagliari, D., Passoni, D., Pinto, L., Sona, G., Dosso, P., 2013. UAV photogrammetry: block triangulation comparisons. *ISPRS – Int. Arch. Photogramm. Remote Sens. Spatial Inform. Sci.*, pp. 157-162.
Lowe D., 2004. Distinctive image features from scale-invariant keypoints. *Int. J. Comput. Vision*, 60, pp. 91-110.

Grading:	Final Exam	50%
	Labs/Projects	40%
	Participation	10%
	Total semester grade	**100%**

General Requirements:

1. Assigned problems are due at the beginning of the class.
2. Late problems will not be accepted unless caused by some event excusable by the instructor.
3. Instructor is not responsible for pertinent dates related to withdrawing of the course for a student.
4. Contact appropriate admission office on time if you need to drop the course.

COVID-19 Information

Students are encouraged to visit the University's COVID-19 website for important information including diagnosis and symptom protocols, testing, vaccine information, and post-exposure guidance. Please check the website throughout the semester for updates. Consult the (select: Undergraduate Excused Absence Policy or Graduate Excused Absence Policy) for information regarding excused absences due to medical reasons.

Reasonable Academic Adjustments/Auxiliary Aids

The University of Houston complies with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990, pertaining to the provision of reasonable academic adjustments/auxiliary aids for disabled students. In accordance with Section 504 and ADA guidelines, UH strives to provide reasonable academic adjustments/auxiliary aids to students who request and require them. If you believe that you have a disability requiring an academic adjustments/auxiliary aid, please contact the Justin Dart Jr. Student Accessibility Center (formerly the Justin Dart, Jr. Center for Students with DisABILITIES).

Excused Absence Policy

Regular class attendance, participation, and engagement in coursework are important contributors to student success. Absences may be excused as provided in the University of Houston Undergraduate Excused Absence Policy and Graduate Excused Absence Policy for reasons including: medical illness of student or close relative, death of a close family member, legal or government proceeding that a student is obligated to attend, recognized professional and educational activities where the student is presenting, and University-

sponsored activity or athletic competition. Under these policies, students with excused absences will be provided with an opportunity to make up any quiz, exam or other work that contributes to the course grade or a satisfactory alternative. Please read the full policy for details regarding reasons for excused absences, the approval process, and extended absences. Additional policies address absences related to military service, religious holy days, pregnancy and related conditions, and disability.

Recording of Class

Students may not record all or part of class, livestream all or part of class, or make/distribute screen captures, without advanced written consent of the instructor. If you have or think you may have a disability such that you need to record class-related activities, please contact the Justin Dart, Jr. Student Accessibility Center. If you have an accommodation to record class-related activities, those recordings may not be shared with any other student, whether in this course or not, or with any other person or on any other platform. Classes may be recorded by the instructor. Students may use instructor's recordings for their own studying and notetaking. Instructor's recordings are not authorized to be shared with *anyone* without the prior written approval of the instructor. Failure to comply with requirements regarding recordings will result in a disciplinary referral to the Dean of Students Office and may result in disciplinary action.

Resources for Online Learning

The University of Houston is committed to student success, and provides information to optimize the online learning experience through our Power-On website. Please visit this website for a comprehensive set of resources, tools, and tips including: obtaining access to the internet, AccessUH, Blackboard, and Canvas; using your smartphone as a webcam; and downloading Microsoft Office 365 at no cost. For questions or assistance contact UHOnline@uh.edu.

Academic Honesty Policy

High ethical standards are critical to the integrity of any institution, and bear directly on the ultimate value of conferred degrees. All UH community members are expected to contribute to an atmosphere of the highest possible ethical standards. Maintaining such an atmosphere requires that any instances of academic dishonesty be recognized and addressed. The UH Academic Honesty Policy is designed to handle those instances with fairness to all parties involved: the students, the instructors, and the University itself. All students and faculty of the University of Houston are responsible for being familiar with this policy.

Title IX/Sexual Misconduct

Per the UHS Sexual Misconduct Policy, your instructor is a "responsible employee" for reporting purposes under Title IX regulations and state law and must report incidents of sexual misconduct (sexual harassment, non-consensual sexual contact, sexual assault, sexual exploitation, sexual intimidation, intimate partner violence, or stalking) about which

they become aware to the Title IX office. Please know there are places on campus where you can make a report in confidence. You can find more information about resources on the Title IX website at https://uh.edu/equal-opportunity/title-ix-sexual-misconduct/resources/.

Syllabus Changes

Please note that the instructor may need to make modifications to the course syllabus. Notice of such changes will be announced as quickly as possible through (*specify how students will be notified of changes*).

Helpful Information

Coogs Care: https://uh.edu/dsa/coogscare/
Student Health Center: https://www.uh.edu/healthcenter/