GGS 680 – Earth Image Processing
Fall 2022 – Wednesday – 4:30 to 7:10
Classroom – Exploratory Hall **2310**

Instructors: Mike Wolf, PhD; Adjunct Professor
Email: mwolf7@gmu.edu (best way to reach me)
Office: Exploratory Hall 2205
Office Hours: By appointment; virtual or office

Course Materials (not required):

- "Digital Image Processing, 4th Edition" by R. C. Gonzalez and R. E. Wood, Prentice-Hall, 2018 (ISBN 978-0-13-168728-8).
- "Remote Sensing Digital Image Analysis – An Introduction" by John Richards, Springer-Verlag, 2015 (ISBN 978-3-642-30062-2). (PDF available for download)
- "Image Operators: Image Processing in Python 1st Edition" by Jason M. Kinser, CRC Press, 2019 (ISBN-13: 978-1498796187). (PDF available for download)

Course Description:
Imagery has become a primary data source in geospatial applications. From satellite remote sensing to aerial and terrestrial imaging systems and networks, vast amounts of imagery are being collected and utilized in various application areas. The wide variety of imagery data sources are now challenging our ability to manage such data, process it, and derive useful high-level information from it. Motivated by this, the primary objective of the course is to provide a systematic introduction to Digital Image Processing (DIP) techniques and related topics in Remote Sensing (RS) and Computer Vision to enable the extraction of spatial and spatiotemporal information from imagery. In particular, the objectives of this course are to:

- Review basic ideas and theories of image processing and their relation to earth observations
- Introduce analytical techniques and tools that are used in image analysis
- Develop the ability to apply these tools in various application areas
- Identify and gain insight into some of the emerging trends in DIP

Course Objectives:
This is an upper-level graduate course and so it is expected that one has advanced research abilities along with refined writing and programming skills. By attending class lectures, performing background topic research and independent study, students will be able to:

- Have a broad knowledge-based on fundamentals, theory, and techniques of Digital Image Processing in the context of earth image processing and Geo-Intelligence and other geospatial applications
- Articulate and effectively communicate concepts and ideas related to Digital Image Processing to both image processing experts, non-experts, and other professionals in a work environment. This objective is particularly important in today's interdisciplinary work environment

- Develop the ability to appropriately apply the tools, algorithms and concepts covered in the course for various hypothetical and real-world data processing tasks
- Given a problem or task, be able to effectively analyze it, identify key elements and potential difficulties, and define a strategy for successfully addressing it
- Perform a critical review of the potential, effectiveness, and reliability of Digital Image Processing and Remote Sensing processing processes and outcomes
- Most importantly, learn how to learn from each other in a collaborative environment

Planned Schedule:

Date	Topic	Homework
8/24/2022	Introduction & Lexicon	Problems at the end of the Jupyter Notebook
8/31/2022	Python & Linear Algebra & Digital Images	Problems at the end of the Jupyter Notebook
9/7/2022	Color & Geometric Transformations	Problems at the end of the Jupyter Notebook
9/14/2022	Image Morphing & PCA	Problems at the end of the Jupyter Notebook Project Teams and Project Scope defined Due
9/21/2022	Eigen Images & Image Frequencies	Problems at the end of the Jupyter Notebook
9/28/2022	Frequency Filtering & Correlations	Problems at the end of the Jupyter Notebook
10/5/2022	Edge Detection & Hough Transforms	Problems at the end of the Jupyter Notebook
10/12/2022	Noise & Texture Recognition	Problems at the end of the Jupyter Notebook Interim Report Due
10/19/2022	Gabor Filtering & Describing Shape	Problems at the end of the Jupyter Notebook
10/26/2022	Imagery Download & Remote Sensing	Problems at the end of the Jupyter Notebook
11/2/2022	QGIS & Image Analysis	Research Project
11/9/2022	Imagery Extraction	Research Project
11/16/2022	OTB	Research Project
11/30/2022	Project Presentations	Research Project Due and Presentations

Grading Policy:

***Homework Assignments* (50%):**
All homework is due at the beginning of class in a Jupyter notebook. Homework that is turned in late is subject receiving a maximum grade no higher than the lowest mark received by assignments turned in on time.

***Research Project* (25%)**
The research project will count for 25% of the student's grade. The research project will be due on the last day of class along with the associated presentation. All students must attend the presentation lecture in order to receive a passing grade for this course.

***Class Participation* (25%):**
Students are expected to attend the class periods of the courses for which they register. In-class participation is important not only to the individual student, but also to the class as a whole. Instructor may use absence, tardiness, or early departure as de facto evidence of non-participation.

Expectations for Participation:

- Students prepare for and actively engage in class discussion (e.g., demonstrate active listening, not distracted by electronics or peers)
- Students thoughtfully engage in in-class assignments and activities
- Students participate in class discussion by:
    - raising informed discussion points
    - connecting discussion to reading material, news, and relevant experiences
    - asking questions
    - listening to other perspectives
    - sharing the floor with others

GMU Email Accounts & Blackboard:
You must use and regularly check your GMU email account and Blackboard to receive information for this class. Please do not send emails from non-GMU accounts, they will be ignored. I will normally respond within 24 hours.

Honor Code:
You are expected to follow the George Mason University rules of student conduct as noted in the catalog.

Office of Disability Services:
If you require academic accommodations due to a permanent or temporary disability, please contact the Office of Disability Services (ODS) at (703)993-2474, http://ods.gmu.edu. GGS will then contact me to arrange appropriate accommodations.

Classroom Expectations and other Miscellaneous:
Students are expected to be on time for class.

1. In the event of any class cancellation (unlikely for a virtual class), including changes in the pandemic situation, inclement weather (e.g. snow), the class will resume where we left off, adjustments, if necessary, will be made later
2. Please turn cell phone sounds off and do not text or talk on your cell phone during class
3. Please be respectful of your peers and your instructor and do not engage in activities that are unrelated to the class. Such disruptions show a lack of professionalism and may affect your participation grade
4. Lecture materials will be posted on Blackboard within 24 hours after the lecture

Technology Requirements

<u>Hardware</u>

- An Intel-based computer with an up-to-date operating system (Windows 10 or Mac OSX 10.13 or higher), at least 4 GB of RAM (8GB recommended), and a dual core or better processor

- A computer graphics card (either integrated or standalone). A standalone graphics card with at least 2GB - 4GB of ram (depending on your screen size) is recommended but not required

Instructional Software

- A supported up-to-date web browser (check which browsers are supported by Blackboard)
- Blackboard (available upon logging into http://mymason.gmu.edu)
- Zoom (available at https://gmu.zoom.us/)
- Adobe Acrobat Reader (free download)

Other Software

In order to be able to fully participate in this course you are required to have regular and reliable access to Python and Jupyter notebooks. It is strongly encouraged to use Anaconda for Python. Alternatively, one could use Google Colab (see https://colab.research.google.com/notebooks/intro.ipynb?utm_source=scs-index)

Recording and/or sharing class materials

- This class or portions of this class will be recorded by the instructor for educational purposes. These recordings will be shared only with students enrolled in the course through the course website. Your instructor will communicate how you can access the recordings
- Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy. Students requesting the use of assistive technology as an accommodation should direct such requests to the Office of Disability
- Sharing of instructor-created or other materials created or provided as part of the course (including recordings), and in particular materials relevant to assignments or exams, to public online "study" sites is considered a violation of Mason's Honor Code. For more information, see the Office of Academic Integrity's summary of information about online study sites

Special Notice

This syllabus is subject to change based on the needs and desires of the students taking the class. An updated syllabus will be posted if changed and the changes clearly described to the students.