Department of Geography and Geoinformation Science

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GGS 416 - Satellite Image Analysis
Spring 2021

1. **General Information**

Instructor:	Dr. Arie Croitoru (a.k.a "Dr. C"); (acroitor@gmu.edu)
Teaching assistant	Mr. Bradley Gay (bgay2@gmu.edu)
Where:	Online
When:	Wednesdays between 1:30pm to 4:10pm.
Course website:	Blackboard
Credits:	3.0
Prerequisites:	60 credits and 379 (or 412), or permission of instructor. Some familiarity with computer programming basics is recommended.
Instructor's Office Hours:	Monday 9:30am - 10:30am, Thursday 2:30pm - 3:30pm or by appointment.
TA's office hours:	Will be announced by the TA at the beginning of the semester
Contact method:	Blackboard discussion board (preferred) or by email. We will make an effort to respond within 48 hrs., Monday to Friday during regular business hours.

2. **Course Objectives**

   Satellite imagery has become a primary data source in geospatial applications. The wide variety of imagery data sources and the vast amounts of imagery are being collected is 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 computer-based processing of satellite imagery techniques for enhancing, processing and extracting spatial information from imagery. Emphasis is put in this course on quantitative computer-based analysis of imagery. In view of this, the objectives of this course are to:

   A. Review basic ideas and theories of image processing and their relation to earth observations.
   B. Introduce analytical techniques and tools that are used in satellite image analysis.
   C. Develop the ability to apply these tools in various application areas.

3. **Learning Outcomes**

   By the end of the course each student will be able to:
   A. Describe some of the key theories and techniques in satellite image analysis.
   B. Effectively communicate concepts and ideas related to image processing and remote sensing to experts, non-experts, and other professionals in a work environment.
   C. Have the ability to appropriately apply the tools and concepts covered in the course for various hypothetical and real-world data processing tasks.
   D. 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.

4. **Delivery Method**
   - The course will be taught as a combination of presentations, topic/problem oriented discussion, and tutorials based on assigned reading and class discussion.
   - As part of the class activities you may be required to turn on your microphone and/or your camera in order to participate. Please be ready to do so when necessary. If you foresee any issue(s) that

might prevent you from using your microphone and/or camera for class activities please contact us so that we could find a suitable solution for your specific needs.

5. **Textbooks**

The primary textbook used in this course is "Computer Processing of Remotely-Sensed Images" by P. Mather and M. Koch (ISBN 978-0-470-74238-9). A digital version of book is available through the Mason Library at: https://tinyurl.com/yc46t9oj (note: if you log in from a computer outside the campus network you will be required to provide your Mason credentials in order to gain full access).

During the course we will also use materials from several other resources, some of which are available electronically through the Mason library:

1. "*Introduction to Video and Image Processing - Building Real Systems and Applications*" by Thomas B. Moeslund, Springer-Verlag, 2012 (ISBN 978-1-4471-2502-0).
2. "*Practical Image and Video Processing Using MATLAB*" by Oge Marques, Wiley-IEEE Press, 2011 (ISBN 978-1-1180-9348-1).
3. "Digital Image Processing, 3rd Edition" by R. C. Gonzalez and R. E. Wood, Prentice-Hall 2009 (ISBN 978-0-13-168728-8).

Additional readings (selected readings from books, research journals, technical reports, and other sources) will be provided via the course website as necessary.

6. **Course outline (tentative)**

In this course we will cover the following topics (please note that the topics and their order are subjected to change at the discretion of the instructor, any changes will be announced in class):

Date	Topic	Exam	Assignment	
			Release	Due
1/27/2021	Introduction and overview			
2/3/2021	Remote sensing principles at a glance			
2/10/2021	Platforms and sensors, sensor geometry (1)		1	
2/17/2021	Sensor geometry (2), Digital image formation	Quiz 1		1
2/24/2021	Color representation		2	
3/3/2021	Image georeferencing			2
3/10/2021	Image interpolation methods	Midterm		
3/17/2021	Image enhancement (1)		3	
3/24/2021	Image enhancement (2)			3
3/31/2021	Image filtering – low pass filters		4	
4/7/2021	Image filtering – high pass filters	Quiz 2		4
4/14/2021	Image transforms		5	
4/21/2021	Introduction to object detection			5
4/28/2021	Introduction to photogrammetric methods			

7. **Course Expectations**
   - This is a 400 level course in the College of Science that involves some use of mathematical and statistical concepts, as well as some principles of computer-based data processing.
   - The course involves the use of computer software. During the course, you will be required to use and demonstrate your understanding of the course materials through hands-on processing (e.g., performing computations by hand or writing computer scripts) of data.
   - Your work should show attention to detail, with the expectation that the experience provide the basis for potential employers to consider your skills.
   - I expect preparation and participation at every class. Your active participation in the class is essential to the success of this course.
   - On average, you should expect 4-8 hours of work per week in this course beyond class hours.

8. **Grades**

At the end of the term all the marks will be totaled as a <u>weighted average</u> according to the following weights:

Assignments	45%
Course Participation*	15%
Midterm exam	20%
Final exam	20%
Total:	**100%**

* The participation component will include 2 components: evidence of active participation in class activities (7%), and quizzes/surveys (8%).

The date of the final exam will be determined by the Office of the University Registrar. Note that, in general, the weight of individual assignments may vary; the weight of each assignment will be indicated on the assignment instructions form. Final grades at the end of the course will be assigned using a combination of absolute achievements and relative standing in the class based on the following score ranges:

Weighted average range[1]	Letter grade
≥ 98.0	A+
97.9 – 93.0	A
92.9 – 90.0	A-
89.9 – 87.0	B+
86.9 – 83.0	B
82.9 – 80.0	B-
79.9 – 77.0	C+
76.9 – 73.0	C
72.9 – 70.0	C-
69.9 – 60.0	D
≤ 59.9	F

> **Incomplete grades policy:** following the university policies, an "Incomplete" grade (IN) <u>may</u> be assigned to a student who is passing a course but who may be unable to complete scheduled course work due to a cause <u>beyond</u> reasonable control. Any requests for an incomplete grade must be submitted in writing during the last week of classes, and should clearly indicate the reason for the request. If an IN grade is granted, it is <u>your responsibility</u> to contact the instructor at the end of the semester to make proper arrangements for completing any missing work. For further details on the IN grade please visit: http://registrar.gmu.edu/records/ incomplete.html

9. **Exams**

The course includes mandatory written exams. The material covered in the exams will be announced in class. A student who cannot write a course examination due to a cause beyond reasonable control can request (in writing) extension of time to complete an assignment. If the request is approved, it is <u>your responsibility</u> to contact the instructor to reschedule the exam. The date of the final examination is set by the Mason Registrar, please check http://registrar.gmu.edu/calendars for details.

10. **Assignments:**

The course includes several mandatory written assignments on selected topics from the material covered in class and in the assigned reading. Assignments may include tasks such as algorithm development and implementation, analysis of data processing results, and discussion/analysis of theoretical concepts and test cases. All assignments are mandatory. Typically, one to two weeks will be allocated for every assignment (please see Section 11 for details on late submission policies). Submission of assignments should be done only **through the Blackboard course website**.

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[1] Final grades will be rounded to the nearest digit.

Please note: Unless noted otherwise, we will grade only assignments that are submitted through the "Assignments" section of the Blackboard system. Please **DO NOT** email assignments directly to the instructor's or the TA's Mason email (@gmu.edu) unless specifically instructed to do so.

11. **Late assignment submission:**
Assignments submitted between 1 to 3 calendar days past the due date would result in a late penalty of **5 points per calendar day**. As a general rule, work submitted after **more than 3 calendar days will not be accepted** and incomplete lab work may not be completed after the due date. Exceptions to this policy may be made on a case-by-case basis at the discretion of the Instructor. Requests for deferrals must be made in writing **at least 24 hrs** before the assignment due date/time.

Please note: Deferral of course work is a privilege and not a right, and there is no guarantee that a deferral will be granted.

12. **Use of computers and electronic devices:**
During the course we will make use of a classroom space equipped with computers. You are expected to use the computers **only for activities directly related to class activities** (e.g., viewing class notes or performing in-class hands-on work). During class hours you are expected not to use the computers for any purpose that is not directly related to class activities. Similarly, you are expected not to **not to use your mobile device** during class time.

13. **COVID-19**
    * All students taking courses with a face-to-face component are required to have completed Safe Return to Campus Training prior to visiting campus. Training is available in Blackboard (https://mymason.gmu.edu). Students are required to follow the university's public health and safety precautions and procedures outlined on the university Safe Return to Campus webpage (www2.gmu.edu/safe-return-plan). Similarly, all students in face to face and hybrid courses must also complete the Mason COVID Health Check daily, seven days a week. The COVID Health Check system uses a color code system and students will receive either a Green, Yellow, or Red email response. Only students who receive a "green" notification are permitted to attend courses with a face-to-face component. If you suspect that you are sick or have been directed to self-isolate, please quarantine or get testing. Faculty are allowed to ask you to show them that you have received a Green email and are thereby permitted to be in class.
    * Please continue to monitor and follow any university announcements and policy changes regarding the safe return to campus during the semester.
    * Students who become ill with COVID-19 (or are quarantined) and as a result are unable to complete required coursework should contact the instructor to discuss a possible remedial plan for any missed work.

14. **Electronic Communication:**
    * All course related email correspondence, including submission of assignments, should be made through the course Blackboard website.
    * On sensitive or personal matters you may email the course teaching team directly. When doing so please include "GGS416Sp21" at the beginning of the email subject line.
    * Students are responsible for activating their MasonLive email account and for checking it regularly. Students must use their MasonLive email account to receive important University information, including communications related to this class. I will not respond to messages sent from or send messages to a non-Mason email address.

15. **Academic integrity:**
George Mason University is committed to the **highest standards** of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the GMU honor code (online at http://oai.gmu.edu). The principle of academic integrity is taken very seriously, and violations are treated gravely. Simply put, in this course academic integrity means

essentially this: when you are responsible for a task, you will perform that task and submit work that reflects your individual effort. If you are uncertain about the academic integrity ground rules on a particular assignment, exam, or task, please ask for clarification.

Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind) please ask for guidance and clarification.

16. **Course website:**
The course has a Blackboard website. This website will provide you a single portal through which you may obtain lecture notes, retrieve assignment data and, review links to additional materials, and receive special announcements. You are required to visit the course website **regularly**. Please contact ITU to resolve any issues accessing this website.

17. **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 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 Services (see Section 21 for details).
    - 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](). Please review the following [short video]() regarding sharing course materials online.

18. **Technology requirements**
In order to be able to fully participate in this course you are required to have regular, reliable access to the following hardware and software components:

Hardware:
- An Intel-based computer (desktop/laptop) with an up-to-date operating system (Windows 10 (recommended), 8, or 7; Mac OSX 10.13 or higher), **at least 8 GB of RAM** (more than 8GB is recommended) and a recent dual core or better processor. In addition to a computer, a tablet or a mobile device may be used for audio/video communication only (e.g., when using Zoom)
- 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
- A **stable** broadband Internet connection (cable modem, DSL, satellite broadband, etc.), with a consistent 1.5 Mbps download speed or higher.
- A microphone (either built-in or as a separate device). A computer headset or "ear buds" with a built-in microphone is highly recommended. If you are using a built-in or a separate microphone a headset is recommended to prevent sound issues.
- A web camera.
- A basic scientific calculator is generally required for class activities (including exams/quizzes).

Software:
- A supported up-to-date web browser (check [which browsers are supported by Blackboard]()). You can check if your particular browser setup (including any plugins) is supported by Blackboard [HERE]().
- Blackboard (available upon logging into [http://mymason.gmu.edu]())
- Zoom (available at [https://gmu.zoom.us/]())
- Adobe Acrobat Reader ([free download]())
- Citrix Workspace App (see [https://its.gmu.edu/service/citrix-virtual-lab/]() for instructions)

- Cisco AnyConnect VPN (see https://its.gmu.edu/knowledge-base/how-do-i-install-the-vpn/ for instructions)
- A document editing software, such as Microsoft Word (part of Office 365 ProPlus) or OpenOffice

19. **Use of technology in class:**
    - During instructor-led class activities you are expected to use your computer and other electronic device(s) only for activities **directly** related to class activities (e.g., viewing class notes or participating in a class activity).
    - The use of mobile devices will not be permitted during class (unless it is a part of an approved ODS accommodation plan). Such usage often distracts you from your class experience, disrupts other students as well as your teaching team, and shows a lack of professionalism. Improper use of electronic devices in class may affect your attendance and participation grade.

20. **Responsible Use of Computing:** Students must follow the university policy for Responsible Use of Computing. [See https://universitypolicy.gmu.edu/policies/responsible-use-of-computing/].

21. **Students with special needs:**
    Disability Services at George Mason University is committed to providing equitable access to learning opportunities for all students by upholding the laws that ensure equal treatment of people with disabilities. If you are seeking accommodations for this class, please first visit http://ds.gmu.edu/ for detailed information about the Disability Services registration process. Then please discuss your approved accommodations with me. Disability Services is located in Student Union Building I (SUB I), Suite 2500. Email: ods@gmu.edu | Phone: (703) 993-2474. All academic accommodations must be arranged through the Office of Disability Services (ODS). Please do not hesitate to contact the course team regarding your special needs if you encounter any issues.

22. **Diversity and inclusion**
    The course team is committed to upholding Mason's Non-Discrimination Policy and Diversity core values. W*e welcome and value individuals and their differences including race, economic status, gender expression and identity, sex, sexual orientation, ethnicity, national origin, first language, religion, age, and disability.*

23. **Title IX**
    George Mason University is committed to providing a learning, living and working environment that is free from discrimination and a campus that is free of sexual misconduct and other acts of interpersonal violence in order to promote community well-being and student success. We encourage students who believe that they have been sexually harassed, assaulted or subjected to sexual misconduct to seek assistance and support. University Policy 1202: Sexual Harassment and Misconduct speaks to the specifics of Mason's process, the resources, and the options available to students.

    As a faculty member and designated "Responsible Employee," I am required to report all disclosures of sexual assault, interpersonal violence, and stalking to Mason's Title IX Coordinator per university policy 1412. If you wish to speak with someone confidentially, please contact the Student Support and Advocacy Center (703-380-1434) or Counseling and Psychological Services (703-993-2380). You may also seek assistance from Mason's Title IX Coordinator (703-993-8730; titleix@gmu.edu).

24. **Other Student Resources:**
    - University Libraries provides resources for distance students. For additional information please see http://library.gmu.edu and http://library.gmu.edu/distance.
    - The George Mason University Writing Center staff provides a variety of resources and services (e.g., tutoring, workshops, writing guides, handbooks) intended to support students as they work to construct and share knowledge through writing. [See http://writingcenter.gmu.edu]. You can now sign up for an Online Writing Lab (OWL) session as well as face-to-face session in the Writing Center (see the Tutoring section in the link above).
    - **Disability services:** Disability Services at George Mason University is committed to upholding the letter and spirit of the laws that ensure equal treatment of people with disabilities. Under the administration

of University Life, Disability Services implements and coordinates reasonable accommodations and disability-related services that afford equal access to university programs and activities. Students can begin the registration process with Disability Services at any time during their enrollment at George Mason University. If you are seeking accommodations, please visit http://ds.gmu.edu/ for detailed information about the Disability Services registration process. Disability Services is located in Student Union Building I (SUB I), Suite 2500. Email:ods@gmu.edu | Phone: (703) 993-2474.

- **Counseling and Psychological Services:** The George Mason University Counseling and Psychological Services (CAPS) staff consists of professional counseling and clinical psychologists, social workers, and counselors who offer a wide range of services (e.g., individual and group counseling, workshops and outreach programs) to enhance students' personal experience and academic performance [See http://caps.gmu.edu].

- George Mason University is committed to providing a learning, living and working environment that is free from discrimination and a campus that is free of sexual misconduct and other acts of interpersonal violence in order to promote community well-being and student success. We encourage students who believe that they have been sexually harassed, assaulted or subjected to sexual misconduct to seek assistance and support. If you wish to speak with someone confidentially, please contact the Student Support and Advocacy Center (703-380-1434) or Counseling and Psychological Services (703-993-2380). You may also seek assistance from Mason's Title IX Coordinator (703-993-8730; titleix@gmu.edu).

- **Family Educational Rights and Privacy Act (FERPA):** The Family Educational Rights and Privacy Act of 1974 (FERPA), also known as the "Buckley Amendment," is a federal law that gives protection to student educational records and provides students with certain rights. [See http://registrar.gmu.edu/privacy].

Disclaimer: Any typographical errors in this Course Outline are subject to change and will be announced in class. The date of the final examination is set by the Registrar and takes precedence over the final examination date reported by the instructor.

Note: Photography and/or recording of any kind (audio, video), reuse of course materials, and further dissemination of the course contents is not permitted unless prior written consent of the professor and George Mason University has been given, or if recording is part of a course activity or an approved accommodation plan.

Appendix
General guidelines for assignment preparation and submission
(For additional instructions please refer to the course website)

Grades of assignments will be based on:

a) **Academic merit** of your work.

b) **Conciseness** and **completeness** of your answers. Please write to the point and explicitly address the question or task. Avoid using unnecessary graphics (figures, tables, graphs etc.) unless they serve a specific purpose. Make sure to use captions and to refer to the graphics you include in your written answer. Graphics without any reference or accompanying explanation will be disregarded.

c) **Presentation**. Remember that your assignment report is a reflection of your thinking and learning process. Please organize your report in a logical fashion so that your answers could be easily identified. A general format for your presentation should, as a minimum, include the following components: (1) a **cover page** clearly indicating your name, the course number (GGS 416) the lab number, and the submission date (2) **Question number**, (3) Your **written answer** and/or description and discussion of your results, and (4) Visualization of your results, e.g. images, graphs, tables, as necessary.

d) **Organization**. Your lab should be submitted as a single PDF file containing your lab report. If you are required to submit multiple files (e.g. code files) all files (including the report) should be submitted in a **single ZIP file**.

Additional hints:

1. Please remember that your assignment is a **professional document**, and should therefore be formatted and constructed accordingly. All assignments are to be typed (including equations and tables). Digital copies of hand-written assignments **will not be accepted**.

2. Submission of a softcopy of your assignment will be made through Blackboard. It is not required to submit a hardcopy of your assignment.

3. When a written assignment report is required, the electronic submission of your assignment report should be made **only in a PDF format**. MS-Word files will **not be accepted**.

4. If more than one file is submitted, you may submit a single **ZIP** file containing all the assignment files. Please note that other compression formats (e.g. rar files) will **not be accepted**.

5. The assignment file you submit should be named as the following:

    GGS416_SP21_<assignment number>_<first name>_<last name>**.**<file extension>

    For example, if the student (Captain) Jack Sparrow is submitting assignment 2 as a PDF file, then the name of the submitted file should be:
    GGS416_SP21_2_jack_sparrow.pdf

6. Please make sure to keep a backup of all the materials you submit.