Department of Geography and Geoinformation Science

4400 University Drive, MS 6C3, Fairfax, Virginia 22030
Phone: 703-993-1210, Fax: 703-993-9299
Email: ggs@gmu.edu   Web: ggs.gmu.edu

GGS 680 - Earth Image Processing
Fall 2016

1. **General Information**

Instructor:	Dr. Arie Croitoru (a.k.a "Dr. C")
Where:	Exploratory Hall 2310
When:	Tuesday 4:30pm to 7:10pm.
Course website:	Blackboard
Credits:	3.0
Prerequisites:	GGS 416 or GGS 579 or permission of instructor.
Instructor's Office Hours:	Mon 4:00pm - 5:00pm, Tue 9:30am - 10:30am, or by appointment (my office is located in Exploratory Hall 2205, the Fairfax Campus).
Contact method:	Blackboard discussion board (preferred) or email. I will make every effort to respond within 24-48 hrs, Monday to Friday during regular business hours.
TA's Office Hours:	TBA

2. **Course Objectives**

   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) to enable the extraction of spatial and spatiotemporal information from imagery. In particular, 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.
   d) Identify and gain insight into some of the emerging trends in DIP as applied to earth image processing.

3. **Learning Outcomes**

   By the end of the course each student will be able to:
   a) Have a broad knowledge-base on fundamentals, theory and techniques of Digital Image Processing and Remote Sensing in the context of earth image processing and Geo-Intelligence and other geospatial applications.
   b) Articulate and effectively communicate concepts and ideas related to Digital Image Processing and Remote Sensing 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.
   c) Have the ability to appropriately apply the tools, algorithms 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.
   e) Perform a critical review of the potential, effectiveness, and reliability of Digital Image Processing and Remote Sensing processing processes and outcomes.

4. Delivery Method

The course will be taught as a combination of lectures, topic/problem oriented discussion, and tutorials based on assigned reading and class discussion.

5. Textbooks

The following book is a required textbook for this course: "Digital Image Processing, 3rd Edition" by R. C. Gonzalez and R. E. Wood, Prentice-Hall 2009 (ISBN 978-0-13-168728-8). **This book is also available as an eBook** (please refer to the Mason Bookstore, the publisher's website, or online textbook retailers for further details).

In addition, during the course we will use materials from several resources, 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. "*Remote Sensing Digital Image Analysis – An Introduction*" by John Richards, Springer-Verlag, 2015 (ISBN 978-3-642-30062-2).

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

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	Test	Assignment	
			Released	**Due By**
8/30	Introduction and overview			
9/6	The Human Visual System / Intro to Matlab (1)			
9/13	The Human Visual System / Intro to Matlab (2)		Lab 1	
9/20	Image formation, resolution, and pixel relations			Lab 1
9/27	Image enhancement - Point processing			
10/4	Image enhancement - Histogram processing	**Test 1**	Lab 2	
10/11	*** Columbus Day Recess (No Tuesday classes) ***			
10/18	Image filtering – spatial domain (1)			Lab 2
10/25	Image filtering – spatial domain (2)		Lab 3	
11/1	Image filtering – spectral domain (1)			Lab 3
11/8	Image filtering – spectral domain (2)	**Test 2**	Lab 4	
11/15	Image morphology			Lab 4
11/22	Introduction to image segmentation methods		Lab 5	
11/29	Introduction to feature extraction methods			Lab 5
12/6	Conclusion and outlook	**Test 3**		

In addition to the course schedule outlined here, please refer to Mason's academic calendar (Fall 2016) for information on important dates and follow Mason's announcements on any calendar changes during the semester. In case of any discrepancy between the course schedule and Mason's academic calendar, Mason's calendar takes precedence over the course schedule.

7. Course Expectations

- This is a graduate 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 code) 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. Attendance and participation is critical for your success, and you are expected to be at all classes and to make productive use of class time.
- 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.

8. **Grades**

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

Lab assignments	45%
Tests (3 x 15)	45%
Course Participation	10%
Total:	**100%**

Please note that, in general, assignments and tests will not have the same weight. The weight of each individual assignment or test will be indicated on the assignment form. Final grades at the end of the course will be assigned using **a combination of absolute achievements and relative standing in the class**.

> **Incomplete grades policy:** following the university policies, an "Incomplete" grade (IN) may be assigned to a student who is passing a course but who may be unable to complete scheduled course work due to a cause beyond 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 your responsibility 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. **Tests**

The course includes mandatory written tests. The material covered in the tests will be announced in class or in the course website prior to the test. A student who cannot write a course examination because of an incapacitating illness, severe domestic affliction or other compelling reasons can apply for extension of time to complete an assignment. Generally, exceptions to the test dates will not be made.

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 or 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**. Please DO NOT email assignments directly to the instructor's @gmu.edu or through their Blackboard email.

> **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 lab submission:**

Labs 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, labs 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.

Please note: Deferral of course work is a privilege and not a right; there is no guarantee that a deferral will be granted. Please make sure you notify the instructor or the teaching assistant in writing as soon as you know you would like to request a deferral.

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

13. **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).

14. **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.

15. **Electronic Communication:**
    - All course related correspondence should be made through the discussion board on course Blackboard website. Please refrain from emailing the instructor or the TA through their @gmu.edu address regarding general questions, as it is very likely that other students would benefit from your questions. If you wish to email the course teaching team directly please include "GGS680Fa16" at the beginning of the email subject line.
    - Students are responsible for the content of university communications sent to their George Mason University email account and are required to activate their account and check it regularly. All communication from the university, college, school, and program will be sent to students solely through their Mason email account. [See https://masonlivelogin.gmu.edu/login].

16. **Responsible Use of Computing:** Students must follow the university policy for Responsible Use of Computing. [See http://universitypolicy.gmu.edu/1301gen.html].

17. **Other Student Resources:**
    - University Libraries provides resources for distance students. [See http://library.gmu.edu].
    - 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).
    - **Students with special needs:** If you are a student with a disability and you need academic accommodations, please contact the Office of Disability Services (ODS) at 993-2474 for guidance on preparing an accommodation plan to suit your needs. All academic accommodations must be arranged through the ODS - http://ods.gmu. Please do not hesitate to contact the course team regarding your special needs if you encounter any issues or have any concerns.
    - **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].

- **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. If
this course includes a final exam then the date of the final examination is set by the Registrar and takes
precedence over the final examination date reported by the instructor.

Note: 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 an approved accommodation plan.

General guidelines for assignment preparation and submission
(For detailed 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 680) 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:

   GGS680_Fa16_<assignment number>_<first name>_<last name>**.**<file extension>

   For example, if the student Jack Sparrow is submitting assignment 2 as a PDF file, then the name of the submitted file should be:
   GGS680_Fa16_2_jack_sparrow.pdf

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