Syllabus for Image Analysis and Recognition with Learning
Fall 2023 Math569,
Cross listed with MATH 569.4RE and MATH 569.7RE
Meets 8/28/2023 through 12/15/2023, Day and Time: TR 6PM-8:40, Bin 329

Instructor: Dr. Nikolay Metodiev Sirakov   **Office:** Bin 322
Office Hours: M 2:15PM- 4:45PM   **E-mail:** Nikolay.Sirakov@tamuc.edu
                   W 2:15PM- 4:45PM   **Office Phone:** 903 886 5943
                    Friday research meetings   **Office Fax:**   903 886 5945
                   Others by appointment

You may find supporting lectures through visiting:
http://faculty.tamuc.edu/nsirakov/Teaching/Image%20Processing%20With%20Applications.aspx
Additional materials on Machine Learning will be given during the course of study.

Text: Digital Image Processing, 3rd Edition, by Rafael C. Gonzalez, Richard E. Woods, Prentice Hull, 2008, 0-13-168728-x, 978-0-13-168728-8
Helpful Text: Linear Algebra and Optimization for Machine Learning, ISBN 978-3-030-40343-0 ISBN 978-3-030-40344-7 (eBook), ©Springer Nature Switzerland AG 2020 .
A book which provides IA algorithms and Matlab code: Digital Image Processing Using Matlab, by Rafael C. Gonzalez, Richard E. Woods, S. L. Eddins, Prentice Hull, 2004,ISBN 0-13-008519-7

Students Learning Outcomes:
(1) Students will gain knowledge and skills and will be able to transform one color model to another;
(2) Students will learn and will be able to utilize the basic multi-resolution methods: Scaling Functions, Wavelet transforms;
(3) Students will learn and will be able to utilize object recognition methods based on distance metrics and matching.
(4) The students will learn the theoretical basis and fundamentals of **Neural Networks** (NN) and **Machine Learning (ML)** architectures, activation functions;
(5) Will know the fundamentals of the **Gradient Descent method** for **NN** optimization;
(6) Students will learn, understand and will be able to apply set of image segmentation methods including;
(7) Upon time permission the students will learn and will be able to utilize the basic Mathematical Morphology operations for image analysis;
(8) Students will conduct independent project development, which will help them develop skills for: survey, theoretical work, coding, performing experiments, writing and presenting reports.

Requirements: *instructor's permission*
 Knowledge which may be of help: Integral and Differential Calculus of two variables;
For the project development the students may use any language including: Python, C++, Java, C sharp, or Computer algebra programming systems as MatLab or Mathematica.

List of Topics
1. Defining the area of Image Analysis and Recognition;
2. Color Image Processing. Color Models. Transformation between models. Automatic coloring of gray level images and movies ;
3. Multi resolution images and processing. Multi resolution Expansion. Scaling and Wavelet functions. Discrete and continuous wavelet transformations.
4. Introduction to the theoretical foundations of Neural Networks, basic concepts and notions;
5. Machine Learning, basic concepts, functions and algorithms;
6. *From the Helpful Text* – section 1.5 Optimization for **Machine Learning (ML)**; 1.5.1-1.5.2 The Taylor Expansion for Function Simplification.

7. Gradient descent method;

8. Pattern Recognition: fundamentals; based on correlation; decision functions; rotational and scaling invariant methods. *From the Helpful Text* section: *1.4.3.*Classification and regression modeling.

9. Image segmentation fundamentals: Points, Lines, Edge detection, Threscholding and Region-based method, Active Contour Models.

10. Upon time permission, the instructor will teach basics of Mathematical Morphology and its applications to image processing and analysis: erosion, dilation, opening, closing, hit and miss;

Course Content & Calendar: *The 1ˢᵗ lecture will take place on August 30.*
1ˢᵗ & 2ⁿᵈ weeks – **topics** 1. and 2.; *3ʳᵈ to 5ᵗʰ weeks* – **topic** 3 and independent study projects assignment; *6ᵗʰ & 7ᵗʰ weeks* – **topic** 4.; *8ᵗʰ to 10ᵗʰ week* – **topic** 5. Guidelines on the projects development and writing reports; *11ᵗʰ & 12ᵗʰ* weeks – **topics** 6. 7; *13ᵗʰ to 15ᵗʰ week* – **topic** 7, 8, 9. Guidelines on how to prepare and deliver a presentation.

COURSE EVALUATION

Mid Term Exam	- 26%
HW	- 20%
Lab work	- 10 %
Project	- 24%
Final Exam (Project Presentation, and corrections)	- 20%

Grading Policy: *A:* 100%- 90%

B: 89% - 80%

C: 79% - 70%

D: 69% - 60%;   *F:* Less than 59 %

The professor reserves the rights to reward students for continuous hard work.

Additional Activities: Experiments; Home Practice Problems; Extra Credit Problems (ECP)

Instructional Method: Teaching lectures with proofs and example applications, testing the students with HW, quizzes, Exams, ECP, Final Project.

If the technical capabilities of the room permit, the lectures will be recorded and posted on the Web.

Final Presentation/Test: Math569 **Date: Thursday**, Dec. 14th **Time:** 6PM-8:30PM	

COURSE POLICIES

As directed from the Provost Office - "A&M-Commerce requires the use of face-coverings in all instructional and research classrooms/laboratories. Exceptions may be made by faculty where warranted. Faculty have management over their classrooms. Students not using face-coverings can be required to leave class. Repetitive refusal to comply can be reported to the Office of Students' Rights and Responsibilities as a violation of the student Code of Conduct. "
"Students should not attend class when ill or after exposure to anyone with a communicable illness. Communicate such instances directly with your instructor. Faculty will work to support the student getting access to missed content or completing missed assignments."

HW: *problems, which involve theoretical and practical skills above the average level.*

Lab work: conduct experiments, during non-class time, with given Image Analysis tools and images

Mid term comprehensive exam: *Is to be given around mid semester. It will take 2/3 of a class period.*

Makeup: *Except in the case of a formal institutional excuse, no individual makeup test will be permitted.*

Project Report (most likely group): *self-contained innovative problem, whose development includes: survey of the present state of the art; theoretical model; its implementation; algorithm design and coding; performing experiment and deriving conclusions.*

The road that will lead you to find a good job is the road of coding, learning, and developing yourself through accumulating a new knowledge.

Commerce, Texas
August 24, 2023   Dr. Nikolay Metodiev Sirakov