

CpE 645 Image Processing and Computer Vision

*Department of Electrical and Computer Engineering*

Summer 2021

Instructor: Hong Man

Course Website: stevens.edu/canvas

Meeting Times: TBD at Canvas Zoom

Classroom Location: Canvas

Contact Info: hman@stevens.edu

Office Hours: Canvas Discussions

Prerequisite(s): Introduction to Digital Signal Processing, or equivalent

Corequisite(s): none

Cross-listed with: none

COURSE DESCRIPTION

The goal is to acquaint the students with the fundamental techniques of image processing. Specific topics include: Digital imaging fundamentals; neighborhood operators; clustering, region growing; split and merge, segmentation; edge and line linking; degradation model, restoration, inverse filtering; zero-crossing methods, gradient edge detectors; gray level cooccurrence, texture analysis; morphological operations; image registration and enhancement; scale space filtering; motion estimation; 3D image recognition and estimation.

STUDENT LEARNING OUTCOMES

This course will provide a comprehensive introduction to pattern recognition methods and related data analysis applications. Upon successful completion, students will be able to

* (Scientific foundations) understand spatial and frequency domain signal and system representations, data transforms, perceptual models, noise models, and information theory.
* (Engineering foundations) image smoothing, sharpening, edge detection, Weiner filters, reconstruction from projections, morphological filtering and entropy coding techniques
* (Technical design) image enhancement, restoration, computed tomography, image analysis, and image compression algorithms
* (Tools) implement image processing designs using computer language (e.g. C/C++) or software package (e.g. Matlab).

COURSE FORMAT AND STRUCTURE

* This is an online lecture based course. New lecture videos will be posted once per week.

TENTATIVE COURSE SCHEDULE

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| --- | --- | --- | --- |
| Class Date | Topic(s) | Readings | Assignment |
| May 25 | Introduction | IP-intro |  |
| June 1 | 1D and 2D Signals and Systems | CPE645-1 | HW 1 assigned |
| June 8 | 1D and 2D Linear Transforms | CPE645-2 |  |
| June 15 | Image Perception and Color Representations | CPE645-3 | HW 2 assigned |
| June 22 | Image Enhancement 1 – Point Processing | CPE645-4 |  |
| June 29 | Image Enhancement 2 – Filtering | CPE645-5 | HW 3 assigned |
| July 6 | Image Restoration | CPE645-6 |  |
| July 13 | Midterm Exam |  |  |
| July 20 | Image Reconstruction from Projection | CPE645-7 |  |
| July 27 | Image Analysis | CPE645-8 | HW 4 assigned |
| Aug 3 | Image Feature Representation | CPE645-9 |  |
| Aug 10 | Mathematical Morphology  (optional) | CPE645-10 | HW 5 assigned |
| Aug 17 | Image and Video Compressions 1 | CPE645-11  CPE645-12 |  |
| Aug 24 | Image and Video Compressions 2 | CPE645-11  CPE645-12 |  |

COURSE MATERIALS

Textbook(s):

Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Third Edition, Prentice Hall, 2007, ISBN: 013168728X

Other Readings:

Online materials

Materials:

Comprehensive lecture notes will be provided on Canvas

COURSE REQUIREMENTS

**Attendance** Attendance is required and will be recorded. Excused absences (religious or medical, noted in via email to the professor prior to the absence occurring) accompanied by proper documentation can be granted.

**Homework** Homework will be assigned periodically. All problem sets are expected to be completed according to the instructions, and they are usually due in one week after the assignment. Discussion of homework problems among students is permitted, but each student must finish his/her homework independently. Homework submissions are expected to be in a neat and complete form, showing all major steps towards the solutions.

**Project** The intention of the term project is to give students an opportunity to investigate a specific topic in the areas of image processing and computer vision. It can be either a research project or survey project. A research project will attempt to solve a practical image processing problem, and produce a publishable research report on the proposed method and the outcome. A survey project will provide a comprehensive literature review on a well selected topic that may have significant impact to future image processing development. It is recommended to take the project in teams. Each team will present its project report in the last lecture of the course.

**Exams** There will be a midterm exam and a final exam. These will be open-book-open-notes exams. No communication is allowed among students in this class during the exams.

GRADING PROCEDURES

Grades will be based on:

Homework (10 %)

Exam (midterm) (30 %)

Exam (final) (30 %)

Team Project (30 %)

Late Policy:

To encourage you to stay on schedule, due dates have been specified for each assignment; 20% of the total points will be deducted for assignments received 1-6 days late; assignments received more than 1 week late will receive 0 points. Extensions and exceptions can be granted for appropriate reasons.

ACADEMIC INTEGRITY

Students in graduate courses (600 level) are bound by the Graduate Student Code of Academic Integrity.

**Graduate Student Code of Academic Integrity**

*All Stevens graduate students promise to be fully truthful and avoid dishonesty, fraud, misrepresentation, and deceit of any type in relation to their academic work. A student’s submission of work for academic credit indicates that the work is the student's own. All outside assistance must be acknowledged. Any student who violates this code or who knowingly assists another student in violating this code shall be subject to discipline.*

All graduate students are bound to the Graduate Student Code of Academic Integrity by enrollment in graduate coursework at Stevens. It is the responsibility of each graduate student to understand and adhere to the Graduate Student Code of Academic Integrity. More information including types of violations, the process for handling perceived violations, and types of sanctions can be found at [www.stevens.edu/provost/graduate-academics](http://www.stevens.edu/provost/graduate-academics).

EXAM ROOM CONDITIONS

The following procedures apply to the exam for this course. As the instructor, I reserve the right to modify any conditions set forth below by printing revised Exam Room Conditions on the exam.

1. Students may use the following devices during exams. Any electronic devices that are not mentioned in the list below are not permitted.

|  |  |  |
| --- | --- | --- |
| **Device** | **Permitted?** | |
| Yes | No |
| Laptops | X |  |
| Cell Phones |  | X |
| Tablets | X |  |
| Smart Watches |  | X |
| Google Glass |  | X |
| Other (specify) |  | X |

1. Students may use the following materials during exams. Any materials that are not mentioned in the list below are not permitted.

|  |  |  |
| --- | --- | --- |
| **Material** | **Permitted?** | |
| Yes | No |
| Handwritten Notes  *Conditions*: no restriction | X |  |
| Typed Notes  *Conditions*: no restriction | X |  |
| Textbooks  *Conditions*: no restriction | X |  |
| Readings  *Conditions*: lecture notes and homework solutions | X |  |
| Other (specify) |  | X |

1. Students are not allowed to work with or talk to other students during exams.

LEARNING ACCOMODATIONS

Stevens Institute of Technology is dedicated to providing appropriate accommodations to students with documented disabilities. The Office of Disability Services (ODS) works with undergraduate and graduate students with learning disabilities, attention deficit-hyperactivity disorders, physical disabilities, sensory impairments, psychiatric disorders, and other such disabilities in order to help students achieve their academic and personal potential. They facilitate equal access to the educational programs and opportunities offered at Stevens and coordinate reasonable accommodations for eligible students. These services are designed to encourage independence and self-advocacy with support from the ODS staff. The ODS staff will facilitate the provision of accommodations on a case-by-case basis.

*Disability Services Confidentiality Policy*

Student Disability Files are kept separate from academic files and are stored in a secure location within the Office of Disability Services. The Family Educational Rights Privacy Act (FERPA, 20 U.S.C. 1232g; 34CFR, Part 99) regulates disclosure of disability documentation and records maintained by Stevens Disability Services. According to this act, prior written consent by the student is required before our Disability Services office may release disability documentation or records to anyone. An exception is made in unusual circumstances, such as the case of health and safety emergencies.

For more information about Disability Services and the process to receive accommodations, visit https://www.stevens.edu/office-disability-services. If you have any questions please contact: Phillip Gehman, the Director of Disability Services Coordinator at Stevens Institute of Technology at pgehman@stevens.edu or by phone (201) 216-3748.

INCLUSIVITY

*Name and Pronoun Usage*

As this course includes group work and in-class discussion, it is vitally important for us to create an educational environment of inclusion and mutual respect. This includes the ability for all students to have their chosen gender pronoun(s) and chosen name affirmed. If the class roster does not align with your name and/or pronouns, please inform the instructor of the necessary changes.

*Inclusion Statement*

Stevens Institute of Technology believes that diversity and inclusiveness are essential to excellence in academic discourse and innovation. In this class, the perspective of people of all races, ethnicities, gender expressions and gender identities, religions, sexual orientations, disabilities, socioeconomic backgrounds, and nationalities will be respected and viewed as a resource and benefit throughout the semester. Suggestions to further diversify class materials and assignments are encouraged. If any course meetings conflict with your religious events, please do not hesitate to reach out to your instructor to make alternative arrangements.

You are expected to treat your instructor and all other participants in the course with courtesy and respect. Disrespectful conduct and harassing statements will not be tolerated and may result in disciplinary actions.

MENTAL HEALTH RESOURCES

 Part of being successful in the classroom involves a focus on your whole self, including your mental health. While you are at Stevens, there are many resources to promote and support mental health. The Office of Counseling and Psychological Services (CAPS) offers free and confidential services to all enrolled students who are struggling to cope with personal issues (e.g., difficulty adjusting to college or trouble managing stress) or psychological difficulties (e.g., anxiety and depression). Appointments are strongly encouraged and can be made by phone (201-216-5177) or in-person (on the 7th floor of the Howe Center). CAPS is open from 9:00 am – 5:00 pm Mondays, Wednesdays, Thursdays and Fridays and from 9:00 am – 7:00 pm on Tuesdays during the Fall and Spring semesters.

EMERGENCY INFORMATION

In the event of an urgent or emergent concern about the safety of yourself or someone else in the Stevens community, please immediately call the Stevens Campus Police at 201-216-5105 or on their emergency line at 201-216-3911.  These phone lines are staffed 24/7, year round.  Other 24/7 resources for students dealing with mental health crises include the National Suicide Prevention Lifeline (1-800-273-8255) and the Crisis Text Line (text “Home” to 741-741). If you are concerned about the wellbeing of another Stevens student, and the matter is *not* urgent or time sensitive, please email the CARE Team at [care@stevens.edu](mailto:care@stevens.edu). A member of the CARE Team will respond to your concern as soon as possible.