

# CS370: Computer Imaging

Fall 2022

**Prerequisites:** CS280

**Credits:** 3

**General Information:**

- Class schedule: Wednesdays and Fridays 2:00 to 3:40pm
- Classroom: Edison
- Instructor: Dr. Bhargav Bhatkalkar

**Contact:**

- Email: [bhargav.bhatkalkar@digipen.edu](mailto:bhargav.bhatkalkar@digipen.edu) (Specify [CS370] in email subject field)
- Class web page: <https://distance.sg.digipen.edu> is the online repository for CS370
- Office hours: 4 pm to 5 pm on Tuesdays, Wednesdays, and Fridays.

**Description:**

Computer Imaging is a rapidly emerging field of interest for the practitioners of Computer Graphics in general and Game Development in particular. Sound theoretical background in Image Processing techniques is often essential to understand the various post-processing algorithms that form an indispensable part of the modern graphics workflow. This course introduces the basic concepts and implementation techniques in Image Processing and Image Analysis primarily focusing on the Gray-scale images. The techniques learned in this module can be easily extended to color images with minor changes to the algorithms. The course is structured into two broad sections, Image Processing and Image Analysis. The first section introduces the classical fundamental image processing tools and techniques. The second half of the course introduces the basic and advanced techniques for the image analysis using both spatial and frequency domain processing techniques.

**Course Objectives and Learning Outcomes:**

At the successful culmination of the course, the students should have a working knowledge of common image processing methods for the gray-scale images and should be able to implement them. In particular, they should be able to:

- Load and store images in a persistent data storage, e.g. disk, using C/C++
- Manipulate image data as buffers in memory
- Perform mathematical operations with images
- Design and implement common filters used for image blur and enhancement
- Understand Spatial and Frequency domain representations of images
- Perform user-guided image enhancement of commonly found images
- Understand and implement pre-processing/post-processing effects for computer games and simulations, using existing code, or as a stand-alone process
- Identify image transformations needed to achieve a particular effect

**Recommended Textbook:**

“Digital Image Processing” by Gonzalez and Woods, 4<sup>th</sup> edition, Pearson, ISBN: 978-0-13-335672-4

- chapter-1
- chapter-2
- chapter-3
- chapter-4
- chapter-5

## Grading Policy

- Quizzes: 20%
- Assignments: 35%
- Midterm: 20%
- Final exam: 25%
- Final letter grade: A: 93 – 100%; A–: 90 – 92.99%; B+: 87 – 89.99%; B: 83 – 86.99%; B–: 80 – 82.99%; C+: 77 – 79.99%; C: 73 – 76.99%; C–: 70 – 72.99%; D: 60 – 69.99%; F: < 60%

**A “C-” grade or above is considered as “Pass”. You must receive an average score of minimum 60% in the midterm and final exams combined to pass this course, regardless of your quiz/assignment scores.**

## Course Outline:

Please note that this is a tentative organization of the course and may be subject to change. Below is a list of topics that will be covered this semester. There will be 4 graded programming assignments and 4 quizzes throughout the semester, a midterm exam, and a final exam.

Week	Topic
1	Fundamentals of Computer Imaging
2	Image Representation and Operations
3	Intensity Transforms, Histogram - 1
4	Histogram – 2, Fundamentals of Spatial Filtering
5	Introduction to Filtering In Frequency Domain
6	<b>MIDTERM EXAM</b> , Sampling of Functions and its Fourier Transform
7	<b>Trimester Break</b>
8	Discrete Fourier Transform and its implementation
9	Procedure of Filtering in Frequency Domain, Image Smoothing/Sharpening in Frequency Domain
10	Selective Filtering in Frequency Domain, Implementation of Fast Fourier Transform
11	Fundamentals of Image Degradation/Restoration ,Noise models, Restoration in the Presence of Noise
12	Periodic Noise Reduction, Position Invariant Degradations, Degradation Function Estimation
13	Fundamentals of Image Compression, Huffman Coding

14	<b>FINAL EXAM</b>
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### Tentative Dates for the Assessments:

Please note that this is a tentative list of Quiz, Assignment and Exam schedule which is subject to changes. The specific assessment dates will be published in the course web page during the ongoing semester based on the syllabus coverage.

Date	Topic
Week 1	Publication of Assignment-1: Specifications (Read/Write Images, Interpolations, etc.)
Week-2	Publication of Quiz-1
Week 4	Submission deadline for Quiz-1 & Assignment-1 Publication of Quiz-2 & Assignment-2: Specifications (Image operations)
Week 6	<b>Midterm Exam</b>
Week 8	Submission deadline for Quiz-2
Week 9	Submission deadline for Assignment-2
Week 10	Publication of Quiz-3 & Assignment-3: Specifications (Fourier Transform)
Week 12	Submission deadline for Quiz-3 & Assignment-3 Publication of Quiz-4 & Assignment-4: Specifications (Noise Removal)
Week 14	Submission deadline for Quiz-4 & Assignment-4 <b>Final exam</b>

### Mechanisms and Procedures:

- **Attendance Policy:** The duration of this semester is 14 weeks. During the first 13 weeks of the semester, the class will meet twice-weekly for a total of 12 sessions(2-lectures/session) excluding the recess week. There will be a midterm exam and a final exam scheduled during 8<sup>th</sup> and 14<sup>th</sup> weeks of the semester. Attendance is mandatory. There are no makeup exams. You will be penalized for unexcused absences from class according to the following scale:
  - Three (3) or more absences will result in a 10% reduction of your overall course grade.
  - Six (6) or more absences will result in a 20% reduction of your overall course grade.
  - Eight (8) or more absences will result in a 30% reduction of your overall course grade.
  - Twelve (12) or more absences will result in your automatic failure in the course irrespective of your performance on homework, assignments, quizzes, and exams.

Medical leave and family emergencies – both accompanied by appropriate documents will be the only exceptions to this policy. Sleeping, studying for another class and/or exam, working on your game, etc., are not valid reasons for an absence. Class participation (active participation in asking/answering questions and discussion) will boost your grade if you are on the border – for example, it is possible to get an A- with an overall grade of 89%.

- **Workload:** There will be two major exams during the semester – midterm and final and there will be four quizzes which help you keep track of the progress. There will be 4 programming assignments to work on outside the class. Some of these assignments are not large while others may be more complex. In all cases, you will have ample time (approximately 2 to 3 weeks) to complete them. Plan on spending 6 hours per week on these assignments. In addition to attending the lectures, you should plan to spend at least 7 hours per week reviewing, reading, and studying for this class.
- **Submitting Assignments:** *Submission procedure for the assignment is detailed below. Failure to follow any of the following submission procedure and guidelines will result in deductions from your assignment grade.*
  - To submit your programming assignment, organize a folder consisting of the following items:
    - a) **./src/** - complete source code of the application including any project/solution files that you create. The instructor will not be responsible for creation of Makefiles or VS Projects/Solutions to make your project work. This folder will have ALL relevant source code (including source files, header files, data files), documentation files, resources files, Visual C++ workspace and project files. In other words, *your submission must be ready for compiling and linking*. If your code does not compile, it will not be graded.
    - b) **./doc/README.docx** - a short description of your solution to the programming project. This should include a description of your data structures for loading and storing images. Include description of extra credit if you have attempted it. Include screenshots of your application in operation.
  - **DO NOT INCLUDE THE FOLLOWING IN YOUR SUBMISSION.**
    - a) TEST IMAGES
    - b) Visual Studio Debug/Release folders
    - c) Visual Studio \*.ncb/\*.sdf files
  - Your project should compile and execute without errors or warnings in Visual Studio Community 2022 environment on DigiPen computers.
  - If your login is **pacquiao.mandy** and assignment 2 is being submitted, your folder would be named **cs370\_pacquiao.mandy\_2**. The folder naming convention is:  
**<class>\_<student.login name>\_<assignment#>**
  - Only submit the requested files. Clean all other extra files.
  - Zip this folder and name the resulting file using the following convention:  
**<class>\_<student.login name>\_<assignment#>.zip**
  - For example, if your login is **pacquiao.mandy** and you are submitting assignment 2, your zipped file would be named as: **cs370\_pacquiao.mandy\_2.zip**
  - Next, upload your zip file in the respective assignment after logging into the course web page using the link <https://distance.sg.digipen.edu>.
  - **Finally, perform a sanity check to determine if your programming submission follows the guidelines by downloading the previously uploaded zip file, unzipping it, then compiling, linking, and executing your submission.**
- **From the “It-shouldn’t-need-to-be-said-but ...” Department:** During lectures, all electronic devices must be turned OFF. This includes cell phones, pagers, PDAs, game consoles, digital cameras, laptop computers, or any other devices. If you absolutely must have a cell phone on for an emergency situation, you must first clear it with me BEFORE class begins. In addition to showing up for class on time, other student responsibilities include proper behavior during class, learning the material, completing assignments correctly, submitting assignments properly and on time, studying for the exams, and participating in class by asking or answering questions during the lectures. Finally, all students are required to bring to class a writing instrument and papers to take notes, answer questions posed during lectures, and perform other tasks.

## Late Policy:

Assignments are due at the specified time on the specified due date. More precisely, any programs and/or non-programming work submitted **after the due time will not be considered**.

#### **Last Day to Withdraw:**

The final date to withdraw from this course is **11 September (without penalty)** and **16 October (with penalty)**. Double check the withdrawal dates with the registrar's office for your confirmation. In order to withdraw from a course, it is not sufficient simply to stop attending class or to inform the instructor. In accordance with policy, contact your advisor or the Registrar to begin the withdrawal process. The last day for withdrawal from this course is cited in the official catalog.

**External Preparation:** It is expected that the students in this class spend 6 hours on average per week for outside classroom activities through the trimester, including, but not limited to, homework, reading assignments, project implementation, group discussions, preparation of examinations, etc.

**Disability Support Services:** Students who have special needs or medical conditions and require formal accommodations in order to fully participate or effectively demonstrate learning in this class should contact the Student Life & Advising Office ([studentlife.sg@digipen.edu](mailto:studentlife.sg@digipen.edu)) at the beginning of each semester. A Student Life & Advising Officer will meet with the student privately to discuss how the accommodations will be implemented.

#### **Academic Integrity Policy:**

CS370 assignments (consisting of written assignments, programming assignments, and/or a project) are NOT group projects. They must represent a student's own individual work. It is reasonable for students to consult or discuss general solutions to an assignment. However, it is unreasonable for students to collaborate on detailed solutions, to copy code, or to give away code.

Cheating, or academic dishonesty in any form will not be tolerated in this course. Cheating, copying, plagiarizing, or any other form of academic dishonesty (including doing someone else's individual assignments) will result in, at the extreme minimum, a zero on the assignment in question, and could result in a failing grade in the course or even expulsion from DigiPen.

Academic dishonesty or cheating occurs when a student represents someone else's work as his/her own, or assists another student in doing so. This can happen on exams, quizzes, homework, or projects. Academic dishonesty may also occur when a student uses any prohibited reference or equipment in the completion of a task. Examples include using a calculator, or notes, or books, or the internet when such sources are prohibited for that task. Plagiarism is a common form of academic dishonesty. This takes the form of copying and pasting excerpts from the web and representing them as original work. The type and severity of any occurrence, as well as the legitimacy of any claim of academic dishonesty will be judged by the instructor and the disciplinary committee. All students are asked to help in promoting a culture of academic integrity by discouraging cheating in all forms. Please consult your student handbook for additional information and details on DigiPen Singapore's academic integrity policy.