Cmp Sci 4420/5420 – Digital Image Processing and Computer Vision

Department of Computer Science
Fall 2024

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url	http://www.cs.umsl.edu/~sanjiv/classes/cs5420
Time	M W, 6:55pm to 8:10pm in 133 SSB
Office Hrs	M W 5:00pm – 6:30pm
	Any other time by appointment
Prerequisites	Math 1900, Math 2450, CMP SCI 2750, and CMP SCI 3130, or
	Graduate standing and consent of instructor

Welcome This is a course about computer vision and image processing. You will learn the fundamentals of image processing to understand the algorithms for computer vision. Computer vision is gaining in importance as a technology of choice in a variety of fields ranging from industrial manufacturing to geospatial intelligence and surveillance to self-driving cars. I am excited by endowing the computers with an ability to *see* and make a decision based on what is viewed. I'll like for you to learn about the library OpenCV and use it to solve some of the problems in computer vision. I have used OpenCV extensively and can help you with making use of it in both Windows and Linux environments.

Teaching Philosophy I believe in learning by doing things. Thus, I'll be assigning a number of projects to solve problems in Computer Vision. I'll be happy to help any student who gets stuck while working on the project. I am comfortable in working with major platforms such as Windows, Linux, and Mac. However, I have mostly worked in C++. I allow the students to work in a language of their choice (Java/Python/C++) but due to my limited experience, I'll be able to provide low-level/debugging help only in C++. You are welcome to stop by my office at any time, or send me a message to meet over zoom to discuss any issue related to class, or even related to your career.

Course Description This course focuses on image analysis and visual perception. Students will learn data structures and algorithms for image processing, region and texture analysis, image filtering, edge detection, contour following, and image enhancement in both spatial and frequency domain. Other topics may include color processing, coding for storage, retrieval, transmission, and image restoration.

Required text

- Richard Szeliski. *Computer Vision: Algorithms and Applications (2nd ed)*.
- Gonzalez and Woods. *Digital Image Processing (4th Ed)*. Pearson. 2018. (Optional)
- You can learn about OpenCV from the web site https://docs.opencv.org/ (there are some tutorials available) or from one of the OpenCV books.
- The O'Reilly books on OpenCV are available as an electronic resource through the library (requires UM system login).

Goals of the course This is your first course in image processing and computer vision. You will apply calculus, linear algebra, and basic programming skills and data structures to build applications that will enhance (or in some cases smear) an image or video. The overall goals of the course are:

- Image acquisition/display/save
- Image processing in spatial domain
- Learn OpenCV

Topics

- Introduction to Digital Image Processing.
- Fundamentals of digital images and visual perception
- Point and geometric transformations and spatial domain filtering
- Color image processing
- Morphological image processing
- Edge and feature detection
- Image compression

Outcomes At the end of the course, you are expected to know how to read an image into the computer memory and process it using some basic image processing algorithms. You are expected to know the theory behind those algorithms and develop enough skills to program those algorithms from scratch. You are also expected to learn the software library OpenCV to be able to use it for coding and implementation. The course will prepare you to apply your knowledge to manipulate the images to meet a given goal.

Time Requirements This is an active class with two in-person weekly class meetings complemented by online learning experiences in Canvas in between class meetings. Our course is a 3-credit hour course and requires 3 hours of your time each week in addition to the time it takes you to read the required materials, watch any videos, and complete the assignments. That means that you need to plan to spend a minimum of 6 hours every week (up to 8-10 hours a week) on activities related to this course. If you would like to explore how the online Canvas activities work, please consult the Online Canvas Overview course in Canvas where you can practice posting to a discussion board, take a practice quiz and more.

How to Succeed in This Course I truly believe in your success as a student and in adapting my instruction to ensure your success. Below you will find several different instructional methods to help me accomplish my goal:

- I'll like good participation in the course. Therefore, I am allowing 10% points for participation. To have objectivity, I'll expect you to give me a one-minute audio-visual report every week on what you learned that week. You can also say things about what is going well with the course and what needs improvement. The comment will come using a tool called *Voice Thread*. The use of web cam will allow me to put a face to your name. You will receive 1 point for submitting the voice thread every week. At the end of the semester, all the points will be aggregated towards 10% of your grade. Since the class meets on Tuesday/Thursday, I can reasonably expect the comment by Sunday midnight. I will not accept any late submission on this and so, please submit this diligently.
- The lectures will cover theoretical aspects of the course. I'll give you some idea on the OpenCV library but I'll expect you to cover most of the material related to OpenCV on your own. Of course, you can always ask me questions, or help with debugging the code outside of class (office hours or otherwise).

- The lecture notes will be available to you in the form of PDF documents. You can print those and annotate on them during lectures. You do not need to take too many notes during lectures.
- It will be nice to see some discussions on Canvas regarding the material discussed in class, or even on new technology that you come across.

Email Requirements All correspondence should be made through your UMSL-provided email. Any unsigned email will go unanswered by me. Please do not send me any attachments without talking to me first.

Attendance Please arrive on time. Also, turn your cell phones to silent during class. I will not be taking attendance but you will be responsible for the material covered in class in case you miss it.

Lack of attendance in-person or non-submission of work in Canvas may result in an automatic course drop.

Projects You will be given programming assignments, typically a set of programs every two weeks. Assignments will be due at 11:59pm on the due date. Assignments should be submitted on `delmar` but demonstrated in-person for proper credit. You should start working on the project as soon as it gets assigned as some of them may get tricky. If you do not know how to work on a project, see me as soon as possible for help.

Grading The grade will be based on programming and homework assignments and two tests. All tests will be given online and will be open book and open notes. Tests will not be proctored but you will have to take them online during the class period (you can do it from home). Each project must be meticulously documented and clearly identify its purpose, author, and date. I will like to *read* your submitted code; I should *not have to figure it out*. It will do you good if you peruse the Gnu Coding Standards. When you come to me for help with the code, or when you submit the code, make sure that you follow good indentation practices. If you miss any test or assignment without making prior arrangements, you will have a zero. I will not give any make up tests. The old tests are available on the class web page. The distribution of grades will be as follows:

Participation	10%
Programming Assignments	50%
Two Tests	20% each

Students taking the course in graduate standing will be required to show a greater mastery of the material. This can be shown by additional work and additional mastery shown in exams.

Anyone desiring an EXC grade after October 31 must be passing the course at that point to get EXC.

Failure to hand in any assignment will result in an automatic zero for that assignment. If some student is unable to hand in an assignment by the deadline, they must discuss it with me *before* the deadline. I'll encourage you to talk to other students regarding homework but you should not collaborate to the extent that two submissions are copies of each other. If you are found copying an assignment (from another student or internet), or if your submission has *unreasonable similarity* to another submission, you get a zero for that assignment automatically. A second offense will be reported to the university officials and students involved will face serious consequences. I may ask you to come to my office and explain your code to me; in case you are not able to explain the code to my satisfaction, I'll assign you a zero in that project. I'll allow you to submit up to two projects over the semester that are seven days beyond the deadline for no penalty. However, you must let me know before the deadline that you are going to be late with submission.

The projects in this class may take up a lot of your time. So, you should start working on those as soon as they are assigned. In the past, students who ask a lot of questions have scored better grades. Do not hesitate to ask a question on Canvas, Teams, in my office, or via email, especially if you do not have an idea on how to start working on the project.

Feedback and Grading Timeline: I expect that you will have feedback and grade on your submitted projects within two weeks of submission. I'll try my best to return the graded tests to you within a week after the test. Under normal circumstances, I'll update your participation grade within 48 hours of the due date. You can find grade in the Grades button on Canvas. However, the overall grade on Canvas is normally incorrect and does not account for different weights for participation, projects, and tests. If there is a rubric attached to the assignment, you can click your score to see my personal feedback on the rubric.

Miscellaneous If you have any disability that requires an accommodation (as per UMSL policy), you must notify me in advance. If you cannot attend the class due to a religious holiday or a university-sanctioned event, please let me know in advance as well. In case you are down with the flu, please stay absent from the class till you recover, and contact me via phone or email. I'll try my best to make accommodation for you in that case.

We'll be using the open source software OpenCV for the class. You can download and install it on your computer. See me in case you need help installing it.

Exam Dates

Test 1	October 14, 2024
Test 2	December 04, 2024

There is no final exam.

Other important dates

August 25, 2024	Last day to enroll in the course
September 16, 2024	Last day to drop without receiving a grade
November 11, 2024	Last day to drop the course with instructor approval

Anyone desiring an EXC grade after October 31, 2024 must be passing the course at that point to get EXC.

Appendix A

Technology Requirements: As a computer science major, you are expected to have reliable internet access almost every day. Please reach out to your academic advisor or student success network if you need hardware or access to the Internet. If you have computing problems, it is your responsibility to address these through the ITS Helpdesk or to use campus computing labs. Problems with your computer or other technology issues are not an excuse for delays in meeting expectations and missed deadlines for the course. If you have a problem, get help in solving it immediately from `http://www.umsl.edu/technology/support/`. At a minimum, you will need the following software/hardware to participate in this course:

1. Computer with an updated operating system (e.g. Windows, Mac, Linux)
2. Updated Internet browsers (Google Chrome (required) or Mozilla Firefox)
3. Ability to navigate Canvas (Learning Management System)
4. Minimum Processor Speed of 1 GHz or higher recommended.
5. OpenCV library.
6. Reliable and stable internet connection.
7. Adobe Reader or alternative PDF reader (free)
8. A webcam and/or microphone is ***highly recommended***.

Course Plan for the Unexpected Please stay informed about university policies, instructions and resources as they relate to any disruption of classes. It is important to me that you stay on track toward your degree completion. This section presents our course continuity plans for how we will handle situations to avoid disruption to your learning.

- All the lecture material will be available to you as PDF documents on the class web page.
- I'll try my best to record and post all the lectures online, in case I have to miss a class.
- All the assignments will be available online. I'll ask you to explain your code to me for the projects in person.
- If I am unable to lecture due to sickness or emergency, I'll inform you before the beginning of class, possibly with enough notice that you do not have to make a special trip to campus just for the class. Please keep a watch on your email and pay attention to announcements on Canvas.

Online Class Netiquette/Behavior

- Be self-reflective before you post an emotional response and reread what you have written to be sure it is positive. Think of your comments as printed in the newspaper. Your online comments will be seen, heard and remembered by others in the class.
- Use effective communication.
  - Avoid the use of all caps or multiple punctuation elements, such as !!! and ???.
  - Be polite, understate rather than overstate your point, and use positive language.
  - If you are using acronyms, jargon or uncommon terms, be sure to explain them so everyone can understand and participate in the discussion.

- Ask for clarification to a point if you feel emotional from a classmates post. It is likely that you misunderstood their point. This strategy will also help you step away from the intensity of the moment to allow for more reflection.
- Sign your name. It is easier to build a classroom community when you know to whom you are responding.
- Foster community. Share your great ideas and contribute to ongoing discussions. Consider each comment you make as one that is adding to, or detracting from, a positive learning environment for you and your classmates.
- Be constructive. You can challenge ideas and the course content, but avoid becoming negative online. When you disagree politely, you stimulate and encourage great discussion. You also maintain positive relationships with others with whom you may disagree on a certain point.
- Keep the conversation on topic by responding to questions, adding thoughtful comments about the topics at hand. Online dialog is like conversation. If there is a certain dialog going on, please add to it, but if you have something new to say, please post it in another thread.
- Define your terms. When using acronyms or terms that are particular to your field (or new to our course), please define them for others.

UMSL Course Policies

1. Participation (expectations)

   If you are unable to participate in the scheduled class activity or discussions, you must notify the instructor within the week of that class module or discussion. The instructor reserves the right to make judgment to accept and/or makeup assignments missed because of failed participation in the course activities.

   - It is vitally important that our classroom environment promote the respectful exchange of ideas. This entails being sensitive to the views and beliefs expressed during discussions whether in class or online. Please speak with me before recording any class activity. It is a violation of University of Missouri policy to distribute such recordings without my authorization and the permission of others who are recorded.
   - I will not respond to each post but will be monitoring each discussion. I'll correct if I find something that is incorrect.
   - Your success in this course will heavily depend on your ability to communicate, engage and participate in all course activities. Successful completion of this course requires that a student keep up with all assignments, coursework and discussions. Timely participation in in-class and online discussions is a very important part of this course and participation in these discussions, and other activities as assigned, is not optional. You are expected to prepare and post to discussions in a timely manner consistent with the requirements contained within the course syllabus.
   - **Online Discussion Guidelines**
     - Participation in the course should maintain a positive work and learning environment, as outlined in the UM Collected Rules & Regulations, 330.080
     - Postings should be evenly distributed during the discussion week.
     - Postings should be a minimum of three sentences, or one short paragraph, and a maximum of two paragraphs. Or you can give a one-minute recorded presentation.
     - Responses should be well written with proper punctuation, spelling and grammar.
     - Avoid short one-word postings, for instance, "I agree," unless accompanied by supporting statements from the readings or prior knowledge (work and life experience).

  - Stay focused on the topic.
  - Ask questions; challenge other postings that lack supporting evidence or present incorrect information.
  - Encourage further discussion by building on current threads.
  - Check your postings for responses from others and respond in kind.
  - Use proper "netiquette".
- Turn off sound on beepers, cell phones, and other devices during class. Adherence to the Student Conduct Code is expected.
- I am committed to ensuring a positive learning environment by respecting that University policy.
- Your success in this course will heavily depend on your ability to communicate, engage and participate in all course activities. Successful completion of this course requires that a student keep up with all assignments, quizzes, projects and tests.
- If you are unable to participate in the scheduled class activities, you must notify me within the week of that class module. **An unexcused failure to engage or participate with the class will be counted as an absence; unexcused absences may result in failure.** I reserve the right to make judgment to accept and/or makeup assignments missed because of failed participation in the course activities.

2. **Academic Integrity/Plagiarism**: We want our learning environment to be honest and fair. The assessments in our course provide you with an opportunity to showcase what you know and learn from what you may not yet have mastered. When you submit work with your name on it, this is a written statement that credit for the work belongs to you alone. If the work was a product of collaboration (such as a group project), each student is expected to clearly acknowledge in writing all persons who contributed to its completion.

   Each assignment and exam in our course will include clear guidelines about the rules around each assessment including what materials are appropriate to use. It is always required that the work you submit is your own, uses proper citation, avoids collusion or falsification.

   If you have a question about an assignment, do not hesitate to contact me for clarification. You are responsible for being attentive to and observant of University policies about academic honesty as stated in the University's Campus Policies and Code of Student Conduct found in the UMSL Bulletin.

   - **Plagiarism, collusion, cheating, and falsification are not acceptable** and will result in failure of an assignment and possible administrative sanctions such as dismissal from the university.

     Plagiarism. Representing the ideas or work of another as your own, intentionally or unwittingly, without proper, clear, explicit acknowledgement.

     Facilitation/Collusion. Supporting malpractice by another student, for example, allowing your work to be copied.

     Duplication of Work. Presenting the same work for a different assessment.

     Cheating. Using any unauthorized sources of information (such as previous or existing exams for this course) and providing or receiving unauthorized assistance on any form of academic work or engaging in any behavior specifically prohibited by the faculty member (e.g., uploading or using test or online homework questions on study sites such as Chegg.com, copying someone elses answers on tests and quizzes, copying/pasting exam or online homework questions from this semester for your peers or publicly in online forums).

     Falsification. Any untruth, either verbal or written, in ones academic work including presenting fabricated/made up data or presenting someone elses work as your own. Unless the instructor explicitly states otherwise, it is dishonest to collaborate with others when completing any assignment or test,

performing laboratory experiments, writing and/or documenting computer programs, writing papers or reports and completing problem sets.

- Academic dishonesty is a serious offense that may lead to probation, suspension, or dismissal from the University. Academic dishonesty can take a number of forms described above: plagiarism, cheating, unauthorized possession or distribution of academic materials including the unauthorized use, selling or purchasing of examinations or other academic work, using or stealing another students work, unauthorized entry or use of material in a computer file, and using information from or possessing exams that an instructor did not authorize for release to students.
- All instances of academic dishonesty will be reported to the Office of Academic Affairs who will determine whether you will appear before the Student Conduct Committee for possible administrative sanctions such as dismissal from the university. The instructor will make an academic judgment about the students grade on that work in this course. The campus process regarding academic dishonesty is described in the "Policies" section of the Academic Affairs website

3. **Title IX Policies**

   Mandatory Reporting: Under Title IX, all UMSL faculty, staff, and administrators (with limited exception) are obligated to report any incidents of sexual harassment, sexual misconduct, sexual assault, or gender discrimination to the Student Affairs office and/or other University officials. This ensures that all parties are protected from further abuses and that victim(s) are supported by trained counselors and professionals. Note: There are several offices at UMSL (e.g., Counseling Services, Health Services, Community Psychological Service, Center for Trauma Recovery, and Student Social Services) whose staff are exempt from Title IX mandated reporting, when the information is learned in the course of a confidential communication.

Student Resources Your academic success is important to me. We all learn differently and bring different strengths and needs to the class. If there are aspects of the course that prevent you from learning or make you feel excluded, please let me know as soon as possible. Together we'll develop strategies to meet both your needs and the requirements of the course.

Access, Disability and Communication If you have a documented disability that may have an impact upon your work in this class, please contact Disability Access Services (DAS) immediately. Students must provide documentation of their disability to the Office of Disability Access Services in order to receive official university services and accommodations. The staff is available to answer questions regarding accommodations or assist you in your pursuit of accommodations. Information about your disability is confidential. Use DAS information and steps to inform me about the accommodations to which you are entitled. Your accommodations will begin as soon as we discuss your approved accommodations.

- 131 Millennium Student Center
- Phone: (314) 516-5671
- Email: `das@umsl.edu`

Office of International Students and Scholar Services If you have difficulty communicating in English with the instructor of this course, contact ISSS.

- 362 Social Sciences & Business Building (SSB)
- Phone: (314) 516-5229
- Email: `global@umsl.edu`

Student Enrichment and Achievement SEA provides comprehensive support and intervention strategies that support your road to graduation!

- 107 Lucas Hall
- Phone: (314) 516-5300
- Email: umslsea@umsl.edu

Office of Multicultural Student Services (MSS) and the University Tutoring Center (UTC) MSS provides comprehensive student retention services to diverse student populations; through their tutoring center, the MSS offers comprehensive tutoring services free to students at UMSL.

- 225 Millennium Student Center (MSC)
- Phone: (314) 516-6807
- Email: multicultural@umsl.edu

Technical Support Please consult UMSL's Keep Learning web resource for technology tips and help with learning in Canvas.

Canvas If you have problems logging into your online course, or an issue within the course site, please contact the Technology Support Center.

- Phone: (314) 516-6034
- Email: helpdesk@umsl.edu

If you are having difficulty with a technology tool in Canvas, consider visiting the Canvas Student Guides, which has overviews of each tool and tutorials on how to use them.

If you continue to experience problems or just have questions, you can also contact the Learning Resource Lab.

- Phone: (314) 516-6704
- Email: lrl@umsl.edu

VoiceThread

- Online Contact Form
- Website

Departmental Tutoring The department offers tutoring for up to Cmp Sci 3130, and occasionally for other courses. Please check Canvas for information.

Use of Generative AI. AI is encouraged in specific assignments with attribution. In this course, learners can choose to use AI tools like ChatGPT to help brainstorm and/or draft assignments or projects, or to revise existing written work. It is expected that submitted assignments will follow the specific assignment instructions regarding the use of AI, and appropriately reference, cite, and attribute any role played, or text generated by AI tools. However, you are not allowed to use Generative AI during tests.