MARYLAND APPLIED GRADUATE ENGINEERING

Perception for Autonomous Robots (ENPM 673)
Sections 0101 and RO01

Term: *Spring/2026*

Professor: Dr. Samer Charifa and Dr. Tommy Chang
Pronouns: he/him
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Office Hours: TBD

Grader: TBD
Pronouns:
Email:
Office Hours:

Credits: 3
Course Dates: From Jan 27, 2026 - May 5, 2026
Course Times: Tu 7:00pm - 9:40pm
Classroom: JMP 3201

Canvas/ELMS: **ENPM673 Canvas Course Site**

Course Description

This course offers a **foundation** in computer vision. It is intended for students who do not have any prior experience in computer vision or image processing. Students will learn techniques and algorithms that can be used to solve an abundance of perception problems. This course is dedicated to anyone interested in giving their autonomous system (e.g., robot, autonomous driving car, or simply a smart camera) means to understand their surrounding world. Throughout the projects of this course students will gain hands-on experience in solving real-life problems such as lane detection for autonomous driving, computing velocities of moving objects, and building a 3D model of an object using 2D images from cameras. Moreover, students will gain experience with state-of-the-art tools such as OpenCV, Python and introduction to Machine Learning using PyTorch.

Prerequisites

Proficiency in a programming language is required. Familiarity with Python is recommended. OpenCV + Python tutorials will be provided during the second week.

Learning Outcomes

After successfully completing this course, you will be able to:

- Find the trend line that best fits a series of data points (curve fitting)
- Detect important features in images such as corners, edges, straight lines and others
- Segment images into background and foreground
- Estimate 3D information of objects based on their 2D images
- Estimate motion metrics of objects such as speed and direction of motion using camera feed
- Perform camera pose estimation for mobile robots
- Basic Machine Learning tasks using images

Course Materials

Readings:

There is no textbook for this class; however, students should use the notes published on the class website, as well as any extra reading material that is sometimes associated with each lecture note posted on the course website.

Hardware/Software:

- Hardware: Any reasonably modern computer will be good.
- Software: Python 3.x with OpenCV. During the course the students will be provided with instructions on how to install these open-source software package

Course Structure

Section 0101 meets face-to-face on Tuesdays 7:00 pm – 9:40 pm in the JMP Building, Room 3201. The structure of the course will include lectures, hands-on activities, and group work. Students are expected to attend class on a regular basis and be prepared to engage with the lecture and materials.

This course includes both on-campus and online sections. To attend synchronously online, log into ELMS-Canvas at the time of the Section 0101 class (Tuesday, 7pm) and select "Video Conference" from the left side menu. This will open a Zoom link to the live classroom.

For asynchronous online students, all lectures will be recorded and made available on ELMS-Canvas under "Panopto Recordings/Video Lectures" within 24 hours of the class time. Be sure to review the recorded lecture in a timely manner.

On-campus students come to class prepared to engage with the lecture and materials. Online students, be sure to log into Canvas regularly and participate in discussions and activities. Regardless of the section you are enrolled in, participation is expected.

Please note that F1 students enrolled in the on-campus section are **required** to attend in person. If you have a conflict on a particular day, please reach out to us in advance to discuss.

Communication Guidelines

Communicating with the Instructor

My goal is to be readily available to you throughout the semester. we can be reached by email at scharifa@umd.edu and chang177@umd.edu. Please DO NOT email us with questions that are easily found in the syllabus or on ELMS-Canvas (e.g., When is this assignment due? How much is it worth? etc.), but please DO reach out about personal, academic, and intellectual concerns/questions.

While we will do our best to respond to emails within 48 hours, you will more likely receive email responses from us after 7pm on weekdays. If you are looking for an immediate response, try to email the TA/grader first.

When constructing an email to us please put "ENPM 673: Your Topic" in the subject line. This will draw our attention to your email and enable us to respond to you more quickly.

Additionally, please review These tips for 'How to email a professor'. By following these guidelines, you will be ensured to receive a timely and courteous response.

If your communication with the professor is related to an objection about a grade given by a grader/TA, then you will get a **one-time chance to state your case in an email or during office hours**, the professor will evaluate the

grading of your paper and determine a final decision on the grade. The new grade is final and no objection is allowed after that. Note that the new grade could be equal, more, or less than the original grade given by the grader/TA.

The late work assignment policy is clear, please refrain from emailing the professors or graders/TAs about due date extension unless it is a major event such as an illness that will prevent you from working on your assignment, where in this case, you are required to provide a doctor note.

Finally, if you need to discuss issues not appropriate for the classroom and/or an email, we can arrange to talk by phone, over Zoom, or in person. Send me an email asking for a meeting and we can set something up.

Announcements

I will send IMPORTANT messages, announcements, and updates through ELMS-Canvas. To ensure you receive this information in a timely fashion, make sure your email and announcement notifications (including changes in assignments and/or due dates) are enabled in ELMS-Canvas (How to change notification settings in CANVAS).
Log into our ELMs-Canvas course site **at least once every 24-hour** period to check your inbox and the Announcements page.

Names/Pronouns and Self-Identifications

The University of Maryland recognizes the importance of a diverse student body, and we are committed to fostering inclusive and equitable classroom environments. I invite you, if you wish, to tell us how you want to be referred to in this class, both in terms of your name and your pronouns (he/him, she/her, they/them, etc.). Keep in mind that the pronouns someone uses are not necessarily indicative of their gender identity. Visit trans.umd.edu to learn more.

Additionally, it is your choice whether to disclose how you identify in terms of your gender, race, class, sexuality, religion, and dis/ability, among all aspects of your identity (e.g., should it come up in classroom conversation about our experiences and perspectives) and should be self-identified, not presumed or imposed. I will do my best to address and refer to all students accordingly, and I ask you to do the same for all of your fellow Terps.

Communicating with your Peers

With a diversity of perspectives and experience, we may find ourselves in disagreement and/or debate with one another. As such, it is important that we agree to conduct ourselves in a professional manner and that we work together to foster and preserve a virtual classroom environment in which we can respectfully discuss and deliberate controversial questions. I encourage you to confidently exercise your right to free speech—bearing in mind, of course, that you will be expected to craft and defend arguments that support your position. Keep in mind, that free speech has its limit and this course is NOT the space for hate speech, harassment, and derogatory language. I will make every reasonable attempt to create an atmosphere in which each student feels comfortable voicing their argument without fear of being personally attacked, mocked, demeaned, or devalued.

Any behavior (including harassment, sexual harassment, and racially and/or culturally derogatory language) that threatens this atmosphere will not be tolerated. Please alert me immediately if you feel threatened, dismissed, or

silenced at any point during our semester together and/or if your engagement in discussion has been in some way hindered by the learning environment.

Netiquette Policy

Netiquette is the social code of online classes. Students share a responsibility for the course's learning environment. Creating a cohesive online learning community requires learners to support and assist each other. To craft an open and interactive online learning environment, communication has to be conducted in a professional and courteous manner at all times, guided by common sense, collegiality and basic rules of etiquette.

Grading

Grade Breakdown

Assignment	Percentage %
Homework 1	**5%**
3 Projects + 1 Final project	**50%**
Midterm Exam	**25%**
Quizzes (only for in person students)	**20%**
Final Exam (only for online students)	**20%**
Total	**100%**

Course Assignments

The course work is organized around four projects and one homework assignment. Through these assignments, students will learn the theory and practical skills required in computer vision engineering. There will also be a midterm exam. Below, please find a brief description of each assignment.

Homework1 Assignment (subject to change)

- In this assignment, students are tasked with:
  - Calculating the Field of View of a camera
  - Determining the minimum and maximum number of pixels occupied by a moving object
  - Computing the optimal focus distance for the camera

Projects (subject to change)

- Project1: detecting object a in video and plotting its trajectory; fitting noisy point cloud data
- Project2: estimating camera pose using homography; creating a panoramic image
- Project3: stereo vision system and camera calibration
- Final project: various topics to select from

Midterm Exam

- Closed book in-class exam
- Covers materials from lectures, homeworks, and projects

IMPORTANT TO NOTE:

- The projects, homework, and midterm exam are intended to be done individually. Any evidence of collaboration or use of AI and/or other answer generating programs will be considered academic dishonesty and treated accordingly. Please see the course academic integrity policy under **Course Policies and Procedures** below.

- The final project is intended to be done in groups of up to three or five, depending on the selected topic.

- The programming language for this course is Python with OpenCV.

- Please ensure that your solutions run on Google Colab with the built-in Python executable. Solution should be using Python 3.x format only.

- Please DO NOT hardcode any file paths in your submissions, ensure relative path names only or use the Python argument parser.

- The use of Generative AI is allowed as long as you disclose your prompts. You are not allowed to ask AI to solve the whole assignment, but you could use AI to help solve small pieces of it.

- You will need to clearly explain your thought process and the main steps of your code/solution.

- If there is any built-in functionality, from any library, that directly solves a part of the assigned question for you, then you are not allowed to use that function. This rule applies to homework and projects. If there is evidence that you used such a function, it will be considered academic dishonesty and treated accordingly.

Grading of Assignments

- All assignments will be graded according to a predetermined set of criteria (i.e., rubric) which will be communicated to students before the assignment is submitted.

- To progress satisfactorily in this class, students need to receive timely feedback. To that end, it is my intention to grade all assignments within 2 weeks of their due date. If an assignment is taking longer than expected to grade, students will be informed of when they can expect to see their grade.

- Full details on the assignments can be found in the Syllabus section of the course website (i.e., CANVAS/ELMS), as well as under Files or Modules.

Grade Computation

All assessment scores will be posted on ELMS/Canvas page. If you would like to review any of your grades (including the exams), or have questions about how something was scored, please email me to schedule a time for us to meet and discuss.

It is expected that you will submit work by the deadline listed in the syllabus and/or on ELMS-Canvas. Late work will be penalized according to the late work policy described in the **Course Policies and Procedures** section below.

Grade Disputes: I am happy to discuss any of your grades with you, and if I have made a mistake, I will immediately correct it. Any formal grade disputes must be submitted in writing and within one week of receiving the grade.

Final letter grades are assigned based on the percentage of total assessment points earned. To be fair to everyone, I have to establish clear standards and apply them consistently, so please understand that being close to a cutoff is not the same as making the cut (89.99 ≠ 90.00). It would be unethical to make exceptions for some and not others.

Final Grade Cutoffs

Letter Grade	Cutoff
A	91.00%
B	80.00%
C	74.00%
D	60.00%
F	<60.00%

Course Schedule

Week # (Date)	Topic	Assignment Due
Week 1 (1/27/26)	– **Class Overview, Introduction to General Perception Sensors ground, UAVs and Underwater Robots.** – **Image Formation, Lenses Properties, and Essential Definitions**	**Software installation, OpenCV with Python 3.x. is required. Download Software installation, OpenCV with Python 3.x. is required.**
Week 2 (2/3/26)	– **Python Tutorial** – **OpenCV Tutorial**	**Homework 1 Due Date**
Week 3 (2/10/26)	– **Linear Algebra, Estimation (LS, TLS, Regularization, RANSAC)** – **Image Filters, Convolution, and Correlation**	
Week 4 (2/17/26)	– **Edge Detection** – **Features Extraction: Corners, SIFT**	**Project 1 Due Date**
Week 5 (2/24/26)	– **Homography Estimation** – **Hough Transform**	

Week 6 (3/3/26)	– **Morphology, Connected Components, Clustering, K-means, GMM** – **Camera Calibration**	**Project 2 Due Date**
Week 7 (3/10/24)	**Midterm Exam**	
Week 8 (3/17/26)	**Spring Break**	
Week 9 (3/24/26)	– **Projective Geometry, Stereo Vision, structure from motion, bundle adjustment, Epipolar Geometry**	
Week 10 (3/31/26)	– **Tracking: Object Tracking, Multi Object tracking , and DeepSort.**	
Week 11 (4/7/26)	– **Optical Flow: Optical Flow, (TTO) Time to contact using Optical Flow**	**Project 3 Due Date**
Week 12 (4/14/26)	– **Deep Learning Based Perception :** – **Light weight Convolutional Neural Network** – **DL based methods to do object classifications**	
Week 13 (4/21/26)	– **Object detection, 2D and 3D, Pose Estimation using YOLO** – **Semantic Segmentation using applied methods such as YOLO v11**	
Week 14 (4/28/26)	– **Localization** – **Kalman Filter** – **Visual SLAM**	
Week 15 (5/5/24)	– **3D data Registration, Range data / point cloud processing** – **Detecting driving surfaces from point clouds and obstacle detection using point clouds,**	
Week 16 (5/12/24)	**Final exam and Project Presentations**	

Note: This is a tentative schedule, and subject to change as necessary – monitor ELMS-Canvas for current deadlines. In the unlikely event of a prolonged university closing, or an extended absence from the university, adjustments to the course schedule, deadlines, and assignments will be made based on the duration of the closing and the specific dates missed.

Course Policies and Procedures

The University of Maryland's conduct policy indicates that course syllabi should refer to a webpage of course-related policies and procedures. For a complete list of graduate course related policies, visit the Graduate School website. Below are course-specific policies and procedures which explain how these Graduate School policies will be implemented in this class.

Satisfactory Performance

The Graduate School expects students to take full responsibility for their academic work and academic progress. The student, to progress satisfactorily, must meet all the academic requirements of this course. Additionally, each student is expected to complete all readings and any preparatory work before each class session, come to class prepared to make substantive contributions to the learning experience, and to proactively communicate with the instructor when challenges or issues arise.

Questions about Assignments

Please ask all questions you may have about an assignment by 5PM the day before the assignment is due. Any questions asked after that time may not be answered in time for you to make changes to your work.

Late Work Policy

Assignments should be completed by the due date and time listed with the assignment, on the syllabus, and/or in the course calendar. If you are unable to complete an assignment by the stated due date, you could still submit the assignment but at a reduced mark. For every day late, there will be a deduction of 10% of the original total grade. **There will be no grade given after five days of the due date. There will be no excuse given unless it is a health-related issue which will only be acceptable with a doctor's note (US-based doctors only). There will be one hour of grace period after the due date where no penalty will be given.**

Responsible Use of Generative AI

- The use of Generative AI is allowed as long as you disclose your prompts. You are not allowed to ask AI to solve the whole assignment but you could use AI to help solve small pieces of it.
- You will need to clearly explain your thought process and the main steps of your code/solution.

Academic Integrity

For this course, some of your assignments will be collected via Turnitin on ELMS/Canvas. I have chosen to use this tool because it can help you improve your scholarly writing and help me verify the integrity of student work. For information about Turnitin, how it works, and the feedback reports you may have access to, visit Turnitin Originality Checker for Students

The University's Code of Academic Integrity is designed to ensure that the principles of academic honesty and integrity are upheld. In accordance with this code, the University of Maryland does not tolerate academic dishonesty. Please ensure that you fully understand this code and its implications because all acts of academic dishonesty will be dealt with in accordance with the provisions of this code. All students are expected to adhere to this Code. It is your responsibility to read it and know what it says, so you can start your professional life on the right path. **As future professionals, your commitment to high ethical standards and honesty begins with your time at the University of Maryland.**

It is important to note that course assistance websites, such as CourseHero, or AI generated content are not permitted sources, unless the instructor explicitly gives permission. Material taken or copied from these sites can be deemed unauthorized material and a violation of academic integrity. These sites offer information that might be inaccurate or biased and most importantly, relying on restricted sources will hamper your learning process, particularly the critical thinking steps necessary for college-level assignments.

Additionally, students may naturally choose to use online forums for course-wide discussions (e.g., Group lists or chats) to discuss concepts in the course. However**, collaboration on graded assignments is strictly prohibited unless otherwise stated**. Examples of prohibited collaboration include: asking classmates for answers on quizzes or exams, asking for access codes to clicker polls, etc. Please visit the **Office of Graduate Studies' full list of campus-wide policies** and reach out if you have questions.

If you ever feel pressured to comply with someone else's academic integrity violation, please reach out to me straight away. Also, ***if you are ever unclear*** about acceptable levels of collaboration, ***please ask***!

To help you avoid unintentional violations, ***the following table*** lists levels of collaboration that are acceptable for each graded exercise. Each assignment will contain more specific information regarding acceptable levels of collaboration.

Assignment Type	 OPEN NOTES	 READ BOOK	 LEARN ONLINE	 GATHER CONTENT WITH AI	 ASK FRIENDS	 WORK IN GROUPS
Homework	✔	✔	✔	---	---	---
Projects	✔	✔	✔	---	---	---
Midterm Exam	✔	✔	---	---	---	---
The Final Project	✔	✔	✔	---	✔	✔

Course Evaluation

Please submit a course evaluation through Student Feedback on Course Experiences in order to help faculty and administrators improve teaching and learning at Maryland. All information submitted to Course Experiences is confidential. Campus will notify you when Student Feedback on Course Experiences is open for you to complete your evaluations at the end of the semester. Please go directly to the **Student Feedback on Course Experiences** to complete your evaluations. By completing all of your evaluations each semester, you will have the privilege of accessing through Testudo the evaluation reports for the thousands of courses for which 70% or more students submitted their evaluations.

Religious Observance

It is the student's responsibility to inform the instructor of any intended absences for religious observances in advance. Notice should be provided as soon as possible but no later than the end of the schedule adjustment period.

Copyright Notice

Tips for Succeeding in this Course

1. **Participate.** I invite you to engage deeply, ask questions, and talk about the course content with your classmates. You can learn a great deal from discussing ideas and perspectives with your peers and professor. Participation can also help you articulate your thoughts and develop critical thinking skills.
2. **Manage your time.** Students are often very busy, and I understand that you have obligations outside of this class. However, students do best when they plan adequate time that is devoted to course work. Block your schedule and set aside plenty of time to complete assignments including extra time to handle any technology related problems.
3. **Login regularly.** I recommend that you log in to ELMS-Canvas several times a week to view announcements, discussion posts and replies to your posts. You may need to log in multiple times a day when group submissions are due.
4. **Do not fall behind.** This class moves at a quick pace and each week builds on the previous content. If you feel you are starting to fall behind, check in with the instructor as soon as possible so we can troubleshoot together. It will be hard to keep up with the course content if you fall behind in the pre-work or post-work.
5. **Use ELMS-Canvas notification settings.** Pro tip! Canvas ELMS-Canvas can ensure you receive timely notifications in your email or via text. Be sure to enable announcements to be sent instantly or daily.
6. **Ask for help if needed.** If you need help with ELMS-Canvas or other technology, IT Support. If you are struggling with a course concept, reach out to me and your classmates for support.

Student Resources and Services

Taking personal responsibility for your learning means acknowledging when your performance does not match your goals and doing something about it. I hope you will come talk to me so that I can help you find the right approach to success in this course, and I encourage you to visit the Counseling Center's Academic Resources to learn more about the wide range of resources available to you. Below are some additional resources and services commonly

used by graduate students. For a more comprehensive list, please visit the Graduate School's Campus Resources Page.

Accessibility and Disability Services

The University of Maryland is committed to creating and maintaining a welcoming and inclusive educational, working, and living environment for people of all abilities. The University of Maryland is also committed to the principle that no qualified individual with a disability shall, on the basis of disability, be excluded from participation in or be denied the benefits of the services, programs, or activities of the University, or be subjected to discrimination. The Accessibility & Disability Service (ADS) provides reasonable accommodations to qualified individuals to provide equal access to services, programs and activities. ADS cannot assist retroactively, so it is generally best to request accommodations several weeks before the semester begins or as soon as a disability becomes known. Any student who needs accommodations should contact me as soon as possible so that I have sufficient time to make arrangements.

For assistance in obtaining an accommodation, contact Accessibility and Disability Service at 301-314-7682, or email them at adsfrontdesk@umd.edu. Information about sharing your accommodations with instructors, note taking assistance and more is available from the Counseling Center.

Writing Center

Everyone can use some help sharpening their communication skills (and improving their grade) by visiting The Graduate School's Writing Center and schedule an appointment with them. Additionally, international graduate students may want to take advantage of the Graduate School's free English Editing for International Graduate Students (EEIGS) program.

Health Services

The University offers a variety of physical and mental health services to students. If you are feeling ill or need non-emergency medical attention, please visit the University Health Center.

If you feel it would be helpful to have someone to talk to, visit UMD's Counseling Center or one of the many other mental health resources on campus.

Notice of Mandatory Reporting

Notice of mandatory reporting of sexual assault, sexual harassment, interpersonal violence, and stalking: As a faculty member, I am designated as a "Responsible University Employee," and I must report all disclosures of sexual assault, sexual harassment, interpersonal violence, and stalking to UMD's Title IX Coordinator per University Policy on Sexual Harassment and Other Sexual Misconduct.

If you wish to speak with someone confidentially, please contact one of UMD's confidential resources, such as CARE to Stop Violence (located on the Ground Floor of the Health Center) at 301-741-3442 or the Counseling Center (located at the Shoemaker Building) at 301-314-7651.

You may also seek assistance or supportive measures from UMD's Title IX Coordinator, Angela Nastase, by calling 301-405-1142, or emailing titleIXcoordinator@umd.edu.

To view further information on the above, please visit the Office of Civil Rights and Sexual Misconduct.

Basic Needs Security

If you have difficulty affording groceries or accessing sufficient food to eat every day, or lack a safe and stable place to live, please visit UMD's Division of Student Affairs website for information about resources the campus offers you and let me know if I can help in any way.

Veteran Resources

UMD provides some additional supports to our student veterans. You can access those resources at the office of Veteran Student life and the Counseling Center. Veterans and active duty military personnel with special circumstances (e.g., upcoming deployments, drill requirements, disabilities) are welcome and encouraged to communicate these, in advance if possible, to the instructor.