IE 549: Machine Vision In Intelligent Robotic Systems
Spring 2026 SEMESTER
DUDL 3465

INSTRUCTOR: Dr. Juan P. Wachs Grissom Hall 262 Tel: 49-67380 jpwachs@purdue.edu
CLASSES: T-TH 9am –10:15am Dudley Hall 3465
OFFICE HOURS: Tuesdays 4:15-5:00 PM, Grissom Hall 262

COURSE TEXTBOOK:
Foundations of Computer Vision. Antonio Torralba, Phillip Isola, and William T. Freeman. Publisher: The MIT Press

ADDITIONAL TEXTBOOKS AND RESOURCES:
Image Processing, Analysis and Machine Vision. Milan Sonka, Vaclav Hlavac, Roger Boyle, Publisher: Thomson, Third Edition, 2008.
Digital Image Processing. Rafael Gonzalez, Richard Woods. Publisher: Pearson. Third Edition 2008
Robotics, vision and control: fundamental algorithms in MATLAB. Corke, Peter. Vol. 73. Springer, 2011.
Computer vision: a modern approach. Forsyth, David A., and Jean Ponce. Prentice Hall Professional Technical Reference, 2002.
Learning OpenCV Computer Vision with the OpenCV Library. Gary Bradski, Adrian Kaehler. Publisher O'Reilly Media, 2008.
OpenCV University: https://opencv.org/get-started/
PCL - Point Cloud Library (PCL): http://pointclouds.org/

PREREQUISITE:
Linear Algebra, Probability, Introduction to Programming (C, Python and Matlab)

COURSE DESCRIPTION:
IE 549 introduces students to robotics, machine vision from a human-machine interaction standpoint. The course focuses on applying techniques from machine vision to the design of cybernetic systems with humans in through lectures, readings, hands-on-tools, discussions, and team projects.

In addition to the basic principles of machine vision and relevant literature, the course will explore some ways in which it has been applied to human-robot interaction, and the involved challenges and opportunities that this presents. The students will learn the practical details of how computer vision methods can be used effectively in robotics through applications tools.

COURSE OBJECTIVES:
1. Overview of machine vision research as it relates to robotics.
2. Teach students how to apply computer vision techniques for interface between users and robots.
3. Develop the critical thinking elements to build useful applications based on computer vision.

COURSE ASSIGNMENTS:
Readings: Each lecture topic will be linked to a reading assignment. Students should complete the reading assignment before the lecture and be prepared to discuss and participate in the class about the readings.
Individual Assignments: Three individual home works are assigned during the semester. Some of these assignments have a written section and an implementation section. The written section requires thought, self-study and problem solving. The implementation sections are small projects that will allow students to become familiar with various machine vision techniques and programming tools.
Project Assignments: During the second half of the semester, students will form teams and implement a working prototype of a machine vision-based interface. The project design includes four milestones: an initial written project proposal, the design and implementation, and a final presentation with a written report.

Laboratories: during the semester, the students will be required to complete a number of laboratories requiring them to solve some real challenge in computer vision. The labs require individual work, and do not involve a frontal lecture.
Mini-homeworks: By the end of every class one min-homework will be presented. This are short programming questions, and usually are small variations of existing solutions on the web. Solving these usually takes about 20 to 30 minutes at most.

GENERAL INFORMATION
Since the homework and/or projects may require special software and hardware, they can be done at the intelligent systems and assistive technologies lab, DUDL 3477. The lab spaces are limited to 6 stations, and therefore, time slots need to be agreed with the instructor beforehand.

A term project will be conducted in teams of two students per project group. The purpose of the project is to design and implement a human-machine interface using machine vision algorithms. Students can decide to which group they want to be assigned, otherwise those students without a group will need to address the instructor to be assigned to a new group. Each group will select a specific topic and conduct a project during the semester. The result of this work will be reflected in a written report, an oral presentation and optionally a conference paper. **Successful completion of a conference paper to a major robotics, computer vision or human computer interfaces will result in a significant bonus to the final score**.

COURSE POLICIES

GRADING: The final grade will be based on the total number of points earned during the semester. The general policy will be approximately 90% for an A, 80% for a B, etc. However, the final scores might be adjusted at the prerogative of the course instructor. Each homework assignment and final project will be graded on the basis of 100 points but will be assigned different weights in terms of the final grade. The specific range of scores for the assignment of letter grades will not be designated at the onset of the course. The conventional A through F grading scale will be used without the plus and minus option. Class evaluation is part of the class participation.

The weighting procedure for determining final letter grades will be as follows:

Homework (3)	30%
Project (phase 1+2+3)	20%
Oral presentation	10%
Participation	10%
Report	10%
Mini-homeworks	10% (check)
Lab completion	10% (check)
TOTAL	100%

CLASS CONDUCT: Class conduct is expected to conform to the Student Code of Honor. The commitment of the acts of cheating, stealing, and deceit in any of their diverse forms will not be tolerated. Plagiarism, copying during examinations, the use of substitutes for taking examinations, illegal cribs, and ghost-written papers are considered serious acts of dishonesty. Knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest

GRADE CORRECTIONS: A given paper (homework or project), can be submitted for re-grading if it appears that insufficient credit was received. In order to request a re-grade:

1) On the back of the paper, indicate which items should be reviewed and briefly state why additional credit should be given. (For example: Problem 9, page 3 – According to the text…). The final grade of the paper can be higher, equal or even lower than the original grade.
2) The paper must be submitted to the laboratory instructor ***within one week*** of the date that the paper was returned. Papers will not be re-graded after the one-week deadline.

LATE ASSIGNMENTS: Students are expected to complete all assignments and turn them in on the due date. Late assignments will not be accepted unless accompanied by a valid excuse and some points might be deducted depending upon the circumstances.

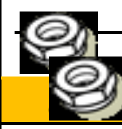
EMERGENCY PREPAREDNESS

EMERGENCY NOTIFICATION PROCEDURES are based on a simple concept – if you hear a fire alarm inside, proceed outside. If you hear a siren outside, proceed inside.

- **Indoor Fire Alarms** mean to stop class or research and immediately **evacuate** the building.
  - Proceed to your Emergency Assembly Area away from building doors. **Remain outside** until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave.

- **All Hazards Outdoor Emergency Warning Sirens** mean to immediately seek shelter (**Shelter in Place**) in a safe location within the closest building. o "Shelter in place" means seeking immediate shelter inside a building or University residence. This course of action may need to be taken during a tornado, a civil disturbance including a shooting or release of hazardous materials in the outside air. Once safely inside, find out more details about the emergency*. **Remain in place** until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave.

**In both cases, you should seek additional clarifying information by all means possible…Purdue Home page, email alert, TV, radio, etc…review the Purdue Emergency Warning Notification System multi-communication layers at http://www.purdue.edu/ehps/emergency_preparedness/warning-system.html*

Week	Class #	Day	Date	Class Chapter	Lecture Topic	Paper Readings	Book
1	1	T	13-Jan	Introduction	Course Information, Goals, Schedule, etc		Gonzales
	2	TH	15-Jan		Basics of image representation, Bias and Ethics		Gonzales
2	4	T	20-Jan	Image Processing I	Sampling , Quantization, Enhancement		Gonzales
	5	TH	22-Jan		Filters & colors & features		Gonzales
3	6	T	27-Jan		Filters & Convolutions		Sonka
	7	TH	29-Jan	Explain project proposal	Descriptors and Moments		Sonka
4	8	T	3-Feb	Team Registration	Edge Detection and Blob Detectors		Forsyth
	9	TH	5-Feb		Correlation and Template matching		Forsyth
5	10	T	10-Feb	Homework 1 - Out	SIFT and Pyramids		Sonka
	11	TH	12-Feb	Project proposal	Background Segmentation		Sonka
6	12	T	17-Feb	Project Phase 1 - Out	Dynamic Background Segmentation		Gonzales
	13	TH	19-Feb	Homework 1 due	RANSAC, Tracking and Gaussian Splatting		
7	14	T	24-Feb	Homework 2 - Out	**Using the Kinect (Laboratory)**	Self Study	S
	15	TH	26-Feb	Project phase 1 - Due	Alignment		Sonka
8		T	3-Mar	**Learning**	Fundamentals of 3D Vision		
	16	TH	5-Mar	Learning	Learning by Clustering	Fails02	Bishop
9	17	T	10-Mar	Project Phase 2 - Out	Support Vector Machines		Bishop
	18	TH	12-Mar	Homework 2 due	Neural networks		Bishop
10		T	17-Mar		SPRING BREAK		
		TH	19-Mar		SPRING BREAK		
11	21	T	24-Mar	Homework 3 - Out	Forward and Inverse Kinematics		
	22	TH	26-Mar	Project Phase 2 due	**Robotic Arm control (Laboratory)**	Self Study	
12	23	T	31-Mar		Neural networks		Corke
	24	TH	2-Apr		Neural networks II		Corke
13	25	T	7-Apr		Autoencoders and Contrastive Learning		Torralba
	26	TH	9-Apr	Project update	Generative Models		Torralba
14	27	T	14-Apr	Homework 3 due	Transformers		Torralba
		TH	16-Apr		Transformers II		Torralba
15	28	T	21-Apr		Project Presentations		
	29	TH	23-Apr		Project Presentations		
16	30	T	28-Apr		Project Presentations		Demo
	31	TH	30-Apr	Full project due	Project Presentations/ LAST CLASS		Demo