

**Credit Hours:** 3

**Contact Hours:** This is a 3-credit course, offered in accelerated format. This means that 16 weeks of material is covered in 8 weeks. The exact number of hours per week that you can expect to spend on each course will vary based upon the weekly coursework, as well as your study style and preferences. You should plan to spend 14-20 hours per week in each course reading material, interacting on the discussion boards, writing papers, completing projects, and doing research.

**Faculty Information:** Faculty contact information and office hours can be found on the faculty profile page.

---

## COURSE DESCRIPTION AND OUTCOMES

---

### Course Description:

This course provides an introduction to the basic concepts in computer vision.

### Course Overview:

Computer Vision will provide an overview and introduction to the basic concepts in computer vision. Students will develop an understanding of low-level image analysis methods, including image formation, edge detection, feature detection, and image segmentation. Additional emphasis will be on Image transformations (e.g., warping, morphing, and mosaics) for image synthesis, methods for reconstructing three-dimensional scene information using techniques such as depth from stereo, structure from motion, and shape from shading. Motion and video analysis, as well as three-dimensional object recognition will also be discussed.

### Course Learning Outcomes:

1. Understand the mathematical tools used in digital image processing and computer vision.
2. Identify basic concepts, terminology, theories, models and methods in the field of computer vision.
3. Describe basic methods of computer vision related to multi-scale representation.
4. Describe edge detection and detection of other primitives, stereo, motion and object recognition.
5. Assess various methods used for solving a given problem.
6. Analyze the accuracy of several problem-solving methods.

---

## PARTICIPATION & ATTENDANCE

---

Prompt and consistent attendance in your online courses is essential for your success at CSU-Global Campus. Failure to verify your attendance within the first 7 days of this course may result in your withdrawal. If for some reason you would like to drop a course, please contact your advisor.

Online classes have deadlines, assignments, and participation requirements just like on-campus classes. Budget your time carefully and keep an open line of communication with your instructor. If you are having technical problems, problems with your assignments, or other problems that are impeding your progress, let your instructor know as soon as possible.

---

## COURSE MATERIALS

---

### Required:

Davies, E.R. (2017). *Computer vision principles, applications, algorithms, learning* (5th ed.). Academic Press, London: Elsevier. ISBN 9780128092842

---

## COURSE SCHEDULE

---

### Due Dates

The Academic Week at CSU-Global begins on Monday and ends the following Sunday.

- **Discussion Boards:** The original post must be completed by Thursday at 11:59 p.m. MT and peer responses posted by Sunday at 11:59 p.m. MT. Late posts may not be awarded points.
- **Opening Exercises:** Take the Opening Exercise before reading each week's content to see which areas you will need to focus on. You may take these exercises as many times as you need. The Opening Exercises will not affect your final grade.
- **Mastery Exercises:** Students may access and retake Mastery Exercises through the last day of class until they achieve the scores they desire.
- **Critical Thinking:** Assignments are due Sunday at 11:59 p.m. MT.

---

## WEEKLY READING AND ASSIGNMENT DETAILS

---

### Module 1

#### Readings

- Chapter 2 in *Computer Vision Principles, Applications, Algorithms, Learning*
- Pantels, T. (2016). What is OpenCV? Retrieved from <https://www.lynda.com/Inspector-XE-tutorials/What-OpenCV/542425/570779-4.html>
- Smith, K., Dong, C. Naghedolfeizi, M., and Zeng, X. (2018). Detail preservation of morphological operations through image scaling. *Proceedings of the ACMSE 2018 Conference*. ACM, Article 20. Retrieved
- Weinman, B. (2018). Installing Python on Komodo on Windows. <https://www.lynda.com/Python-tutorials/Installing-Python-Komodo-Windows/614299/687475-4.html>
- Weinman, B. (2018). Installing Python on Komodo on a Mac. Retrieved from <https://www.lynda.com/Python-tutorials/Installing-Python-Komodo-Mac/614299/687474-4.html?org=csuglobal.edu>

**Opening Exercise (0 points)**

**Discussion (25 points)**

### **Critical Thinking (30 points)**

Choose one of the following two assignments to complete this week. Do not do both assignments. Identify your assignment choice in the title of your submission.

#### **Option #1: Sequential Operations**

So far, we have looked at the operations geared towards grayscale images. You may have realized in your readings that most of the operations that we discussed started with an image in one space and finished with an image in a different space. However, as your book indicated, many of the operations will not work satisfactorily if we do not use separate input and output spaces in this way.

For this assignment, you will discuss the reasons behind it, with special emphasis on sequential operations.

In your answer, specifically think of and give a real-life scenario where:

- Sequential Operations can be applied
- The benefits of applying sequential operations are demonstrated.

Your paper should meet the following requirements:

- Be two pages in length, not including an APA title page and APA reference page.
- Include at least one reference from the readings or an outside source. The CSU-Global Library is a good place to find your sources.
- Follow the CSU-Global Guide to Writing and APA.

#### **Option #2: Parallel Operations**

So far, we have looked at the operations geared towards grayscale images. You may have realized in your readings that most of the operations that we discussed started with an image in one space and finished with an image in a different space. However, as your book indicated, many of the operations will not work satisfactorily if we do not use separate input and output spaces in this way.

For this assignment, you will discuss the reasons behind it with special emphasis on parallel operations.

In your answer, specifically think of and give a real-life scenario where:

- Parallel Operations can be applied
- The benefits of applying parallel operations are demonstrated.

Your paper should meet the following requirements:

- Be two pages in length, not including an APA title page and APA reference page.
- Include at least one reference from the readings or an outside source. The CSU-Global Library is a good place to find your sources.
- Follow the CSU-Global Guide to Writing and APA.

### **Mastery Exercise (10 points)**

## **Module 2**

### **Readings**

- Chapter 3 in *Computer Vision Principles, Applications, Algorithms, Learning*

- Gupta, A., & Singhal, D. (2018). Analytical global median filtering forensics based on moment histograms. *ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM)*, 14(2), 1-23.

### Opening Exercise (0 points)

### Discussion (25 points)

### Critical Thinking (60 points)

Choose one of the following two assignments to complete this week. Do not do both assignments. Identify your assignment choice in the title of your submission.

#### Option #1: Median Filter

This week's discussion has provided an introduction to working with image filtering and morphology, particularly with respect to filters. One of these filters is median. Complete the following problem, as described under 3.17 problems:

Draw up a table showing the numbers of operations required to implement a median filter in various sizes of the neighborhood. Include in your table (1) results for a straight bubble sort of all  $n^2$  pixels, (2) results for bubble sorts in separated  $1 \times n$  and  $n \times 1$  neighborhoods, and (3) results for the histogram method of Section 3.3. Discuss the results, taking account of possible computational overheads.

In your answer, specifically think of and give a real-life scenario where:

- The median filters can be utilized
- Median filters play practical role.

Your paper should meet the following requirements:

- Be two pages in length (screenshots), not including an APA title page and APA reference page.
- Include at least one reference from the readings or an outside source. The CSU-Global Library is a good place to find your sources.
- Follow the CSU-Global Guide to Writing and APA.

#### Option #2: Median Filter on Binary Image

This week's discussion has provided an introduction to working with image filtering and morphology, particularly with respect to filters. One of these filters is median. Complete the following problem as described under 3.17 problems:

Show how to perform a median filtering operation on a binary image. Show, also, that if a set of binary images is formed by thresholding a grayscale image at various levels, and each of these binary images is median filtered, then a grayscale image can be reconstructed which is a median filtered version of the original grayscale image. Consider to what extent the reduced amount of computation in filtering a binary image compensates for the number of separate thresholded images to be filtered.

In your answer, specifically think of and give a real-life scenario where:

- The median filters can be utilized
- Median filters play practical role.

Your paper should meet the following requirements:

- Be two pages in length (screenshots if necessary), not including an APA title page and APA reference page.

- Include at least one reference from the readings or an outside source. The CSU-Global Library is a good place to find your sources.
- Follow the CSU-Global Guide to Writing and APA.

### **Mastery Exercise (10 points)**

## **Module 3**

### **Readings**

- Chapter 5 in *Computer Vision Principles, Applications, Algorithms, Learning*
- Wardhani Mega, K. Yu, X., and Li, J. (2018). Comparative analysis of color edge detection for image segmentation. *Proceedings of the 2018 International Conference on Computing and Pattern Recognition*, 93-101.

### **Opening Exercise (0 points)**

### **Discussion (25 points)**

### **Critical Thinking (70 points)**

Choose one of the following two assignments to complete this week. Do not do both assignments. Identify your assignment choice in the title of your submission.

#### **Option #1: Canny Operator**

This week's discussion has provided an introduction to edge detection, particularly with respect to various detection operators. In this assignment, you will discuss and provide implementation (using Python, Matlab, or OpenCV) for Canny Edge Detection Operator, one of the most popular in the field.

In your answer, specifically think of and give a real-life scenario where:

- Canny Operator is or may be used
- Canny Operator solves a real world problem.

In your program:

- Include screenshots of your working program
- Submit all the source files of your working program.

Your paper should meet the following requirements:

- Be two pages in length (screenshots, if necessary), not including an APA title page and APA reference page.
- Include at least one reference from the readings or an outside source. The CSU-Global Library is a good place to find your sources.
- Follow the CSU-Global Guide to Writing and APA.

#### **Option #2: Laplacian Operator**

This week's discussion has provided an introduction to edge detection, particularly with respect to various detection operators. In this assignment, you will discuss and provide implementation (using Python, Matlab, or OpenCV) for Laplacian Edge Detection Operator.

In your answer, specifically think of and give a real-life scenario where:

- Laplacian Operator is or may be used
- Laplacian Operator solves a real world problem.

In your program:

- Include screenshots of your working program
- Submit all the source files of your working program.

Your paper should meet the following requirements:

- Be two pages in length (screenshots, if necessary), not including an APA title page and APA reference page.
- Include at least one reference from the readings or an outside source. The CSU-Global Library is a good place to find your sources.
- Follow the CSU-Global Guide to Writing and APA.

### **Mastery Exercise (10 points)**

## **Module 4**

### **Readings**

- Chapter 6 in *Computer Vision Principles, Applications, Algorithms, Learning*
- Jia, Q, Wang, X., and Zhou, L. (2017). Convolutional features with Unsupervised Feature Learning for interest point detection and patch description. *Proceedings of the 2017 International Conference on Artificial Intelligence, Automation and Control Technologies*, Article 25.

### **Opening Exercise (0 points)**

### **Discussion (25 points)**

### **Critical Thinking (70 points)**

Choose one of the following two assignments to complete this week. Do not do both assignments. Identify your assignment choice in the title of your submission.

#### **Option #1: Harris Interest Point Operator**

This week's discussion has provided an introduction to Corner, Interest Point, and Invariant Feature Detection, particularly with respect to Harris Interest Point Detection Operator. In this assignment, you will discuss and provide implementation (using Python, Matlab, or OpenCV) for Harris Interest Point Detection Operator.

In your answer, specifically think of and give a real-life scenario where:

- Harris Interest Point Detection Operator is or may be used
- Harris Interest Point Detection Operator solves a real world problem.

In your program:

- Include screenshots of your working program
- Submit all the source files of your working program.

Your paper should meet the following requirements:

- Be two pages in length (screenshots, if necessary), not including an APA title page and APA reference page.
- Include at least one reference from the readings or an outside source. The CSU-Global Library is a good place to find your sources.
- Follow the CSU-Global Guide to Writing and APA.

#### **Option #2: Local Invariant Feature Detectors**

This week's discussion has provided an introduction to Corner, Interest Point, and Invariant Feature Detection, particularly with respect to Local Invariant Feature Detectors. In this assignment, you will

discuss and provide implementation (using Python, Matlab, or OpenCV) for local invariant feature detector of your choice.

In your answer, specifically think of and give a real-life scenario where:

- Local invariant feature detector of your choice is or may be used
- Local invariant feature detector of your choice solves a real world problem.

In your program:

- Include screenshots of your working program
- Submit all the source files of your working program.

Your paper should meet the following requirements:

- Be two pages in length (screenshots, if necessary), not including an APA title page and APA reference page.
- Include at least one reference from the readings or an outside source. The CSU-Global Library is a good place to find your sources.
- Follow the CSU-Global Guide to Writing and APA.

### **Mastery Exercise (10 points)**

## **Module 5**

### **Readings**

- Chapter 9 in *Computer Vision Principles, Applications, Algorithms, Learning*
- Zhang, Q., Lu, X., and Yuan, Y. (2018). Enhancing boundary for video object segmentation. *Proceedings of the 2nd International Conference on Vision, Image and Signal Processing*, 10.

### **Opening Exercise (0 points)**

### **Discussion (25 points)**

### **Critical Thinking (70 points)**

Choose one of the following two assignments to complete this week. Do not do both assignments. Identify your assignment choice in the title of your submission.

#### **Option #1: Centroidal Approach Problems**

This week's discussion has provided an introduction to working with boundary pattern analysis, particularly with respect to centroids related issues. There are four of these issues, to be exact. In this assignment, you will briefly research in addition to reading about these issues and then discussed them in detail giving sketches/illustration as needed:

In your answer, specifically think of and give a real-life scenario where:

- The issues are most prevalence
- The issues are less prevalence.

Your paper should meet the following requirements:

- Be two pages in length (screenshots, if necessary), not including an APA title page and APA reference page.
- Include at least one reference from the readings or an outside source. The CSU-Global Library is a good place to find your sources.
- Follow the CSU-Global Guide to Writing and APA.

### **Option #2: Centroidal Approach**

This week's discussion has provided an introduction to working with boundary pattern analysis, particularly with respect to centroids. In this assignment, you will briefly research, in addition to reading about centroids, and then discuss them in detail, giving sketches as needed:

In your answer, specifically think of and give a real-life scenario where:

- The centroids are most prevalence
- The centroid are less prevalence.

Your paper should meet the following requirements:

- Be two pages in length (screenshots, if necessary), not including an APA title page and APA reference page.
- Include at least one reference from the readings or an outside source. The CSU-Global Library is a good place to find your sources.
- Follow the CSU-Global Guide to Writing and APA.

### **Mastery Exercise (10 points)**

### **Portfolio Milestone (25 points)**

In your first four CTAs, chances are you missed a concept and did not earn all the possible points. This is an opportunity to correct any mistakes you may have made in the previous CTAs. Go back and make the appropriate corrections to one program of your choosing and resubmit your programs with corrections (if necessary) that reflect feedback from your instructor. If no corrections are necessary, resubmit one program anyway and indicate that to your instructor.

## **Module 6**

### **Readings**

- Chapter 10 in *Computer Vision Principles, Applications, Algorithms, Learning*
- Xu, H., Yu, Z., & Yang, J. (2016). Talent circle detection in job transition networks. *Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*.

### **Opening Exercise (0 points)**

### **Discussion (25 points)**

### **Critical Thinking (70 points)**

Choose one of the following two assignments to complete this week. Do not do both assignments. Identify your assignment choice in the title of your submission.

### **Option #1: Diameter Bisection Method**

This week's discussion has provided an introduction to line, circle, and ellipse detection, particularly with respect to their applications. In this assignment, you will discuss the problem below as stated in your textbook:

It is found that the diameter bisection method sometimes becomes confused when several ellipses appear in the same image, and generates false "centers" that are not situated at the centers of any ellipses. It is also found that certain other shapes are detected by the diameter bisection method. Ascertain in each case quite what the method is sensitive to, and consider ways in which these problems might be overcome.

In your answer, specifically think of and give a real-life scenario where:

- The Diameter Bisection Method is most prevalence
- The Diameter Bisection Method is less prevalence.

Your paper should meet the following requirements:

- Be two pages in length (screenshots, if necessary), not including an APA title page and APA reference page.
- Include at least one reference from the readings or an outside source. The CSU-Global Library is a good place to find your sources.
- Follow the CSU-Global Guide to Writing and APA.

### **Option #2: Diameter Bisection Method Speed**

This week's discussion has provided an introduction to line, circle, and ellipse detection, particularly with respect to their applications. In this assignment, you will the problem below as stated in your textbook:

For the diameter bisection method, searching through lists of edge points with the right orientations can take excessive computation. It is suggested that a two-stage approach might speed up the process: (1) load the edge points into a table which may be addressed by orientation; (2) look up the right edge points by feeding appropriate orientations into the table. Estimate how much this would be likely to speed up the diameter bisection method.

In your answer, specifically think of and give a real-life scenario where:

- The diameter bisection method is most prevalent
- The diameter bisection method is less prevalent.

Your paper should meet the following requirements:

- Be two pages in length (screenshots, if necessary), not including an APA title page and APA reference page.
- Include at least one reference from the readings or an outside source. The CSU-Global Library is a good place to find your sources.
- Follow the CSU-Global Guide to Writing and APA.

### **Mastery Exercise (10 points)**

## **Module 7**

### **Readings**

- Chapter 13 in *Computer Vision Principles, Applications, Algorithms, Learning*
- Pan, L., Yao, Y. (2018). K-nearest neighbor regression with principal component analysis for financial time series prediction. *Proceedings of the 2018 International Conference on Computing and Artificial Intelligence*. ACM, 127-131.

### **Opening Exercise (0 points)**

### **Discussion (25 points)**

### **Mastery Exercise (10 points)**

### **Portfolio Milestone (25 points)**

In your last two Critical Thinking Assignments, chances are you missed a concept and did not earn all the possible points. This is an opportunity to correct any mistakes you may have made in Modules 5 and 6 CTAs. Go back and make the appropriate corrections to both CTAs and resubmit your programs with

corrections (if necessary) that reflect feedback from your instructor. If no corrections are necessary, resubmit them anyway and indicate that to your Instructor.

## **Module 8**

### **Readings**

- Chapters 14 & 15 in *Computer Vision Principles, Applications, Algorithms, Learning*
- Thomas, C., Nair, N., and Jayagopi, D. (2018). Predicting engagement intensity in the wild using temporal convolutional network. *Proceedings of the 20th ACM International Conference on Multimodal Interaction*, 604-610.

### **Discussion (25 points)**

### **Mastery Exercise (10 points)**

### **Portfolio Project (300 points)**

Your Portfolio Project for CSC415 consists of the following:

- Module 5 Milestone (due in Module 5)
- Module 7 Milestone (due in Module 7)
- Lessons Learned Reflection (from all Modules)
- Final Program/CTA

In Week 8, the components left to complete for your Portfolio Project are the **Lessons Learned Reflection** and the **Final Program**. Carefully review the requirements below:

#### **Lessons Learned Reflection:**

Write a two- to three-page summary that outlines the lessons you have learned in this course. Reflect on how these lessons can be applied to a real-world problem or to specific real application.

#### **Final Program:**

Using Matlab or any other language/library your Instructor recommends (OpenCV, or Python for example), Implement 1D Gaussian smoothing using convolution. Apply 1D Gaussian convolution on the 1D data of your creation (see the format below).

```
0.00000000
0.00000000
0.00000000
1.00000000
1.00000000
1.00000000
```

Clearly provide the details of your program, including the screenshots of your working program.

- Describe the language/environment you are working with.
- Adequately comment your source code.

Assemble your Lessons Learned Reflection, your source code, and screenshots of the application executing and results into a single document. Submit your completed Portfolio Project by the posted due date.

#### **Portfolio Project Option #2**

Your Portfolio Project for CSC415 consists of the following:

- Module 5 Milestone (due in Module 5)
- Module 7 Milestone (due in Module 7)
- Lessons Learned Reflection (from all Modules)
- Final Program/CTA

In Week 8, the components left to complete for your Portfolio Project are the **Lessons Learned Reflection** and the **Final Program**. Carefully review the requirements below:

**Lessons Learned Reflection:**

Write a two- to three-page summary that outlines the lessons you have learned in this course. Reflect on how these lessons can be applied to a real-world problem or to specific real application.

**Final Program:**

Using Matlab or any other language/library your Instructor recommends (OpenCV, or Python for example), implement 2D Gaussian convolution. Consult Gaussian masks code (for possible extension) snippet here. Then apply the 2D Gaussian convolution using 2D masks on the Lenna image using  $\sigma=1, 5,$  and 11. Show and discuss your results.

Clearly provide the details of your program, including the screenshots of your working program.

- Describe the language/environment you are working with.
- Adequately comment your source code.

Assemble your Lessons Learned Reflection, your source code, and screenshots of the application executing and results into a single document. Submit your completed Portfolio Project by the posted due date.

---

## COURSE POLICIES

---

Grading Scale	
A	95.0 – 100
A-	90.0 – 94.9
B+	86.7 – 89.9
B	83.3 – 86.6
B-	80.0 – 83.2
C+	75.0 – 79.9
C	70.0 – 74.9
D	60.0 – 69.9
F	59.9 or below

### Course Grading

20% Discussion Participation

0% Opening Exercises

8% Mastery Exercises

37% Critical Thinking Assignments

35% Final Portfolio Project

---

## IN-CLASSROOM POLICIES

---

For information on late work and incomplete grade policies, please refer to our [In-Classroom Student Policies and Guidelines](#) or the Academic Catalog for comprehensive documentation of CSU-Global institutional policies.

### **Academic Integrity**

Students must assume responsibility for maintaining honesty in all work submitted for credit and in any other work designated by the instructor of the course. Academic dishonesty includes cheating, fabrication, facilitating academic dishonesty, plagiarism, reusing /repurposing your own work (see CSU-Global Guide to Writing & APA for percentage of repurposed work that can be used in an assignment), unauthorized possession of academic materials, and unauthorized collaboration. The CSU-Global Library provides information on how students can avoid plagiarism by understanding what it is and how to use the Library and internet resources.

### **Citing Sources with APA Style**

All students are expected to follow the CSU-Global Guide to Writing & APA when citing in APA (based on the most recent APA style manual) for all assignments. A link to this guide should also be provided within most assignment descriptions in your course.

### **Disability Services Statement**

CSU-Global is committed to providing reasonable accommodations for all persons with disabilities. Any student with a documented disability requesting academic accommodations should contact the Disability Resource Coordinator at 720-279-0650 and/or email [ada@CSUGlobal.edu](mailto:ada@CSUGlobal.edu) for additional information to coordinate reasonable accommodations for students with documented disabilities.

### **Netiquette**

Respect the diversity of opinions among the instructor and classmates and engage with them in a courteous, respectful, and professional manner. All posts and classroom communication must be conducted in accordance with the student code of conduct. Think before you push the Send button. Did you say just what you meant? How will the person on the other end read the words?

Maintain an environment free of harassment, stalking, threats, abuse, insults, or humiliation toward the instructor and classmates. This includes, but is not limited to, demeaning written or oral comments of an ethnic, religious, age, disability, sexist (or sexual orientation), or racist nature; and the unwanted sexual advances or intimidations by email, or on discussion boards and other postings within or connected to the online classroom. If you have concerns about something that has been said, please let your instructor know.