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# Multidimensional Digital Signal Processing

## ECG782 Spring 21

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<http://www.egr.unlv.edu/~b1morris/ecg782>

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### Textbook

Digital Image Processing, Gonzalez and Woods, 3rd Edition

ISBN: 978031687288

### Recommended Text

Computer Vision: Algorithms and Applications, Szelisk [pdf]

ISBN: 1848829345

Image Processing, Analysis, and Machine Vision, 4th Edition,  
Sonka, Hlavac, and Boyle

ISBN: 9781133593607

### Grading

Project:	25%	Sat 5/15
Final:	25%	W 5/12
Midterm:	20%	W 03/10
Homework:	15%	Weekly
Presentation	10%	M 05/03
Participation:	5%	Weekly

- Students may study together in groups but all assignments must be completed individually. Homework will be due via Webcampus (Canvas) on designated date. No late homework will be accepted unless prior notification and arrangements are made.
- Class participation will be recorded through online “quizzes” each week. These are high-level concept questions that are designed to ensure you can identify any material that requires further study.
- The course will have a final computer vision project. You will be required to submit a project report in the form of a conference styled manuscript for publication and make a presentation.
- Exams are cumulative but will emphasize new material.
- Exams should be i) completed by you alone ii) without the use of any books or reference material other than explicitly allowed iii) without access to internet outside of Webcampus and iv) should not be discussed with any other student until after the exam is closed.
- NOTE: Homework and exams will be submitted online via Webcampus. You must obtain tools to scan or make pdf images of your work.

### Catalog Description

Theory and applications of multidimensional (M-D) digital signal processing. M-D signals and systems. M-D z-transform. M-D DFT and FFT. Design and implementation of M-D FIR and IIR filters. Applications to image processing such as image enhancement and restoration. Advanced topics chosen according to class interests.

**Prerequisites:** None

### Course Description

Introductory graduate course in computer vision, machine learning, and pattern recognition with real-time systems. The course will be divided into two parts: image and video processing. Image processing topics will include image formation, morphology and connected components, feature detection and representation, segmentation, and stereo imaging. Video processing techniques will focus on motion estimation, tracking, and object detection and recognition.

The course will have programming homework assignments and a final project. Readings will be assigned in from the textbook as well as recent papers from top academic publications.

Programming assignments will make use of popular vision tools such as Matlab, OpenCV, and Tensorflow.

## Topics

### Image Processing

1. Image Formation - geometric primitives, camera model, digital imaging (sampling and quantization)
2. Image Processing - point operations, color transformations, histogram equalization, spatial image enhancement and filtering, frequency domain processing, connected components, morphology, multi-resolution pyramids
3. Feature Detection and Representation - corner detectors, invariant features (SIFT, SURF), HoG, edge detection, Canny edge-detector, non-maximal suppression, Hough transform, RANSAC
4. Segmentation - thresholding, region-based segmentation, split-and-merge, mean-shift, graph cuts

### Video Processing

1. Motion Estimation - optical flow, background modeling, mixture of Gaussians
2. Object Detection - nearest neighbor classification, correlation, Adaboost classifier, SVM
3. Object Recognition - Bayes classifier, Eigenfaces and Fisher faces, bag of words
4. Tracking - Kalman filter, particle filters, Condensation tracking, Mean-Shift tracking, multiple target tracking, feature tracking

### Deep Learning

1. Mathematical fundamentals - neural networks, convolutional neural networks (CNN)
2. Network architectures for classification, detection, segmentation

Additional course material not present in the textbook will be distributed to the class when needed. Extra examples and problems can be found in the recommended texts.

## Course Outcomes

Upon completion of this course:

- Students will have a clear understanding of image processing and computer vision fundamentals as well as the challenges.
- Students will be able to design and implement computer vision algorithms for real-time video processing.
- Students will have an overview of deep learning for vision.
- Students will be able to design and implement deep CNN networks for computer vision applications.
- Students will be able to search for and read academic papers and critically evaluate their importance.

- Students will be able to present technical material orally in a clear and concise manner.

**Course Policies**

- There will be no make-up exams or late homework without prior arrangements.
- Extensions will only be granted for medical emergencies or due to the observance of a religious holiday. The instructor must be notified of the absence prior to the last day of late registration.
- As a university student it is your responsibility to conduct yourself ethically and with integrity as described in the Academic Misconduct Policy. Cheating and plagiarism will not be tolerated. Any student caught cheating will be given an F grade.  
(<https://www.unlv.edu/studentconduct/student-conduct>)



Instructors are required to include the academic policies listed below in the syllabi for their courses, perhaps under a section entitled University Policies. This document is posted on the [University Policies](https://www.unlv.edu/about/policies/current-policies) webpage, <https://www.unlv.edu/about/policies/current-policies>, in the Executive Vice President and Provost section, under Academic Year Memos. Please address questions to Javier A. Rodríguez, Vice Provost for Academic Programs, [javier.rodriquez@unlv.edu](mailto:javier.rodriquez@unlv.edu).

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### **Public Health Directives**

[Face coverings are mandatory for all faculty and students in the classroom](#). Students must follow all active UNLV public health directives while enrolled in this class. [UNLV public health directives](https://www.unlv.edu/coronavirus/health-requirements) are found at <https://www.unlv.edu/coronavirus/health-requirements>. Students who do not comply with these directives may be asked to leave the classroom. Refusal to follow the guidelines may result in further disciplinary action according to the [UNLV Student Conduct Code](#), [https://www.unlv.edu/sites/default/files/page\\_files/27/StudentConduct-Code.pdf](https://www.unlv.edu/sites/default/files/page_files/27/StudentConduct-Code.pdf), including being administratively withdrawn from the course.

### **Academic Misconduct**

Academic integrity is a legitimate concern for every member of the University community. We all share in upholding the fundamental values of honesty, trust, respect, fairness, responsibility, and professionalism. By choosing to join the UNLV community, students accept the expectations of the Student Academic Misconduct Policy, and are encouraged to always take the ethical path whenever faced with choices. Students enrolling at UNLV assume the obligation to conduct themselves in a manner compatible with UNLV's educational mission. An example of academic misconduct is plagiarism. Plagiarism is using the words or ideas of another person, from the Internet or any other source without proper citation of the source(s). See the [Student Conduct Code](#), <https://www.unlv.edu/studentconduct/student-conduct>.

### **Auditing Classes**

Auditing a course allows a student to continue attending the lectures and/or laboratories and discussion sessions associated with the course, but the student will not earn a grade for any component of the course. Students who audit a course receive the same educational experience as students taking the course for a grade, but will be excused from exams, assessments, and other evaluative measures that serve the primary purpose of assigning a grade.

### **Classroom Conduct**

Students have a responsibility to conduct themselves in class and in the libraries in ways that do not interfere with the rights of other students to learn, or of instructors to teach. Use of devices such as pagers and cellular phones, or potentially disruptive activities are only permitted with the prior explicit consent of the instructor. Students are specifically prohibited to record classes without instructor authorization, including online/remote classes (either audio only, or video and audio). The instructor may rescind permission at any time during the class. If a student does not comply with established requirements or obstructs the functioning of the class, the instructor may initiate an administrative withdrawal of the student from the course.

Since the COVID-19 pandemic forced most instruction to be delivered remotely starting on March 2020, numerous students have asked instructors to record their synchronous classes, so that they can access them at their convenience. Instructors who agree to record their classes (audio only, or video and audio) should inform students in advance. Recorded lectures may not be broadly released to anyone, but made available exclusively to those students enrolled in the class during the particular academic term. Recorded lectures must be stored securely, and are subject to the Nevada System of Higher Education's Records Retention Policy, meaning that the recordings can only be deleted 120 days after the end of class (i.e., after grades are posted). Once this requirement is met, the recordings should be deleted. Class recordings are protected from disclosure, as they are deemed part of an educational record under the Family Educational Rights and Privacy Act (FERPA).

**Copyright**

The University requires all members of the University Community to familiarize themselves with, and to follow copyright and fair use requirements. You are individually and solely responsible for violations of copyright and fair use laws. The University will neither protect nor defend you, nor assume any responsibility for employee or student violations of fair use laws. Violations of copyright laws could subject you to federal and state civil penalties and criminal liability, as well as disciplinary action under University policies. Additional [copyright policy information](https://www.unlv.edu/provost/copyright) is available at <https://www.unlv.edu/provost/copyright>.

**Disability Resource Center (DRC)**

The [UNLV Disability Resource Center](https://www.unlv.edu/drc) (SSC-A, Room 143, <https://www.unlv.edu/drc>, telephone 702-895-0866) provides resources for students with disabilities. Students who believe that they may need academic accommodations due to injury, disability, or due to pregnancy should contact the DRC as early as possible in the academic term. A Disabilities Specialist will discuss what options may be available to you. If you are registered with the UNLV Disability Resource Center, bring your Academic Accommodation Plan from the DRC to the instructor during office hours, so that you may work together to develop strategies for implementing the accommodations to meet both your needs and the requirements of the course. Any information you provide is private and will be treated as such. To maintain the confidentiality of your request, please do not approach the instructor in front of others to discuss your accommodation needs.

**Final Examinations**

The University requires that final exams given at the end of a course occur on the date and at the time specified in the Final Exam schedule. The Final Exam schedule is typically available at the start of the semester, and the classroom locations are available approximately one month before the end of the semester. See the [Final Exam Schedule](https://www.unlv.edu/registrar/calendars), <https://www.unlv.edu/registrar/calendars>.

**Identity Verification in Online Courses**

All UNLV students must use their Campus-issued ACE ID and password to log in to WebCampus-Canvas.

UNLV students enrolled in online or hybrid courses are expected to read and adhere to the [Student Academic Misconduct Policy](https://www.unlv.edu/studentconduct/misconduct/policy), <https://www.unlv.edu/studentconduct/misconduct/policy>, which states that “acting or attempting to act as a substitute for another, or using or attempting to use a substitute, in any academic evaluation or assignment” is a form of academic misconduct. Intentionally sharing ACE login credentials with another person may be considered an attempt to use a substitute, and could result in investigation and sanctions, as outlined in the Student Academic Misconduct Policy.

UNLV students enrolled in online courses are also expected to read and adhere to the [Acceptable Use of Computing and Information Technology Resources Policy](https://www.it.unlv.edu/policies/acceptable-use-computing-and-information-technology-resources-policy), <https://www.it.unlv.edu/policies/acceptable-use-computing-and-information-technology-resources-policy>, which prohibits sharing university accounts with other persons without authorization.

To the greatest extent possible, all graded assignments and assessments in UNLV online courses should be hosted in WebCampus-Canvas or another UNLV-managed platform that requires ACE login credentials for access.

**Incomplete Grades**

The grade of “I” (Incomplete) may be granted when a student has satisfactorily completed three-fourths of course work for that semester/session, but cannot complete the last part of the course for reason(s) beyond the student’s control and acceptable to the instructor, and the instructor believes that the student can finish the course without repeating it. For undergraduate courses, the incomplete work must be made up before the end of the following regular semester. Graduate students receiving “I” grades in 500-, 600-, or 700-level courses have up to one calendar year to complete the work, at the discretion of the instructor. If course requirements are not completed within the period indicated, a grade of “F” will be recorded, and the student’s GPA will be adjusted accordingly. Students who are fulfilling an Incomplete grade do not register for the course, but make individual arrangements with the instructor who assigned the “I” grade.

**Library Resources**

Librarians are available to consult with students on research needs, including developing research topics, finding information, and evaluating sources. To make an appointment with a subject expert for this class, please visit the [Libraries’ Research Consultation](https://guides.library.unlv.edu/appointments/librarian) website, <https://guides.library.unlv.edu/appointments/librarian>. You can also [ask the library staff](https://ask.library.unlv.edu/) questions via chat and text message at <https://ask.library.unlv.edu/>.

**Missed Classwork**

Any student missing class, quizzes, examinations, or any other class or laboratory work because of observance of religious holidays will be given an opportunity during that semester to make up the missed work. The make-up opportunity will apply to the religious holiday absence only. It is the responsibility of the student to notify the instructor within the first 14 calendar days of the course for Fall and Spring courses (except for modular courses), or within the first 7 calendar days of the course for Summer and modular courses, of their intention to participate in religious holidays which do not fall on state holidays or periods of class recess. For additional information, please visit the Missed Classwork policy, under Registration Policies, on the [Academic Policies](https://catalog.unlv.edu/content.php?catoid=29&navoid=7326) webpage, <https://catalog.unlv.edu/content.php?catoid=29&navoid=7326>.

In accordance with the policy approved by the Faculty Senate regarding missed class time and assignments, students who represent UNLV in any official extracurricular activity will also have the opportunity to make up assignments, provided that the student provides official written notification to the instructor no less than one week prior to the missed class(es).

The spirit and intent of the policy for missed classwork is to offer fair and equitable assessment opportunities to all students, including those representing the University in extracurricular activities. Instructors should consider, for example, that in courses which offer a “Drop one” option for the lowest assignment, quiz, or exam, assigning the student a grade of zero for an excused absence for extracurricular activity is both contrary to the intent of the Faculty Senate’s policy, and an infringement on the student’s right to complete all work for the course.

This policy will not apply in the event that completing the assignment or administering the examination at an alternate time would impose an undue hardship on the instructor or the University that could be reasonably avoided. There should be a good faith effort by both the instructor and the student to agree to a reasonable resolution. When disagreements regarding this policy arise, decisions can be appealed to the Department Chair/School Director, College/School Dean, and/or the Faculty Senate Academic Standards Committee.

For purposes of definition, extracurricular activities may include, but are not limited to: academic recruitment activities, competitive intercollegiate athletics, fine arts activities, liberal arts competitions, science and engineering competitions, and any other event or activity sanctioned by a College/School Dean, and/or by the Executive Vice President and Provost.

**Rebelmail**

Rebelmail is UNLV's official email system for students and by University policy, instructors and staff should only send emails to students' Rebelmail accounts. Rebelmail is one of the primary ways in which students receive official University communications, information about deadlines, major Campus events, and announcements. All UNLV students receive a Rebelmail account after they have been admitted to the University. Emailing within WebCampus-Canvas is also acceptable.

**Tutoring and Coaching**

The Academic Success Center (ASC) provides tutoring, academic success coaching, and other academic assistance for all UNLV undergraduate students. For information regarding tutoring subjects, tutoring times, and other ASC programs and services, please visit the [ASC website](https://www.unlv.edu/asc), <https://www.unlv.edu/asc>, or call 702-895-3177. The ASC building is located across from the Student Services Complex (SSC). Academic success coaching is located on the second floor of SSC A, Room 254. Drop-in tutoring is located on the second floor of the Lied Library, and on the second floor of the College of Engineering building (TBE A 207).

**UNLV Writing Center**

One-on-one or small group assistance with writing is available free of charge to UNLV students at the [Writing Center](https://writingcenter.unlv.edu/), <https://writingcenter.unlv.edu/>, located in the Central Desert Complex, Building 3, Room 301 (CDC 3–301). Walk-in consultations are sometimes available, but students with appointments receive priority assistance. Students may make appointments in person or by calling the Center, telephone 702-895-3908. Students are requested to bring to their appointments their Rebel ID Card, a copy of the instructions for their assignment, and two copies of any writing they have completed on their assignment.

*Optional statement for inclusion in syllabi.*

**Diversity Statement**

As an institution of higher learning, UNLV represents a rich diversity of human beings among its faculty, staff, and students, and is committed to aspiring to maintain a Campus environment that values that diversity. Accordingly, the University supports understanding and appreciation of all members of its community, regardless of race, sex, age, color, national origin, ethnicity, creed, religion, disability, sexual orientation, gender, gender identity, marital status, pregnancy, genetic information, veteran status, or political affiliation. Please see [University Statements and Compliance](https://www.unlv.edu/about/statements-compliance), <https://www.unlv.edu/about/statements-compliance>.

A successful learning experience requires mutual respect and trust between the students and the instructor. Accordingly, the instructor asks that students be willing to listen to one another's points of view, acknowledging that there may be disagreements, keep discussion and comments on topic, and use first person, positive language when expressing their perspectives.