**6367**  **COMPUTER VISION**  **SPRING 2019**

**3 UNITS**

**Class Schedule:** Tuesday and Thursday 15:30-16:50, Room 208, Woolf Hall (WH)
**Section Information:** CSE 6367-001
**Instructor:** William Beksi
**Office:** ERB 523
**Phone:** 817-272-3602
**Email:** william.beksi@uta.edu
**Faculty Profile:** https://mentis.uta.edu/explore/profile/william-beksi
**Office Hours:** Tuesday and Thursday 14:00-15:00, ERB 523
**TA:** TBA
**TA Email:** TBA
**TA Office Hours:** TBA

# 1   Course Objective

The objective of this course is to provide an introduction to the fundamental concepts of computer vision - how to make computers make sense of images. Computer vision is studied in a bottom up fashion. At the lowest level, images are processed to obtain simple features (e.g. lines, edges). Then comes geometry in which these features are used to build 3D models of the environment. Next is mid-level vision in which features are grouped into segments or other salient regions. At the highest level is the problem of scene understanding.

This course is suitable for gaining a solid technical background and as a preparation for more advanced work in computer vision. Upon successful completion of the course the student will be able to:

- Learn about the basic tools and techniques for designing and analyzing computer vision algorithms.

- Gain hands-on experience in building computer vision systems.

- Understand the potential and current research challenges in computer vision.

# 2   Prerequisites

The student must be familiar with the basic concepts of calculus, linear algebra, and discrete math. If the student has not taken the equivalents of these courses, then they need permission from the instructor. The student also needs to have taken CSE 5301 or CSE 5360 or EE 5356 or EE 5357.

# 3  Textbook

There is no required textbook for the course. We will take a hands-on approach and combine lectures with MATLAB-based programming assignments.

# 4  Additional References (Not Required)

[1] R. Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011. ISBN: 1848829343

[2] R. Hartley and A. Zisserman, "Multiple View Geometry in Computer Vision", Cambridge University Press, 2nd Edition, 2004. ISBN: 0521540513

[3] D. Forsyth and J. Ponce, "Computer Vision: A Modern Approach", Pearson, 2nd Edition, 2011. ISBN: 013608592X

[4] S. J.D. Prince, "Computer Vision: Models, Learning, and Inference", Cambridge University Press, 2012. ISBN: 1107011793

# 5  Expectations

This course will cover a relatively large range of topics which rely on various background material. As a result, at times the current topic may be very challenging or rather basic. For example, dynamic programming may be easy to grasp for a student who has taken an advanced algorithms course. However, the same student may find projective geometry quite challenging. Here are some tips that may be helpful:

- Do not rely on a single source to learn the material. If the topic in one book does not make sense, then do not hesitate to review other books even basic texts such as a linear algebra book. If guidance is needed, then do not hesitate to talk to the instructor or the TA. There are also excellent resources online.

- The diversity of the class is a big asset, learn from each other.

- Since the list of topics is quite varied, it is extremely important to work regularly and review the material in a timely fashion.

# 6  Grading

The grade of the course will consist of the following components:

| | |
|---|---|
| Assignments | 40% |
| Project | 30% |
| Exam 1 (2/26/19) | 15% |
| Exam 2 (4/23/19) | 15% |

Grades: 90% and above yields an A, 89% - 80% = B, 79% - 70% = C, 69% - 60% = D, and less than 60% yields an F.

Late assignment submissions will not be accepted. Questions regarding a specific grade must be raised within seven days after the grade is given. In general, an incomplete (or make up exams) will not be given. Exceptions will only be considered when a serious family or personal emergency arises, proof is presented, and the student has already completed all but a small portion of the work.

# 7    Assignments

There will be four assignments during the semester. The assignments will consist of theory and implementation, specifically they will require writing a lot of MATLAB code. Attempting and completing the assignments is vital to the success of the student in this course. Information on obtaining a copy of MATLAB can be found on the UT Arlington OIT website: https://www.uta.edu/oit/cs/software/mathworks/matlab-r2017a-win/index.php.

The student is welcome to use standard matrix functions or utilities to read and write images in MATLAB. However, when the assignment asks to implement a specific function the built-in MATLAB functions cannot be used. When in doubt ask. Using implementations from the Internet, or elsewhere, will result in no credit (zero points) for the assignment. If code is used from anyone or anywhere, then it must be referenced. Otherwise, this constitutes cheating.

# 8    Project

The course project will consist of the design and implementation of a computer vision system to solve a real world problem. The student is free to choose a project of their own interest. Students may also work in groups of at most three on the project. The project schedule is as follows.

Project Proposal (February 7th): Submit a document with the names of the group members and the task assignments of each group member. The task assignments for each group member must be clearly identified.

Progress Report (March 7th): Describe the progress of the project by meeting with the TA and giving a demo, and by posting a video.

Project Presentation (April 30th and May 2nd): A five minute in-class presentation given as a group.

Final Report (May 7th): A 6 to 8 page paper written by all group members. The report must include the following: abstract; introduction to the problem; literature review; explanation of the problem; detailed description of the problem solution; detailed description of the experiments performed; conclusion that includes what worked, what did not, and the lessons that were learned; list of references

More details on the course project and potential topics will be given during the first week of class. The course project will be graded as follows:

| Project Proposal | 1% |
|---|---|
| Progress Report | 4% |
| Project Presentation | 5% |
| Final Report | 20% |

# 9 Course Schedule

| Week | Date | Topics | Assignments |
|---|---|---|---|
| 1 | 1/15/18 | Course Overview and Introduction, Sensors | |
| | 1/17/2019 | Project Overview, MATLAB Tutorial | |
| 2 | 1/22/2019 | Euclidean Geometry | Assignment 1 Out |
| | 1/24/2019 | Projective Geometry | |
| 3 | 1/29/2019 | Camera Geometry, Camera Calibration | |
| | 1/31/2019 | Least Squares, SVD | |
| 4 | 2/5/2019 | Linear Filters | Assignment 1 Due, Assignment 2 Out |
| | 2/7/2019 | Point and Neighborhood Operators | Project Proposal Due |
| 5 | 2/12/2019 | Edge Detection | |
| | 2/14/2019 | Hough Transform | |
| 6 | 2/19/2019 | Texture, Shading, and Color | Assignment 2 Due |
| | 2/21/2019 | Feature Descriptors (SIFT) | |
| 7 | 2/26/2019 | Exam 1 | |
| | 2/28/2019 | Convolutional Neural Networks | |
| 8 | 3/5/2019 | Segmentation | |
| | 3/7/2019 | Feature-based Alignment | Project Progress Report Due |
| 9 | 3/12/2019 | Spring Vacation | |
| | 3/14/2019 | Spring Vacation | |
| 10 | 3/19/2019 | Epipolar Geometry | Assignment 3 Out |
| | 3/21/2019 | Stereo Systems | |
| 11 | 3/26/2019 | Structure from Motion | |
| | 3/28/2019 | Dense Motion Estimation | |
| 12 | 4/2/2019 | Optical Flow, Tracking | Assignment 3 Due, Assignment 4 Out |
| | 4/4/2019 | 3D Reconstruction | |
| 13 | 4/9/2019 | Image-based Rendering | |
| | 4/11/2019 | 3D Point Cloud Processing | |
| 14 | 4/16/2019 | Object Recognition | Assignment 4 Due |
| | 4/18/2019 | Scene Understanding | |
| 15 | 4/23/2019 | Exam 2 | |
| | 4/25/2019 | Digital Topology | |
| 16 | 4/30/2019 | Project Presentations | |
| | 5/2/2019 | Project Presentations | |
| 17 | 5/7/2019 | | Project Final Report Due |

This schedule is tentative and subject to change at instructor's discretion. Changes will be announced in class and on the course page. The instructor reserves the right to adjust this schedule in any way that serves the educational needs of the students enrolled in this course.

# 10  Attendance

Students are expected, but not required, to attend all lectures. Any material that the student missed will not be covered again in class. If the student is unable to attend a class due to personal reasons, then it is the responsibility of the student to use the textbook and online slides to learn the content and meet with either the instructor or the TA to clarify any doubts.

# 11  Drop Policy

Students may drop or swap (adding and dropping a class concurrently) classes through self-service in MyMav from the beginning of the registration period through the late registration period. After the late registration period, students must see their academic advisor to drop a class or withdraw. Undeclared students must see an advisor in the University Advising Center. Drops can continue through a point two-thirds of the way through the term or session. It is the student's responsibility to officially withdraw if they do not plan to attend after registering. **Students will not be automatically dropped for non-attendance**. Repayment of certain types of financial aid administered through the University may be required as the result of dropping classes or withdrawing. For more information, contact the Office of Financial Aid and Scholarships (http://wweb.uta.edu/aao/fao/).

# 12  Disability Accommodations

UT Arlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including The Americans with Disabilities Act (ADA), The Americans with Disabilities Amendments Act (ADAAA), and Section 504 of the Rehabilitation Act. All instructors at UT Arlington are required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of disability. Students are responsible for providing the instructor with official notification in the form of **a letter certified** by the Office for Students with Disabilities (OSD). Only those students who have officially documented a need for an accommodation will have their request honored. Students experiencing a range of conditions (Physical, Learning, Chronic Health, Mental Health, and Sensory) that may cause diminished academic performance or other barriers to learning may seek services and/or accommodations by contacting: **The Office for Students with Disabilities, (OSD)** http://www.uta.edu/disability/ or calling 817-272-3364. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at www.uta.edu/disability.

# 13  Counseling and Psychological Services (CAPS)

www.uta.edu/caps/ or calling 817-272-3671 is also available to all students to help increase their understanding of personal issues, address mental and behavioral health problems and make positive changes in their lives.

# 14 Non-Discrimination Policy

The University of Texas at Arlington does not discriminate on the basis of race, color, national origin, religion, age, gender, sexual orientation, disabilities, genetic information, and/or veteran status in its educational programs or activities it operates. For more information, visit uta.edu/eos.

# 15 Title IX Policy

The University of Texas at Arlington ("University") is committed to maintaining a learning and working environment that is free from discrimination based on sex in accordance with Title IX of the Higher Education Amendments of 1972 (Title IX), which prohibits discrimination on the basis of sex in educational programs or activities; Title VII of the Civil Rights Act of 1964 (Title VII), which prohibits sex discrimination in employment; and the Campus Sexual Violence Elimination Act (SaVE Act). Sexual misconduct is a form of sex discrimination and will not be tolerated. For information regarding Title IX, visit www.uta.edu/titleIX or contact Ms. Michelle Willbanks, Title IX Coordinator at (817) 272-4585 or titleix@uta.edu.

# 16 Academic Integrity

Students enrolled in all UT Arlington courses are expected to adhere to the UT Arlington Honor Code:

*I pledge, on my honor, to uphold UT Arlington's tradition of academic integrity, a tradition that values hard work and honest effort in the pursuit of academic excellence.*

*I promise that I will submit only work that I personally create or contribute to group collaborations, and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and uphold the spirit of the Honor Code.*

UT Arlington faculty members may employ the Honor Code in their courses by having students acknowledge the honor code as part of an examination or requiring students to incorporate the honor code into any work submitted. Per UT System Regents' Rule 50101, 2.2, suspected violations of university's standards for academic integrity (including the Honor Code) will be referred to the Office of Student Conduct. Violators will be disciplined in accordance with University policy, which may result in the student's suspension or expulsion from the University. Additional information is available at https://www.uta.edu/conduct/. Faculty are encouraged to discuss plagiarism and share the following library tutorials http://libguides.uta.edu/copyright/plagiarism and http://library.uta.edu/plagiarism/.

# 17 Electronic Communication

UT Arlington has adopted MavMail as its official means to communicate with students about important deadlines and events, as well as to transact university-related business regarding financial aid, tuition, grades, graduation, etc. All students are assigned a MavMail account and are responsible for checking the inbox regularly. There is no additional charge to students for using this account, which

remains active even after graduation. Information about activating and using MavMail is available at http://www.uta.edu/oit/cs/email/mavmail.php.

## 18    Campus Carry

Effective August 1, 2016, the Campus Carry law (Senate Bill 11) allows those licensed individuals to carry a concealed handgun in buildings on public university campuses, except in locations the University establishes as prohibited. Under the new law, openly carrying handguns is not allowed on college campuses. For more information, visit http://www.uta.edu/news/info/campus-carry/.

## 19    Student Feedback Survey

At the end of each term, students enrolled in face-to-face and online classes categorized as "lecture," "seminar," or "laboratory" are directed to complete an online Student Feedback Survey (SFS). Instructions on how to access the SFS for this course will be sent directly to each student through MavMail approximately 10 days before the end of the term. Each student's feedback via the SFS database is aggregated with that of other students enrolled in the course. Students' anonymity will be protected to the extent that the law allows. UT Arlington's effort to solicit, gather, tabulate, and publish student feedback is required by state law and aggregate results are posted online. Data from SFS is also used for faculty and program evaluations. For more information, visit http://www.uta.edu/sfs.

## 20    Final Review Week

For semester-long courses, a period of five class days prior to the first day of final examinations in the long sessions shall be designated as Final Review Week. The purpose of this week is to allow students sufficient time to prepare for final examinations. During this week, there shall be no scheduled activities such as required field trips or performances; and no instructor shall assign any themes, research problems or exercises of similar scope that have a completion date during or following this week unless specified in the class syllabus. During Final Review Week, an instructor shall not give any examinations constituting 10% or more of the final grade, except makeup tests and laboratory examinations. In addition, no instructor shall give any portion of the final examination during Final Review Week. During this week, classes are held as scheduled. In addition, instructors are not required to limit content to topics that have been previously covered; they may introduce new concepts as appropriate.

## 21    Emergency Exit Procedures

Should we experience an emergency event that requires us to vacate the building, students should exit the room and move toward the nearest exits, which are located northeast and southwest of the classroom. These exits are shown in the Woolf Hall evacuation diagram for Room 208 (http://www.uta.edu/campus-ops/ehs/fire/Evac_Maps_All/Evac_WH/Evac_WH_208.pdf). When exiting the building during an emergency, one should never take an elevator but should use the stairwells. Faculty members and instructional

staff will assist students in selecting the safest route for evacuation and will make arrangements to assist individuals with disabilities.

## 22 Student Support Services

UT Arlington provides a variety of resources and programs designed to help students develop academic skills, deal with personal situations, and better understand concepts and information related to their courses. Resources include tutoring, major-based learning centers, developmental education, advising and mentoring, personal counseling, and federally funded programs. For individualized referrals, students may visit the reception desk at University College (Ransom Hall), call the Maverick Resource Hotline at 817-272-6107, send a message to resources@uta.edu, or view the information at http://www.uta.edu/studentsuccess/success-programs/programs/resource-hotline.php.

The IDEAS Center (2nd Floor of Central Library) offers FREE tutoring to all students with a focus on transfer students, sophomores, veterans and others undergoing a transition to UT Arlington. Students can drop in, or check the schedule of available peer tutors at www.uta.edu/IDEAS, or call (817) 272-6593.

The English Writing Center (411LIBR): The Writing Center offers FREE tutoring in 15-, 30-, 45-, and 60-minute face-to-face and online sessions to all UTA students on any phase of their UTA coursework. Register and make appointments online at https://uta.mywconline.com. Classroom visits, workshops, and specialized services for graduate students and faculty are also available. Please see www.uta.edu/owl for detailed information on all our programs and services. The Library's 2nd floor Academic Plaza offers students a central hub of support services, including IDEAS Center, University Advising Services, Transfer UTA and various college/school advising hours. Services are available during the library's hours of operation: http://library.uta.edu/academic-plaza.

## 23 Emergency Phone Numbers

In case of an on-campus emergency, call the UT Arlington Police Department at 817-272-3003 (non-campus phone), 2-3003 (campus phone). You may also dial 911. The non-emergency number is 817-272-3381.