جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Contemporary Topics in ErSE - ErSE 294

Division	Physical Science and Engineering Division
Course Number	ErSE 294
Course Title	Contemporary Topics in ErSE
Academic Semester	Spring
Academic Year	2018/2019
Semester Start Date	01/27/2019
Semester End Date	05/23/2019
Class Schedule (Days & Time)	09:00 AM - 10:30 AM | Mon Wed

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Gerard Thomas Schuster	gerard.schuster@kaust.edu.sa	+966128080296		By appointment

Teaching Assistant(s)

Name	Email

Course Information

Comprehensive Course Description	This course presents the theory and practice of image processing methods used in seismic processing, aerial photography and astrophotography. The equations for seismic migration and optical imaging are identical under the 15 degree approximation. Therefore there is important synergy by combining the best image processing methods from both worlds, such as the wavelet transform, sparse Radon transform , sparse inversion, PCA analysis, cluster analysis, SVD rank reduction, PSF deconvolution, seismic attribute analysis and dictionary learning. All of these methods will be covered and applied to seismic images, aerial photographs and astronomical images. The astronomy image processing program PIXINSIGHT and MATLAB will be the main processing tools used in this class. Students will record their own astronomical images using the KAUST Meade telescope and the instructor's astrophotography telescope. The last several weeks of the course will show how to get the most from your images using new methods of superresolution.
Course Description from Program Guide	The course covers a number of Machine Learning methods and their applications in solving geoscience problems. The main focus is on using supervised learning methods to solve geoscience problems, with an emphasis on the practical use of convolutional neural networks. At the end of the course, the diligent student will know how to design the architecture of a convolutional network and employ it in solving a particular geoscience problem. Students are expected to have experience in programming a high-level language such as MATLAB and have a background in partial differential equations and linear algebra.
Goals and Objectives	Goal: Learn the theory and practice of image processing of seismic, aerial, and astrophotography images. At the end of the course the student will be proficient in using advanced image processing methods for seismic, aerial and astronomical images.
Required Knowledge	Basic knowledge of MATLAB, probability, linear algebra and partial differential equations and familiarity with Machine Learning methods.
Reference Texts	1). Lecture Notes on Signal and Image Processing by Schuster 2). Inside PixInsight (Warren Keller) 2016 Springer -Verlag
Method of evaluation	**25.00**% - Research Project **20.00**% - Midterm exam **25.00**% - Homework /Assignments **30.00**% - Final exam

Nature of the assignments	The final grade will be determined as follows: 25% Midterm 25% Final 25% Homework 25% Project Homework includes: -Assigned paper reading and paper presentation -Written homework for equation derivation and manual calculation -Projects using Pixinsight and Project: Course project to be presented to class at end of semester.
Course Policies	Each student is expected to prepare for and attend all of the class sessions during the semester. Students in the class are expected to treat one another respectfully, and to offer constructive criticism in course discussions about their classmates' work. Participation in class is strongly encouraged. Punctuality is required. Students' excused absences include official university business and personal emergencies (medical, legal, death in the family, etc). It is the student's responsibility to contact the instructor prior to the absence (when possible) and provide the documentation required for excused absences. It is the student's responsibility to make up any deficiency resulting from class absence in a timely manner, including getting class notes (from other students) and assignments. Please carefully read the university attendance policy for additional specifics.
Additional Information	

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Mon 01/28/2019	Overview. Digital sampling, histogram analysis, contrast, illuminance, coherence
1	Wed 01/30/2019	Filtering: Low-pass, high-pass, bandpass, matched
2	Mon 02/04/2019	Deterministic Deconvolution
2	Wed 02/06/2019	Stochastic Deconvolution Concepts
3	Mon 02/11/2019	Stochastic Deconvolution Concepts II
3	Wed 02/13/2019	2D PSF Decon Filters, Blind Deconvolution
4	Mon 02/18/2019	Predictive Filters
4	Wed 02/20/2019	Adaptive Filters
5	Mon 02/25/2019	Machine Learning and Sparse/Robust Inversion I
5	Wed 02/27/2019	Machine Learning and Sparse/Robust Inversion II
6	Mon 03/04/2019	Machine Learning and Sparse/Robust Inversion III
6	Wed 03/06/2019	Machine Learning and Sparse/Robust Inversion IV
7	Mon 03/11/2019	Sparse Encoding Machine Learning: Denoising Seismic Data
7	Wed 03/13/2019	Sparse Encoding Machine Learning: Denoising Astrophtographic Data
8	Mon 03/18/2019	Signal Detection: Aerial Photographs
8	Wed 03/20/2019	Wavelet Transform I
9	Mon 03/25/2019	Wavelet Transform II
9	Wed 03/27/2019	Total Variation I
10	Mon 04/01/2019	Total Variation II
10	Wed 04/03/2019	Fundamentals of Astrophotography I
11	Mon 04/08/2019	Fundamentals of Astrophotography I
11	Wed 04/10/2019	Processing Astrophotograhs with Pixinsight I
12	Mon 04/15/2019	Processing Astrophotograhs with Pixinsight II
12	Wed 04/17/2019	Pixinisght Workshop with Consultant
13	Mon 04/22/2019	Astrophotograph Field Trip
13	Wed 04/24/2019	Astrophotography Field Trip
14	Mon 04/29/2019	Attribute and Feature Extraction from Seismic Images I
14	Wed 05/01/2019	Attribute and Feature Extraction from Seismic Images II
15	Mon 05/06/2019	Attribute and Feature Extraction from Seismic Images III
15	Wed 05/08/2019	Attribute and Feature Extraction from Seismic Images IV
16	Mon 05/13/2019	Dictionary Learning I
16	Wed 05/15/2019	Dictionary Learning II
17	Mon 05/20/2019	Final Exam Week
17	Wed 05/22/2019	Final Exam Week

Note

The instructor reserves the right to make changes to this syllabus as necessary.