**Course Number:** CSC 821
**Course Title:** Biomedical Imaging and Analysis
**Number of Credits**: 3
**Schedule**: Three hours of lecture/discussion per week.
**Prerequisite**: a grade of C or better in CSC 510 and MATH 325

**Catalog Description**
Introduction to medical and biological imaging, imaging physics, 3D imaging, image formats, visualization. Basic digital image processing and analysis, filtering, registration, segmentation, quantification, performance evaluation. This course is paired with CSC 621. Students who completed CSC 621 may not take CSC 821 for credit. **For graduate credit, additional written report of literature survey is required.**

**Expanded Description**
(1 week) Introduction to imaging in biology and medicine, history of biomedical imaging

(2 weeks) Survey of imaging methods
biological applications: microscopic imaging, microarray imaging
3D imaging, X-ray, CT, MRI, PET, ultra-sound

(1 week) Imaging standards, databases, image formats: DICOM, Analyze

(1 week) Visualization: color spaces, 3D cross-section viewing, 3D volume rendering

(1 week) Introduction to digital image processing, sampling, quantization, image noise

(1 week) Image filtering: convolution, smoothing, sharpening, background removal

(1 week) Advanced processing, edge detection, morphological operations

(1.5 week) Image registration: feature-based registration, mutual information maximization

(1.5 week) Image segmentation: thresh-holding, advanced algorithms

(1.5 week) Image quantification: connected-component analysis, change analysis, statistical features, classification

(1.5 week) Performance validation: ground-truth, statistical performance analysis

**Course Objectives and Role in Program**
The objectives of this course include:
- Comprehensive overview of basic topics in biomedical imaging and analysis.

- Through project work, develop deeper knowledge of a specific biomedical imaging and analysis application.
- Through in-class student presentations, develop public speaking skills
- Through conducting literature survey, develop intimate understanding on current research directions for a subtopic in the biomedical imaging and analysis field.

Students will engage on hands-on collaborative project for analyzing biomedical data. They will take a leading role for formulating the project topics/goals and will be assigned to mentor undergraduate teammates in their group project, facilitating to develop their leadership and mentoring skills. They will conduct additional literature survey on a biomedical imaging and analysis subtopic of their choice and submit the result as a report in the university's MS thesis format. This literature survey will allow the students to identify their thesis topic in the field of biomedical imaging and analysis that s/he wishes to explore more deeply, and prepare them for writing a MS thesis by familiarizing them with the SFSU thesis guidelines and providing an opportunity to complete the literature survey part of their thesis draft.

**Learning Outcomes**

At the end of this course students will

- Know and understand basic concepts related to biomedical imaging and analysis including various imaging methods, image processing algorithms and performance evaluation techniques
- Know the basics and role of digital image processing in major biomedical applications
- Experience developing software for biomedical image analysis by utilizing existing libraries and descriptions of algorithms on the internet.
- Learn about oral presentation skills
- Learn about teamwork skills as well as leadership and mentoring skills in collaborative work settings
- Learn about current research directions in a cutting-edge biomedical imaging topic through independent literature survey study.

**Method of Evaluation**

Student learning will be evaluated on the basis of

- Completeness and quality of final project work (**30%** of the grade)
- Completeness and quality of assignments (20% of the grade)
- Grade on midterms (**30%** of the grade)
- Completeness and quality of literature survey report (20% of the grade)

**Assignments**: there will be regular quiz and/or homework.
**Midterms**: there will be two midterms
**Final Project**: students will help identifying project topic/goal, mentor undergraduate teammates, engage on a group project, present results in class individually, and submit a written report of the results.
**Literature survey report**: students will identify a subtopic related to biomedical imaging and analysis research, conduct a survey of the subtopic's recent literatures

consisting of minimum of three representative peer-reviewed published articles, and submit a written report summarizing and critiquing the survey results. The report must be in the SFSU thesis format following the university guidelines and should be no shorter than 10 pages (one page introduction, two pages for each paper, two pages critique and conclusion, and one page reference list).

Students will be evaluated on their ability to devise, organize and present complete solutions to problems. Solutions need to be presented in a neat and organized way; cryptic answers or untidy assignments will not be graded. Complete answers to all problems with sound and in-depth analytical reasoning are required; a correct answer with no reasoning or with wrong reasoning will result in **no** credit

The grade distribution is as follows: A (100% - 92.5%), A- (92.4%-90%), B+ (89.9% - 87.5%), B (87.4% - 82.5%), B- (82.4% - 80%)%), C+ (79.9% - 77.5%), C (77.4% - 72.5%), C- (72.4% - 70%), D+ (69.9% - 67.5%), D (67.4% - 62.5%), D- (62.4% - 60%), F (59.9% - 0%).

**Required Textbooks**
*Introduction to Biomedical Imaging,* A. Webb, IEEE Press. 2003
*Digital Image Processing,* R.C. Gonzalez and R.E. Woods. Prentice Hall. 2001

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