The University of Vermont
Department of Biomedical Engineering

BME240 – Wearable Sensing

Spring 2020
Votey 307
TR 2:50-4:05 PM
3 credits

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I'm happy to discuss the course, outside interests, or career development. Also, please feel free to come by and just introduce yourself ☺

Required Textbook

No textbooks are required for this course. Required reading will be published journal articles.

Course Overview

Course will cover the current state-of-the-art in wearable sensors and the biomechanical and physiological phenomena they are being used to measure. Emphasis will be given to applications related to human health. Topics covered in undergraduate engineering courses will be reviewed and applied to studying the structure and function of a variety of aspects of the human body.

Course Objectives

By the end of this course, students should be able to:

- Describe the operating principles of a variety of sensors used for monitoring human biomechanics and physiology (i.e. MEMS accelerometers, MEMS angular rate gyros)
- Describe the biomechanical and physiological phenomenon measured by these sensors.
- Apply basic signal processing (filtering, etc.) to wearable sensor data in Matlab.
- Analyze wearable sensor data in Matlab to test hypotheses related to human biomechanics and physiology.
- Execute a literature search to identify potential areas of scientific contribution.
- Design an experiment to address hypotheses related to human biomechanics and physiology.
- Draft a research article including introduction, methods, results, discussion, and conclusion sections.

Grading Policy

Final grades will be issued according to the traditional grading scheme: A+, A, A- ≥ 90%, 90% > B+, B, B- ≥ 80% and so on. This scheme may be modified, but any such modification will be to improve student grades. Students are expected to read, ask questions, participate, perform background research, and keep up with the class. The nature of this course is such that students will be evaluated in a variety of ways (i.e. though homework, quizzes, papers, and presentations). The individual contribution of each of these assessments to a student's final grade are listed below. Please note that late assignments will not be accepted.

Final Grade Contribution:

- Journal Article Reviews & Data Analysis Assignments 20%
- Participation 20%
- Quizzes 5%
- Midterm Report 15%
- Written Project Proposal with Literature Review 10%
- Final Written Research Paper 15%
- Final Oral Research Presentation 15%

Journal Article Reviews and Discussions

Prof. McGinnis will distribute the article to be reviewed, at least one week before the due date of individual reviews. Reviews will include creation of 3-4 multiple choice questions. On the due date, students will turn in their reviews and come to class prepared to discuss the article. The final course grade will be based partially on participation in class discussion. Journal article review discussions will take place during the scheduled lecture.

Quizzes

During the first 10 minutes of classes when an article review is due, we will have a short (3-5 questions) quiz composed of questions selected from student reviews.

Data Analysis Assignments

Data Analysis Assignments will include algorithm implementation and data analysis in Matlab (or python). Code students develop will be used to answer specific questions about the data collected during our study replications.

Midterm Report

Students will write a formal report for one of the first two articles that we read and replicate. This report will include introduction, methods, results, discussion, and conclusion sections and should be written like the scientific articles that we've read. The report should be based directly on data that we collect during our replication experiments. A problem statement for this assignment,

template for the report, and rubrics describing how each component will be assessed are available on blackboard.

Final Project

Students will work in groups of 2 to propose and complete a project that uses wearable sensors to address a hypothesis related to human health and performance. Projects should include some aspect of experimental design, data processing, and data analysis. The course is designed to help enable completion of this project, and as such includes several key deliverable deadlines, described below, to keep students on track. Furthermore, each homework assignment will include small steps to facilitate timely completion of these larger deliverables. A problem statement for this project, template for the report, and rubrics describing how each component will be assessed are available on blackboard.

Project Proposal with Literature Review
Each group will be required to write a formal proposal (1 pg., single spaced) introducing the topic of their project. This proposal should be in the format of a specific aims page with one aim and should include reference to at least five peer-reviewed articles (references can be included on a second page), a clear statement of the problem and hypothesis, and an overview of how the techniques learned in class will be used to address that hypothesis.

Written Research Paper
At the end of the semester, each group, or student in the case of graduate students, will be required to write a formal research paper (IEEE conference format – templates for word and LaTeX readily available from IEEE, max 4 pgs. with references, single spaced, 2 columns) that includes Abstract, Introduction, Methods, Results, Discussion, and Conclusion sections. Descriptions of appropriate content to include in each of these sections is on blackboard.

Oral Research Presentation
During the final exam period, each group, or student in the case of graduate students, will present their research findings to the class during a 5-minute formal oral presentation. The presentation will cover the motivation for the project and specific hypothesis addressed, the methodology employed, the experimental results, and a discussion about why these results are important to human health.

Graduate Students

To receive graduate credit for this course, students will be required to:

- AMP students must alert Prof. McGinnis that you are taking the course for graduate credit within the first two weeks.
- Deliver a 50-minute job-talk style research presentation to the class. This talk should be scheduled with Dr. McGinnis within the first two weeks of the semester. Talk duration may be reduced based on the number of graduate students in class. An assessment rubric for the talk is on blackboard, this will account for 50% of the participation grade for graduate students.
- Complete the final project alone. Performance will be assessed as for undergraduate students, but it is expected that all components of the project are completed by the graduate student.

Academic Integrity

Students are encouraged to work together and to exchange ideas when working on their homework and projects. However, students must be sure to submit only their own work and to reference that work properly, including all web sources. UVM's policy on academic integrity is clearly defined and can be found at: http://www.uvm.edu/~uvmppg/ppg/student/acadintegrity.pdf

Tentative Schedule

Date	Lecture Topic	Assignment Due
T 1/14	Class introduction	
R 1/16	Balance – Background on balance control, accelerometers, subjective assessments	
T 1/21	Quiz Balance Parameters Article Discussion, Replication experiment design	**-Balance Assessment Article Review**
R 1/23	Balance Parameters Replication Experiment	
T 1/28	Review of statistical concepts and Matlab coding, Assignment Discussion and Help Session	**-Matlab code questions**
R 1/30	Balance Parameters Discussion of Results	**-Balance Assessment Data Analysis**
T 2/4	Fall Detection – Background on fall detection, basic signal processing, introduce midterm	
R 2/6	Quiz Fall Detection Article Discussion, Replication experiment design	**-Fall Detection Article Review**
T 2/11	Fall Detection Replication Experiment	
R 2/13	Review of statistical concepts, Data Analysis Discussion and Help Session, Peer review of midterm outline	**-Draft outline of midterm** **-Matlab code questions**
T 2/18	Fall Detection Discussion of Results	**-Fall Detection Data Analysis** **-Midterm outline**
R 2/20	Gait – Background on gait, angular rate gyros, wavelets	
T 2/25	Quiz Gait Article Discussion, Replication experiment design	**-Gait Analysis Article Review**
R 2/27	Gait Replication Experiment	
T 3/3	Town Hall Meeting Day	**-Matlab code questions**
R 3/5	Gait Discussion of Results	**-Gait Parameters Data Analysis** **-Midterm Report**
T 3/10	*SPRING BREAK*	*FUN*
R 3/12	*SPRING BREAK*	*FUN*

T 3/17	Emotion – Background on mental health and emotions, introduce final project, brainstorm final project topics	
R 3/19	Quiz Emotion Article Discussion, replication experiment design	**-Emotion Article Review**
T 3/24	Emotion Replication Experiment	**-Final group and topic**
R 3/26	Data Analysis Discussion and Help Session	**-Matlab code questions**
T 3/31	Emotion Discussion of Results	**-Emotion Data Analysis**
R 4/2	Study design peer review Grad student job talk	**-Draft project proposal and protocol**
T 4/7	Experiment planning, Data Analysis Discussion and Help Session	**-Final Project Proposal**
R 4/9	Experiments (student led), data analysis help	
T 4/14	Experiments (student led), data analysis help	
R 4/16	Experiments (student led), data analysis help	
T 4/21	Methods and results peer review Grad student job talk	**-3x Draft Methods and Results**
R 4/23	Discussion peer review Grad student job talk	**-3x Draft Discussion**
T 4/28	Final paper peer review Grad student job talk	**-3x Draft Final**
R 4/30	Final presentation peer review Grad student job talk	**-Final paper due** **-Draft presentation outline**
Final Exam*		**-Final Presentation**