ENME 489C, ENME 808M – Medical Robotics

Fall 2017

Course Information

Instructor:
Professor Axel Krieger
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Office Hours: Friday 130pm-230pm

Teaching Assistant:
Rishabh Biyani
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Office Hours: TBD

Textbook:

Lectures:
Mon & Wed 2:00pm–3:15pm. EGR 0135

Homework and Labs:
Homework and Labs are typically assigned in lecture Wednesdays. Unless explicitly stated otherwise, Homework and Labs will be due on Mondays of the following week at 5pm. Homework assigned online must be completed by 5pm on Monday and any hardcopy problems must be given to Dr. Krieger in Monday’s class or placed in the drop box outside of Dr. Krieger’s office by 5pm. Since the solutions are posted after the homework is due, no late homework can be accepted. The lowest Homework or Lab grade will be dropped.

Midterm Exams:
There will be one midterm exam, given approximately Wednesday, October 11.

Final Exam:
There will be one final exam, date TBD

Grades:
Your final grade will be determined by the following components:
Homework and Labs 25%
Course Description:
The evolution of robotics in surgery is a new and exciting development. Surgical robotics brings together many disparate areas of research such as development and modeling of robotic systems, design, control, safety in medical robotics, haptics (sense of touch), ergonomics in minimally invasive procedures, and last but not the least, surgery. The primary goal of this course is to acquaint the students with the fundamentals of robot design and control and different areas of research that lead to the development of medical robotic systems. As a result, the course will cover basic robot kinematics such as forward and inverse kinematics as well as velocity and acceleration analysis. We will also cover additional topics specific to medical robotics such as medical image guidance. The course will include a project, where students will learn to develop, build, and control a medical robot.

a. Prerequisites or co-requisites: ENME 361

b. This course is an elective.

Topics:

- Review of Mathematical Preliminaries and Introduction to Medical Robotics
- Robot Forward Kinematics - Position, velocity, and acceleration analysis
- Robot Inverse Kinematics
- Manipulator Jacobian
- Introduction to Robot Dynamics
- Introduction to medical image guidance
- Medical robot design and control

Learning Outcomes:

This course addresses the following student outcomes:
(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
(l) an ability to work professionally in mechanical systems areas

**Syllabus:**
The following is a list of the material that will be covered. The dates and materials, however, are approximate and could be changed during the course of the semester.

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
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<tbody>
<tr>
<td>Week 1</td>
<td>28-Aug</td>
<td>Introduction, Math Refresher</td>
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<tr>
<td>Week 2</td>
<td>4-Sep</td>
<td>Manipulators</td>
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<tr>
<td>Week 3</td>
<td>11-Sep</td>
<td>Rigid Body Transformations</td>
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<td>Week 4</td>
<td>18-Sep</td>
<td>Kinematics</td>
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<td>Week 5</td>
<td>25-Sep</td>
<td>Inverse Kinematics</td>
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<td>Week 6</td>
<td>2-Oct</td>
<td>DH Parameters</td>
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<td>Week 7</td>
<td>9-Oct</td>
<td>Midterm</td>
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<td>Week 8</td>
<td>16-Oct</td>
<td>Velocity Kinematics</td>
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<td>Week 9</td>
<td>23-Oct</td>
<td>Jacobian, Singularities</td>
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<td>Week 10</td>
<td>30-Oct</td>
<td>Camera Models, Calibration</td>
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<td>Week 11</td>
<td>6-Nov</td>
<td>Medical Imaging and Guidance</td>
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<td>Week 12</td>
<td>13-Nov</td>
<td>Force Sensing and Control</td>
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<td>Week 13</td>
<td>20-Nov</td>
<td>Final Project Start</td>
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<td>Week 14</td>
<td>27-Nov</td>
<td>Medical Robotics Special</td>
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<td>Week 15</td>
<td>4-Dec</td>
<td>Project Demos</td>
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<tr>
<td>Week 16</td>
<td>11-Dec</td>
<td>Finals Prep</td>
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**How will I use this professionally:**
Robotics and Automation is a rapidly growing market with the potential to disrupt areas of employment such as self-driving cars and trucks, manufacturing, and healthcare. This change is projected to provide a rise in employment opportunities for robotic engineers. The technical matter on robot design and control taught in this class is directly used for solving a variety of practical engineering problems in industry and government laboratories, not just for medical robotics but also other areas of robotics. The training on group interaction during technical projects is also invaluable for later professional work.

**Course Organization/Management:**
This course will be managed through the Information Technology Clark School Online Internet course software (https://myelms.umd.edu).
Assistance is available through the Clark School of Engineering Information Technology via http://elms.umd.edu.

Attendance Policy:
Regular attendance at lectures is expected. Students are responsible for inquiring about and obtaining course material delivered in their absence (from course colleagues). University policy excuses the absences of students for illness (self or dependent), religious observances (http://www.president.umd.edu/policies/iii510a.html), participation in University activities at the request of University authorities, and compelling circumstances beyond the student's control. Students must submit the request in writing and supply appropriate documentation, e.g. medical documentation. Students with written, excused absences are entitled to a makeup exam (or assignments if applicable) at a time mutually convenient for the instructor and student. For more information, see UMD's policy on medically necessitated absences from class.

University wide Honor Code:
The University of Maryland, College Park has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating on exams, cheating on clicker quizzes in lecture, fabrication, facilitation, and plagiarism. Copying work done by another is considered an act of academic dishonesty and will be reported according to University policy. Please review the Code of Academic Integrity and the University’s policy on academic dishonesty at http://www.jpo.umd.edu/ and http://www.shc.umd.edu
Note that no form of plagiarism will be tolerated. All work presented to the instructor is assumed to be the original work of the course participant(s). Words, diagrams, figures, or original contributions of anyone other than a student must be referenced when included in a student’s work. The course instructor may use plagiarism checking software and/or request evidence of references for any submitted work. A useful website on avoiding plagiarism is found at the Purdue Online Writing Lab at http://owl.english.purdue.edu/owl/.