Introduction to Medical Robotics and Surgical Technologies

Instructors: [Office Hours]

Siobhan Oca (she/her)	[Rm 131 3-4p on Tuesdays and Thursdays]
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Prerequisites: None

Course Description

This course is a broad introduction to medical robotics and surgical technologies, developed specifically for trainees in the NSF NRT for Advancement of Surgical Technologies. This course covers technical instruction in core areas of surgical technology and requires the completion of 3 mini-projects where trainees address real-world problems in surgery. It is designed to provide trainees with the required academic foundation to navigate the field of surgical technology and transition to more in-depth impactful, research during their second year. Broad subjects covered are listed below.

Learning Objectives:

- Describe solved and research level problems in robotics, ML, imaging, and specific surgical applications
- Debate pros/cons of different surgical robotics applications with respect to current clinical workflow
- Define a problem and generate a solution that interfaces a specific surgical need and engineering application regarding IP, Regulatory and Design considerations
- Outline a research project based on your prior experience applied to a specific problem in surgery
    - Specifically: with potential hypothesis and further, experiments. Additionally, define potential collaborative clinical/engineering advisors
- Overall: After students are exposed to clinical and engineering partners with surgical and robotic applications, students will generate 1 year research project proposal.

Topics

1. Surgery: Insight into the surgical life-cycle through instruction by specialist surgeons from multiple surgical areas. Trainees will also receive basic training on using various surgical tools and surgical robots.
2. Robotics: Robotic applications in surgery, including manipulator dynamics, control systems, sensor systems, AI, and human-robot interaction
3. Machine Learning and Artificial Intelligence: Fundamentals of techniques used in Machine Learning and Artificial Intelligence with a focus on practical applications of these techniques in the medical domain.
4. Medical Imaging: Techniques for medical image acquisition and analysis, including computer-aided diagnosis, X-ray, CT, MRI and ultrasound.

5. Medical Technology Development: Instruction in approaches and techniques used in the development of medical technologies such as 3D printing of multiple materials, 3D Computer aided design and analysis software and multiple facets of the design lifecycle.
6. Problems in Surgery: Introduction to a range of issues within the surgical life-cycle to facilitate future project-based work and research.
7. Medical Law, Policy and Ethics: Intersection of law, policy, and ethics as it relates to the development and use of medical technologies.
8. Shadow a Surgeon: Exposure to a variety of holistic analysis techniques, develop needs assessments and identify research opportunities in multiple live surgical procedures

Grading

20% Homework
10% Shadowing and user feedback interviews
20% Project 1: Proposed Problem and Solution in Surgery
20% Project 2: Startup Pitch Deck
30% Project 3: Project Proposal with Collaborators

Assessments

Homework

Homework will be assigned to help you learn the technical course material and prepare you for in class learning experiences. Since the primary purpose is to give you a chance to practice the skills introduced in the lectures, your lowest assignment grades will be ignored when calculating your overall assignment grade.

You are welcome to work with classmates, but 1) credit anyone who helped you with a footnote, and 2) be mindful of whether you are developing each skill. You will turn in your homework assignments through GradeScope. Code, graphs, or other files should be included in the same file as the rest of your homework. For most software, you can create pdf printouts and append them together to create a single file. Assignments submitted over 2 days late or through any other means will not earn the privilege of TA feedback and will count as 0% grades. Assignments submitted within two days of the deadline, but late will receive a maximum 80%. The two lowest assignment grades will be dropped.

Projects

There will be 3 group projects (groups will change in between projects) throughout the semester. The first will focus on defining key surgical problems as defined by multiple clinicians and designing initial solutions to present to the class. The second will be in form of pitch deck of a startup, presenting IP, market, and regulatory considerations for a particular medical solution. The third will be a project proposal, that will be completed next semester by TAST students, with collaborators identified and initial project plans. All projects will be introduced in class and have a respective rubric and expectations document provided on Sakai at the beginning of the project work.

Shadowing and User Feedback Interviews

Shadowing of physicians will be set up by the instructional staff for 3 hours of the course of the semester. Additionally, 4 total user interviews are expected for the first two projects (2 per project) using the template provided in Sakai.

Course Expectations

It is the expectation that students, TAs, and the instructor will regard each other with mutual respect. Students will abide by the Duke Community Standard:

I will not lie, cheat, or steal in my academic endeavors;
I will conduct myself honorably in all my endeavors;
and I will act if the Standard is compromised.

Absences and Late Work

Absence due to illness will need to be reported within the same day of missed lecture or assignment deadline by submitting a Short Term Illness Notification Form (STINF); late work will not be accepted and will be assigned a 0, unless proper STINF documentation is supplied. Varsity athletes must comply with all regulations given by Trinity College. In addition to these formalities, students need to communicate with the instructor in person or by email.

Extenuating circumstances (such as family emergencies) that will prevent a student from attending class or lab or reaching assignment deadlines should be discussed with the instructor as soon as possible and will be accommodated on a case-by-case basis.

Disability Statement

Students with disabilities who believe they may need class accommodations should read through the Student Disability Access Office webpage (in particular, the Rights and Responsibilities for Students section) or contact the Office directly at (919) 668-1267. Note that accommodation requests should be submitted very early in the semester.

Tentative Schedule

Aug 30	Introduction to Course
Sep 1	Mini Project 1Introduction
Sep 6	Robotics, OB/GYN Visit
Sep 8	Robotics, ENT Visit
Sep 13	Robotics, Neurosurgeon Visit
Sep 15	Robotics, General Surgeon Visit
Sep 20	SEAL Visit (DaVinci Systems)
Sep 22	ML/AI
Sep 27	ML/AI
Sep 29	ML/AI
Oct 4	Mini Project 1 Presentations

Oct 6	Mini Project 2 Introduction
Oct 11	Medical Imaging
Oct 13	Medical Imaging
Oct 18	Fall Break
Oct 20	Medical Tech Dev: How to define the Market
Oct 25	Medical Tech Dev: Case studies in MedTech startups
Oct 27	Medical Policy and Ethics: FDA Regulations
Nov 1	Medical Law: IP and Startup Law
Nov 3	Mini Project 2 Presentations
Nov 8	Mini Project 3 Introduction
Nov 10	Writing Project Proposal Workshop
Nov 15	Guest Lecture
Nov 17	Guest Lecture
Nov 22 (PreT)	
Nov 29	Group Work
Dec 1	Mini Project 3 Presentations