RBE 595 – ST: Advanced Topics in Surgical Robotics

Syllabus – B Term 2021

COURSE AT A GLANCE

Instructor	Loris Fichera, PhD lfichera@wpi.edu Office: 50 Prescott, Room 4808 https://www.wpi.edu/~lfichera
Lectures	M W 4:00-5:50 pm Olin Hall 218
Office hours	By appointment
Course URL	https://canvas.wpi.edu/courses/27945
Suggested readings	There is no textbook for this course. Readings will be provided electronically on the Canvas course website.

Welcome to RBE595 – Advanced Topics in Surgical Robotics! In *RBE 595 - Advanced Topics in Surgical Robotics* you will learn about some of the most recent advances in surgical robotics research, and how these advances enable new treatment options for medical conditions that are currently considered inoperable. Topics covered in the course include (time permitting):

- Taxonomy of surgical robots: CAD/CAM systems, surgical extenders, and autonomous systems
- Kinematics and statics of continuum manipulators and examples of applications in surgery
- Automatic mechanism synthesis with applications in the design of surgical instruments
- Overview of Common Medical Imaging modalities
- The development cycle for surgical technology, and the "Clinical pull/Technology push" duality

<u>**Assignments**</u> The course will involve individual bi-weekly MATLAB programming assignments.

<u>**Final Project**</u> The course will culminate in a final team writing project aimed to generate a literature review around a surgical robotics topic. Research themes will be provided by the instructor, but students are encouraged to propose ideas of their own. The papers will be evaluated through a peer review mechanism.

<u>**About the instructor**</u>: Dr. Fichera is an Assistant Professor of Robotics Engineering, with courtesy appointments in Computer Science and Biomedical Engineering. His research interests are in medical robotics, and image-guided surgery. An alumnus of the Italian Institute of Technology (PhD, 2015), he was a postdoc at Vanderbilt University before joining WPI in 2017. He leads the Cognitive Medical Technology (COMET) Laboratory, located at 50 Prescott, suite 4832.

<u>**The instructor reserves the right to modify the course outline and policies mentioned in this syllabus at any time during the term.**</u>

COURSE OBJECTIVES

By the end of this course, students will be able to:
- Model/Control continuum surgical manipulators
- Utilize medical imaging to guide a surgical manipulator
- Formulate a literature review in the field of surgical robotics
- Critically evaluate research studies performed by other researchers

COURSE LOGISTICS

- **COVID-19 Accommodations:** If you need course accommodations because of a COVID-19-related matter (including, but not limited to, the need to isolate/quarantine, caring for a loved one, etc.), you must inform the instructor as soon as possible.

- **Out-of-class communication**: A discussion board will be set up on Piazza, and it will be accessible from the Canvas course website. Piazza will provide a forum to discuss questions around the course material, lectures, assignments, and expectations. You may ask questions, answer others' questions, discuss topics with your peers, etc. Allow up to 24 hours for responses on Piazza, and 48 hours for e-mails. Expect longer response times for messages sent during the weekend.

- **Student Accessibility Services:** If you need course accommodations because of a disability, or if you have medical information to share with the instructor, you must inform your instructor within the first week of classes. If you have not already done so, students with disabilities, who believe that they may need accommodations in this class, should contact the Office of Accessibility Services (OAS), as soon as possible to ensure that such accommodations are implemented in a timely fashion. More information: https://www.wpi.edu/offices/office-accessibility-services

RECOMMENDED BACKGROUND

Recommended background: RBE 500 (Foundation of Robotics), RBE 501 (Robot Dynamics).
This class is for graduate students and advanced undergraduates in robotics engineering. No medical/clinical background is required. You should be familiar with and have access to MATLAB, since it will be required for the homework. Interested students from other courses of study (particularly BME and CS) are encouraged to contact Prof. Fichera to discuss their background prior to attending the course.

GROUND RULES

1. **Assignments and grading:** You must complete all of the homework assignments and the final project in order to receive a passing grade for the course. Assignments will be docked 50% if turned in within 24 hours of the due date/time. No credit will be given for assignments turned in after this time. No extensions are given without prior notice and approved rationale (emergency). Any appeals of assignment scores must be resolved within one week of the return of the graded assignment.

   - **Homework:** Homework will be posted on the Canvas course website and will be due on the dates indicated on the course schedule below.

   - **Final Project:** Specific instructions on the writing assignment will be posted on the Canvas

course website. A mid-term review of the project progress will be conducted, and the results will count towards the final assignment grade (see the grading breakdown table below). Evaluation of the project will be conducted in a blind peer-review manner, with other students in the class evaluating your work.

- **Grading breakdown:** The final grade for the course will be determined as follows:
  - Homework assignments: 40%
  - Final project review: 60%

  There are no exams for this course.

2. **Attendance and participation:** attendance and active participation in lectures are expected. Class participation will be used to make decisions when grades are close to cutoff points.

3. **Academic Integrity Policy:**
   Rule of thumb: *Any work you present as your own should represent your own understanding of the material.*

   Review WPI's Academic Integrity Policies at:
   https://www.wpi.edu/about/policies/academic-integrity

4. **Students are encouraged to use campus support services**, which include the Academic Resources Center, the Writing Center and MASH (Math and Science Help).

TENTATIVE SCHEDULE

Class	Date	Topic	What is due?
1	Oct-25	Course Introduction	
2	Oct-27	In-class discussion: What is clinical significance?	
3	Nov-1	Introduction to Continuum Robots for Surgery	**Homework 1**
4	Nov-3	Case study: Notched-tube Continuum Wrists	
-	Nov-7	-	**Scoping Search Completed**
5	Nov-8	In-class discussion: projects	
6	Nov-10	Differential Kinematics of Continuum Robots, Part I	
-	Nov-14	-	**First Round of Bibliographic Search**
7	Nov-15	In-class discussion: projects	**Homework 2**
8	Nov-17	Differential Kinematics of Continuum Robots, Part II	
-	Nov-19	-	**First paper draft due**
9	Nov-22	Project Peer Reviews – Panel Discussion	**Paper peer reviews**
10	Nov-29	Case Study: Concentric Tube Robots	
11	Dec-1	In-class discussion: projects	
-	Dec-3	-	**Homework 3**
12	Dec-6	Lasers in Robotic Surgery	
13	Dec-8	Image Guidance in Robotic Surgery	
14	Dec-14	Final Project Presentations	**Final Paper Submission**
-	Dec-16	-	**Homework 4**