STAR Summer Camp: Control of a Surgical Robotic Arm

Professor: Dr. Yousef Sardahi, Mechanical Engineering
Aims: Control the motion of the surgical arms by developing an expert control algorithm with simple if-then statements.
Grade: 9 – 12 (Programming Language Knowledge required)

Faculty Profile:
Dr. Yousef Sardahi is leading the research project: "**Control of a Surgical Robotic Arm"**

Dr. Yousef Sardahi is an assistant professor in the Weisberg Department of Mechanical Engineering at Marshall University. He earned Ph.D. from the Department of Mechanical Engineering at the University of California, Merced in 2016. His research interest includes Control System Design and Multi-Objective Optimization. He was a summer Faculty Fellow at Air Force Research Lab. His teaching experience includes Control Systems, Digital Controls, Automation and Control, System Modeling, Advanced Vibrations, Mechatronics, Circuits and Instrumentations, and Mechanical Engineering Computations. Please visit https://www.marshall.edu/cecs/profile/dr-yousef-sardahi/ for more information.

Project Description:
Robotized surgical arms have received much attention recently and been used in many hospitals. Applications include removal of a segment of an organ or body part like excision biopsy, linear thin layer of soft tissue, triangular mass, and tangential excision in burn management. In this project, we will modify the Servo Rotary Flexible Joint manipulator that we have in the industrial control lab by replacing its flexible arm by a medical grade scalpel. Then, the motion of the surgical arm will be controlled by an expert control algorithm based on simple *if-then* statements. Furthermore, a filter will be built for estimation and removal of noisy signals from feedback sensors. During a 4-week summer camp, students will learn how to successfully control the motion of the surgical arm robot.

Weekly Activities Description:

Week 1: Get to Know the Surgical Robot Components	
Day 1-2	Learn about the components and functionalities of the surgical robot that we have in the Industrial Control Lab.
Day 3-4	Survey the control algorithms applied to surgical robotic arms used for tissue ablation and summarize the challenges.
Day 5	Writing
Week 2: Get to know the Computer Control Interface	
Day 1	Build a Simulink Model to read data from sensors
Day 2	Collect Data from the Servo Motor Sensors (Encoders) and calibrate them
Day 3	Build a Simulink Model to drive the manipulator's actuators
Day 4	Use the Simulink Model from Day 3 to drive the manipulator manually to a certain location and make sure the actuators are functioning correctly.
Day 5	Combine the Simulink Model from Day 1 with that from Day 3.
Week 3: Coding	
Day 1	Build a control algorithm using simple if-then statements
Day 2	Test the control algorithm and make sure it is functioning correctly.
Day 3	Build a Filter/estimator that minimizes the number of sensors needed for the control algorithm.
Day 4	Test the filter and make sure the estimation error is very small
Day 5	Combine the control and filter algorithms and run the controlled system.
Week 4: Testing and Writing	
Day 1	Test the control and filter algorithms on cutting different shapers of a sponge and collect data.
Day 2	Writing
Day 3	Writing
Day 4	Writing
Day 5	Writing