BIOENGINEERING
Spring 2021 Seminar

Date: Thursday, April 8, 2021
Time: 12:00 pm - 1:00 pm
Location: Virtual

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Meeting ID: 988 0549 4005 Passcode: 454698

Axel Krieger, Ph.D.

Biography: Axel Krieger, PhD, is an Assistant Professor at Johns Hopkins University in the Department of Mechanical Engineering. He is leading a team of students, scientists, and engineers in the research and development of robotic tools and laparoscopic devices. Projects include the development of a surgical robot called smart tissue autonomous robot (STAR) and the use of 3D printing for surgical planning and patient specific implants. Professor Krieger is an inventor of over twenty patents and patent applications. Licensees of his patents include medical device start-ups Activ Surgical and PeriCor as well as industry leaders such as Siemens, Philips, and Intuitive Surgical. Before joining Johns Hopkins University, Professor Axel Krieger was an Assistant Research Professor and Program Lead for Smart Tools at the Sheikh Zayed Institute for Pediatric Surgical Innovation at Children's National. He has several years of experience in private industry at Sentinelle Medical Inc and Hologic Inc. His role within these organizations was Product Leader developing devices and software systems from concept to FDA approval and market introduction. Dr. Krieger completed his undergraduate and master's degrees at the University of Karlsruhe in Germany and his doctorate at Johns Hopkins, where he pioneered an MRI guided prostate biopsy robot used in over 50 patient procedures at three hospitals.

Title: Autonomous Surgical Robots: Will future surgeons need caffeine or 120V?

Abstract: Robotic assisted surgery (RAS) systems, incorporate highly dexterous tools, hand tremor filtering, and motion scaling to enable a minimally invasive surgical approach, reducing collateral damage and patient recovery times. However, current state-of-the-art telerobotic surgery requires a surgeon operating every motion of the robot, resulting in long procedure times and inconsistent results. The advantages of autonomous robotic functionality have been demonstrated in applications outside of medicine, such as manufacturing and aviation. A limited form of autonomous RAS with pre-planned functionality was introduced in orthopedic procedures, radiotherapy, and cochlear implants. Efforts in automating soft tissue surgeries have been limited so far to elemental tasks such as knot tying, needle insertion, and executing predefined motions. The fundamental problems in soft tissue surgery include unpredictable shape changes, tissue deformations, and perception challenges.

My research goal is to transform current manual and teleoperated robotic soft tissue surgery to autonomous robotic surgery, improving patient outcomes by reducing the reliance on the operating surgeon, eliminating human errors, and increasing precision and speed. This presentation will review my previous work in robot design, robot control, and image guidance to perform complex autonomous soft tissue surgeries such as anastomosis and tumor resections. This presentation will also discuss novel strategies to overcome the challenges encountered in soft tissue autonomous surgery. These innovations include: a) surgical tools that are optimized for robotic use and incorporate the maneuverability and complex actuations in the tool tip; b) improved surgical imaging coupled with fluorescent dyes and other intra-operative imaging to track and differentiate diseased from normal tissue; and c) robot control strategies that effectively enhance the surgeon's capabilities. The presentation will conclude with my vision for future autonomous robotic systems for trauma care, emergency surgery, and MRI compatible surgical robots.