MECHANICAL ENGINEERING MSc SEMINAR (30 min.)

Thursday, January 15 2026 at 13:30-14:00 Lady Davis Building, Auditorium 250

Reinforcement Learning of Admittance Control policies for Autonomous Surgical Needle Driving

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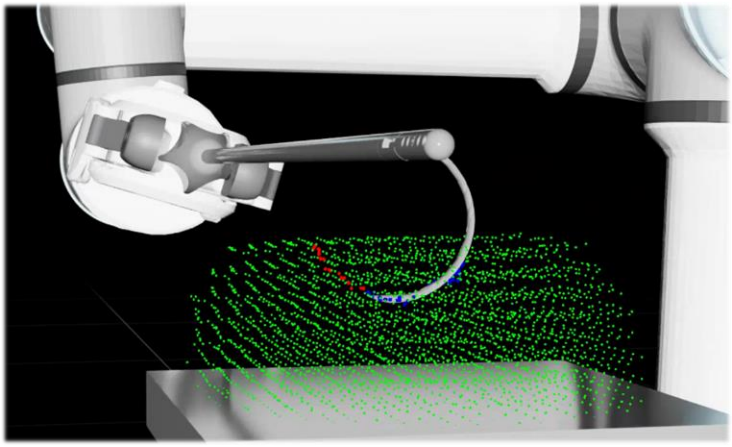
Robotic assistance is now common in minimally invasive surgery, but progressing from teleoperation to reliable autonomy requires controllers that adapt to soft-tissue mechanics. We address a core subtask of autonomous suturing: precision needle driving through deformable tissue; where the robot must follow a prescribed circular arc between tissue-fixed entry and exit points despite tissue motion and partial needle occlusion. We formalize the task in the local tissue frame and model the resulting time-varying robot–tissue interaction as a compliance-modulation problem. To solve it, we propose a Neural Network Admittance Controller (NNAC) that preserves the structure of classical admittance control while replacing fixed gains with a learned, history-aware compliance policy. The policy, implemented as an LSTM-based Actor–Critic network, infers appropriate compliance from recent force/torque and motion signals and outputs bounded Cartesian trajectory updates. Trained in NVIDIA Isaac Sim with domain randomization over tissue stiffness and needle–tissue friction, NNAC achieves sub-millimeter average tip-to-tissue error and significantly reduces peak and exit errors relative to tuned baselines. These results demonstrate that learning-based online admittance control can robustly track tissue-frame trajectories, advancing the field toward dependable autonomous suturing.



Simulation of the robotic arm performing the needle driving task. Tissue nodal elements are presented in green, tissue target points and previous tip-skin contact points are represented in red and blue, respectively, in the tissue frame of work.

Note: the seminar will be given in English

Seminars Coordinator: Prof. Sefi Givli