CAREER: Advancing Autonomy for Soft Tissue Robotic Surgery and Interventions

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The **research goal** of this CAREER proposal is *to advance fundamental knowledge in robotics to enable complex autonomous intervention in varying, unstructured, and deformable environments*.

Motivation and Challenges:

- Autonomous robotic surgery systems could significantly improve efficiency, safety, and consistency over current tele-operated robotically assisted surgery.
- Present day approaches to automated manipulation are unable to emulate highly trained humans in the performance of complex manipulation tasks in varying, unstructured, and deformable environments.

Research Objectives:

1. Develop machine learning (ML) based methods for real-time, accurate identification, and tracking of deformable tissue targets.
2. Develop new biomechanical and data driven models simulating the physical interaction between the surgical tool and the tissue.
3. Develop novel confidence-based collaborative control strategy enabling success guarantees for autonomous control.

Broader Impact – Impact on Society:

- Enable a new generation of surgical robots that reduce complication rates and improve outcomes.
- This research has the potential to democratize access to the highest level of healthcare by providing consistent expert-level results, reducing costs, and help in future pandemics.

Scientific Impact:

- Deformable tissue tracking will yield new techniques for identifying and tracking subtle tissue targets in unstructured environments.
- Deformation prediction will produce methodologies for understanding tissue behavior and how to compensate for deformations.
- Control-design activities will address shortfalls in autonomous robot controllers by providing new strategies maximizing autonomy, while providing fail-safe operation.

Robotic Testbed:

- Smart Tissue Autonomous Robot (STAR) with KUKA LWRs
- Custom 3D/NIR endoscope
- Recent Science Robotics Article: https://www.science.org/doi/10.1126/scirobotics.abj2908

Broader Impact - Education and Outreach:

- Outreach programs at the K-12 and collegiate levels that will encourage full participation of women and URMs in STEM.
- Enhancing the infrastructure for education through creation of open-source competition framework in robotics.

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