Affordable Robots with Biosensors for Minimally Invasive Surgery

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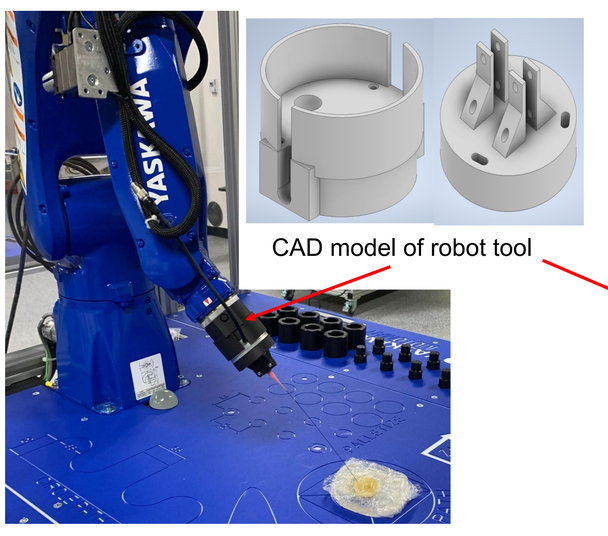
(Aspiring PI)

Commercial robots for minimally invasive surgery help surgeons insert incision tools into the patient body with minimal effort and high accuracy. Accurate tissue mapping is required to ensure procedure safety.

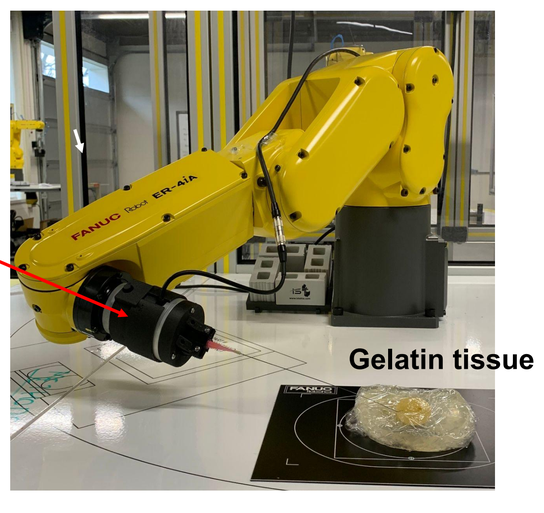
Limitations: High equipment and imaging costs[1]; procedure-specific; large room space[2-3]

***Goal*:** *Design cost-effective robotic systems using industrial robots and develop biocompatible sensors using laser fluorescence spectroscopy.*

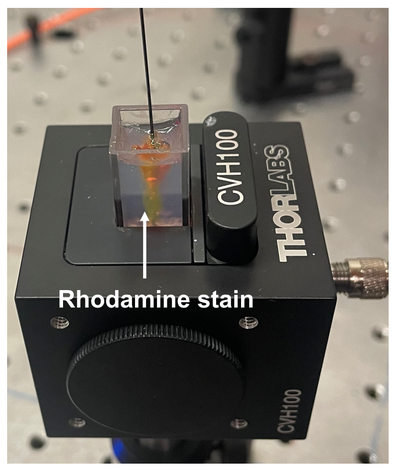


Yaskawa robot with attached 3D printed tool for needle interventions

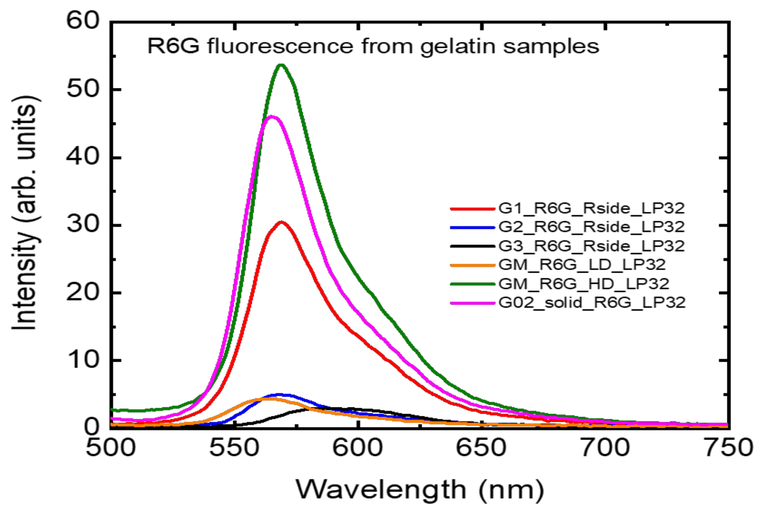
CAD model of robot tool



FANUC robot with attached 3D printed tool for needle interventions



Needle-tip stained with rhodamine in gelatin



Rhodamine fluorescent peaks for different gelatin densities

Preliminary Work

A 3D printed detachable robot tool is ready for integration with industrial robots (Fanuc and Yaskawa) for needle-based interventions. The tool is light weight to meet payload requirements enough for invasive surgeries.

Able to characterize gelatin layers using rhodamine (R6G) as fluorescent biosensor.

Ongoing Work

Novel needle designs to hold biosensor solution for real-time needle tracking in tissue.

Compare performance with commercial medical robots.

Main impact

Uniform platform to integrate and operate any robot.

Tissue characterization extended to object identification with haptic feedback for rehabilitation.

Enable teleoperation control of robotic systems for operation in hazardous environments.

Impact on Society

- Cost-effective technology for poor sections of societies/countries.
- Healthcare business – safe and affordable technology.
- Manufacturing companies that use robots for automated tasks.

Impact on Education and Society

- Undergraduate research for workforce development.
- High school student recruitment/retention initiatives.

References

1. Issatayeva, Aizhan, et al. "Design and analysis of a fiber-optic sensing system for shape reconstruction of a minimally invasive surgical needle." *Scientific reports* 11.1 (2021): 1-12.
2. Leal Ghezzi, Tiago, and Oly Campos Corleta. "30 years of robotic surgery." *World journal of surgery* 40.10 (2016): 2550-2557.
3. Babaiasl, Mahdieh, Fan Yang, and John Paul Swensen. "Robotic needle steering: state-of-the-art and research challenges." *Intelligent Service Robotics* (2022): 1-33

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