

Autonomous Suture Management for STAR Robot Design Specifications

Form Specifications

1. The prototype must be able to fit into a 25mm diameter tube in at least one configuration [1].
2. Any cross-sectional areas of the prototype with a diameter greater than 25mm must be placed at least 12" back from the tip of the endo360 on the STAR robot [2].
3. Device must operate within a 10cm x 10cm x 10cm workspace [2].

Functional Specifications

1. Thread catching accuracy of greater than 90% [2].
2. Thread releasing accuracy of greater than 90% [2].
3. Must be able to apply 1N of force to tension to the thread [3].
4. Time per stitch of 24 seconds or less [2].
5. Must stop suture tensioning when a force of 5N is reached with 100% accuracy [2].
6. Coefficient of variance of bite depth of 26% [4].
7. Coefficient of variance of suture spacing of 30% [4].
8. Force on the suture needle inside of the Endo360 must be less than 5N/ must be minimized to avoid damage [4].
9. Device must be able to pull 25 cm of thread within a 10x10x10cm workspace [2].
10. Device should not influence Endo360 suture placement, placement should still be 0.5mm [5].

References

1. Tsai, A. Y., & Selzer, D. J. (2010). Single-port laparoscopic surgery. *Advances in Surgery*, 44(1), 1–27. <https://doi.org/10.1016/j.yasu.2010.05.017>
2. Leonard, S., Opfermann, J., Uebele, N., Carroll, L., Walter, R., Bayne, C., Ge, J., & Krieger, A. (2021). Vaginal Cuff Closure With Dual-Arm Robot and Near-Infrared Fluorescent Sutures. *IEEE Transactions on Medical Robotics and Bionics*, 3(3), 762–772. <https://doi.org/10.1109/tmrb.2021.3097415>
3. Phan, P. T., Hoang, T. T., Thai, M. T., Low, H., Davies, J., Lovell, N. H., & Do, T. N. (2021). Smart surgical sutures using soft artificial muscles. *Scientific Reports*, 11(1), 1–16. <https://doi.org/10.1038/s41598-021-01910-2>
4. Saeidi, H., Opfermann, J. D., Kam, M., Wei, S., Leonard, S., Hsieh, M. H., Kang, J. U., & Krieger, A. (2022). Autonomous robotic laparoscopic surgery for intestinal anastomosis. *Science Robotics*, 7(62). <https://doi.org/10.1126/scirobotics.abj2908>

5. Leonard, S., Shademan, A., Kim, Y., Krieger, A., & Kim, P. C. W. (2014). Smart Tissue Anastomosis Robot (STAR): Accuracy evaluation for supervisory suturing using near-infrared fluorescent markers. *Proceedings - IEEE International Conference on Robotics and Automation*, 1889–1894. <https://doi.org/10.1109/ICRA.2014.6907108>