University of Utah
UNDERGRADUATE RESEARCH JOURNAL

INVERSE-KINEMATICS BASED OPTIMIZATION OF TENDON-DRIVEN CONTINUUM ROBOTS

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ABSTRACT

Tendon-driven continuum robots are characterized by having a fixed number of tendons routed along a flexible backbone. These are complex robots that have shown promise in minimally invasive surgery [1] as they typically have a wider range of motion compared to the more popular rigid instrumentation of traditional surgical systems[2]. However, tendon-driven robots have complex mechanics dependent on their specific tendon-routing that make designing their tendon routing difficult.

Adaptive simulated annealing (ASA) is a simple, yet powerful gradient-free optimization method that enables optimization of non-convex and nonsmooth problems where popular methods such as gradient descent may fail [3]. Because tendon-driven robots have these complex and expensive mechanics, ASA was a natural choice for our research.

Using an inverse kinematics-based cost function, our method optimized the tendon routing of a tendon-driven robot to reach a set of 25 points within the brain of a hydrocephalus patient. Although collision-free control is not yet guaranteed, the optimized robot was able to reach all desired points in the brain structure to within 0.5mm of error in simulation. This research shows the potential for these robots to be optimized for patient-specific surgical settings, with the future goal to improve the method to guarantee collision-free motion.

REFERENCES

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