

氏名	陸 昱羲
学位（専攻分野）	博士（工学）
学位記番号	千大院理工博甲第工 186 号
学位記授与の日付	令和 6 年 9 月 3 0 日
学位記授与の要件	学位規則第 4 条第 1 項該当
学位論文題目	Stiffness-Modulation of Multi-DoF Pneumatic Soft Actuator for Minimally Invasive Surgery（低侵襲手術のための多自由度空気駆動型ソフトソフトアクチュエータの剛性調整に関する研究）
論文審査委員	(主査) 教授： 中口 俊哉 (副査) 教授： 並木 明夫 教授： 中川 誠司 教授： 兪 文偉 (審査協力者) 五十嵐 辰男 フロンティア医工学センター名誉教授 ゴメス タメス ホセ 融合理工学府准教授

論 文 内 容 の 要 旨

In minimally invasive surgery (MIS), the role of antagonistic soft actuators in enhancing stiffness modulation, especially in procedures like transvesical prostatectomy, is becoming increasingly important. While previous studies have primarily focused on single-pair actuators, our investigation delves into the challenges of multi-DoF (Degree of Freedom) designs with multiple chambers. Our study first identified the actuator's key performance determinants. The chamber's cross-sectional design significantly influences the actuator-endoscope interaction. Through FEA (Finite Element Analysis) simulation and prototype tests, we discovered that wider chambers amplify frictional forces, improving stiffness adjustability and overall actuator performance. Leveraging this insight, we crafted a 3-DoF pneumatic actuator with six chambers arranged in three antagonistic pairs. Our FEA simulations elucidated how internal stress distributions within the actuator's multiple antagonistic chambers, along with the structure of the central hollow duct, collectively modulate stiffness. We pinpointed optimal stiffness strategies and assessed their impact on actuator performance metrics, suggesting enhanced surgical precision and adaptability. Preliminary surgical simulations were testament to our actuator's potential, spotlighting its capability to elevate surgical precision and safety in transvesical prostatectomy.