Project title

Vision-based High-resolution Tactile Sensing Probe for Real-time Force feedback and Stiffness Recognition in Minimal Invasive Surgery

Project description

Abnormal tissues, such as tumors, typically exhibit greater stiffness than healthy tissues, which physicians often detect through traditional palpation based on experience. In recent years, minimally invasive surgery (MIS) has developed rapidly, offering significant advantages in reducing surgical trauma. However, despite these advancements, MIS can also limit the surgeon's ability to receive tactile feedback. This tactile feedback is crucial for accurately identifying abnormal tissues, such as tumors, and assessing their boundaries during surgery. Without the ability to feel variations in tissue stiffness, surgeons may find it more challenging to precisely locate and differentiate tumors from surrounding healthy tissue. As a result, the lack of tactile feedback in MIS could potentially lead to less precise resections and increased difficulty in ensuring complete tumor removal, underscoring the need for alternative methods to provide real-time tactile information during surgery.

With recent advancements in camera technology, high-resolution micro cameras can now be incorporated into palpation devices, enabling the conversion of visual information into tactile sensations. This innovation has fueled growing demand for the development of vision-based palpation systems that can offer surgeons or surgical robots real-time tactile feedback. Such devices would significantly enhance intraoperative tumor localization, facilitate clearer boundary differentiation, and improve surgical planning, ultimately leading to more precise and effective procedures.

With the support of the supervisors, the student will be responsible for developing a vison-based palpation device tailored to a specific clinical application scenario. This undertaking may encompass hardware manufacturing, including tasks such as 3D modelling, as well as software development, particularly in the realm of image processing.

Keywords

Tactile Sensing, Vision-based Palpation, Stiffness, Visual Sensation

Prerequisites

OpenCV, SolidWorks/Fusion 360

Relevant papers

* Jia X, Li R, Srinivasan M A, et al. Lump detection with a gelsight sensor[C]//2013 World Haptics Conference (WHC). IEEE, 2013: 175-179.
* Kara O C, Ikoma N, Alambeigi F. HySenSe: A hyper-sensitive and high-fidelity vision-based tactile sensor[C]//2022 IEEE Sensors. IEEE, 2022: 1-4.
* Yeh, Chien-Shien, et al. "Development of vision-based tactile sensor for palpation of pathological soft tissues." 6th World Congress of Biomechanics (WCB 2010). August 1-6, 2010 Singapore: In Conjunction with 14th International Conference on Biomedical Engineering (ICBME) and 5th Asia Pacific Conference on Biomechanics (APBiomech). Springer Berlin Heidelberg, 2010.
* Kim, Youngwoo, et al. "Vision-based fluid-type tactile sensor for measurements on biological tissues." Medical & biological engineering & computing 56 (2018): 297-305.