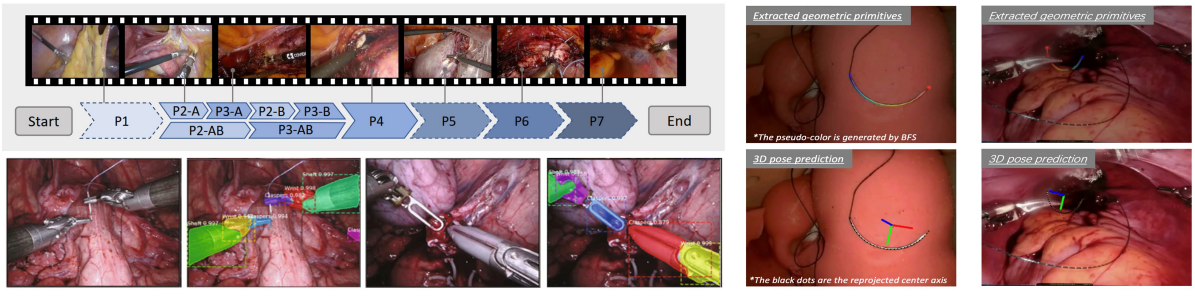
THEME-BASED RESEARCH SCHEME
PUBLIC SYMPOSIUM 2024
主題研究計劃研討會

Image-guided Automatic Robotic Surgery

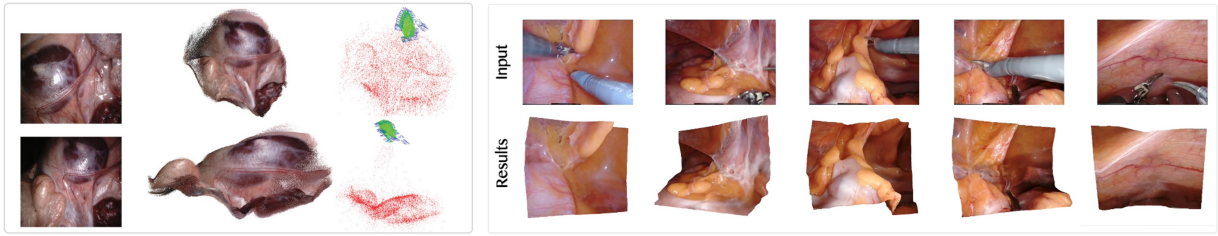
The current paradigm of surgical robotic systems relies on teleoperation which still demands surgeons' full attention throughout surgical operations. We aim to automate intra-operative surgical procedures by leveraging newly designed surgical robots with image-guided online analysis of surgical scenes. Laboratory and/or clinical studies have demonstrated the feasibility and significant potential to enhance efficacy in practice.

Surgical Visual Perception and Intelligence

- New dataset and algorithms for surgical workflow recognition, surgical instrument detection and segmentation, and needle pose estimation.
- Novel algorithms for 3D reconstruction of tissue surfaces from surgical videos.



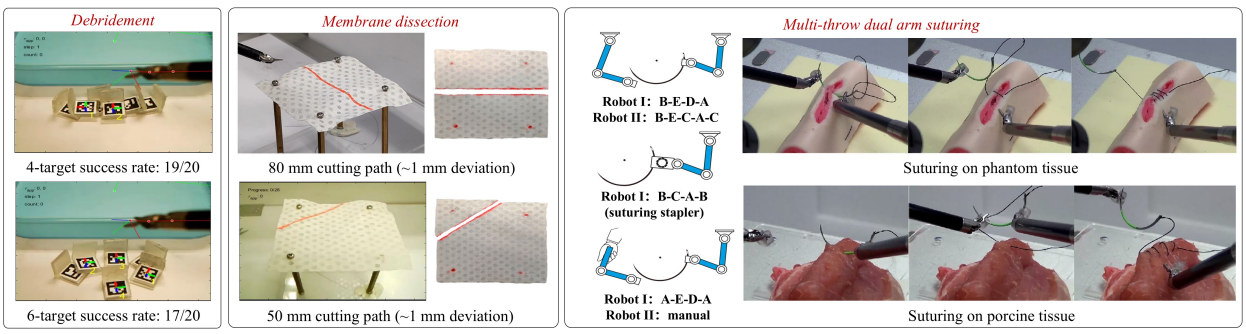
Recognition of the current surgical phase (P1-P7) and instruments (left), and 3D pose estimation of needles (right).



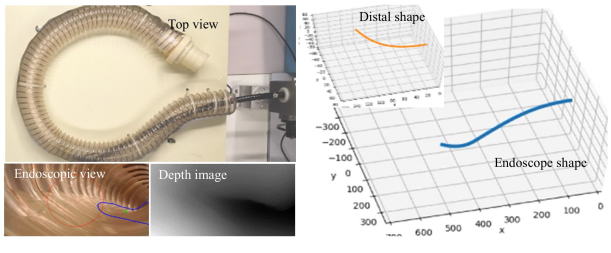
Deformable tissue reconstruction from binocular captures in robotic surgery under the single-viewpoint setting.

Image-guided Planning and Control

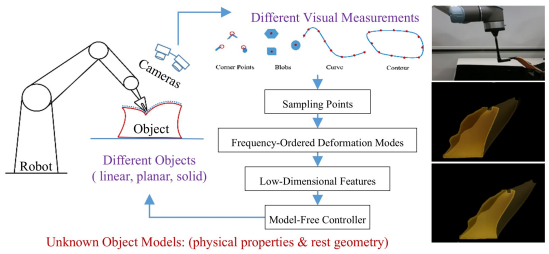
- A unified surgical task autonomy framework that automates various simulated surgical tasks, achieving greater precision and consistency than novices.
- A robotised colonoscope equipped with an FBG sensor enables automatic in-vivo navigation using integrated shape and vision-based control.
- A robust marker-less feature-based controller for soft object manipulation provides deformation control, effectively handling various types of soft materials.



Dual-arm automated tasks (debridement, membrane dissection, and suturing) using our unified surgical autonomy framework.



FBG-embedded colonoscope for autonomous navigation.

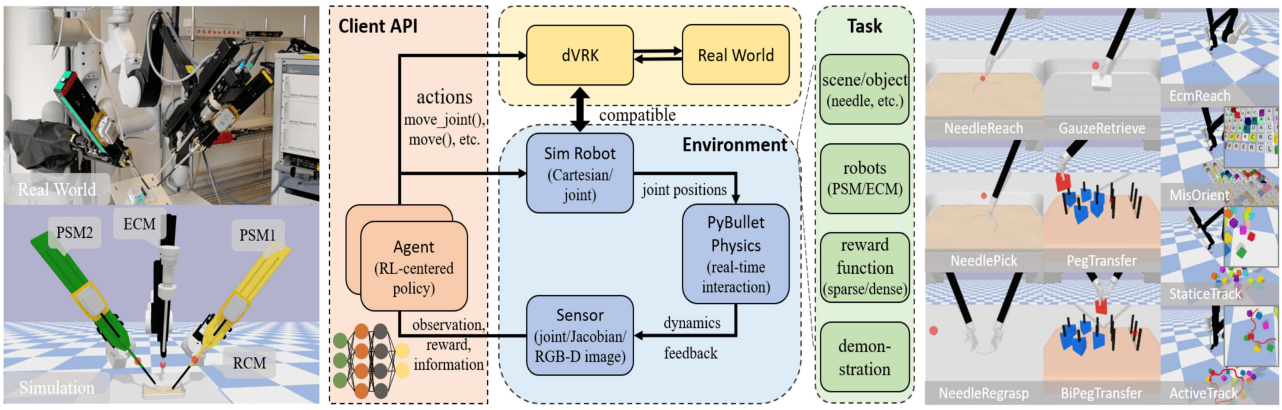


Deformation control using our controller across various objects.

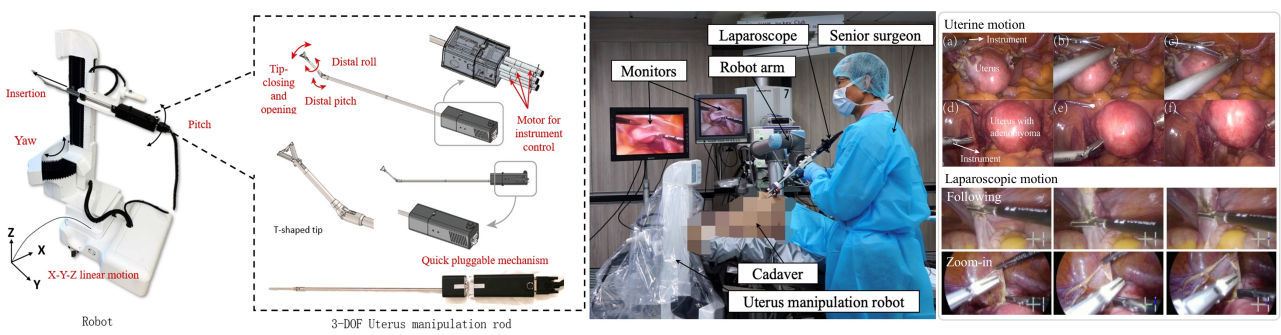
Image-guided Automatic Robotic Surgery

Robot-Assisted Surgical System

- An open-source reinforcement learning-centered simulation platform, SurRoL, for surgical robot learning, compatible with the da Vinci Research Kit (dVRK).
- A one-surgeon-four-arm human-robot collaboration system for total laparoscopic hysterectomy, verified by cadaver study in Prince of Wales Hospital.



The system design of SurRoL, which provides dVRK compatible simulation environments and supports ten common surgical tasks.

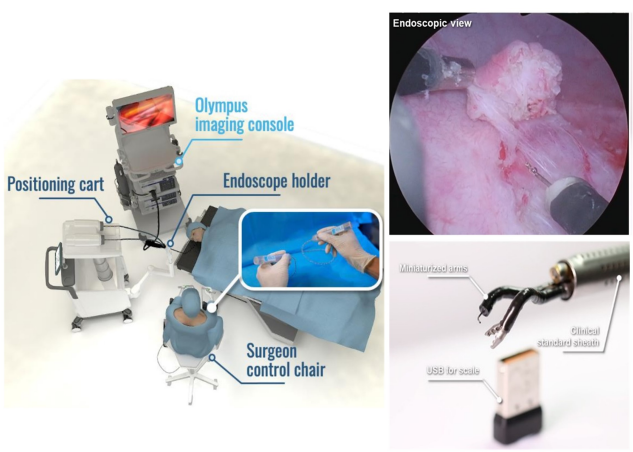


The designed uterine manipulation robot (left), the cadaver study of the developed one-surgeon-four-arm system (middle), and the laparoscopic views of the uterine motion from the clinical trials and automatic laparoscopic motion prediction (right).

Spin-offs

- Cornerstone Robotics' Sentire Endoscopic Surgical System incorporates advanced technologies from clinical medicine, mechanical engineering, and software to enhance the precision and outcomes of minimally invasive surgeries, improving patient care.
- Agilis Robotics' instruments are ultra-thin and fully flexible, with diameters ranging from 2.8 to 3.5 mm and lengths up to 1.8 meters, enabling surgeons to access and excise tumours from the bladder deep within the colon.

Sentire Endoscopic Surgical System from Cornerstone Robotics



Flexible robotic system from Agilis Robotics