

## **Research Proposal (ME, HKU)**

### **Proposed Research Topic:**

Robotic technologies for surgery to minimally invasive surgery (MIS).

### **Purposes:**

I would like to do research on the robotic technologies for surgery to MIS and try to solve the related difficulties on present stage, such as the fulcrum effect, unfamiliar relationship between visual and motor coordinates, limited field-of-view and poor perceptual capabilities.

### **Background:**

The MIS has brought about great revolution to the surgical practice and was gradually replacing the traditional open surgery with the introduction of advanced instrumentation. The advantages of MIS lie in faster recovery and lower hospitalisation costs as a result of reduction in patient trauma. However, there are a range of ergonomic challenges, because of the very nature of MIS. Take the laparoscopy as an example, it involves the use of long, rigid tools inserted into the patient via small incisions and is very difficult to operate in reality. In addition, the fulcrum effect, which was caused by the inversion of motion direction at the trocar, and the loss of wrist articulation limits the manual dexterity of the surgeon. What's more, as the visual feedback from a laparoscopic camera was conveyed by a separate display, the hand-eye coordination of the surgeon was affected.

Robotic technologies for MIS potent lots of benefits, such as improved control and dexterity. The loss of wrist articulation, which was caused by the traditional approach, was also compensated as a result of the enhanced surgical instruments. The master-slave control has also been introduced to improve the safety and consistency of MIS. However, even with the current surgical systems, tools are still too rigid and careful port placement to ensure required access and workspace for a given procedure are required. It is a big challenge to ensure the safe performance of surgical interventions within the tight confines of the chest or cluttered peritoneal cavity involving large-scale tissue deformation. Based on the reasons mentioned before, current medical robotics research focused on the integration of multiple control modalities together with enhanced visualisation and intraoperative image guidance.

Most initial research in robotics are focused on solving known limitations of industrial robots, especially in adaptability and autonomy. Compared with humans, robots are able to integrate lots of data precisely through different sensors, thus being able to perform and repeat repetitive tasks with good positional accuracy and stability. In addition, combining diverse sources of information is better for surgeons to make difficult decisions. However, existing surgical robots are still limited to simple procedures under surgeons' control. Surgery robotics must be seen as extender rather than replacement of surgeon.

Robotic-assisted surgery is only one of the various computer-aided surgeries. Robot represents a single component of a multifunctional system, which was specifically

designed to improve the surgical efficiency. In addition to automated or manually controlled surgical devices, such system also combines preoperative planning, intraoperative registration and image-guided navigation and visualisation. In this context, medical imaging leads an important role in the development of CAS systems. It is also a research branch of MIR.

**Methodology:**

1. Conduct vast literature review related to themes related.
2. Get familiar with the whole process of previous improvement in lab.
3. Locate the main difficulties and devote my energy into them.
4. Discuss the problem with colleagues and advisor.
5. Form my own idea and discuss the feasibility with advisor.
6. Carry out experiments to verify my idea.
7. Record the results and write papers.

**Outcomes and Value:**

After the efforts I made, I think the current method in this area could be improved and this will promote many new research afterwards.