

## **COST EFFECTIVE ALTERNATIVES FOR ROBOTIC SYSTEMS IN MINIMALLY INVASIVE SURGERY**

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Performing complex tasks like endoscopic suturing or static tasks like camera holding or organ retracting in Minimally Invasive Surgery (MIS) is very demanding, cumbersome and labour intensive, due to a disturbed hand-eye co-ordination, indirect way of observing, non-ergonomic instruments with limited degrees of freedom and a lack of easy to use assisting devices. Robotic tele-manipulators and camera systems enhance surgical dexterity and control. This allows the surgeon to operate in an ergonomically favourable position with more intuitive manipulation of the instruments and the camera. Robotic systems, however, are very bulky, expensive, do not provide ergonomic benefits for the rest of the team and did not really proof the benefits for patient outcome. In our view robotic systems are only beneficial for manipulation beyond the capabilities of the human hand or for standard repetitive tasks. Because human hands are capable of performing complex tasks in MIS and are very intuitive to control, the aim of our project was to develop simple, mechanical, economic and easy to use alternatives for robotic systems for MIS.

The Minimally Invasive Manipulator (MIM) is designed as a purely mechanical device, for intuitive manual control of surgical instruments in 7 DoFs. When manipulating the handle of the MIM, the instrument tip should follow the handle movements, without any scaling or mirroring effect. Our third prototype is evolved into a slender but stiff device, roughly equal to that of a conventional endoscopic instrument and therefore provide force feedback. First phantom experience indicates that the system functions properly and that complex manipulations like endoscopic suturing are feasible in an ergonomically way.

The last generation of our camera and retractor positioning device is designed as a simple construction that aims at user friendly operation of the device. This includes easy one-handed operation of the device and a slender design that minimizes the interference with other instruments in the sterile field. The positioning system actually fixates all degrees of freedom of the trocar and the instrument going through it simultaneously, in a drag 'n drop manner. First experiments with the system showed its feasibility and demonstrated the system is intuitive and easy to use. A combination of the MIMs and the positioning system can be a cost effective, ergonomically<sup>1</sup> and intuitive alternative for robotic systems. In addition to complete safety, they are completely manual controlled ad provide (limited) force feedback. It

will offer surgeons the capability to perform complex MIS, and will provide a more labour-efficient way of performing Minimally Invasive Surgery.