

Minimally Invasive Surgery: Empirical Comparison of Manual and Robot Assisted Force Feedback Surgery

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Abstract. Manual and robot assisted minimally invasive surgery techniques were compared by a dissection task. While there was no force feedback in one robot condition, forces were scaled adjusting to psychophysical thresholds in four other trials. The conditions turned out to have specific advantages: When it is essential to avoid any unintentional transection a robot assisted surgery displaying forces near absolute threshold seems to be most suitable; when operating time has to be reduced a manual intervention seems to be superior. Thereby it has to be considered that both techniques require different abilities and robot assisted surgery affords acquisition instead of manual surgical skill transfer.

1 Introduction

Minimally invasive surgery (MIS) challenges a surgeon's skills due to separation of the operating area. The operating area can be reached with long instruments only, which are inserted into the patient through trocars. The surgeon can hardly feel the contact forces between instrument and tissue because of high friction between instrument and trocar. This lack of force feedback causes long operating times and unintentional damage of tissue and suturing material. To overcome this drawback minimally invasive robotic surgery (MIRS) provides an interesting alternative: sensorized instruments allow for the measurement of contact forces which can be displayed to the surgeon by appropriate force feedback devices [2] [3] [4]. To evaluate the importance of force feedback in MIRS two setups, one for manual MIS and one for MIRS, were developed (fig. 1).

The slave side of the MIRS setup consists of two AESOP (Computer Motion Inc.) robots: one robot was equipped with a stereo laparoscope, the other with a sensorized scalpel developed by DLR. Both were inserted into an artificial patient torso using conventional trocars. The scalpel was remotely controlled by a PHANToM (Sensable Inc.) which was also used to display the contact forces. The video stream was displayed in high quality on a stereo monitor. The manual MIS setup differs from the MIRS setup in that the scalpel was manipulated directly at the operating table.

