

## DESIGN AND DEVELOPMENT OF SMART LAPAROSCOPIC GRASPERS WHICH INHIBIT SLIP

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The aim of the work is to develop a closed loop system which will autonomously control the force applied to tissue by laparoscopic graspers. The jaws of the device will have one/ multiple PVDF sensors which will generate a voltage output when slip occurs, as these have already been reported as detectors for slip<sub>[1]</sub>. The jaws of the new device are additionally designed to minimise tissue damage during grasping. Several design features were investigated including fenestrations despite prior reports that these do not affect the retention force<sub>[2]</sub>.

PVDF sensors developed in house were attached to the distal end of parallel occlusion jaws. Ex vivo porcine bowel was placed in the jaws and a compression force was applied to the upper jaw (1N,2N,4N and 8N). The tissue was then retracted at various rates by a tensiometer. The PVDF signal was processed and recorded by Labview.

Three fenestration designs were investigated and compared to similar non-fenestrated jaws. The surface contact area was constant with the variable being fenestration area. Designs were tested as above and maximum traction force was recorded. Additionally, three surface profile designs were investigated, again using the same methodology.

For PVDF sensing, two criteria were investigated: voltage magnitude for 'no slip' and 'slip' condition and voltage rate of change (i.e. gradient).

Results from the fenestration experiments show that jaw fenestrations significantly increase the force needed to pull tissue from the jaws.

Initial results on PVDF sensing confirmed that this sensor can be used in a closed loop system to detect slip. This information will now be used in a closed loop system with actuators to control the grasping force. Fenestration features will be implemented in the design after further studies to optimize the ratio of contact/ fenestration area.

1. Byungjune, C., et al. *Development of Anthropomorphic Robot Hand with Tactile Sensor : SKKU Hand II*. in *Intelligent Robots and Systems, 2006 IEEE/RSJ International Conference on*. 2006.
2. Heijnsdijk, E.A.M., et al., *Fenestrations in the jaws of laparoscopic graspers*. *Minimally Invasive Therapy & Allied Technologies*, 2005. **14**(1): p. 45-48.