

Surgical Technology - Instrumented Endoscopic Tool

Abstract

The Instrumented Endoscopic Tool (IET) was incorporated into experimental setup that included two sources of information acquired while performing the Minimally Invasive Surgical (MIS) procedures: (i) force/torque data measured at the human/tool interface and (ii) visual information of the tool tip interacting with the tissues. The two sources of information were synchronized in time and recorded simultaneously for off-line analysis.



The forces and torques at the interface between the surgeon's hand and the endoscopic grasper handle were measured by two sensors. The first sensor was a three-axis force/torque (F/T) sensor (modified ATI - Mini model) which was mounted into the outer tube (proximal end) of a standard reusable 10mm endoscopic grasper (Karl Storz). The sensor was capable of simultaneously measuring three components of force (F_x , F_y , F_z) and three components of torque (T_x , T_y , T_z) in the Cartesian frame. The sensor orientation was such that X and Z axes generated a plane that was parallel to the end effector's internal contact surface when closed, and the Y and Z axes defined a plane which was perpendicular to this surface. The second force sensor (Futek - FR1010) was mounted on the endoscopic grasper handle measuring the forces applied by the surgeon's thumb on the grasper's handle. Due to the sensor's two beam parallel structure, it measured only the force component that was perpendicular to the handle. This force component (F_g) generates the moment on the handle which in turn creates the grasping/spreading interactions between the tissue and the tool tip. The seven channels of force/torque data (F_x , F_y , F_z , T_x , T_y , T_z) were sampled at 30 Hz using a laptop computer with a PCMCIA 12 bit A/D card (National Instruments - DAQCard 1200). In addition to the data acquisition, a LabView (National Instruments) application was developed incorporating a graphical user interface for visualizing the F/T data in real-time superimposed with the view from the endoscopic camera monitoring the movement of the grasper while interacting with the internal tissues and organs. This synchronized visual integration was achieved by using a video mixer in a picture-in-picture mode. The integrated interface was recorded during the surgical operation for off-line analysis.

Real-Time user interface of force/torque information synchronized with the endoscopic view of the procedure using picture-in-picture mode - Laparoscopic Nissen Fundoplication (Placing a Wrap Around the Esophagus)

