The world’s first flexible endoscopy robotic surgery in the stomach

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Master And Slave Transluminal Endoscopic Robot (MASTER)

Current Gastroscopy
Objectives

Robotic Suturing of Gastric Wall to Stop Bleeding
Objective
To perform surgery without making incisions.

Robotic Flexible Endoscopic Surgical Procedures For GI Tract (e.g. ESD)

Natural Orifices Transluminal Endoscopic Surgery - NOTES
Design: Overview

Conventional endoscopy system

- Patient
  - Inside GI tract
  - Perform treatment
- Slave Robotic System
  - Attach together
  - Parameters changes
  - Changes proximal load cell readings
- Endoscopist
  - Assist
  - Stabilised position
- Surgeon
  - Provide vision feedback
- Conventional endoscopy system
  - Master Console System
  - Control actuator torque
- Master Console System
  - Control
  - Distal end
  - Changes proximal load cell readings
  - Send signals
  - Control actuator torque
- Slave Robotic System
  - Actuate
  - Microporcessor/Motion Controller
    - Control
    - Send signals
  - Actuators housing
    - Control
- Slave Manipulator
  - Actuator Housing
  - Electronics Housing
- Robot User
- Endoscope System
- Endoscopist
  - Attend to
  - Attend to

Surgeon

- Provide vision feedback
- Assist
- Stabilised position
- Attend to

Master Console System

- Control
- Control actuator torque
- Send signals
- Control

Slave Robotic System

- Actuate
- Distal end
- Parameters changes
- Changes proximal load cell readings
- Control

Endoscopy System

- Inside GI tract
- Perform treatment
- Attatch together
- Parameters changes
- Changes proximal load cell readings
- Control actuator torque
- Control
- Send signals
- Control

Patient

- Inside GI tract
- Perform treatment
- Attatch together
- Parameters changes
- Changes proximal load cell readings
- Control actuator torque
- Control
- Send signals
- Control

Endoscopist

- Assist
- Stabilised position
- Attend to
- Attend to
Benefits for Clinicians

• Enable endoscopist to perform intricate procedures otherwise normal performed by surgeons
• Intuitive, easy to use, very short learning curve
Benefits for Patients

• Minimally invasive
• No holes = no scars
• Shorter hospitalization stays, if any
• Lower costs
Prototype (Slave)
Prototype (Master & Slave)
2011 Prototype (Master & Slave)
Animal Trials: Natural Orifices Transluminal Endoscopic Surgery (NOTES)

Step 3
Gastrectomy
Surgical Navigation System for NOTES

Position & orientation of endoscopic tip showed by 3D virtual model of patient & instrument

Video from endoscope camera

Electromagnetic tracker

Endoscope fixed with tracking sensor
Force Feedback

Master Console → Slave Motor Housing → Slave End-effector

Master Movement $X_m$ → PID Controller in Galil Card → Slave Movement $X_s$

Forces at the Motor Housing the Proximal-end of the Sheath $f_z'$ → LPF → Forces at the Slave End-effector the Distal-End of the Sheath $f_z$

Reflection Force on the Master Console $f_R$ → Scaling Coefficient $K$
Envisaged NOTES Platform
The “Da Vinci” system