Medical Robotics

Understanding a Biomedical Model of the Liver

Drexel University Research Experiences for Teachers Program 2004
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The field of robotics has brought many new possibilities to the medical field. One group of tools can be categorized as surgical extenders. Such tools provide increased reach, stability or vision.

Another category, auxiliary surgical supports, automate some of the tasks and require less of the attention of the surgeon. An example would be video feedback that controls the position of an endoscopic probe. A combination of smaller tools and advanced methods has changed the concept of minimally invasive surgery. The value of these methods can be measured by success rates as well as shortened operation and recovery times.

Research History

While the tools have improved, the skills and the touch of a doctor's hand are more difficult to mimic. New devices, labeled haptic, provide the operator with that sense of touch to reproduce the reality of the operation. Combinations of force and vision feedback provide real time information and sensation during procedure. Testing the material property of soft tissue is an important part of the process of diagnosis.

The Apparatus

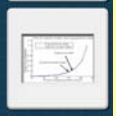
Testing has been done on the device shown here. The lead screw is driven by a dc motor and controls the motion of the testing probe. A force / torque sensor provides six axis feedback. When turned on its side a surgical blade replaces the indentation probe and measures cutting forces.

Computer Control

Experiment controls are set and force and displacement are measured using dSpace control board. The operator provides the velocity and acceleration of the probe as well as the sampling rates and times. The position and force data is shown graphically during each trial.

The Results

This graph shows the force applied measured in Newtons against the displacement measured in millimeters. This information can be used to create a stress to strain graph, the slope of which provides the elastic modulus needed for future models. Results are compared to classic models.



A Portable Probe

Work has been done this summer to develop a portable device. Smaller motors, a battery and USB flash drive, in combination with a programmed microchip will allow this tool to be used in a wider variety of environments.

Summer 2004

A current step in the advancement of medical robotics is to develop a realistic model for soft tissue for haptic feedback simulation. Finite element modeling software has been using standard material models. These include certain assumptions about the soft tissue properties and, in general, only over small deformations. Current testing in the PRISM (Program for Robotics Intelligent Sensing and Mechatronics) labs at Drexel may confirm and improve the models used. The reality of large deformation as well as real tissue properties needs to be understood. Using precision measurements of controlled displacement and force, new experimental models can be developed and verified against the accepted models.

Micro-controller Board

The chip on this board does an analog to digital conversion, provide communication with a PC and controls the motor.

The Displacement and Force Cell

A change in the position of linear potentiometer adjusts the Voltage. This circuit also amplifies the load cell signal.

Linear Motor

The test probe will be moved at a controlled velocity and acceleration during each trial

Step Motor Controller

This circuit controls the position, velocity and acceleration of the step motor

Linear Shaft Support

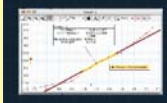
A much more portable arrangement than the previous model

Program Board

Code written in C is transfered from a computer and stored on a microchip using this board

Drexel University offers many outreach programs to help high school students make knowledgeable decisions about their future. Wissahickon students will have the opportunity to meet with Drexel engineers and learn first-hand about advances in science. A combination of tours and guest speakers will both teach and inspire.

A Model at Wissahickon



Students at Wissahickon High School will be able to try the same lab using candy to replace the liver. A Pasco Force Sensor and Motion Sensor will be used in the student version of this research. Analysis of the graphs will build lab skills and provide a good understanding of the concepts of stress, strain, and an elastic modulus.

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RET Program 2004