Research Interests
Biography
Labs & Groups
Projects
Publications

Search
People
go
Advanced Search

Look in
Name Email
Include
Former RI Members

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Research Interests

I am interested in control systems, robotic devices, signal processing, learning algorithms, and high-precision interfaces for biomedical applications, including surgery and rehabilitation. I seek to develop intelligent tools that:

- Are as transparent as possible to the user (i.e., he feels he is doing a task rather than controlling a robot)
- Augment rather than replace the capabilities of the user (e.g., using active noise control in a fully hand-held instrument rather than a telerobotic system to cancel hand tremor during microsurgery)

Most of my projects involve one or more of the following areas.

Robotic and mechatronic devices for microsurgery and minimally invasive surgery.
One such project is "Micron," a fully hand-held intelligent microsurgical instrument with active compensation of the surgeon's hand tremor. I have also recently begun a project in robotic instrumentation for minimally invasive heart surgery.

Filtering methods for tremor and non-tremulous error.
Distinguishing between desired and undesired motion in user interfaces often requires nonlinear filtering. I develop techniques such as adaptive filters and neural-network-based methods for online estimation of both tremor and non-tremulous types of erroneous motion.

High-precision instrumentation to track microsurgical tools.
Performance validation for microsurgical tools is not a trivial task, since movements as small as a few microns are significant. My research involves the need for precision tracking instrumentation in order to establish the performance baseline of unassisted surgeons, provide raw data for further filter development, and validate the performance of microsurgical devices. Using one such instrument I have acquired what are believed to be the world's first recordings of physiological hand tremor during actual microsurgery.

Research Interest Keywords

control, machine learning, mechatronics, medical applications, medical robotics