EEK2002

ANNUAL RESEARCH REVIEW

Electrical Engineering Kaleidoscope

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WELCOME TO EEK2002

The Electrical Engineering Department is the largest department in the College of Engineering at UW. We are dedicated to maintaining an atmosphere of cooperation that nurtures high-quality research and education, and which develops mature undergraduate and graduate engineers. Our department is in the midst of a period of dramatic growth and positive change. We moved into a new building in February 1998, and construction of an adjoining new CSE/EE building is underway. Since August 1998 we have grown through the addition of 14 outstanding new faculty. ALL of the assistant professors who have joined the department from 1998-2001 have received the NSF Early Career Development Award. Externally funded research in the department is increasing at a rate close to Moore's law—from $5 million in 1998-1999 to approximately $12.6 million in 2000-2001, and over $14M for the first six months of 2001-2002. Our goal is to become one of the very top EE departments in the world, through the delivery of outstanding and innovative education and the conduct of cutting edge research.

We are aggressively recruiting the very best graduate students. If you are a prospective graduate student, I encourage you to consider applying to our department. We have an extraordinary range of new and growing research projects that provide outstanding opportunities for graduate education and professional growth.

— Howard Chizeck,
Professor and Chair
Department of Electrical Engineering

EDITORIAL CREDITS

PUBLISHER
Electrical Engineering Department of the University of Washington
Howard Chizeck, *Chair*
Mari Ostendorf, *Associate Chair for Research*
John Sahr, *Associate Chair for Education*

EDITORIAL STAFF:
Mary Ann Krug, *Editor*

DESIGN STAFF:
Sarah Conradt, *Designer*

CONTRIBUTING WRITERS:
Mary Ann Krug, Rob Harrill, Tim Midgett, Howard Chizeck

EDITORIAL ASSISTANCE PROVIDED BY:
Tim Wade, Ann Fuchs, Bill Harris

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It looks like aerobics class, except these participants only move their hands. The instructor makes a rotating motion with his wrist and forearm, and his only pupil copies it closely.

Closely, but not perfectly.

The instructor shakes his head, and repeats the motion. The pupil concentrates harder, trying to mimic the movement exactly. When he succeeds, the instructor stops and nods quickly. The pupil repeats the motion correctly one more time, and nods slowly in understanding.

This exchange occurred during a meeting between members of EE Professor Blake Hannaford's research team, including Prof. Jacob Rosen and graduate student Jeff Brown, and medical surgical residents who train under Dr. Mika Sinanan in the UW Medical School Department of Surgery. The two groups are collaborating on developing instrumentative surgical tools and algorithms for objectively evaluating surgical skills that will improve the teaching of Minimally Invasive Surgery (MIS) to surgical fellows.

(MIS) has been practiced on a large scale for about 10 years in the United States. MIS replaces traditionally more invasive procedures for common operations such as gall bladder removal, and provides tremendous benefits for patients. Unlike traditional surgery, which involves making large incisions in the patient to accommodate the surgeons hands, MIS incisions consist of small ports, through which long tools and a camera are inserted. Because of these smaller incisions, patient recovery times are much shorter: 1-2 days instead of 1-2 weeks with traditional surgery. The shorter recovery times and decreased incidence of complications result in reduced healthcare costs.

The differences between MIS and more traditional invasive techniques present a unique set of challenges for training surgeons. In MIS procedures, surgeons lack direct physical contact with patients,

Most improvement in technique was achieved during the first 2-3 years of the 5-year surgical residency. After that point, technical progress increases less dramatically and cognitive skills develop more fully.

The Blue Dragon, a device for measuring the properties of endoscopic tools and for objectively evaluating a surgeon's performance.

making it difficult to gauge the appropriate amount of force and torque to apply during the operation. Surgeons also lack a direct line of sight, watching their progress through images projected onto a television from a tiny camera inserted into the patient.

Consequently, teaching by expert surgeons necessarily becomes more abstract, and evaluations of student progress more subjective. Currently expert surgeons evaluate progress by commenting on videotapes of procedures done by young surgeons. Still another challenge is distinguishing between technical skills and cognitive development of young surgeons. For example, if a procedure has 30 steps in it, and an inexperienced surgeon is having problems completing the operation effectively, is it due to a lack of surgical skill, or is it because they have a hard time remembering the precise sequence of steps 21-24? Current training techniques make it difficult to evaluate these kinds of questions.

"We started out designing special surgical instruments that measure the forces a surgeon is applying during the operation," says Hannaford. The sensors on the instruments collect large amounts of data on the mechanical forces exerted by the surgeons. The data is evaluated using statistical techniques, including Hidden Markov modeling.

Hannaford's team collected data from expert and inexperienced surgeons, who operated on an animal model system, and created a quantitative basis for comparing their respective skill levels. Comparing data generated by surgeons of different levels of expertise provides a more objective method of evaluating skill level and progress.

Their preliminary data revealed some interesting facts about development of surgical skills. Most improvement in technique was achieved during the first 2-3 years of the 5-year surgical residency. After that point, technical progress increases less dramatically and cognitive skills develop more fully. The EE researchers and their collaborators in the department of surgery are currently planning a longitudinal study of surgical residents in the department of surgery.

Editor's Note: *Blake Hannaford, Jacob Rosen, and Mika Sinanan recently received a 4-year, $1.4 million grant to develop minirobots for telesurgery for battlefield surgery.*