EEK

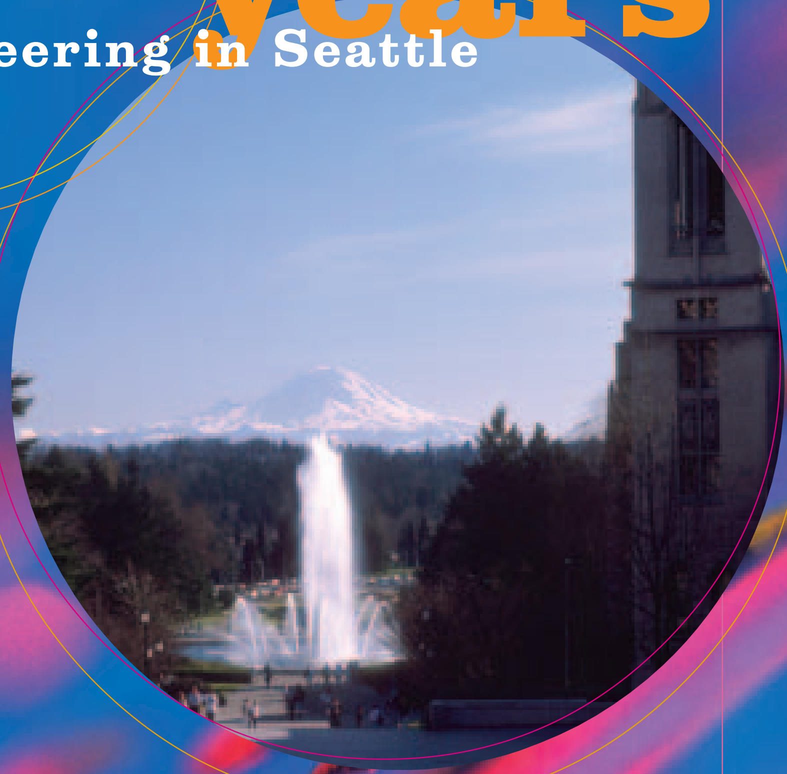
Electrical Engineering Kaleidoscope

1904-2004

A PUBLICATION OF THE ELECTRICAL ENGINEERING DEPARTMENT UNIVERSITY OF WASHINGTON

100 years

of Electrical Engineering in Seattle

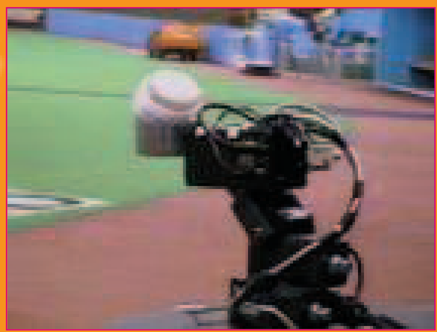


ANNUAL AND CENTENNIAL RESEARCH REVIEW

Control and Robotics

The EE Department has long recognized the fundamental role of control and robotics, starting in the 1950s and 1960s when Professors Robert N. Clark, Laurel J. Lewis, and Dean W. Lytle developed the core EE controls curriculum in conjunction with the advent of the space age and in cooperation with the Aeronautics and Astronautics (AA) and Mechanical Engineering (ME) departments.

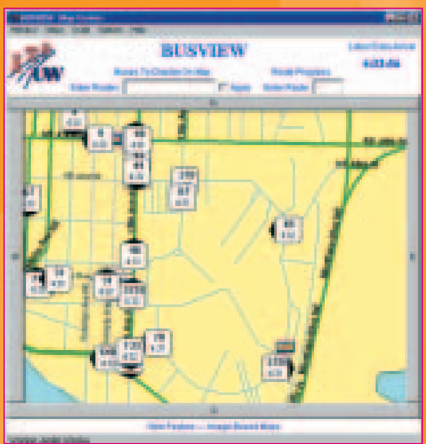
In robotics, Professor Robert Albrecht introduced a mobile robotics research laboratory in the 1980s that was funded by the Nuclear Regulatory Commission. This work spawned several robotics courses funded by NSF, which have always been very popular amongst students since their inception. One of his robots, quite famously, even delivered the ball to "Scotty," of Star Trek fame, who threw out the first pitch at a Seattle Mariners game in the now imploded Kingdome. Others who were active in developing the Controls courses in the late 50s and early 60s were Endrik Noges, Chih-Chi Hsu, and Robert Pinter.



PROFESSOR ROBERT ALBRECHT'S ROBOT WAS USED TO CARRY OUT THE BALL TO SCOTTY, WHO THREW OUT THE FIRST PITCH DURING THE "TURN AHEAD THE CLOCK NIGHT," AT A MARINERS BASEBALL GAME. ADS FOR THE EVENT PROMISED MARINERS AND ROYALS IN FUTURISTIC UNIFORMS PLAYING IN A "BIODOME" (FORMERLY KNOWN AS THE KINGDOME), WITH LASER LIGHTS AND ROBOTS PROVIDING THE 21ST CENTURY ATMOSPHERE.

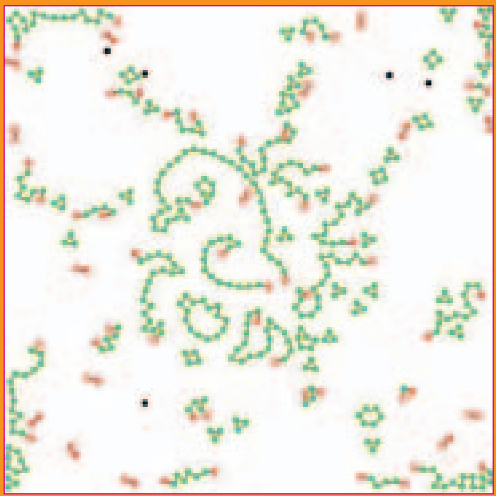
Presently, there are 11 active Robotics and Controls faculty, and several emeritus faculty in a UW Robotics, Controls, and Mechatronics (RCM) effort, which includes faculty from EE, AA, ME, and Chemical Engineering.

One of the projects from Research Professor Daniel Dailey's Intelligent Transportation Systems Lab tracks transit vehicles over a three county, 1800 square mile region. The vehicle locations can be viewed in "Busview" and are used to do the following: (1) help travelers by predicting bus departure at thousands of locations (see Mybus.org), (2) measure congestion by using the buses as probe vehicles (see http://www.its.washington.edu/transit-probes/), (3) and calibrate stochastic, predictive traffic congestion models (See EEK2001, page 5).



A MAP OF THE UW CAMPUS AND SURROUNDINGS DISPLAYING ALL THE ACTIVE BUSES NEARBY AT 4:32 PM. THE LOCATION OF ALL THE BUSES OPERATING IN KING COUNTY CAN BE DISPLAYED USING THIS APPLET: http://busview.org

Research Assistant Professor Linda Bushnell and Dr. Andy Crick continue to offer their popular LEGO-based mobile robotics courses—now in its fourth year. They recently expanded the Autonomous Robotics & Control Systems Laboratory, which consists of an impressive infrastructure of robots, camera systems, and test platforms into Sieg Hall.



A SIMULATION OF "PROGRAMMABLE PARTS" ASSEMBLED INTO STRANDS AND RINGS. THE PARTS FLOAT IN A (SIMULATED) FLUID MEDIUM. UPON RANDOM COLLISIONS, TWO PARTS MAY CHOOSE TO ATTACH TO EACH OTHER OR NOT, BASED ON THEIR PROGRAMMING.

Imagine a complex electronic device or a tiny molecular motor that puts itself together from its pieces, eliminating the need to move each part separately into place. This challenge is one of the problems studied by Assistant Professor Eric Klavins, who joined the department in Autumn 2003 from a position as a postdoctoral researcher at the California Institute of Technology. His research on multi-vehicle formation control has led him to develop algorithms that allow "programmable parts" to assemble themselves into pre-specified shapes.

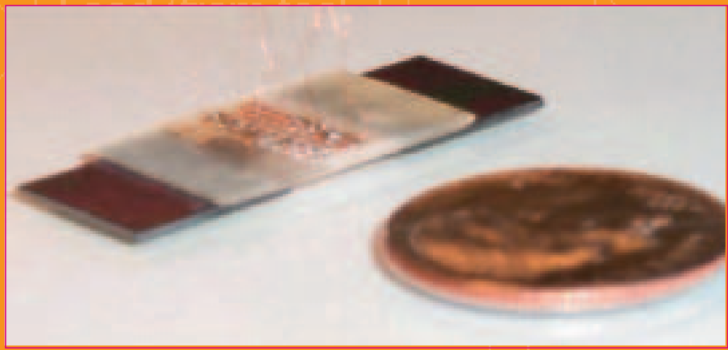
Professor Blake Hannaford, Research Assistant Professor Jacob Rosen, and the Bio-Robotics lab study robot assisted tele-surgery, which allows surgeons to operate on their patients from miles away by using robotic extensions of their hands and eyes. They want to improve minimally invasive surgery training and procedures by developing new surgical robotics, devising objective assessments of surgical performance, creating high fidelity simulations, and further understanding of the mechanics of soft tissue. Rosen is developing a robotically assisted upper limb exoskeleton (wearable robot) with a human machine interface at the neural levels proving a more natural control of the exoskeleton as intuitive extension of the operator body. The system is studied as an assisting device that may apply to rehabilitation medicine and as a force feedback haptic device that may apply to virtual reality simulations.

A PROTOTYPE OF A POWER LINE CRAWLING MICROROBOT.

EXPOSED VIEW OF UPPER LIMB POWERED EXOSKELETON WITH 7 DEGREES OF FREEDOM.

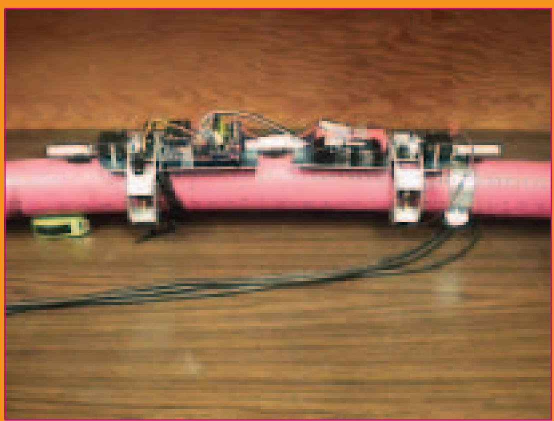
An interdisciplinary robotic activity tied to MEMS research recently created an omnidirectional mobile microrobot that moves via MEMS "cilia" actuator arrays. The microrobot consists of two rigidly connected microcilia array chips, each having an 8x8 array of "motion pixels" that are composed of four orthogonally-oriented thermal bimorph actuators. This arrangement provides the microrobot with reliable and accurate motion, a first for this type of microrobot. The microrobot is approximately 3cmx1cmx1mm and weighs less than one-half gram. Associate Professor Karl Böhringer and students are able to precisely control the velocity of the chip by varying the input power, actuation frequency, and motion gait strategy.

A WALKING MICROROBOT IN RELATION TO A US DIME - LENGTH 3CM, WIDTH 1CM, HEIGHT 1MM. TWO CILIA CHIPS WITH 256 MICROACTUATORS EACH ARE BONDED TO A TINY PCB "BACKBONE." THIS REMOTELY CONTROLLED ROBOT CAN EXECUTE MOTION IN FULL 3 DEGREES OF FREEDOM, WITH INDIVIDUAL STEPS DOWN TO ABOUT 2 MICROMETERS, AND SPEEDS OF UP TO 1 MM/SEC."



Professor Howard Chizeck is conducting research in telerobotics in the presence of communication channel properties such as noise and time delays. Also, in work supported by the MLSC, he and his students are applying algebraic systems theory to the modeling and analysis of DNA and genomic and proteomic processes. The goal is to discover and exploit underlying mathematical structures that are involved in these biological systems (See EEK2003, page15).

Assistant Professor Alex Mamishev's Sensors, Energy, and Automation Laboratory has developed a robot that crawls along an electric power cable, scanning the cable with infrared, acoustic, and dielectrometry sensors to search for developing faults and estimate cable aging. In addition to enhancing sensitivity and subsequent reliability, the use of these robotic platforms for power system maintenance could potentially have other significant advantages such as replacing human workers for dangerous and highly specialized operations.



FAR LEFT A PROTOYPE OF THE MOBILE ROBOT.

LEFT ON JULY 29-30, 2003, THE GYRE TEAM, ADVISED BY RESEARCH ASSISTANT PROFESSOR LINDA BUSHNELL, TESTED AN AUTONOMOUS SELF-ORIENTING FREE-FLYING ROBOT IN LOW GRAVITY CONDITIONS (DURING A "FREE FALL" FLIGHT).

As described in the Genomics and Proteomics article on pages 12-15, Professor Deirdre Meldrum's Genomation Laboratory is working on "ACAPELLA," a system that performs basic steps in the handling of submicroliter fluid samples, such as sample aspiration, reagent dispensing, mixing, and thermal cycling. The goal of the instrument is to process 5,000 one microliter reactions inside glass capillaries in 8 hours of unattended operation. They are currently developing automated methods for thermal cycling, real-time DNA quantitation and gel loading. The system will be used initially for PCRs, restriction digests, and sequencing reactions and will later run multiple experiments in the UW Genome Center. Meldrum is also studying applications to clinical medicine and whole-genome studies.

Contributions to this story made by: Eric Klavins, Jacob Rosen, Dan Dailey, and Robert Albrecht.