

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

The RESEARCH LABORATORY *of* ELECTRONICS

PROGRESS REPORT

NO. 137

JANUARY 1–DECEMBER 31, 1994



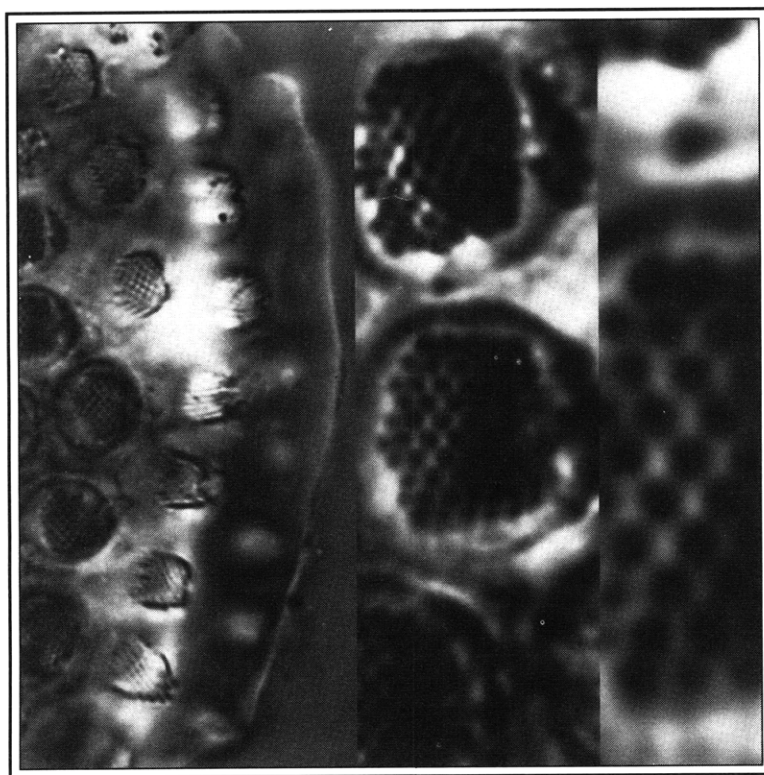
RLE Progress Report

No. 137

January 1 - December 31, 1994

Submitted by

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Cover and title page: Zooming in on Hearing

Microscopic mechanics of single sensory receptor cells play an important signal processing role in the inner ear. However, there are few direct measurements—in large part because the measurements are technically challenging. The important structures are small (micrometer scale) and the motions are even smaller as well as fast (20 Hz to 20 kHz).

Recently, members of RLE's Auditory Physiology Group have developed a video microscopic system in which stroboscopic illumination is used to take stop-action images of sound-induced motions of inner ear structures. Motions as small as 14 nm are determined directly from video images using a new algorithm based on optical flow techniques that are commonly used in machine vision.

The system has been applied to characterize inner ear motions at three levels of organization, illustrated on the cover. The left panel shows a cluster of approximately 25 sensory cells and associated structures. The center panel shows a magnified view of three of the cells. Each cell (8 micrometer diameter) contains a bundle of approximately 50 sensory hairs (0.7 micrometer diameter). The right panel shows a magnified view of the sensory hairs of a single cell. Analysis of images at these three different levels provides information about the coding of sounds at a systems level, at a cellular level, and at a level that provides insight into the molecular mechanisms of transduction.

These photomicrographs were taken by C. Quentin Davis, a graduate student in the Department of Electrical Engineering and Computer Science and in the Medical Engineering/Medical Physics (MEMPh) program in Health Sciences Technology, and by Dr. Dennis M. Freeman, research scientist in RLE. More information and slow-motion video sequences of these structures are available through the Cochlear Physiology home page on the World Wide Web (<http://behn.mit.edu>). For background information on the work of the Auditory Physiology Group, write the RLE Communications Group for a copy of *RLE currents* (volume 3, number 1, Fall 1989).

Our special thanks to the following staff members of the RLE Communications Group: Mary J. Ziegler for her exceptional organizational skills, editing, and graphics scanning and processing; Michelle M. Scheer for her excellent formatting and technical typing; Rita C. McKinnon for proofreading, and Andrew Beharrie for formatting. We also want to thank David W. Foss, Manager of the RLE Computer Facility, for his time and invaluable technical assistance, and Mary S. Greene for inputting information for the publications chapter.

We thank the faculty, staff, and students of RLE for their generous cooperation.

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The Research Laboratory of Electronics

The Research Laboratory of Electronics (RLE) was established in 1946 as the Institute's first interdepartmental laboratory. Originally organized under the joint sponsorship of the Departments of Physics and Electrical Engineering, RLE has broadened its interests to cover a wide range of research.



Professor Jonathan Allen, Director, Research Laboratory of Electronics (Photo by John F. Cook)

The RLE environment provides both the freedom of action essential in an academic institution and the availability of large-scale laboratory facilities and services required by researchers. RLE's interdisciplinary setting offers many opportunities for creative and collaborative research. By fostering this powerful combination of research and education, RLE effectively penetrates beyond the horizon of new ideas and information.

RLE Progress Report

RLE Progress Report Number 137 describes research programs at RLE for the period January 1 through December 31, 1994. Each chapter of the *Progress Report* includes a summary of research efforts for research projects listed. Faculty, research staff, students and others who participated in these projects are identified at the beginning of each project, along with sources of funding.

There are four appendices at the end of the report: Appendix A is a bibliography of RLE publications and papers presented by RLE staff during 1994; Appendix B is a roster of current RLE staff; Appendix C is a list of RLE faculty and staff milestones and honors received during 1994; and Appendix D is an index of RLE sponsors. The Project Staff and Subject Index provides additional access to the information in this report.

RLE Publications

RLE also publishes *RLE currents*, a biannual newsletter which focuses on RLE research interests; a technical report series; *Speech Group Working Papers*; and other information related to the Laboratory. The *RLE Brochure*, published in 1991 for RLE's 45th anniversary, is also available at no charge.

RLE has a presence on the World Wide Web (<http://rleweb.mit.edu>). RLE web pages include an introduction to RLE research and services; information about RLE's history, research groups, staff, and publications along with news of RLE events, and a history of the Radiation Laboratory (1940-1945).

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