GROUNDBREAKING, WORLD-CHANGING PROGRESS

COMPUTER SCIENCE AND ENGINEERING

A PIONEERING DEPARTMENT:

DESIGNING AND MAPPING THE FUTURE

Ever since the University at Buffalo became one of the first higher learning institutions to offer degree programs in the computing field more than 40 years ago, our Department of Computer Science and Engineering has succeeded in establishing itself as a leading research department, well known both nationally and internationally for its groundbreaking foresight and pioneering innovations.

For decades, our highly motivated and dedicated faculty have engaged in world-class research in every aspect of computing science and technology, and are recipients of numerous national and international awards. They have founded, and currently direct, major research centers devoted to biomedical computing, biometric systems, cognitive science, document analysis and recognition, information assurance, and high-performance computing. In addition, they have played key roles in many other major areas of research, including optical and wireless networks, computer security, databases, algorithms, complexity theory, and software and hardware systems.

Among many of their cutting-edge achievements, our faculty have pioneered in the science and technology of automated handwriting recognition and developed software systems for machine reading of handwritten addresses, which has saved the U.S. Postal Service more than a billion dollars in just a few years. They have also been credited with an algorithm developed for crystal structure determination, which has been ranked as one of the top algorithms of the 20th century. Moreover, one of our faculty members has helped establish UB as one of the leading academic supercomputing centers in the world.

Equally distinguished are the accomplishments of our alumni, many of whom are prize-winning researchers and CEOs of some of the fastest-growing companies of information technology worldwide.

Our department has led the way in advancing the science and technologies of information, computing, and communication technologies that are indispensable to our world today, and we will continue to lead the way into the future.

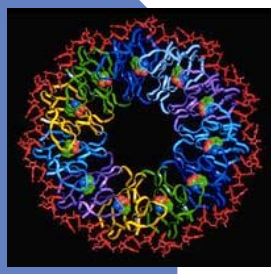
Aidong Zhang Professor and Chair

ON THE COVER

A VIEW OF THE NEW HOME FOR COMPUTER SCIENCE AND ENGINEERING, ALONG WITH ELECTRICAL ENGINEERING, TO OPEN IN 2011.

NEW CSE HOME TO RISE

UB DOWNTOWN CAMPUS



CSE RESEARCH CENTERS

BUFFALO CENTER FOR BIOMEDICAL COMPUTING

Merging the research activities of computational and biomedical scientists, the focus is on common diseases, such as cancer, multiple sclerosis, and coronary artery disease in which the underlying causes are multifactorial. Advanced computational techniques and approaches are used to convert raw genomic data into knowledge to advance the understanding of these diseases and potentially identify new modalities of treatment.

CENTER FOR UNIFIED BIOMETRICS AND SENSORS

The center's mission is to establish a unified biometric framework, facilitating the development of next-generation biometric systems from proof-of-concept to product readiness. This includes radically different biometric technologies geared toward applications to improve comfort, convenience, and security for personal and commercial use.

CENTER FOR COGNITIVE SCIENCE

Cognitive science is the study of how the mind works, both in its conceptual organization and in its computational and neural infrastructure. It brings together researchers from a number of traditionally separate disciplines to build a new and unified understanding of cognition that is compounded from the different disciplinary perspectives and that moves beyond them.

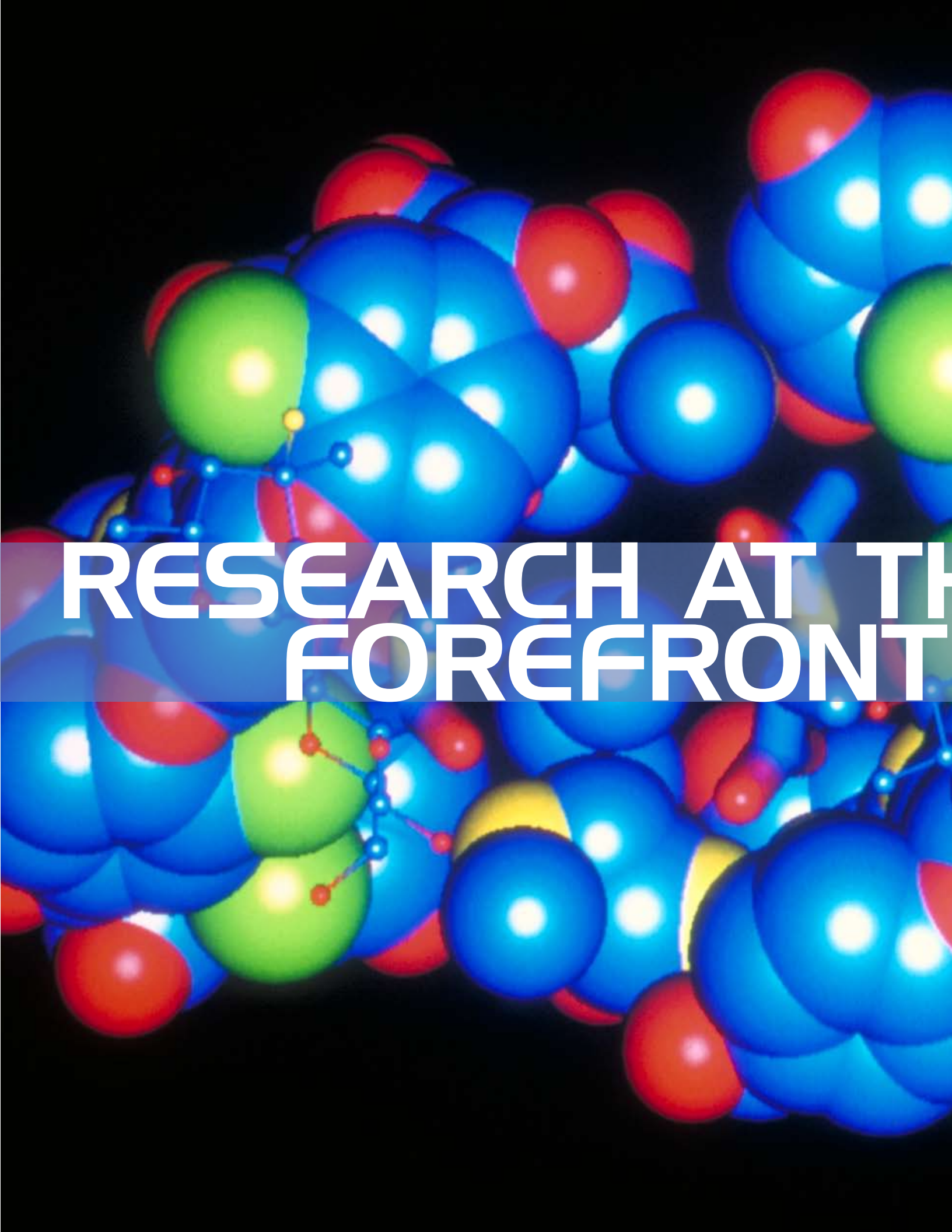
CENTER OF EXCELLENCE FOR DOCUMENT ANALYSIS AND RECOGNITION

The focus is on the development of computational methods for pattern recognition, machine learning, and information retrieval. While analysis of paper documents and handwriting recognition has been the center's core strength since 1978, the application has since been diversified to include biometrics, computational forensics, and text analytics.

CENTER OF EXCELLENCE IN INFORMATION SYSTEMS ASSURANCE RESEARCH AND EDUCATION

With growing demands for information assurance expertise to meet the challenges and threats to the national information infrastructure, the center's goals are graduate education and coordinated research in computer security and information assurance. Collaborations with companies engaged in security research and a multidisciplinary research focus in information assurance and cyberwarfare are promoted.

Groundbreaking for a new $61-million, state-of-the-art classroom and laboratory building occurred on UB's North Campus. The new engineering building will be home to the Department of Computer Science and Engineering and the Department of Electrical Engineering, modernizing their programs and facilities. Designed by renowned architects Perkins & Will, the 130,000-square-foot structure will increase facility space of the School of Engineering and Applied Sciences by nearly one-third, accommodating significant new growth in the school's student enrollments, faculty hires, and research expenditures. The building will feature a cybertorium or smart auditorium, outfitted with the most sophisticated communications devices and smart technologies. Flexible research labs, classrooms, and meeting areas will foster interdisciplinary work. The building is expected to be completed in 2011.


RESEARCH AT TH
FOREFRONT

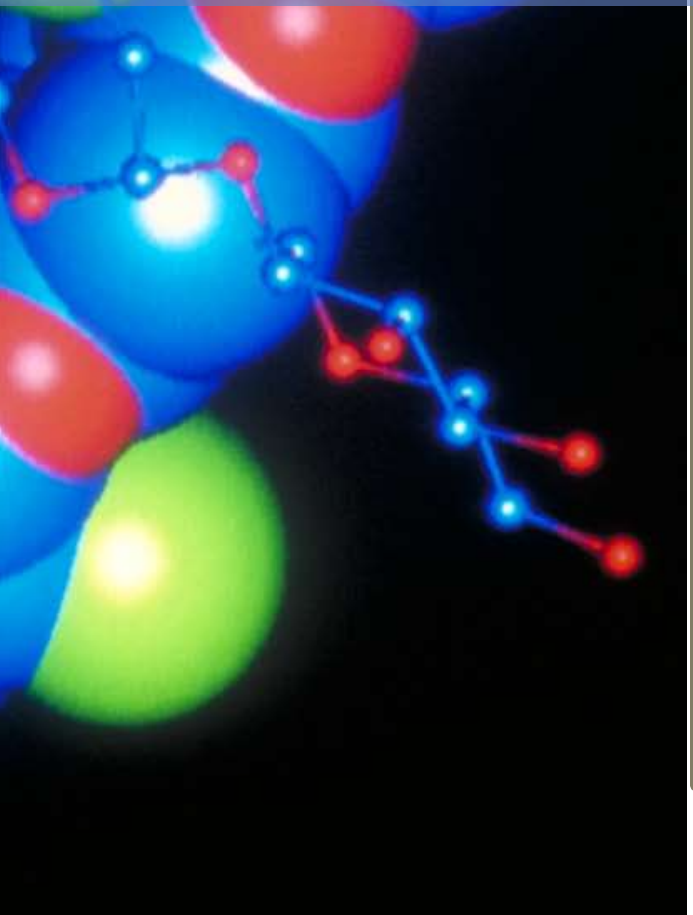
VANCOMYCIN, "THE ANTIBIOTIC OF LAST RESORT" THAT WAS SOLVED BY CSE'S SHAKE-AND-BAKE PROGRAM.

BIOMEDICAL COMPUTING

Aidong Zhang's focus is on the areas of protein-protein interaction network analysis, microarray data analysis, and high-dimensional data visualization. She is developing intelligent content-analysis programs to automatically analyze images, replacing human coding of semantic content. To develop and ultimately predict the best treatment strategies for multiple sclerosis patients, she recently teamed up with pharmaceutics researchers at UB and Buffalo General Hospital to apply the technique of data mining to MS patient data generated by DNA microarray technology.

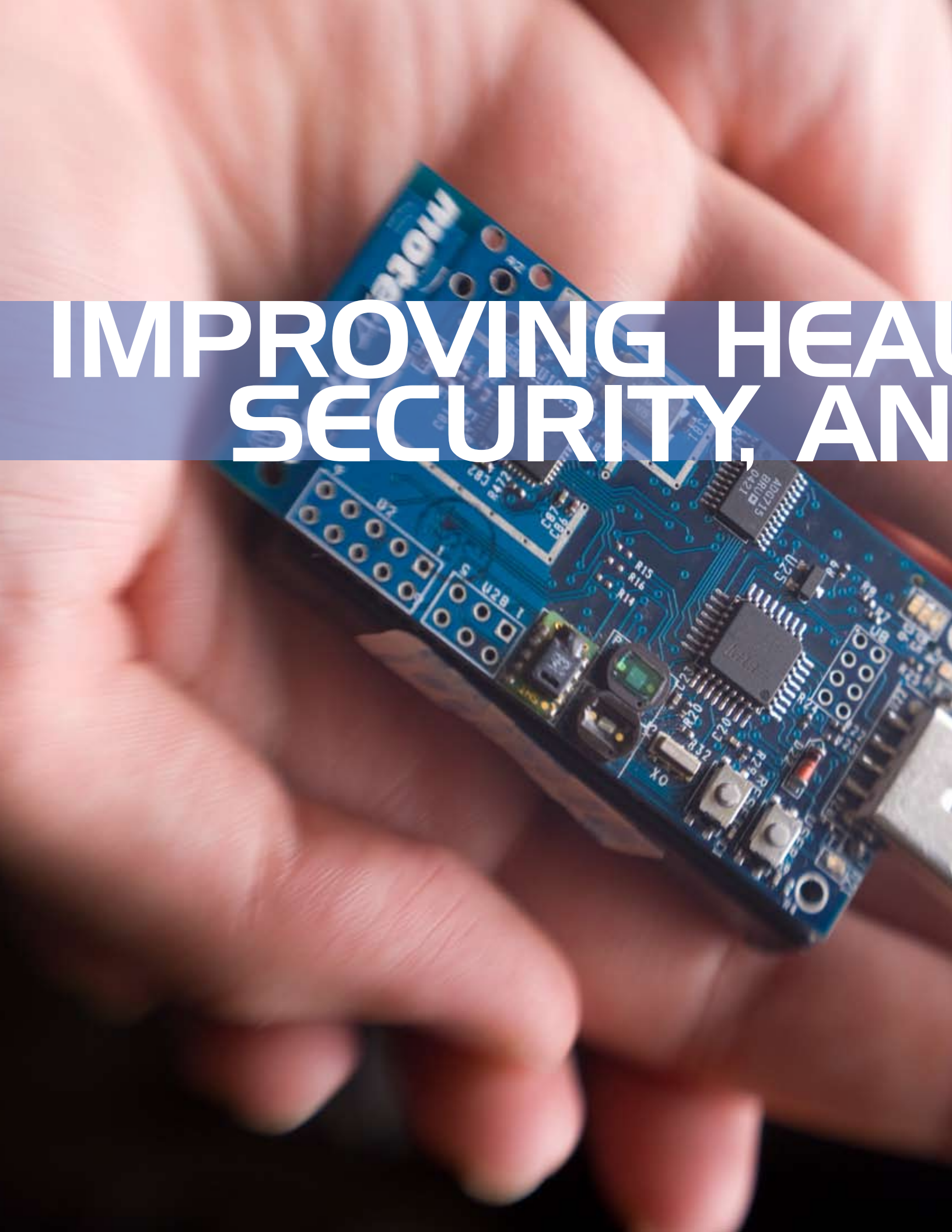
Zhang is the principal investigator and program director of the Buffalo Center for Biomedical Computing, which she helped develop through an NIH grant. Her work focuses on delineating genomic mechanisms in chronic complex diseases, pharmacodynamic analysis of drug-responsive gene expression changes, a central access data warehouse spanning multiple disease types, and a new technology for genome-wide detection of cancer-related genomic alterations.

HE



CYBERINFRASTRUCTURE

Russ Miller considers cyberinfrastructure at the core of modern simulation and modeling, allowing for entirely new methods of investigation that allow scholars to address previously unsolvable problems. Specifically, the development of necessary software, algorithms, portals, and interfaces that will enable research and scholarship by freeing end-users from dealing with the complexity of various computing environments is critical to extending the reach of high-end computing, storage, networking, and visualization to the general user community. The grid represents the next generation of clustering that is revolutionizing science and engineering through cyberinfrastructure. Workloads can be spread across multiple processors and are not bound by a single platform or geographic location. Harnessing this emerging and expanding technology allows geographically distributed and independently operated resources to be linked together in a transparent fashion. Miller's Cyberinfrastructure Laboratory has been responsible for the establishment of several prominent grids in New York State.



IMPROVING HEAL
SECURITY, AN

FAR-REACHING WIRELESS SENSOR NETWORKS ARE BEING DEVELOPED.

LTH, D LIFE

CYBERSECURITY

Shambhu Upadhyaya's research focus is on various aspects of security and dependability that include user-level anomaly detection, insider threat modeling, event correlation and cyber-attack recognition, security in mobile ad hoc networks, emergency sensor networks, malware detection, human-centered security, and empirical cyber-security.

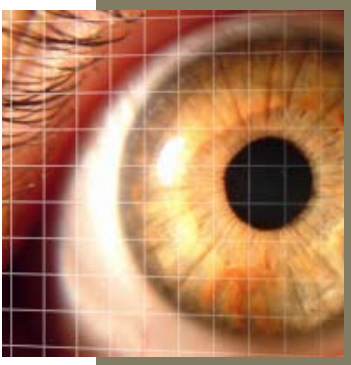
SURGERY

Vipin Chaudhary's research interests include all aspects of computer-assisted diagnosis and surgery, and architectures and parallelization of bioinformatics algorithms. His current focus is on diagnosis of orthopedic problems, computer-assisted neurosurgeries, and parallel implementations and architectures for bioinformatics algorithms. He is building a neurosurgery planning tool that incorporates multimodality image segmentation and registration, brain shift prediction, intelligent real-time planning, augmented reality, and telesurgery.

SOCIAL RELEVANCE

Michael Buckley and **Kris Schindler** are employing computing technology to improve the quality of life of people with disabilities. Among the research projects and products under development are natural-voice talkers for the speech impaired, single-switch Internet surfing for quadriplegics, robotic wheelchairs, sensory systems to teach cause-and-effect to severely delayed children, Tablet PCs (in conjunction with Microsoft Corporation) that translate the uncharacteristic handwriting of people with spastic cerebral palsy, and a means to extend special-education classwork to home- and hospital-bound children.

THE SMART TALKER HELPS PEOPLE WITH SPEECH PROBLEMS



A WORLD OF CSE RESEARCH

ARTIFICIAL INTELLIGENCE

Stuart Shapiro | William Rapaport | Jason Corso | Rohini Srihari

Computational linguistics (or natural-language processing) and knowledge representation and reasoning are core areas of classical artificial intelligence (AI)—the computational understanding of human-level cognitive abilities. Knowledge representation and reasoning is the study of techniques for representing and reasoning about the information used by an AI program.

Research at CSE is concerned with the abilities that underlie natural-language use, reasoning, and rational acting. The objective is to build a computerized rational agent—a computer system that can converse in English about various everyday and specialized topics; be taught about such subjects by instruction carried out in English, possibly with the aid of gestures, drawings, and diagrams; and reason about those subjects, discuss them with humans, and perform as instructed.

The Semantic Network Processing System (SNePS) is a fully intensional, propositional, knowledge-representation, reasoning, and acting system that is being used in many sites around the world for studies in expert systems, knowledge representation, reasoning, natural-language understanding and generation, belief revision, planning and acting, and cognitive modeling.

PATTERN RECOGNITION
MACHINE LEARNING
COMPUTER VISION

Sargur Srihari | Venu Govindaraju | Peter Scott | Jason Corso |

Pattern recognition is the study of methods and algorithms for putting data objects into categories. While classical pattern recognition techniques are rooted in statistics and decision theory, the machine learning paradigm is commonly used to design practical systems. Machine learning is a method of programming computers in which the machine is programmed to learn from an incomplete set of examples. Prominent work on automated systems for pattern recognition and machine learning has made an impact on statistical methods, information retrieval, the analysis and recognition of handwriting, and computational forensics.

The interdisciplinary field of computer vision draws on concepts from signal processing, artificial intelligence, neurophysiology, and perceptual psychology. The primary goal of computer vision research is to endow artificial systems with the capacity to see and understand visual imagery at a level rivaling or exceeding human vision. CSE research includes developing techniques for visualizing common data-structures such as graphs and multidimensional data sets, and visualizing molecular structures. Applied research includes visualizing data from practical applications, such as bioinformatics, software engineering, pharmacokinetics, engineering and design, bioimaging, and digital art.

COMPUTER SYSTEMS

Chunming Qiao | Sheng Zhong | Murat Demirbas | Chang Wen Chen | Shambhu Upadhyaya | Ramalingam Sridhar | Vipin Chaudhary | Steven Ko | Raymond Fu

Research in networks involves both hardware and software, and spans both user space and operating systems. Topics include wide-area networks and local-area networks, wired technology and wireless/mobile technology, data and telephony communications and integrated services, and applications and modem access. Networking includes enabling technologies for other systems in distance learning, multimedia systems, distributed supercomputing, telemedicine, collaborative research, electronic commerce, and online entertainment. Distributed systems studies communication and coordination patterns of components found in networked computers.

CSE laboratories and research groups conduct research on networking architectures, protocols, network control and management issues, and performance evaluation. They focus on switching networks (including multichannel networks), wireless networks, and interconnection networks. They study wireless sensor networks and distributed and dependable computing. Work is done on security, privacy, and economic problems in wireless networks and mobile computing. Distributed systems research includes peer-to-peer alternatives to traditional client-server models and ubiquitous computing with location-based services at the application program level.

SOFTWARE AND INFORMATION SYSTEMS

Jan Chomicki | Michalis Petropoulos | Aidong Zhang | Sheng Zhong | Rohini Srihari | Bharat Jayaraman

The database research design study focuses on implementing and evaluating novel query interfaces and new query language constructs. Of special interest are the challenges of data integration, in which data coming from many autonomous and hetereogenous sources is combined and presented to the users in a unified way. Other topics include inconsistency resolution, queries with preferences, Web services, and query processing and optimization. The research projects combine engineering prototype systems with rigorous mathematical analyses.

The data mining research focuses on extracting valid, previously unknown, and ultimately comprehensible information from large databases and using it to make crucial decisions. Of special interest are cluster analysis of high dimensional data, outlier detection of unusual cases, feature extraction and analysis of data, and visualization tools for interactive pattern analysis.

The field of programming languages is concerned with concepts, notations, methodologies, tools, and environments for the construction of robust, efficient, maintainable, evolvable software. CSE focus is on languages that support high-level, declarative, and visual modeling of complex systems.

ALGORITHMS AND THEORY

Hung Ngo | Jinhui Xu | Roger He | Russ Miller Kenneth Regan | Alan Selman | Atri Rudra

The design of efficient algorithms is often a critical first step in solving problems in many areas. Depending on the model of computation or computer platform that is required for an application, algorithmic research in specific sub-areas may be referenced.

Complexity theory is a mathematical discipline that classifies computational problems by relative difficulty and measures the computational resources needed to solve them. It explains why certain problems have no practical solutions and helps researchers anticipate the difficulties involved in solving problems of certain types. In general, complexity theory deals with the quantitative laws of computation and reasoning. For this reason, complexity theory concerns issues and problems of direct interest to many other disciplines as well. Research in this area is concerned with properties of complexity classes, relationships between classes, identification of properties of problems that affect their computational complexity, and the obstacles to proving non-trivial lower bounds in complexity theory.

EMBEDDED SYSTEMS

Shambhu Upadhyaya | Vipin Chaudhary | Ramalingam Sridhar

Hardware and software issues from the circuit to the system have three main foci: very large scale integration (VLSI) circuits and systems, computer architecture, and computer security. VLSI includes circuits and systems design, systems on chip,testing, computer-aided design, and synthesis. Computer architecture deals with the study and design of computer systems to meet functional, cost, and performance requirements of applications. CSE research focus is in the area of built-in self testing of circuits, scheduling for SOC testing, defect analysis, and fault model extensions in RF circuits and circuit diagnosis.

BIOINFORMATICS

Aidong Zhang | Daniel Fischer | Russ Miller

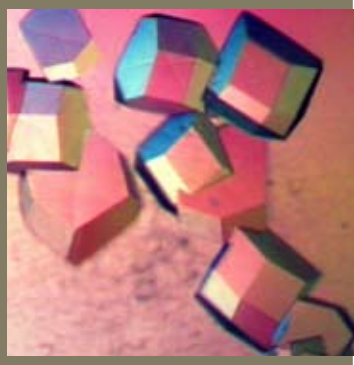
Research in bioinformatics focuses on development of novel algorithms and architectures for genomics, proteomics, and biomedical applications. The research areas include protein-protein interaction network analysis, microarray data analysis, high-dimensional data visualization, and a better understanding of life at the molecular level using “in silico” or computational tools to interpret the information encoded in biological macromolecules, from individual proteins to complete genomes.

COMPUTER SCIENCE EDUCATION

Michael Buckley | Kris Schindler | Carl Alphonce | Adrienne Decker | Bina Ramamurthy

Computer science education is an area of research which focuses on curricular and pedagogic issues in the teaching of computer science, as well as related issues such as recruitment and retention of underrepresented groups in the discipline.

Research interests of faculty in this area include object-oriented pedagogy, the pedagogy of CS1-CS2 courses and rapidly emerging areas (such as grid computing and server-side programming), software tools which support course pedagogy, and student and community engagement through socially relevant projects.



IEEE FELLOWS

FELLOWS IN THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE) CONSTITUTE AN ELITE GROUP OF LEADERS AND INNOVATORS IN THE FIELD. THOSE IN CSE INCLUDE:

Chang Wen Chen was elected an IEEE fellow for his contributions in digital image and video processing, analysis, and communications. He has been editor-in-chief of IEEE Transactions on Circuits and Systems for Video Technology (CSVT) since January 2006. He has served as an editor for Proceedings of the IEEE, IEEE Transactions on Multimedia, IEEE Journal of Selected Areas in Communications, and IEEE Multimedia Magazine, and has also chaired and served on numerous technical program committees for IEEE and other international conferences.

Venu Govindaraju was elected an IEEE fellow for his contributions to handwriting recognition. He has made significant contributions to many areas of pattern recognition, which is a major branch in the field of artificial intelligence within computer science. Much of his early work focused on the automated recognition of written language, both machine-printed and handwritten text, and more recently his research has expanded to information retrieval and biometrics.

Sargur Srihari was elected an IEEE fellow for his work on automated systems for pattern recognition and machine learning. The principal impact of his work has been on statistical methods, on the analysis and recognition of handwriting, and in defining the field of computational forensics. Srihari's handwriting recognition work led to the first handwritten address interpretation system ever used by post offices in the world. His studies on individuality measurement are widely cited in the context of forensic testimony. His research also led to a software system in use by forensic document examiners worldwide.

Satish Tripathi is UB Provost and an internationally accomplished computer scientist who has been involved in substantial funded research. A fellow of the IEEE Computer and Communications Societies, he is a founding member of the editorial board of IEEE Pervasive Computing, and a member of the editorial board of the International Journal of High-Speed Networks. He previously was on the editorial boards of IEEE Transactions on Computers and ACM/IEEE Transactions on Networking, among others.

Aidong Zhang was named an IEEE fellow for her contributions to multimedia data indexing. She is the author of more than 200 publications pertaining to her research in such areas as datamining, bioinformatics, content-based image retrieval, distributed database systems, multimedia database systems, and geographic information systems.

SARGUR SRIHARI ILLUSTRATING A POINT

DISTINGUISHED PROFESSORS

Sargur Srihari holds the title of **SUNY Distinguished Professor,** the highest faculty rank in the SUNY system. Srihari, who teaches courses in pattern recognition, machine learning, and data mining, founded the Center of Excellence for Document Analysis and Recognition (CEDAR) in 1991. The handwriting-recognition technology developed by him and the center served as the basis for the mail-sorting machines utilized today by the U.S. Postal Service, which has funded the work continuously for more than 20 years. Since 1991, Srihari has been funded by the National Institute of Justice to develop software tools for forensic science applications.

Two CSE faculty members hold the title of UB Distinguished Professor for achieving distinction and leadership in their fields:

UB Distinguished Professor **Venu Govindaraju** has authored more than 300 scientific papers, including more than 60 journal papers. His seminal work in handwriting recognition was at the core of the first handwritten address interpretation system used by the U.S. Postal Service. He was also the prime technical lead responsible for technology transfer to Lockheed Martin and Siemens Corp. for deployment by the U.S. Postal Service, Australia Post, and UK Royal Mail. Govindaraju has been the principal or coprincipal investigator of projects funded by government and industry for about $50 million. The Center for Unified Biometrics and Sensors (CUBS) that he founded in 2003 has since received over $8 million in research funding.

UB Distinguished Professor **Russ Miller** founded the Center for Computational Research (CCR) at UB and was its director from 1998 to 2006. During his tenure, CCR was continuously ranked as one of the leading supercomputing centers worldwide, supporting nearly 25TF of computing, 300TB of data storage, and a wide variety of high-end visualization devices. Miller is a codeveloper of the Shake-and-Bake method of molecular structure determination, which was included in the poster "Top Ten Algorithms of the Century" in Computing in Science & Engineering, produced in cooperation with the IEEE and the Computer Museum History Center.

(CAREER) AWARD WINNERS

Seven members of the CSE faculty have received the prestigious Faculty Early Career Development (CAREER) Award from the National Science Foundation. The award is one of the NSF's highest recognitions of junior faculty who "exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organizations." The funding is typically in the range of $400,000-$500,000 for a period of five years. Recent CSE awardees include:

Jason Corso is focusing on developing techniques for automatically learning hierarchical statistical models of complex phenomena and deriving robust efficient inference algorithms on these models.

Murat Demirbas is investigating the design and implementation of an in-network collaboration and coordination framework for wireless sensor networks, providing a platform for developing and deploying distributed control applications.

Hung Ngo aims to resolve the problem of switching speed in optical switching network infrastructures with a rigorous framework that bridges research and education on various areas of computer science and mathematics.

Atri Rudra is studying efficient techniques for computing approximate solutions to problems involving very large amounts of data, especially for handling the increasing number of errors that will occur as more data is packed into physical media.

Jinhui Xu is developing efficient geometric techniques for application in cardiovascular interventional procedures, improving the quality of projection imaging (such as angiogram and CT imaging) and the guiding of stent implant procedures.

Sheng Zhong is studying the design of an enforceable economic mechanism for mobile ad hoc wireless networks that will provide sufficiently strong incentives for cooperative behavior and security protection against cheating.

Aidong Zhang was recipient of a CAREER Award in 1998 for multimedia database systems research and education.

AWARDS AND HONORS

Venu Govindaraju received a Defense Advanced Research Projects Agency award of $1.24 million for multilingual document analysis research.

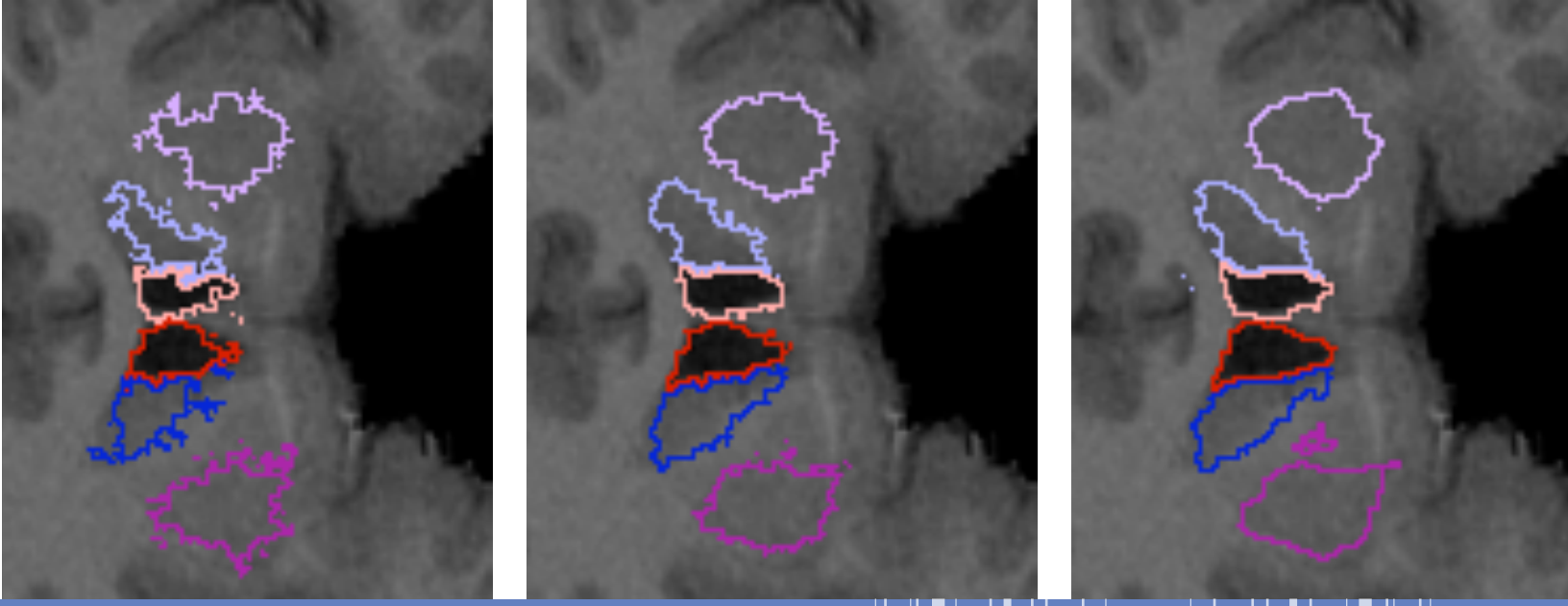
Shambhu Upadhyaya received a $149,000 National Science Foundation award for digital forensics curriculum development.

Chang Wen Chen received a Best Paper award from IEEE Transactions on Multimedia for his paper, "Joint Source-Channel-Authentication Resource Allocation for Multimedia Over Wireless Networks."

Michael Buckley received two awards for teaching excellence: the Richard T. Sarkin award from the Alumni Association and the Milton Plesur award from the Student Association. He also received a $62,000 gift from Microsoft for assistive technologies research. A project team in his Hardware/Software Integrated Systems Design course won the Microsoft ImagineCup competition in Cairo with a tablet PC-based teaching aid for occupational and speech therapists.

William Rapaport has been a recipient of the SUNY Chancellor's Award for Excellence in Teaching.

Adrienne Decker received the Milton Plesur Award for Excellence in Teaching from UB's Student Association.



GRANTS

THE CSE FACULTY AVERAGES $4.5 MILLION ANNUALLY IN GRANTS FOR RESEARCH IN AREAS THAT RANGE FROM HIGH-PERFORMANCE COMPUTING TO DATA MINING. GRANTS IN RECENT YEARS HAVE INCLUDED:

CSE's **MultiStore Research Group** is funded by a $1 million National Science Foundation (NSF) grant for the development of high-performance online data-storage systems.

Shambhu Upadhyaya will lead a multi-investigator $868,000 Federal Cyber Service grant from NSF. He also received $150,000 from the NSF for computer forensics and $128,000 from DoD/NSA for information security. The funding enables faculty development, research, and education in these areas.

The proposal from **Venu Govindaraju,** director of UB's Center for Unified Biometrics and Sensors, is one of 41 projects from around the world that HP Labs is funding with an Innovation Research Award, worth up to $100,000 for each of three years. Instead of using a keyboard, a mouse, or some other device to move an object on a computer screen, users would be able to manipulate the object on the screen with just their voice and gestures. Govindaraju also received an NSF grant of $853,000 for deceit detection through person-specific behavioral dynamics.

Daniel Fischer received a $1 million National Institutes of Health grant in 2005 for bioinformatics research.

The New York State Office of Science, Technology and Academic Research (NYSTAR) awarded $700,000 to recruit **Vipin Chaudhary** in 2006 to design and build a high-performance computing platform to enable both high-end medical computing and computer-assisted surgery.

Jinhui Xu received $414,000 from NSF for research on algorithms for determining the organization and dynamics of the cell nucleus.

Sargur Srihari was granted $300,000 for his shoe print forensics from the National Institute of Justice (NIJ), which funds research into new technology and approaches to law enforcement. He also received a $597,000 grant from the NIJ in 2005 for fingerprint recognition.

Shambhu Upadhyaya received $150,000 from the NSF for computer forensics and $128,000 from the Department of Defense/National Security Administration for information security. The funding will enable faculty development, research, and education in these areas.

Roger He was awarded a $240,000 NSF grant in 2006 for research in algorithms and applications of planar graphs and meshes.

Sheng Zhong was awarded a $212,000 NSF grant in 2005 for research on incentive-compatible protocols.

Stuart Shapiro received $148,000 from the John R. Oshei Foundation for ontology-based support for large field studies in psychiatry.**Bina Ramamurthy** received a $75,000 NSF award for embedded operating systems course development.

Chunming Qiao was awarded a $50,000 NSF grant in 2005 for the project, "SGER Exploring Sociological Orbits in Mobile Users' Mobility Pattern."

AIDONG ZHANG CONSULTS

EDITORSHIP OF JOURNALS

CSE faculty serve on the editorial boards of over 30 prestigious journals, of such groups as Fellows of the Association for Computing Machinery (ACM), American Association for Artificial Intelligence, Institute for Electrical and Electronics Engineering (IEEE), International Association for Pattern Recognition (IAPR), and American Association for Advancement of Science (AAAS).

Editorships include the following:

Jan Chomicki has been an associate editor of ACM Transactions on Database Systems since 2004. Considered the premier database journal that publishes original archival papers in the area of databases and closely-related disciplines, the majority of papers published address the logical and technical foundation of data management.

Since 2002, **Venu Govindaraju** has been an associate editor of IEEE Transaction on Systems, Man, and Cybernetics. He has professional interest in the closely interrelated fields of man-machine systems, systems science, systems engineering, and cybernetics.

Alan Selman has been editor-in-chief of Theory of Computing Sciences since 2001. The journal focus is on computer science, mathematics and statistics, and numerical analysis.

NORTH CAMPUS

NORTH CAMPUS STUDENT UNION

NORTH CAMPUS CENTER F

DOWNTOWN BUFFALO

THIS IS UB

The University at Buffalo is a premier research-intensive public university, a flagship institution in the State University of New York system and its largest and most comprehensive campus with three locations across Buffalo Niagara. UB's more than 28,000 students pursue their academic interests through more than 300 undergraduate, graduate, and professional degree programs. Founded in 1846, the University at Buffalo is a member of the Association of American Universities.

FOR THE ARTS

SOUTH CAMPUS

DOWNTOWN CAMPUS

A GREAT PLACE TO LIVE AND WORK

THIS IS BUFFALO NIAGARA

The second-largest city in New York State, Buffalo is one of the most livable, lively, and comfortable places in which to live, work, and play. It's an easygoing, inviting mix, from great music and food to spirited professional sports teams, renowned architecture and cultural institutions, and top-notch entertainment. Situated at the eastern end of Lake Erie where the Great Lakes empty into the Niagara River, Buffalo is in easy reach of the Canadian lakeshore and Niagara Falls, the most accessible of the world's natural wonders.

The Buffalo Niagara region offers all of the amenities of a major urban area—without the headaches. The average workday commute is less than twenty minutes, which is the lowest out of fifty major U.S. cities.

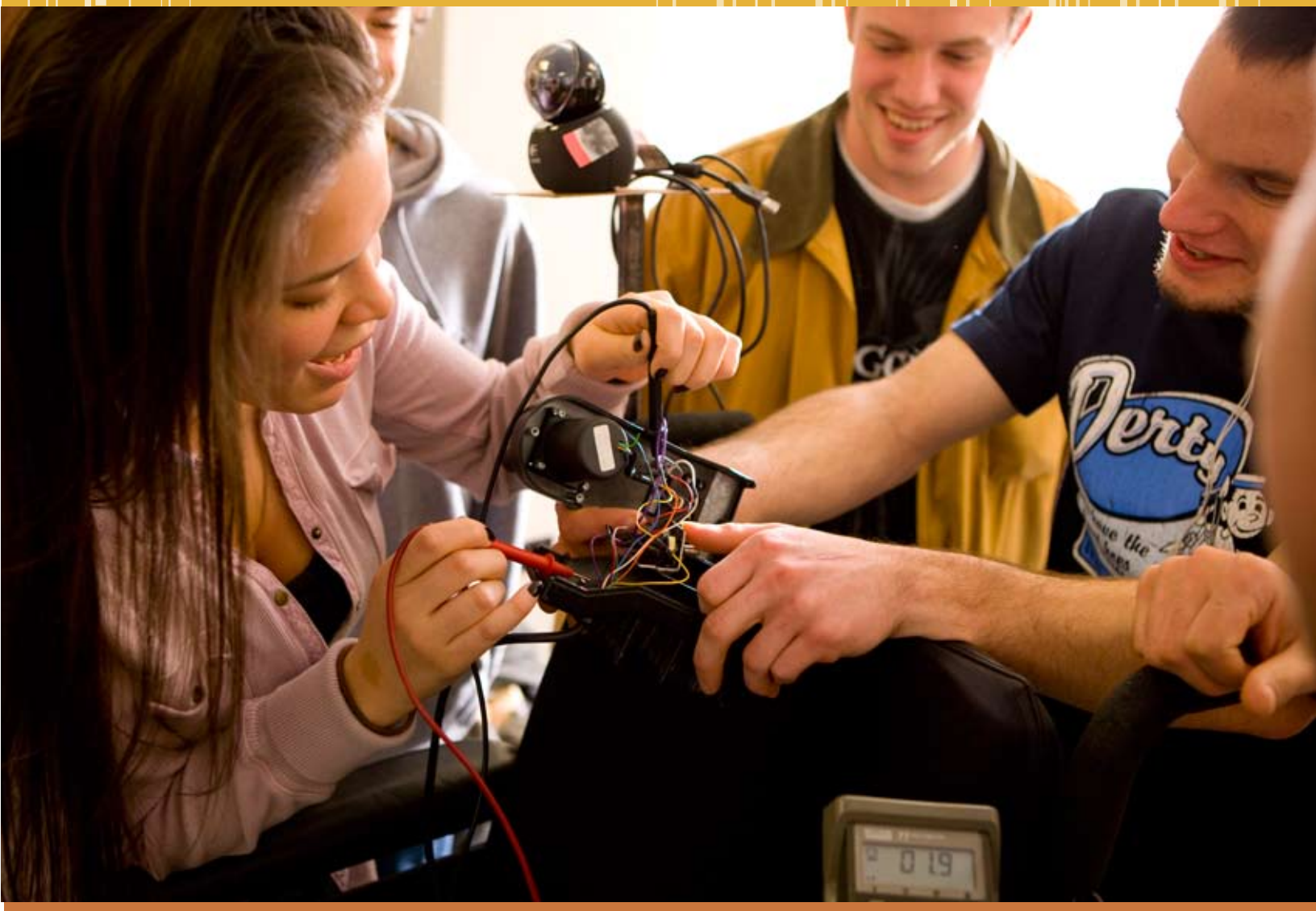
Affordable housing is widely accessible throughout the region, and a reasonable cost of living makes the good life possible on any budget. Most neighborhoods offer easy access to shopping, recreation, dining, and excellent schools.

NIAGARA FALLS

University at Buffalo *The State University of New York* | **REACHING OTHERS**

Department of Computer Science and Engineering
University at Buffalo
412 Bonner Hall
Buffalo, NY 14260-1900

NONPROFIT ORG.
U.S. POSTAGE
PAID
BUFFALO, NY
PERMIT NO. 311



CSE STUDENTS AT WORK ON THE DEVELOPMENT OF A ROBOTIC WHEELCHAIR.