

Published by the Integrated Media Systems Center, a National Science Foundation Engineering Research Center at the University of Southern California

Director's Message

Welcome to new Board of Councillors members

I'd like to welcome three new members of our Board of Councillors—Newton Lee, Senior Staff Engineer at Disney Online; Andre Mika, Chief Creative Consultant to the Creative Technology Lab at Louisiana State University (LSU) and Director of Production/Development for The Football Network; and Michael Silevitch, professor of electrical and computer engineering at Northeastern University (NU) and Director of the Center for Subsurface Sensing and Imaging Systems (CenSSIS) at Northeastern. They will bring invaluable expertise and experience to the BOC.

New ChevronTexaco initiative

I am pleased to announce that IMSC is taking an integral role in the new Center of Interactive Smart Oilfields (CiSoft) at USC. ChevronTexaco is joining with USC to establish this center to develop advanced technologies to improve oil and gas exploration and production efficiency. ChevronTexaco will provide research and development funding to launch CiSoft, which will draw on faculty expertise and resources at the School's Petroleum Engineering Program, IMSC, and the Information Sciences Institute.

Petroleum Engineering faculty member Prof. Iraj Ershaghi will be Co-Executive Director of the center with Mike Hauser,



Dr. Ulrich Neumann

—“Data Fusion and Analysis for Multi-Sensor Earth System Science” for the National Aeronautics and Space Administration (in collaboration with the Jet Propulsion Laboratory);

—“Management and Processing of Continuous Streams from Moving Sensors” for NSF (as co-Principal Investigator, with USC Prof. Shahram Ghandeharizadeh as Principal Investigator); and

Program Manager at ChevronTexaco Exploration and Production Technology Co., as the other Co-Executive Director.

The new center will form a major component of ChevronTexaco's i-field program, which focuses on the integration of field automation, reservoir simulation technologies, new and emerging well technologies, and real-time reservoir management. IMSC brings its expertise in data management, networks, and user interfaces to this new domain, and we look forward to a productive collaboration.

IMSC faculty earn recognition

IMSC faculty members continue to earn notable recognition. I'd like to congratulate Prof. Cyrus Shahabi as IMSC's second recipient of a prestigious 2003 National Science Foundation (NSF) Early Career Award. Since the Center was established in 1996, 10 IMSC faculty have won Career awards.

Prof. Shahabi, an assistant professor of computer science and IMSC's Research Area Director for Information Management, will use the five-year, \$400,000 award for research, teaching and outreach activities involving the management of immersive sensor data streams.

I also want to congratulate Prof. Robert Scholtz, professor of electrical engineering and key IMSC investigator, for receiving the Fred H. Cole Professorship in Engineering, as announced by Dean Nikias. Prof. Scholtz launched IMSC's UltRa Lab, a
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Prof. Shahabi receives NSF Early Career award

Prof. Cyrus Shahabi, IMSC's Research Area Director for Information Management, has received a prestigious 2003 Early Career Award from the National Science Foundation (NSF) as well as three other significant grants this year in the area of multidimensional data analysis.

Prof. Shahabi, an assistant professor of computer science, specializes in streaming architectures and multidimensional databases. He received the five-year, \$400,000 NSF Career award for research, teaching and outreach activities involving the management of immersive sensor data streams.

The other three grants are:



Prof. Cyrus Shahabi

—“A Framework for Integrating Geospatial and Online Data to Respond to Unexpected Events” for NSF (as co-Principal Investigator, with IMSC key investigator Prof. Craig Knoblock as Principal Investigator and Prof. John Wilson, professor of geography and Director of the Geographic Information Systems Lab, as co-Principal Investigator).

Prof. Shahabi, who holds a Ph.D. in computer science from USC, has been a key investigator with IMSC since it was founded in 1996. He came to the United States from Iran in 1992 to study at USC after receiving a B.S. degree in computer engineering from Sharif University of Technology. He directs
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Community outreach program assists high schoolers

In a community outreach initiative, IMSC is helping financially-disadvantaged high school students develop skills in engineering research.

With a three-year grant from the

National Science Foundation (NSF), IMSC is working with the Jisan Research Institute (JRI), a non-profit organization in Pasadena, CA, that provides opportunities for students to work on research sponsored by

universities and companies.

Nine students work at the Institute under the guidance of an IMSC graduate research assistant on an IMSC research project tailored specifically for them.

"We hope this early hands-on introduction to engineering will have a lasting effect on these young people's interest in pursuing a career in the field," according to Prof. Jerry Mendel, IMSC's Associate Director for Education and Outreach and professor of electrical engineering.

He said such initiatives could help to convince more young people to become engineers to assist in alleviating a projected national shortage in the field.

The students in the IMSC project are among the approximately 65 students enrolled at JRI. The Institute attracts students from eighth grade to 12th grade who have a strong interest in science and math. A minimum 3.5 grade point average is required to enter the three-year program.

Students are recruited from financially disadvantaged areas, and many are under-represented minorities. They attend the Institute during the summer and after school and on weekends during the school year. Some have been able to present papers at scientific conferences and publish in journals.

JRI was started eight years ago by Dr. Sanza Kazadi to provide an early introduction to college-level research in science and math to young people. Dr. Kazadi holds a Ph.D. in Computation and Neural Systems from the California Institute of Technology.

The IMSC project started last fall, with the students first studying basic theoretical mathematics and computer programming before learning the required research skills.

They work under the guidance of Hua Yang, one of Prof. Mendel's Ph.D. students. "They all work very hard and make good progress every day," she said.

Prof. Mendel said the project is not only an excellent outreach activity for IMSC, but also is designed to potentially contribute to the Center's research program.

The students are applying principles of fuzzy logic and evolutionary computing to solve data classification problems. Fuzzy

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IMSC'S OUTREACH TO HIGH SCHOOLERS—IMSC Research Assistant Hua Yang, a Ph.D. student in electrical engineering, teaches high school students in an IMSC project at the Jisan Research Institute, a Pasadena, CA, organization that provides college-level research opportunities in science and medicine to financially disadvantaged young people. The students are (from left) Diana Jue, an 11th grader at Westridge School; James Yang, an 11th grader at Arcadia High School; and Andy Bae, a 10th grader at Crescenta Valley High School.

New Board of Councillors members named

Three new members have been named to the IMSC Board of Councillors.

They are Newton Lee, Senior Staff Engineer at Disney Online; Andre Mika, Chief Creative Consultant to the Creative Technology Lab at Louisiana State University (LSU) and Director of Production/Development for The Football Network; and Michael Silevitch, professor of electrical and computer engineering at Northeastern University (NU) and Director of the Center for Subsurface Sensing and Imaging Systems (CenSSIS) at Northeastern.

Lee founded the Disney Online Technology Forums and has developed more than 100 games and activities on Disney.com and Disney's Blast. He has also created enhanced TV programs for ABC's "Summer Jam Concert" and the Disney Channel's "In Concert." He is the Editor-in-Chief of the Association for Computing Machinery's (ACM) Computers in Entertainment magazine and a former Bell Labs researcher.

In 1993, Lee developed an object-oriented scripting language and cross-platform compiler for interactive CD-ROMs.

Mika has a background in entertainment, production, scripting, animation, voice-over direction, business management, technology, product development and Web development. He proposed and developed LSU's new Creative Technology Lab, a

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IT TAKES TWO TO TANGO—IMSC researchers demonstrated their concept of how two musicians in different locations could play a tango together over the Internet. Dennis Thurmond, lecturer of keyboard studies, and Elaine Chew, assistant professor of industrial and systems engineering, performed in different campus buildings as they played an eight-minute adaptation of Astor Piazzolla’s “Le Grand Tango” for a National Science Foundation site visit team in June.

Two musicians linked over the Internet for tango

They say it takes two to tango, and IMSC researchers recently added a new twist to the old adage—they used a tango to demonstrate their concept of how two musicians in different campus buildings could perform together over the Internet.

Elaine Chew, assistant professor of industrial and systems engineering, and Dennis Thurmond, lecturer of keyboard studies, played an adaptation of Astor Piazzolla’s (1921-1992) “Le Grand Tango” over the Internet for a small group in IMSC’s Powell Hall theater.

Their demonstration showed an early realization of an interactive Internet performance, with the musicians themselves compensating for Internet delay. The fast-paced tango was filled with syncopations (off-beats), which posed challenges for both the engineers and musicians.

Thurmond played the accordion in front of the audience in Powell, while Chew appeared on a large screen, playing the piano in Ramo Hall, a quarter mile away. To coordinate their playing, Thurmond watched her on the screen, and Chew watched him on a monitor. Since Chew needed to listen to both the sound of Thurmond’s accordion and the sound of her own piano playing, she used a single earphone, allowing her to hear the piano with one ear and to hear the accordion with the earphone.

“By the time I heard the reaction to an action that I had initiated,” Chew said, “many more notes had already been played. So I had to craft a musical interpretation and hold a steady pulse while keeping an ear out for delayed cues of possible ensemble issues at Powell.”

She said that Thurmond had to anticipate her every move to make sure that the piece was synchronized to create a coherent performance. And, she pointed out, “a little creative license was taken once or twice” in the eight-minute performance “to ensure that all ends were met.”

The occasion was a demonstration for a National Science Foundation (NSF) site visit team touring IMSC in June as part of the Center’s annual evaluation by NSF.

The demonstration was part of IMSC’s Distributed Immersive Performance (DIP) project, aimed at developing the technology for a concert with the conductor, musicians and audience in different physical locations, delivered in real-time over the Internet. Other phases of the five-year project will be a concert by a trio and then a concert involving a full orchestra.

Roger Zimmermann, research assistant professor of computer science and co-director of the project, said that playing together over the Internet is one of the most difficult problems to solve. He pointed out that the main concern is reducing the delay in the delivery of both audio and video to a tolerable level for each musician as he or she tries to follow the conductor and play along with the other musicians.

When a conductor is included in a later phase, the researchers will have the three goals of ensuring that concurrent, synchronized video of the conductor is transmitted to all players; synchronized video and audio are transmitted among the players; and delayed, synchronized video and audio are transmitted to the audience.

The researchers are taking a unique approach in considering the entire end-to-end process of acquisition, transmission and rendering as an integrated system that will be jointly optimized rather than presented as a set of individual pieces of technology.

In addition to investigating transmission delay, researchers will conduct research on numerous other issues, including data loss management; network error correction; precision timing, using highly accurate Global Positioning System (GPS) clocks; distributed event recording and recall; and evaluation of musician coordination.

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Tech Spotlight

A special feature on IMSC projects

New algorithm improves peer-to-peer networks

IMSC researchers have developed a new algorithm that greatly improves the efficiency of peer-to-peer (P2P) computer networks, according to Prof. Cyrus Shahabi, IMSC's Research Area Director for Information Management.

The researchers are working to develop a P2P streaming system that will enhance the capabilities of such networks on the Internet.

Dr. Shahabi, an assistant professor in computer science who supervises this project, said the new algorithm can potentially reduce the redundancy of P2P communications by up to 99 percent.

The researchers used probabilistic methods and complex system theory to substantially reduce the duplicate reception of queries from multiple paths in the network, thus addressing a fundamental inefficiency in P2P networking. As a consequence, P2P networks will become less congested.

Dr. Shahabi described P2P networks as "overlays" on the Internet that provide additional services and pointed out that IMSC's use of complex system theory, which has been applied successfully to social and biological networks, is a novel approach to P2P networking research. He is collaborating with Prof. Muhammad Sahimi, chairman of the chemical engineering department, who is an expert on complex system theory.

Researchers are in the process of integrating P2P capabilities into IMSC's Yima™ streaming architecture, which handles multiple simultaneous high-bandwidth streams of images and sound, all synchronized to single-frame accuracy over the Internet. The result will be a P2P-Yima™ system in which both server and client capabilities will reside on every node of the P2P network and will provide tremendously enhanced streaming video and audio over the Internet.

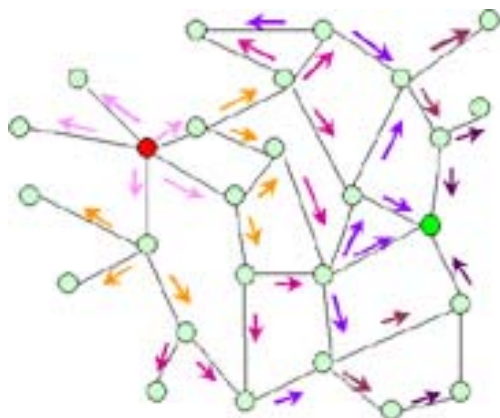
In a separate project, Prof. Roger Zimmermann, IMSC's Research Area Director for the Media Immersion Environment, is applying P2P network tech-

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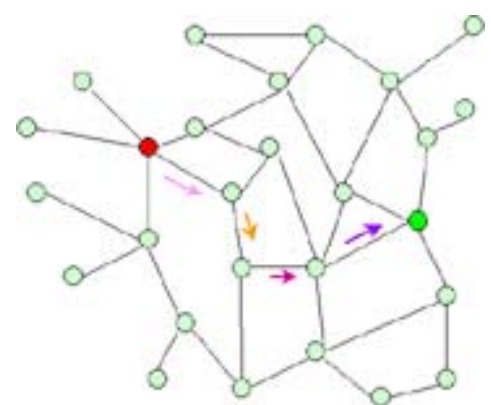
Prof. Cyrus Shahabi (left) and Prof. Roger Zimmermann, with the Yima™ server:

Figure A: Current Full Flooding Search in P2P Networks



Time Step : 1	
Time Step : 2	
Time Step : 3	
Time Step : 4	
Time Step : 5	
Time Step : 6	

Figure B: IMSC's Probabilistic Flooding Search in P2P Networks



With full flooding (Figure A), each P2P node queries all its neighbors to find the requested item. Although this results in good coverage, several redundant queries are generated within the network. With IMSC's probabilistic flooding (Figure B), only a minimum number of P2P nodes get involved in the search process, significantly reducing the number of redundant queries.

Tech Spotlight

A special feature on IMSC projects

IMSC investigators establishing new research area

IMSC researchers are moving forward in establishing an entirely new research area in multimedia—digital geometry processing (DGP).

IMSC key investigator Mathieu Desbrun, who heads the project, said the goal of DGP is to develop the mathematical and computational foundations for the next wave of multimedia data—three-dimensional geometry.

“We are looking at three-dimensional geometric data as the newest data type in addition to such other data types in the multimedia revolution as sound, image and video,” he said.

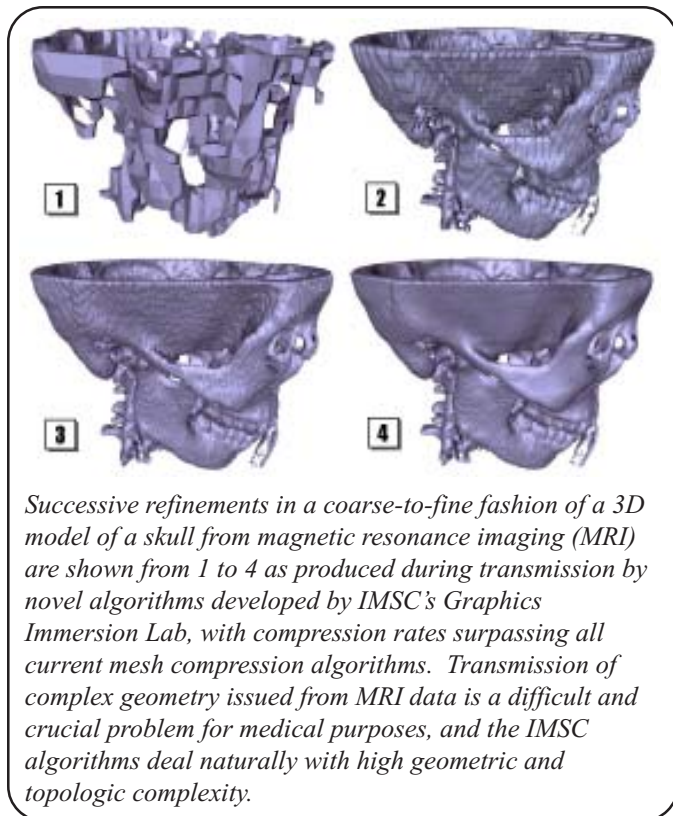
He also pointed out that geometry—the description of shapes—is at the core of today’s computer graphics, as well as of many other computational fields.

Prof. Desbrun, an assistant professor of computer science, said developments in the new research area will have a substantial impact on society, especially in such areas as engineering, science, medicine and entertainment. “We can anticipate that advances in digital geometry processing will lead to such diverse applications as 3D cameras for the consumer, the streaming of 3D topographic or medical datasets directly to personal digital assistants, and 3D product catalogs for manufacturers,” he said.

Prof. Desbrun said that in the three years of the IMSC



PROF. DESBRUN HONORED—Prof. Mathieu Desbrun (second from left), head of IMSC’s project on digital geometry processing, displays his 2003 Significant New Researcher Award plaque presented by the Association for Computing Machinery (ACM) SIGGRAPH at its annual conference in July in San Diego. Three of Prof. Desbrun’s students also participated in the conference. They are (from left) Yiying Tong, a Ph.D. student; Maithili Dandige, a Master’s student; and Haeyoung Lee, who recently received her Ph.D.



Successive refinements in a coarse-to-fine fashion of a 3D model of a skull from magnetic resonance imaging (MRI) are shown from 1 to 4 as produced during transmission by novel algorithms developed by IMSC’s Graphics Immersion Lab, with compression rates surpassing all current mesh compression algorithms. Transmission of complex geometry issued from MRI data is a difficult and crucial problem for medical purposes, and the IMSC algorithms deal naturally with high geometric and topologic complexity.

DGP project, significant progress has been made in compression, discrete differential geometry, simulation, and topology.

Prof. Desbrun’s work and vision are drawing widespread interest in the computer graphics field. The Association for Computing Machinery (ACM) SIGGRAPH, the major scientific organization on graphics research, presented him with its annual Significant New Researcher award in July in recognition of his original contributions to animation and deformable models. He was also cited for his contributions to discrete differential geometry, mesh processing and compression and for his strong grasp of the mathematics of graphics problems and sound understanding of user needs.

Prof. Desbrun began working at IMSC and started the Graphics Immersion Lab (<http://www-grail.usc.edu>) when he joined the USC faculty in 2000. He has also been a Visiting Associate in the Computer Science Department at the California Institute of Technology (Caltech) since 2000. He was a post-doctoral scholar at Caltech for two years before he came to USC.

In 2001, he received a prestigious Early Career Award from the National Science Foundation (NSF) that provides

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New IMSC Student Council actively planning events

This year's IMSC Student Council is well on its way to ensuring the success of the annual seminar series, Industry Day and the Student Conference, according to Council President Mike Maturo.

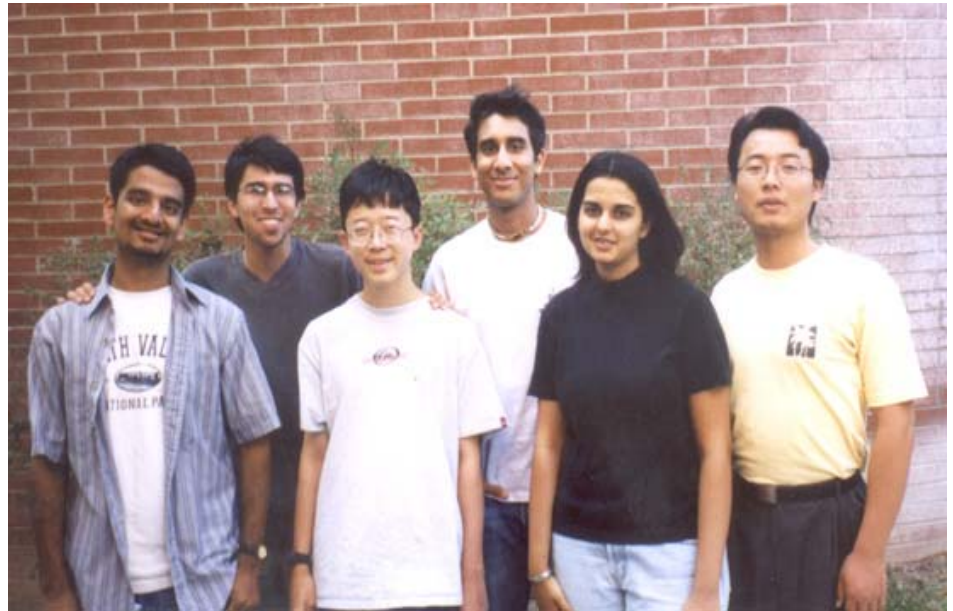
He pointed out that IMSC offers a wide range of research opportunities, even for undergraduates, and that the Council will work hard to assist in publicizing the Center to attract more student participation.

The seminar series began on September 5 with a presentation by IMSC Director Ulrich Neumann on the Center. A barbecue followed his talk.

Additional seminars are being planned for October and November. They will be held at 12 noon in Olin Hall 122. Speakers and topics will be announced on the IMSC Student Council Web site at <http://imsc.usc.edu/souncil>.

Maturo, a junior in computer engineering/computer science, said Industry Day will be held on October 30 this year and that planning is well underway. On Industry Day, corporate representatives speak on the latest multimedia and Internet research topics and meet with students.

Maturo also pointed out that planning is underway for the Student Conference in the spring semester.



IMSC STUDENT COUNCIL 2003-04—Council members are, from left to right, Nitin Sharma, Treasurer; Mike Maturo, President; Blake Kawamoto, Webmaster; Alnur Ali, Conference Co-chair; Nirali Shah, Vice President; and Jin Hui Hu, Conference Co-chair. Not pictured is Pamela Fox, who handles public relations.

Director's Message . . .

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key research laboratory in the nation for the study of ultrawideband radio, a promising new wireless technology.

Media coverage continues to highlight IMSC's research. United Press International distributed a long article on tracking software we've licensed to Rhythm & Hues, a Hollywood special effects house, to improve the process of adding computer-generated effects to movies. Our software, called Fastrack by Rhythm & Hues, reduces the time it takes for a key part of the process—feature tracking in image sequences—from minutes to seconds per frame.

The company has used the software in several films, including X-Men 2, Daredevil and the upcoming Dr. Seuss' The Cat in the Hat. NSF has distributed a media release on Fastrack, and the release, video footage and photos are on the NSF Web site at <http://www.nsf.gov/od/lpa/news/03/pr0380.htm>.

The largest public television station in Germany, ARD, aired an extensive report on IMSC in August, spotlighting our research on Remote Media Immersion (RMI), haptics and virtual reality for journalism. The ARD report focused on the future of television and included reports on other research centers in Japan and Germany. The ARD reporter, producer and camera crew spent two and a half days at IMSC shooting the footage.

Additionally, I was quoted on the future of handheld video players in a New York Times article in July. The article spotlighted the new palm-sized portable video players that play compressed video files on a small screen and are designed to be less expensive and more convenient than portable DVD players. See http://imsc.usc.edu/news/pdfs/imsc_nyt_03_07_17.pdf.

We are also busy upgrading a portion of our research space, including the creation of two new labs for our Education and Communications vision projects, and we are looking forward to a busy academic year.

IMSC News

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Prof. Shahabi awarded NSF Early Career grant . . .

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USC's Information Laboratory (<http://infolab.usc.edu>).

He is one of the co-authors of "Streaming Media Server Design," a new book published by IMSC Press that includes IMSC's major contributions to streaming media technology. (The other co-authors are Ali Dashti, an IMSC Ph.D. graduate and faculty member at the University of Kuwait; Seon Ho Kim, an IMSC Ph.D. graduate and faculty member at the University of Denver; and Roger Zimmermann, IMSC's Director of the Media Immersion Environment (MIE) research. Dashti is one of Prof. Shahabi's former students.)

The book spotlights Yima™, IMSC's streaming architecture, which handles multiple simultaneous high-bandwidth streams of images and sound, all synchronized to single-frame accuracy over the Internet. Yima™ is a key component of IMSC's Remote Media Immersion (RMI) technology, which is available for streaming movies, concerts and other entertainment over the Internet.

Prof. Shahabi was instrumental in developing Yima™ over the years. His pioneering paper in the area of continuous media servers was published in the early days of the field in 1993. His Ph.D. dissertation in 1996 was on the synchronization of multiple streams of continuous media. He developed a vision of a scalable and distributed streaming media server that would support both intra-stream and inter-stream synchronization. He gave the server the ancient Persian name of Yima™ as suggested by his colleague, Prof. Zimmermann. In Persian

mythology, Yima™ was the first man, the progenitor of the human race and the son of the sun. In 2000, Prof. Shahabi received a \$500,000 NSF Information Technology Research grant to pursue his vision. He said that now Yima™ has evolved into a workable end-to-end streaming architecture recognized by the research community as a second-generation continuous media server.

Since he envisions a future role for Yima™ as the main component in peer-to-peer (P2P) video/audio sharing architectures, his current research focuses on these P2P systems. (See page 4 for an article on P2P networking.)

Prof. Shahabi is on the editorial board of the Digital Symposium Collection (DiSC) of the Association for Computing Machinery's (ACM) Special Interest Group on Management of Data (SIGMOD) and the ACM Computers in Entertainment magazine.

He serves on numerous conference program committees, including committees for the International Conference on Multimedia and Expo (ICME) 2003 of the Institute of Electrical and Electronics Engineers (IEEE); and the ACM Conference on Information and Knowledge Management (CIKM) 2003. He also serves on the program committees for the flagship database conferences of IEEE and ACM—the IEEE International Conference on Data Engineering (ICDE) 2004; and ACM Special Interest Group on Management of Data (SIGMOD) 2004 conference.

He was the program committee chair of an ACM Web Information and Data Management (WIDM) 1999 workshop and the local chair of the ACM Special Interest Group on Metrics (SIGMETRICS) 2002 conference.

Community outreach . . .

(Continued from page 2)

logic is a humanistic kind of logic in that everything is not just black and white as it is in the usual logic, but can also be different shades of gray. Evolutionary computing is a computer design system that bases mechanical designs on the evolution of natural, biological life forms.

"There's the hope that their research results might address some of IMSC's data classification problems involving human speech and emotions," Prof. Mendel said.

JRI's Web site is <http://www.jisan.org>.

Immersive performance . . .

(Continued from page 3)

IMSC Deputy Director Alexander (Sandy) Sawchuk, professor of electrical engineering and the other co-director of the project, said the project is a test bed for cross-disciplinary investigation into psycho-acoustical, neurological and artistic issues. He pointed out that the project is the first step in meeting the overall goal of IMSC's entertainment vision project to create seamless distributed environments for highly realistic interaction among people in entertainment, online games, simulations, teleconferencing, social gatherings, performance events, and sports.

Peer-to-peer networking . . .

(Continued from page 4)

niques to the development of an audio chat room capability, called YimaCast™, for the School of Engineering's Distance Education Network (DEN). Audio chat will supplement the traditional text chat rooms for professors and students. Students will be able to conduct on-line discussions among themselves and with teaching assistants and the professor. Prof. Zimmermann said plans call for launching the audio chat room sometime during the fall semester.

He said that the YimaCast™ system is being designed to meet the need to scale to the hundreds of on-campus and off-campus students enrolled in DEN classes and pointed out that traditional, centralized audio chat systems do not have this capability. Additionally, he said, the YimaCast™ system will be integrated seamlessly with USC's TOTALe online learning portal to allow access to all of the University's electronic classroom resources and assets.

Prof. Zimmermann also said the YimaCast™ system will allow students to search for previous discussion sequences of interest and replay them at a convenient time. Speech-to-text generation will produce a transcript of each session, and the sessions will be archived and available for retrieval.

New research area . . .

(Continued from page 5)

multi-year funding for his research. The NSF Early Career Development Program identifies and supports young faculty who are most likely to become academic leaders.

Prof. Desbrun holds a Ph.D. in computer science from the National Polytechnic Institute of Grenoble, France. He has a graduate degree in computer graphics and vision (equivalent to the M.Sc.) from the University of Grenoble and an engineering degree (equivalent to the M.Eng.) from National Engineering School of Computer Science and Applied Mathematics in Grenoble.

Prof. Desbrun said researchers plan to develop “theoretical and algorithmic foundations for acquisition, coding, transmission, enhancement, editing, authentication, simulation and many other types of digital geometry processing operations.”

“We can’t rely on current theoretical and algorithmic tools because geometric data has intrinsic properties like topology, curvature and non-uniform sampling that make most of the existing tools useless,” he said.

He also pointed out that “the development of basic mathematical foundations is essential to the overall design of digital geometry processing.”

Areas of continuing research will include sampling theory for surfaces, approximation for surfaces, discrete differential-geometry operators, irregular meshes and compression.

Prof. Desbrun said the team works in close collaboration with researchers from Caltech (in particular, with Dr. Peter Schröder, professor of computer science and applied and computational mathematics), New York University, Rice University, the Massachusetts Institute of Technology and the University of Washington.

New BOC members . . .

(Continued from page 2)

division of the University’s Center for Applied Information Technology and Learning, and now serves as Chief Creative Consultant.

Mika has been Director of Business Development/Production for Liquid Audio; Director of International Dubbing for DreamWorks; and Senior Producer, Product Development, for the Walt Disney Co. For Home Box Office/Planet Grande, he created, wrote and produced “The Deadwood Mysteries,” the first Web-based dramatic series ever produced by a major television network.

Prof. Silevitch directs CenSSIS, a National Science Foundation Engineering Research Center established in 2000 to unify the methodology for finding hidden structures in diverse media, such as the underground environment or within the human body.

His training has encompassed the disciplines of both physics and electrical engineering. His research interests include laboratory and space plasma dynamics, nonlinear statistical mechanics, and science and math curriculum implementation for kindergarten through 12th grade.

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