



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

Director's Message

NSF site visit and SAB meeting go well

By **Chrysostomos L. (Max) Nikias**

We had a very active spring, first with our semi-annual Scientific Advisory Board meeting in late May and then with the annual National Science Foundation site visit in early June. Both went very well, and we received extremely valuable feedback on how to strengthen our strategic plan and research program.

We also continue to have outstanding results with our aggressive efforts to augment the unique expertise in our research program by the hiring of outstanding faculty members, expanding our capabilities in 3D graphics, haptics and networking. We will also add expertise in speech processing with the hiring of another new faculty member in the fall.

Dr. Christos Papadopoulos, Assistant Professor of Computer Science (networking), and Dr. Gaurav Sukhatme, Assistant Professor of Computer Science (haptics), are the most recent faculty to join IMSC. They join two other faculty hired recently—Dr. Mathieu Desbrun, Assistant Professor of Computer Science (3D graphics and haptics) and Dr. Joao P. Hespanha, Assistant Professor of Electrical Engineering-Systems (haptics and tracking). The new investigator

providing speech processing expertise will be Dr. Shrikanth S. Narayanan, Assistant Professor of Electrical Engineering-Systems. (See page 2 for an article on the new faculty).

IMSC's research program has been

receiving a good deal of attention in the media in the past seven months. In the electronic media, CNN's Moneyline and KABC-TV, Los Angeles, broadcast extensive reports. In the print media,

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Mark & Mary Stevens contribute to Tutor Hall, future home of IMSC

Mark Stevens, an IMSC Board of Councillors member, and his wife, Mary, have given \$2 million toward construction of the School of Engineering's planned academic center, Ronald

Tutor Hall, which will be the new home of IMSC. A floor in the proposed five-story, 101,000-square-foot building will be named after them.

Ronald Tutor Hall will house all School of Engineering undergraduate student support services, world-class classrooms and instructional laboratories that will employ the latest in communications and information technologies, and a cyber-café.

All IMSC administrative offices and laboratories and most IMSC faculty and student offices will be in the building.

Ronald Tutor Hall will be part of the USC Science and Technology Complex that will also include the Alfred E. Mann Institute for Biomedical Engineering and the LAS Molecular

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Mark and Mary Stevens

Vice Provost lauds IMSC in Washington

USC's Vice Provost for Research Neal Sullivan praised IMSC as an outstanding example of the best of the National Science Foundation (NSF) Engineering Research Center (ERC) program when he appeared before the Subcommittee on Basic Research of the House Committee on Science in March to support NSF's annual budget request.

Dr. Sullivan showed the lawmakers a video of the CNN Moneyline report by Co-Ancor Willow Bay on how IMSC's 3D immersive technologies will affect the future of the Internet, which aired worldwide in January.

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Vice Provost Sullivan

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New faculty enhance IMSC's capabilities

Four new faculty members joining IMSC recently have boosted the Center's capabilities in 3D computer graphics, haptics and networking.

All three areas of technology are important to IMSC's rapid expansion of the Media Immersion Environment (MIE), the Center's hardware and software infrastructure for the integration of multimedia technologies.



Dr. Gaurav Sukhatme

The new IMSC faculty are

Dr. Mathieu Desbrun, Assistant Professor of Computer Science; Dr. Joao P. Hespanha, Assistant Professor of Electrical Engineering-Systems; Dr. Christos Papadopoulos, Assistant Professor of Computer Science; and Dr. Gaurav Sukhatme, Assistant Professor of Computer Science.



NEW IMSC FACULTY MEMBERS—Three of the four new IMSC faculty members are (from left) Dr. Mathieu Desbrun, Dr. Joao Hespanha and Dr. Christos Papadopoulos.

Dr. Desbrun, who heads a computer graphics lab, will work in the 3D computer graphics area. His work will contribute to IMSC's research in the haptics area, ultimately benefiting the Haptic Museum project, which is developing technologies to allow the user to experience realistic tactile sensations of representations of remote museum objects transmitted over the Internet.

Prof. Desbrun also expects to contribute to IMSC's research in the 3D modeling of humans. He holds a Ph.D. in Computer Science from the National Polytechnic Institute of Grenoble, France, and was a post-doctoral fellow in Computer Science at California Institute of Technology.

Prof. Joao Hespanha, who holds a Ph.D. in Electrical Engineering from

Yale University, will also contribute to the Haptic Museum project. As a specialist in control systems, he is conducting research to improve the functionality of the haptic devices used in IMSC's research—the PHANToM, a pen-like device that provides force feedback to the fingertip as the user traces the contours of the object, and the CyberGrasp, a glove that provides realistic whole-hand force feedback as the user grasps, pokes and prods objects on the screen.

Dr. Christos Papadopoulos specializes in multicasting, the transmission of data from a single source to multiple receivers, and will provide expertise in networking to improve the MIE. He holds a D.Sc. in Computer Science from Washington University in St. Louis,

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MUA GRADUATION—Demetrios Boutris, Secretary of Legal Affairs and Counsel to California Governor Gray Davis, gave the commencement address to the fourth graduating class of IMSC's Multimedia University Academy (MUA) in June. The MUA trains at-risk youth in multimedia technologies.

Director's Message . . .

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IMSC was featured in the Los Angeles Times, Washington Post, Philadelphia Inquirer, Christian Science Monitor, San Diego Union-Tribune, San Jose Mercury News, The Zone News magazine in Los Angeles, Stereo Review's Sound & Vision magazine and The Forum, a major business magazine in Greece.

With this increased public awareness of IMSC and how its technologies will affect the future of multimedia and the Internet and the addition of new faculty expertise in major areas of our research program, we are looking forward to an especially busy and productive upcoming academic year.

Prof. Neumann oversees Computer Interfaces research

As one of three IMSC Associate Directors for Research, Prof. Ulrich Neumann oversees research in the Computer Interfaces (CI) area, where IMSC seeks to expand the diversity and effectiveness of the communication links between people and computing systems.

Prof. Neumann also conducts research in the two CI sub-areas of Human Face Modeling and Animation and Tracking for Augmented Reality. IMSC envisions augmented reality as a means of interacting with mixtures of real and synthesized scene elements.

In overseeing CI research, Prof. Neumann also coordinates research in the other CI sub-areas of Immersive Audio,TM the GlobeAll Camera Array and Intelligent Room, Precise Mosaicing, Image-Based Rendering and Modeling and Human Factors for Integrated Media Systems.

Folding CI research into the MIE

One of Prof. Neumann's responsibilities is folding CI research into the Media Immersion Environment (MIE), IMSC's hardware and software framework for the integration of multimedia technologies.

In pursuing his research in visual immersion, he works with a team of two research associates, 12 graduate students and two undergraduates. Dr. Neumann has been an Assistant Professor of Computer Science at USC since 1994 and holds a Ph.D. in Computer Science from the University of North Carolina at Chapel Hill.

In the area of human face modeling and animation, he pointed out that "our aim is to produce realistic 3D representations, or avatars, of human faces and heads from images of real people."

First, researchers construct 3D geometric and appearance models from imagery, then analyze image sequences to extract dynamic models of 3D deformations and appearance changes produced by expressions and speaking, and finally animate the head models



PANORAMIC CAMERA DELIVERED—Prof. Ulrich Neumann (left), IMSC Associate Director for Research in Computer Interfaces, and Larry Eells, the Product Manager for Desktop Visualization of Panoram Technologies, discuss the set up of IMSC's new panoramic camera (foreground) in an IMSC lab. The Panoram camera, which was delivered in May, will be used in demonstrations of immersive technologies involving the recording and playback of concerts in USC's Alfred Newman Recital Hall.

based on both synthetic and real analyzed expression and speaking data.

New method to simulate hair

Prof. Neumann explained that the modeling project also includes a new method to simulate the complex behavior of long human hair, a particularly difficult problem in modeling people, and explained that the work contributes to IMSC's goal of developing virtual environments that can be populated with realistic and expressive people.

In the area of augmented reality, new technology is being developed to enhance the MIE's just-added panoramic video capability through acquisition of a 360-degree camera from Panoram. Already, Prof. Neumann's team has developed a motion-estimation method suitable for computing large motions from panoramic images. This may lead to accurate tracking over large areas based on panoramic imagery.

In collaboration with Prof. Chris Kyriakakis, an IMSC key investigator in the audio research area, the team plans to

showcase its panoramic immersion research by two first-of-a-kind demonstrations of immersive technologies with the participation of USC's Thornton School of Music.

In the fall, the IMSC researchers plan to record one of the concerts in the Alfred Newman Recital Hall, using the panoramic camera, Immersive AudioTM and a synchronized multichannel digital recording system.

Then, they will recreate the performance in a smaller space, equivalent to a living room, so that a person will experience the visual and aural sensation of sitting in the concert hall.

Live concert planned on Internet 2

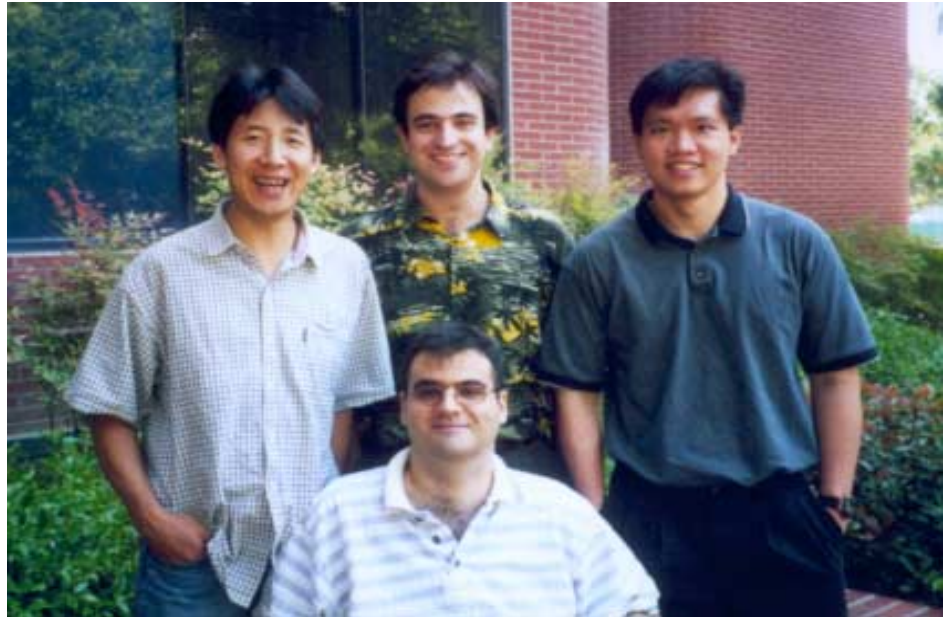
For the second demonstration next spring, they will work with the School of Music to broadcast a live concert through Internet 2, so that people will be able to experience a completely new level of 3D visual and aural immersion in the performance. Another aspect of the experiment will allow local or
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Students hold successful Industry Day & Conference

IMSC students organized two highly successful events this spring—the First Annual IMSC Industry Day in February and the Fourth Annual IMSC Student Conference in April.

On Industry Day, students learned about opportunities in the multimedia field from representatives from such IMSC industry partners as Digital LAVA, Compaq, NASA's Jet Propulsion Laboratory, Lockheed Martin, NCR, Rockwell Science Center and TRW. Students organized a program consisting of invited plenary presentations, interactive breakout sessions, technical demonstrations and lunchtime discussions. Topics included employment opportunities, hot technical fields and market growth.

Over 100 students attended the Student Conference, which was organized around the theme of "Leadership in Technology." Activities included student research presentations; speeches by industry representatives, including executives from IMSC corporate partners Digital LAVA and Litton Industries; and a panel discussion on "Market Insertion Strategies, Strategic Planning and Leadership in Technology."



IMSC STUDENT COUNCIL MEMBERS—Members of IMSC's Student Council, who helped organize Industry Day and the Student Conference are (from left) Xiaoming Tian, Vice Chair, Student Conference, and Master's student in Computer Science; Ali Taha, President and Ph.D. student in Electrical Engineering; Kemal Demirciler (seated) Chairman, Student Conference, and Ph.D. student in Electrical Engineering; and Douglas Yap, Vice Chairman, Industry Day, Liaison to Student Organizations, and Master's student in Computer Science. Other members of the Student Council are Pushkar Joshi, Vice President, and undergraduate in Computer Engineering/Computer Science, and Matthew Sheby, Treasurer and Master's student in Computer Science.



LOCKHEED MARTIN ANNUAL CONTRIBUTION—Chrysostomos L. (Max) Nikias, (center) IMSC Director, receives Lockheed Martin's annual contribution to IMSC from Frank Ashford, Manager, Structural Criteria, Lockheed Martin Aeronautics Co., Palmdale. Aram Mika, Vice President of the Advanced Technology Center at Lockheed Martin Space Systems, Missiles and Space Operations, joined in the May presentation.

Prof. Mendel receives Millennium Medal

Dr. Jerry Mendel, IMSC Associate Director for Education and Professor of Electrical Engineering-Systems, has been awarded a Third Millennium Medal by the Institute of Electrical and Electronics Engineers (IEEE) for his contributions to the IEEE Control Systems Society.

Prof. Mendel is one of four USC faculty members chosen to receive Millennium Medals as part of the Institute's celebration of the third millennium.

He has chaired task forces that have led to five new academic programs at USC in the area of multimedia and integrated media systems and a new undergraduate electrical engineering curriculum.

He is the author of four textbooks and three research monographs.

Prof. Shahabi conducts research on “immersidata”

IMSC key investigator Prof. Cyrus Shahabi’s research in multimedia storage and database systems, Internet databases and data mining is working to strengthen the information management aspect of IMSC’s Media Immersion Environment (MIE).

Central to Prof. Shahabi’s work for the MIE is his groundbreaking research on “immersidata™”—a comprehensive term encompassing the varied classes of data generated in immersive environments.

He pointed out that data types integrated in immersive environments, such as video, audio, text, haptic, avatar and application coordination data, are transformed to exhibit special characteristics that require new approaches to managing them, hence the new name of immersidata™.

Prof. Shahabi is the Director of the Distributed Information Management Laboratory, which includes about 20 graduate and undergraduate students. He has been a key investigator in IMSC’s Information Management research area since the Center was founded in 1996. He received both his Ph.D. and M.S. in Computer Science from USC.

Prof. Shahabi is the project leader for “Immersidata™ Content Extraction and Analysis” and “Immersive Media Real-time Storage and Retrieval.” In the content extraction and analysis research, he and his team are developing technologies to record user activities in immersive environments, query elements of the immersion and then analyze the results to extract the user behavior.

The team’s work has led to INSITE, a project in the incubation stage that uses unique patent-pending technologies for real-time tracking, acquisition, analysis and visualization of a user’s navigation paths on Web sites. Aiming to assist Internet e-commerce companies in transforming the anonymous user visiting their Web sites into a loyal customer, INSITE facilitates real-time target advertising,



PROJECT DEVELOPS WEB TOOLS—Prof. Cyrus Shahabi, an IMSC key investigator, is developing INSITE, a project that uses unique technologies for real-time tracking, acquisition, analysis and visualization of a user’s navigation on the Web.

personalization of contents and customer behavior analysis. IMSC is taking steps to commercialize INSITE.

“With INSITE, we have proved that the accuracy of our tracking is better than the server log that is traditionally used to evaluate any kind of user interaction with Web sites,” Prof. Shahabi said.

For the storage and retrieval project, he and his team are designing Yima, a real-time file server; Red Hi, a distributed version of Yima; and Superstreaming™, a technique for using client-side resources to improve system performance. Prof. Shahabi pointed out that the current Internet-based infrastructure cannot support the real-time end-to-end delivery of high-quality video and audio because of the lack of both a scalable and distributed server architecture and a global resource management protocol. He explained that Yima, Red Hi and Superstreaming™ will implement a scalable immersive media architecture that will satisfy the real-time data requirements

of immersive applications.

In addition, Prof. Shahabi cited Yima as an example of how IMSC’s research program integrates technologies developed in the Center’s different research areas by pointing out that the server will play a major role in IMSC’s planned demonstrations of immersive technologies in the recording and playback of concerts at USC’s Alfred Newman Recital Hall. IMSC’s work in panoramic video and Immersive Audio™ in the Center’s Computer Interfaces research area will be used in the demonstrations.

Prof. Shahabi has been active in disseminating his research through conferences and publications in the field. He was Program Chair of the Second International Workshop on Web Information and Data Management of the Association of Computing Machinery in November 1999, and editor of the workshop proceedings.

He introduced immersidata™ in a paper entitled, “Immersidata™
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IMSC student develops software solutions for MIE

Alexandre R.J. (Alex) François, a Ph.D. student in Computer Science and Research Assistant at IMSC, sees the Center's Media Immersion Environment (MIE) as a key to the future of computing, and he's working hard to keep improving it.

Under the guidance of IMSC key investigator Dr. Gérard Medioni, François is one of the Vision Group of students who are doing work for the Institute for Robotics and Intelligent Systems (IRIS) and IMSC. For IMSC, he is developing software solutions to MIE challenges.

The MIE is IMSC's physical hardware and software framework for the vertical and horizontal system integration of multimedia engineering and scientific developments from IMSC and elsewhere. The MIE is based on a heterogeneous system infrastructure for the implementation and demonstration of multiple, diverse system applications in an operational environment. An evolutionary platform that will change dynamically over time, the MIE serves as a national test bed for the integration, evaluation and demonstration of advanced multimedia technologies.

François is working on a new software architecture for the MIE as it evolves further as a highly robust integrated system.

François, who hails from Villejuif,



Graduate student Alex François created this application to isolate moving objects from the background, allowing the substitution of a different background, all carried out in real-time. In the upper window, the monitor displays a tram recorded by a camera focused on traffic outside of François' office window and, in the lower window, the monitor shows the tram with a green background, instead of the real one.

an area just outside of Paris, started in the Ph.D. program in 1995, after working with Prof. Medioni as a visitor in 1994. That six-month research experience with Prof. Medioni was a turning point for him. "I decided that I didn't want to go into industry, but instead wanted to conduct research and enter the Ph.D. program, working specifically with Prof. Medioni," he said.

François received a Master's in Computer Science from USC in 1997. Before coming to USC, he earned a Master's from the University of Paris, Dauphine, and a diplôme d'Ingénieur from the Institut National Agronomique Paris-Grignon.

François pointed out that the MIE is being constructed specifically to provide a common platform for use in building diverse applications and then integrating them so they will work together seamlessly. Researchers and developers can program their algorithms and build applications within the

MIE, calling on the functionality it makes available. He said that applications frequently are written without consideration of making the programming code portable, with the resulting problem that a particular application cannot be easily used in conjunction with other applications, as is required in media systems development. To solve this problem, he said, the MIE is defining a ready-made environment that offers functionality that researchers and developers can rely on when writing their code for new applications.

This role of the MIE is especially important in interactive multimedia development because of the need to use data processing to transform the data, rather than to simply focus on storage, delivery and presentation speed through improved hardware and data compression, as has been mostly the case in the past. For example, he said, in creating an immersive environment with 3D visuals and sound for advanced telecon-

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IMSC News

July 2000

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IMSC organizes teleconference on e-entertainment

In a three-way teleconference with a business class at Rensselaer Polytechnic Institute (RPI) in Troy, New York, in February, IMSC Director Chrysostomos L. (Max) Nikias, IMSC key investigator Tomlinson Holman and Dr. James Baker, President and CEO of Fuji Xerox Palo Alto Laboratory (FXPAL), presented the latest trends in “e-entertainment”—Internet-based entertainment involving video, music, e-cinema and other diversions. With Prof. Nikias and Prof. Holman in Los Angeles and Dr. Baker in Palo Alto, the three panelists spent two hours discussing relevant issues with the 80 students via a satellite link connecting the USC School of Engineering’s Distance Education Network studio and FXPAL’s Northern California facility with the New York campus.

Prof. Nikias described IMSC’s vision of the future of the Internet as moving from our current two-dimensional world of computers, television and film to three-dimensional immersive environments transmitted over the Internet into our living

rooms—or anywhere. Prof. Holman talked about the trends in the motion picture industry and e-cinema. He is the primary developer and patent holder of the Lucasfilm THX Sound System®, also known as Tomlinson Holman’s experiment (hence the “THX”).

Dr. Baker, who is a member of IMSC’s Board of Councilors and Scientific Advisory Board, described the e-entertainment trends in Silicon Valley as well as avatar technology for interactive software developed by FXPAL. Fuji Xerox Palo Alto Laboratory is a major laboratory in the field of multimedia that provides research in software and information technology for Fuji Xerox Co., Ltd.

The teleconference was moderated by Prof. Susan Sanderson, who arranged the session with IMSC. She teaches the course, entitled Strategy, Technology and Entrepreneurship, in RPI’s School of Management. Portions of the teleconference were taped by RPI for future use as a resource.

Ulrich Neumann . . .

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remote spectators to wear an immersive display system and experience the performance from different viewing directions. Prof. Neumann pointed out that this present research, using panoramic video scene representations, represents a step toward IMSC’s longer-term vision of placing spectators into realistic 3D scenes that include avatar representations of people. In fact, he said, this eventual goal is most likely to be feasible initially as a blend of panoramic video and 3D scene elements.

Prof. Neumann’s professional activities have been extensive. He serves as an associate editor for the Institute for Electrical and Electronics Engineers (IEEE) Transactions on Multimedia. He was a keynote speaker at the 1999 Chinese National Conference on Multimedia in October 1999 and serves as a Technical Program Co-Chair for the SIGGRAPH/Eurographics Computer Graphics Hardware Workshop to be held in August 2000. He was on the Technical Program Committee of the International Workshop on Augmented Reality in October 1999 and the IEEE Virtual Reality 2000 Conference in March 2000. He has over 60 publications in academic journals and major conference proceedings.

Alex François . . .

(Continued from the previous page)

ferencing, online data processing is required for many tasks, including computing the view of a person from different points of view, computing the sound from different places, and processing interaction data.

When he’s not writing code, François likes to relax playing the piano. He’s been playing since he was five years old and, in France, he was in a band that played acid jazz. Also, in France, he won regional, national and international competitions in classical piano. He also enjoys rugby—he’s a lettered alumnus of the Trojan Rugby Football Club—and racquetball.

Prof. Medioni calls François the most well-rounded student he’s ever had, saying, “He’s an extraordinarily good programmer—he’s done work that’s, frankly, quite amazing. And Alex takes notice of both the details and the global picture. He’s always concerned with not only the pieces themselves, but also how they fit into the whole framework. He’s also very friendly to others and always ready to help.”

François sees his work for IMSC in visionary terms: “I appreciate the goals and interdisciplinary approach, the cutting edge research at IMSC and the ambitious new ideas. IMSC is probably setting out the basis of what computing will be in this new millennium. It’s very exciting to be part of it.”

Mark Stevens . . .

(Continued from page 1)

Biology and Center for Computational and Experimental Genomics.

Stevens, who is a director of the Menlo Park-based venture capital firm of Sequoia Capital, praised the plan to centralize IMSC operations, which are now spread out over several buildings.

“I feel it will be very advantageous to have IMSC located under one roof,” he said. “Since IMSC, by definition, is a multidisciplinary research effort, then frequent and easy communication in person among faculty, students and staff members is very important to achieve high research productivity.”

“Historically, departments and research programs at the School of Engineering have been physically dispersed around the campus, but I think this inhibits student interaction, both interaction among students themselves, as well as student interaction with the faculty. I think having everyone under one roof will be very appealing to the student participants of IMSC.”

Stevens is also a member of the School of Engineering’s Board of Councillors. He is a USC graduate, earning a Bachelor of Science in Electrical Engineering, a Bachelor of Arts in Economics and a Master of Science in Computer Engineering.

Vice Provost Sullivan . . .

(Continued from page 1)

“The CNN show certainly got the attention of the committee members,” Dr. Sullivan said. “Willow Bay was a very effective spokesperson for government funding of the NSF’s ERC program.” (The CNN report is available from IMSC on CD-ROM or videotape.)

“IMSC is one of the top ERCs—the best of the best. The Center has done a great job in all areas,” he said. Dr. Sullivan, who has been a Professor of Biological Sciences at USC since 1974, served at NSF, under the Intergovernmental Personnel Act, as Director of NSF’s Office of Polar Programs from 1993-97.

In his testimony before the subcommittee, Dr. Sullivan said that IMSC’s numerous successes in technology transfer are particularly noteworthy since the Center has only been in existence for four years.

“The transfer of lab bench discoveries through the technology transfer process and to the marketplace is one of the clear objectives of the ERC program,” and IMSC’s technology transfer program “is showing tangible results and successes on a time scale that is quite remarkable,” he said.

He pointed out that technology has been transferred to such companies as Boeing, Lockheed Martin, NCR, TMH and Time Domain.

New IMSC faculty . . .

(Continued from page 2)

Mo., and will investigate problems in such areas as routing protocols, reliability, congestion control and security.

As a member of the Haptic Museum project team, Dr. Gaurav Sukhatme is working on developing new capabilities for the PHANToM and CyberGrasp. He is the Associate Director of USC’s Robotics Research Lab and said his work in robotics is well suited for research with these haptic devices, pointing out that they can be viewed as “robots that interact with people.” He has been a Research Assistant Professor at USC since 1997, and was recently named Assistant Professor. He holds an M.S. and Ph.D. in Computer Science from USC.

A fifth new faculty member, Dr. Shrikanth S. Narayanan, will join IMSC from AT&T Labs-Research in September as an Assistant Professor of Electrical Engineering-Systems. He will contribute in the area of speech processing. He holds a Ph.D. in Electrical Engineering from UCLA.

Cyrus Shahabi . . .

(Continued from page 5)

Management: Challenges in Management of Data Generated within an Immersive Environment,” at the Fifth International Workshop on Multimedia Information Systems in October 1999. He also produced an article on “Distributed Multimedia Systems” for the Wiley Encyclopedia of Electrical and Electronics Engineering in 1999.

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