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## Director's Message

### Oil industry initiative & others make rapid progress

We have been making substantial progress with several initiatives, especially in assisting ChevronTexaco in the project to develop the oilfield of the future through the Center's expertise in data management, data transmission and visualization.



**Prof. Ulrich Neumann**

The project is being developed under the auspices of the Center of Interactive Smart Oilfield Technologies (CiSoft), headed by Prof. Iraj Ershaghi of the Petroleum Engineering Department. CiSoft was estab-

lished by ChevronTexaco and the USC Viterbi School of Engineering. IMSC is collaborating in CiSoft with the Information Sciences Institute. At Chevron Texaco, the project is headed by Michael Hauser. There was a key meeting in April of the project's Decision Review Board that defined projects and budgets.

We are also making progress in our work on the Korean Air and Pratt & Whitney project and as well as with USC's emerging Mobile Media Institute (MMI).

For Korean Air and Pratt & Whitney, the airline's major jet engine supplier, we are using IMSC's Remote Media Immersion (RMI) technologies to develop a cutting-edge wireless Internet communications system that will cut costs and save time in engine maintenance.

In May, IMSC researchers participated in a retreat to define a university-wide research agenda for the Mobile Media Institute, which was established in March to focus on research in the areas of wireless communications, entertainment and information.

Six USC Schools joined together to form MMI: the Marshall School of Business, School of Cinema-Television, Annenberg School for Communication, Viterbi School of Engineering, Law School and Thornton School of

Music. The Cellular Telecommunications & Internet Association (CTIA) is a founding sponsor of MMI. The institute also has the support of the Wireless Internet Caucus, a component of CTIA. Information on how  
(Please turn to page 7)

### High school students score big with IMSC-sponsored research

Nine high school students, learning advanced research skills in an IMSC community-outreach program with a Pasadena, CA, research institute, recently scored a major success when their IMSC-sponsored research paper was accepted for presentation at a key international conference.

They will travel to Budapest, Hungary, this summer to present the paper at the Institute of Electrical and Electronics Engineers (IEEE) International Conference on Fuzzy Systems, July 25-29.

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**HIGH SCHOOL STUDENTS SUCCEED IN IMSC-SPONSORED RESEARCH PROGRAM**—Dr. Sanza Kazadi, director of the Jisan Research Institute (JRI), (sitting, on left) and Taehoon Shin, IMSC graduate research assistant, (also sitting) guide the research of the high school students in the IMSC-sponsored program at JRI. The students are (standing, from left) Andy Bae, Christine Seng, Dharshan Chancramohan, David Choi, John Lee, James Yang, Andrew Lee, Valerie Muñoz (joined group after paper for IEEE was written), Diana Jue, and Peter Lim.

## Interdisciplinary Initiative Program moves ahead

Six projects launched this academic year by IMSC's new Interdisciplinary Initiative Program (IIP) have made substantial progress.

"We are moving forward nicely," according to IMSC Creative Producer Victor LaCour, who serves as the Center's interdisciplinary collaborations developer.

He pointed out that the program allows for a "unique alchemy" of USC's broad expertise. "It expands our research potential and diversifies our practices and products. We have such distinctive and abundance resources here at USC, the key here is to connect them through projects that strengthen their mutual purpose and benefit," LaCour said.

As part of this initiative, IMSC has worked closely with USC's Annenberg Center for Communication (ACC), and students involved in five of the six IIP projects receive fellowships as part of a Communications Critical Pathway initiative sponsored by the ACC.

Scott Fisher, Chair of the USC School of Cinema-Television's Interac-



**INTERDISCIPLINARY INITIATIVE PROGRAM**—Participants in IMSC's new Interdisciplinary Initiative Program are, from left to right, seated, students Glenn Song; Todd Furmanski; and Will Carter; and, standing, IMSC Creative Producer Victor LaCour, who serves as IMSC's interdisciplinary collaborations developer; students Monica Adjemian; Leo Natanian; Tripp Millican; Diego Borro; and Prasanna Joshi; and Prof. Suyu You.

tive Media Division, who collaborates closely with IMSC in the program, said, "These kind of collaborations are essential to meet our goals. It is a

perfect combination with the Viterbi School of Engineering working with our interactive media students."

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## MRI used to create movies of speech production

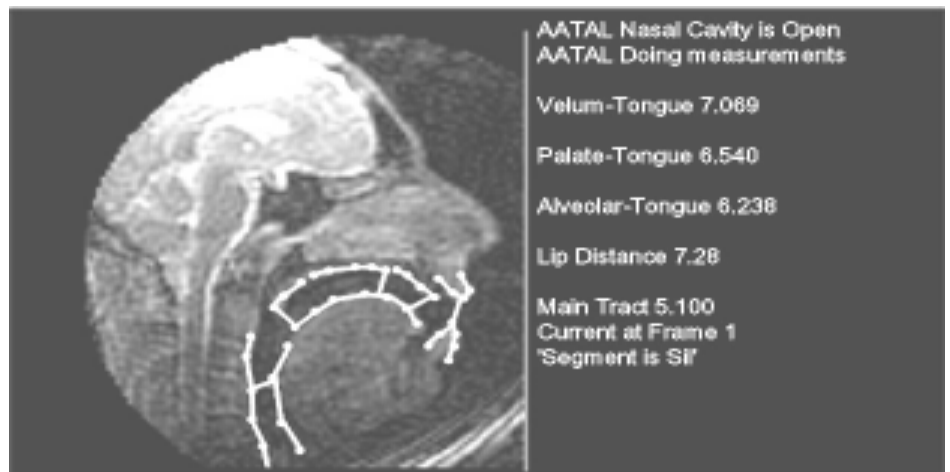
Using magnetic resonance imaging (MRI), IMSC key investigator Prof. Shri Narayanan and a team of interdisciplinary collaborators have created real-time movies of speech production for the first time—a development that will assist IMSC in meeting its long-term goal of creating realistic humanlike avatars.

With the MRI movies, researchers can now see much more clearly how the vocal tract moves during speech to assist them in constructing realistic facial expressions and movements of the tongue by avatars.

The MRI technique enables better understanding of the underlying speech production mechanisms that, in turn, can lead to better ways of doing robust automatic voice recognition.

Prof. Narayanan, an associate professor of electrical engineering,

(Please turn to page 6)



**MRI PICTURE**—A snapshot of the automatic tracking method of real-time magnetic resonance images developed by researchers. In the left panel, each group of points connected by lines represents a Kalman snake (i.e., contour), which is individually updated through an optical flow method applied to the sequence of images. In this demonstration, the midsagittal dimensions (represented by lines connecting the upper and lower walls of the vocal tract) at some positions along the vocal tract were computed, and corresponding values are displayed in the right panel. The real-time MRI movie can be downloaded at <http://sail.usc.edu/production/rtmri/jasa2004>.



# Disney Online strives to make Internet mark

Dr. Newton Lee, senior staff engineer at Disney Online, told attendees at IMSC's Eighth Annual Student Conference in March that the organization is striving to establish itself as "a major provider of rich media over the broadband Internet."

He described several Disney initiatives, including Toontown online, which "has games to play and bad guys to deal with." Other Disney Web sites are Disney.com; Familyfun.com, for parents; and movies.com, an information service on all movies, not just Disney films.

Dr. Lee, who is an IMSC Board of Councillors member, gave the keynote at the conference.

He also said that "Disney Mobile" for wireless is now in 21 countries. Services for cell phones include screensavers, greeting cards, games, movie information, and news.

Dr. Lee is the founder and editor-in-chief of Computers in Entertainment, a new journal from the Association for Computing Machinery. He pointed out that the journal not only publishes research articles, but also interviews with well-known entertainers and articles on education and games.

Dr. Lee founded the Disney Online Technology Forums. He has produced more than 100 games and activities since 1996 on Disney Web sites and has developed enhanced-TV programs for ABC's "Summer Jam Concert" and Disney Channel's "In Concert."

Another speaker, Dr. Qiong Liu, a research scientist at IMSC partner FX Palo Alto Laboratory, described "shared interactive video for teleconferencing." He said the system features camera clusters and an imaging system that provides users with independent views and zoom capability. Remote users can see an overview as well as use their mouse to show an up-close view. The same cameras are used to provide images for all users.

He also pointed out how the "video canvas" can function as a shared black board. Slides can be annotated and dragged to the room displays visible in the camera images. Files can also be dragged to a printer in the image for printing on that real printer.



**Conference Keynote  
Dr. Newton Lee  
Senior Staff Engineer  
Disney Online**

Prof. Tomlinson Holman, a professor of film sound at USC and an IMSC key investigator, spoke about "The Bit-Rate of Reality" and IMSC's 10.2-channel audio technology, the

next generation of surround sound. The technology employs multichannel rendering algorithms that use acoustics, psychoacoustics and adaptive audio signal processing to immerse a group of listeners in a seamless sonic environment.

He told the group that he had traveled to Paris a week earlier to install the 10.2-channel system at the Institut International du Multimedia, a part of the young and dynamic Pôle Universitaire Leonardo de Vinci as the first installation in Europe and 20th around the world.

He pointed out that two large cinemas and one home theater demonstration room have installed the 10.2-channel system in anticipation that films will be made in the format in the future. Prof. Holman and Prof. Chris Kyriakakis made the most recent permanent installation at Inha University in Incheon, Korea, last fall.

Prof. Holman, who received an Academy Award in 2002 for his research and systems integration in improving movie loudspeaker systems,

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**STUDENT CONFERENCE PANEL**—Panelists listen to Prof. Tomlinson Holman, left, professor of film sound at USC's School of Cinema-Television, discuss new trends in multimedia. The other panelists are, from left, Prof. Alan Willner, professor of electrical engineering; Isaac Maya, IMSC's Director of Industry and Technology Transfer Programs; Prof. Gérard Medioni, chairman of the Computer Science Department; Darren Shou, senior project manager, Symantec; and Dr. Qiong Liu, research scientist, FX Palo Alto Laboratory.

## Tech Spotlight

A special feature on IMSC projects

# IMSC improves Internet video & audio streaming

Prof. Christos Papadopoulos, an IMSC key investigator and assistant professor of computer science, and his team are developing technology to improve reliability and synchronization of Internet video and audio streaming.



**Prof. Christos Papadopoulos**

They have developed protocols for fast data retransmission to recover lost data in real-time for unicast and multicast streaming.

The distinguishing feature of both the

unicast and multicast protocols is that they do not rely on timers, but use supplemental information from the sender about the retransmissions made previously to enable the receivers to trigger multiple retransmissions.

The researchers have also recently

implemented technology that overcomes audible clicks and other disruptions in the streaming audio.

"We found that the problem was created because the sound card of the sending computer and the sound card of

the audio stream, resulting in the audible disruptions," he said.

To solve the problem, they enhanced a previously developed error-concealment algorithm to adapt to the "clock drift" between different sound

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*(The researchers) have developed protocols for fast data retransmission to recover lost data in real-time for unicast and multicast streaming. They have also recently implemented technology that overcomes audible clicks and other disruptions in the streaming audio.*

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the receiving computer normally have some skew since the clocks in the two computers do not achieve the same nominal rate," according to Prof. Papadopoulos.

"This skew causes a mismatch in the rate of production and consumption in

cards. The error-concealment algorithm uses two techniques to approximate missing samples from an audio stream.

The first technique is based on interpolation from multiple channels, and the second technique is based on Bezier curves to smoothly stitch together reconstructed samples.

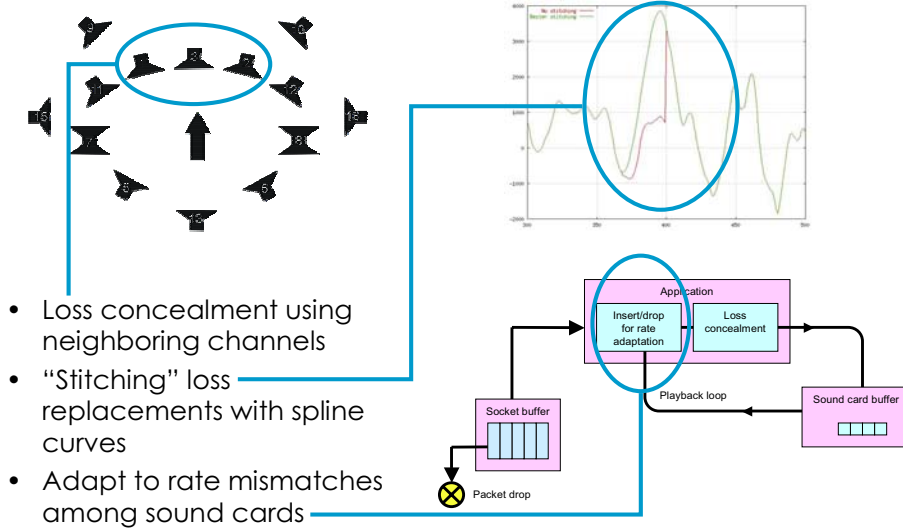
The team's technology not only adapts to mismatched sound cards, but also minimizes delay.

The team's advances are being applied to IMSC's Distributed Immersive Performance (DIP) project, which is developing the technology for a concert with the conductor, musicians and audience in different physical locations, delivered in real-time over the Internet.

The team uses a synchronization platform with the satellite global positioning system (GPS) and Real-Time Linux.

For more information on fast data retransmission and error-correction protocols, go to <http://imsc.usc.edu/research/project/errconcealstream>, and for additional information on the DIP project, visit <http://imsc.usc.edu/dip>.

## Live Multichannel Audio Streaming



## Tech Spotlight

### A special feature on IMSC projects

# Researchers investigate multi-path streaming

IMSC researchers are investigating multi-path streaming to improve the Internet video and audio streaming experience.

Prof. Leana Golubchik, a key IMSC investigator and associate professor of computer science, and her team are experimenting with a prototype multi-path streaming system that uses a peer-to-peer type architecture.



**Prof. Leana Golubchik**

They have been using wide-area networks nationally and internationally in their experiments.

Prof. Golubchik said initial experiments have shown that significant degradations in perceptual quality can result from data loss correlations exhibited by single path streaming.

She explained that the multi-path approach is designed to significantly reduce such correlations and hence should lead to improved perceptual quality.

Moreover, she said, initial experiments have shown that novel models are needed to evaluate streaming approaches over the Internet and that the multi-path project provides such models.

She noted that extensive experiments are underway to validate the techniques.

The team is working with IMSC key investigator Prof. Roger Zimmermann to integrate the system with IMSC's Yima™ streaming architecture, which handles multiple simultaneous high-bandwidth streams of images and sound synchronized to single-frame accuracy over the Internet.

Presently, IMSC's Remote Media Immersion (RMI) video and audio streaming with Yima™ uses single-path streaming with one remote server, such as the New World Symphony's server at its concert hall in Miami Beach or an

path streaming, researchers would have the flexibility to call on multiple servers in different locations to avoid lowering the data rate or reducing the quality because of possible data rate limitations.

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*Initial experiments have shown that significant degradations in perceptual quality can result from data loss correlations exhibited by single path streaming. The multi-path approach is designed to significantly reduce such correlations and should lead to improved perceptual quality.*

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IMSC server at the University of Maryland, College Park.

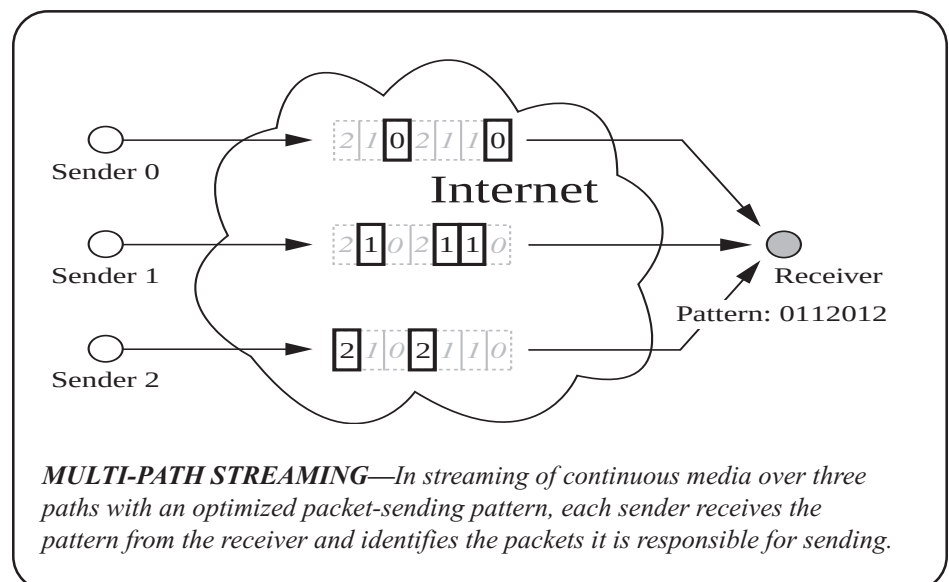
But with multi-path streaming, IMSC could use both the Miami Beach server and the College Park server for the same transmission, according to Prof. Golubchik.

In that case, she said, each remote server would be required to transmit at only half of the data rate needed from a server in a single-path transmission.

She pointed out that, with multi-

Prof. Golubchik said the team is also experimenting to show that using optimization algorithms they developed in conjunction with existing error-correction codes will provide higher video quality with multi-path streaming than with single-path streaming.

For more information on IMSC's multi-path streaming system, go to <http://imsc.usc.edu/research/project/videostream/index.html>.





## Computer vision & speech synthesis books published

Two new books from IMSC Press—one on computer vision and the other on text to speech synthesis—were published in late June.

*Emerging Topics in Computer Vision*, edited by Prof. Gérard Medioni and Sing Bing Kang, presents recent advances in computer vision theory, applications and programming.

Topics include camera calibration, multi-view geometry and face detection, vision for special effects and the tensor voting framework.

Prof. Medioni is a key IMSC investigator and chairman of the Computer Science Department, and Dr. Kang is a member of the Interactive Visual Media Group at Microsoft Research.

*Text to Speech Synthesis*, edited by Prof. Shrikanth Narayanan and Prof. Abeer Alwan, covers such key areas as new unit selection approaches, speech representations and modeling, data-driven synthesis schemes and expressive speech synthesis.

Prof. Narayanan is a key IMSC investigator and associate professor of electrical engineering, computer science and linguistics, and Prof. Alwan is a professor of electrical engineering at UCLA.

IMSC Press Editor in Chief Andrew G. Tescher, principal with AGT Associates, said contributions are welcome for consideration, and potential

contributors should contact him at [andy.tescher@alumni.usc.edu](mailto:andy.tescher@alumni.usc.edu).

IMSC Press is a partnership between IMSC and Prentice Hall

Professional Technical Reference (PTR). To order IMSC Press books, go to Prentice Hall PTR's Web site at <http://www.phptr.com>.

## Outreach to high schoolers . . .

*(Continued from page 1)*

The students are conducting the research at the Jisan Research Institute (JRI), a private non-profit organization they attend after school hours. JRI's mission is to provide opportunities for high school students, including those who are financially disadvantaged, to work on research projects sponsored by universities and companies.

IMSC began working with JRI two years ago under a three-year grant from the National Science Foundation.

IMSC designed the project specifically for the students, and they are working under the guidance of Prof. Jerry Mendel, IMSC's Associate Director for Education, Outreach and Student Affairs; Taehoon Shin, an IMSC graduate research assistant; and Dr. Sanza Kazadi, the JRI Director.

Prof. Mendel, who also oversees IMSC's collaboration with JRI, said of the students' work, "This paper represents the culmination of about two years of work for these students. They had a lot to learn, and they did so admirably."

"The JRI research experience has given them a leg-up on other students because they have demonstrated research skills that most high school students have not had the opportunity to display," he said.

Their paper, "Open Product Analysis of Genetic Algorithm-Generated Fuzzy Rule Sets," focuses on technology being developed that would assist the military in distinguishing between tanks and other kinds of vehicles by the sound they make as they move forward on a battlefield. Using sensors in the battlefield, a system employing the technology would alert soldiers to the threat of tanks that were out of their line of sight.

The students applied the principles of fuzzy logic to solve data classification problems in the research. Fuzzy 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. For more information on the JRI, visit <http://www.jisan.org>.

## MRI used in speech research . . .

*(Continued from page 2)*

computer science and linguistics, and his collaborators reported the MRI research in the April issue of the Journal of the Acoustical Society of America. The article, "An approach to real-time magnetic resonance imaging for speech production," is available in the Publications section at <http://sail.usc.edu>.

The collaborators are Dani Byrd, an associate professor of linguistics; Krishna Nayak, an assistant professor of electrical engineering and medicine; Sungbok Lee, a research scientist in linguistics and electrical engineering; and Abhinav Sethy a doctoral student in electrical engineering.

Magnetic resonance imaging, commonly used in cardiac and abdominal imaging, was previously employed in speech production analysis primarily to study static postures through still images, but now the USC team has developed its use for studying fluent speech through video.

Researchers can now learn more about the timing of how the speech articulators, such as the tongue and jaw, work together during fluent speech, according to Prof. Narayanan. This new MRI technique for speech production analysis might also be useful in helping people learn a foreign language, developing machines to produce speech more naturally and assisting people with speech problems because of a stroke.

### IMSC News

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# IMSC prominent in media in recent months

IMSC has been prominent in the media recently.

Multimedia magazine of the Institute of Electrical and Electronics Engineers (IEEE) published a major article by IMSC faculty members on IMSC's Remote Media Immersion (RMI) system in its June issue ([http://imsc.usc.edu/press/pdfs/04\\_04\\_01\\_2.pdf](http://imsc.usc.edu/press/pdfs/04_04_01_2.pdf)). The authors were Prof. Roger Zimmermann, Prof. Chris Kyriakakis, Prof. Cyrus Shahabi, Prof. Christos Papadopoulos, Prof. Alexander A. (Sandy) Sawchuk and Prof. Ulrich Neumann.

Prof. Shri Narayanan's project on voice recognition technology to recognize frustration in callers' voices when they interact with automated phone call centers continued to receive press coverage three months after the media first reported on the project. Newsweek featured the project in its May 17 issue ([http://imsc.usc.edu/press/pdfs/Shri\\_Newsweek\\_5\\_17\\_04.pdf](http://imsc.usc.edu/press/pdfs/Shri_Newsweek_5_17_04.pdf)).

Other coverage of the voice recognition-call center project included:

—Panorama magazine, a major newsweekly in Italy, the first week in May.

—Communications magazine of the Association for Computing Machinery, May edition.

—Texas Innovator, a four-page publication on social trends published by the state of Texas for consumers throughout the state, June issue.

Prof. Adam C. Powell, a member of IMSC's Board of Councillors and visiting professor at the Annenberg School for Communication, spoke about IMSC's research into immersive television news coverage on the Research Channel in a program that was first broadcast in early May and then re-broadcast later in the month.

The June edition of IEEE's Computer magazine published a major article by IMSC investigators and researchers with the IMSC spin-off, Digital Media Works, on IMSC's Virtual Classroom, which is being developed for assisting children with attention deficit hyperactivity disorder

([http://imsc.usc.edu/press/pdfs/04\\_04\\_01.pdf](http://imsc.usc.edu/press/pdfs/04_04_01.pdf)). The authors were Prof. Skip Rizzo, Dr. Todd Bowerly, Prof.

Cyrus Shahabi, Prof. J. Galen Buckwalter, Dean Klimchuk and Roman Mitura.

## Reporters see VR journalism demo

IMSC key investigator Prof. Skip Rizzo and his team demonstrated IMSC's virtual reality journalism project to television and radio journalists at the annual conference of the Associated Press Television and Radio Association of California and Nevada in April at Disneyland's Paradise Pier Hotel in Anaheim, CA.

Reporters tried out IMSC's headset and "pano-chamber" in experiencing the Center's vision of a TV news report of the future as recorded by a panoramic, 360-degree camera. As a cross-disciplinary endeavor, the project calls on investigators from IMSC and the Annenberg School of Journalism. Prof. Rizzo and Prof. Larry Pryor of the Annenberg School are conducting a user study to determine the effectiveness of the system.

## Students showcase SAI projects

Students showcased projects being developed with IMSC's Software Architecture for Immersipresence (SAI) at a successful Spring 2004 SAI Workshop in April.

The SAI architecture framework is a model for designing, analyzing and implementing applications performing distributed, asynchronous parallel processing of generic data streams. SAI enables modular design and fast prototyping of real-time systems. The projects were:

—"Expression Synthesis Project: Driving Through a Musical Landscape," which is developing a car-like driving interface that enables users to control the tempo and dynamics of a musical performance. Presented by Aaron Yang and Jie Liu. (Yang and Liu won the best undergraduate paper award at the IMSC Student Conference in March for their paper on this project.) Prof. Elaine Chew directs this project.

—Distributed Immersive Performance project, which is developing the technology for a concert with the conductor, musicians and audience in different physical locations, delivered in real-time over the Internet. Presented by Frances Hui-Yun Kao and Kanika Malhotra. This project is an IMSC Vision project.

—Sound visualization, presented by Janaki Amin.

—Visual SAI, presented by Kevin Cheng Zhu.

Prof. Alexandre R.J. François, who developed SAI, organized the session. Janaki Amin conducted directed research with Prof. François, and Kevin Cheng Zhu is working with him as an IMSC Research Assistant on the SAI project.

For more information on SAI, go to <http://imsc.usc.edu/research/project/sai>.

## Director's Message . . .

*(Continued from page 1)*

IMSC companies can participate in MMI will be forthcoming.

At the end of April, I attended a workshop in Philadelphia sponsored by the National Science Foundation (NSF) on its new Cyberinfrastructure initiative. I was involved as an organizer and contributor to this third exploratory workshop by NSF on the initiative. We identified research needs in cyberengineering/cyberinfrastructure and highlighted those that promise significant returns due to the scope, scale or breadth of their potential impact. I also attended the previous exploratory workshop that focused on commercial issues related to this new NSF initiative.

After five years of working with IMSC, Ann Spurgeon, IMSC's Associate Director of Industry Programs, has moved on to become the Director of Major Gifts for the School of Cinema-Television on campus. We wish her well in her new endeavors.

## Interdisciplinary initiative . . .

*(Continued from page 2)*

The six IIP projects are:

—Chojo, a mobile game for students to interact with a virtual 3D USC campus. Collaborators: USC School of Cinema-Television's Interactive Media Division, Scott Fisher, Chair; and IMSC, Victor LaCour and Suya You.

—Media Scholar, a digital application to explore how different media, including video, film, music, speech, 3D objects in sculpture or architecture, photography and painting, can be used effectively in scholarly discourse. Collaborators: Institute for Multimedia Literacy at USC, Chris Gilman and Eric Gordon; and IMSC, Victor LaCour.

—Sim-Finance, a multimedia game that demonstrates how a sequence of financially critical decisions and life events affect a user's economic situation over time. Collaborators: USC Marshall School of Business, Prof. J. Kimball Dietrich; USC Credit Union, Gary J. Perez, President; and IMSC, Ulrich Neumann, IMSC Director, and Victor LaCour.

—Augmented Reality for Enhancing Medical Training and Education. Collaborators: USC School of Dentistry, James Mah; and IMSC, Suya You and Reyes Enciso.

—An Intelligent Grammar Checker for Compositions in the Style of Palestrina, a tool that can assist composers in the creation of better Palestrina-style music compositions. Collaborators: USC Thornton School of Music and IMSC,

Cheng-Zhi Anna Huang and Elaine Chew.

—An Integrated Analysis and Modeling of Speech and Gestural Characteristics in Conversational Child-Computer Interactions. Collaborators: USC College of Letters, Arts & Sciences, Elaine Andersen; and IMSC, Shri Narayanan.

## Student conference . . .

*(Continued from page 3)*

developed the Lucasfilm THX Sound System® during the 15 years he was at Lucasfilm, Ltd.

The conference also featured a luncheon panel on future trends in multimedia and presentations by students on their research projects.

Aaron Yang and Jie Liu received the best undergraduate paper award for the "Expression Synthesis Project: Driving Through a Musical Landscape," which is developing a car-like driving interface that enables users to control the tempo and dynamics of a musical performance.

Two students tied for the best graduate paper award. Salvador Fallorina of California State University, Los Angeles (CSULA), won for his paper, "Fault Tolerant Parallel Processing for the SPACE Testbed."

Karim Seada received the award for the paper, "Service Location in Wireless Ad Hoc Networks," which described a project developing a novel scalable rendezvous-based architecture for wireless networks.

Fallorina was eligible to participate in the competition as a result of a cooperative initiative between IMSC and CSULA.

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