

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

## Director's Message

# IMSC launches initiative with top university in China

By Prof. Ulrich Neumann

IMSC recently launched an exciting initiative in China with the Key Lab on Pervasive Computing of Tsinghua University in Beijing. I traveled to Beijing in January to sign a memorandum of understanding that established the USC-Tsinghua Multimedia Sciences Consortium and calls for collaboration in education and research and faculty and student exchanges.

I toured the lab and had meetings with Lab Director Prof. Guangyou Xu, numerous professors, university officials, Chinese government officials, and a group from the NSF-China.

The Tsinghua Lab is conducting excellent multimedia and Internet research, and I believe our collaboration will bring substantial benefits to both centers. The lab's designation as a national "key lab" by the Chinese government is a major distinction similar to IMSC's Engineering Research Center designation by the National Science Foundation (NSF). This relationship is the first between such national centers.

We have been following Tsinghua's multimedia research over the years through a fortunate personal contact by IMSC key investigator Prof. Suya You, who was a visiting researcher there from 1994-96. At the time, Prof. Xu directed the Human-Computer Interaction Lab, and became director of the Key Lab when it was created recently. Prof. Xu visited IMSC in 2000, and, at his invitation, I attended the China National Conference on Multimedia as a keynote speaker.

We have begun exploring collaboration with the Key Lab on new multimedia technology for the classroom of the future. Both organizations have been

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**IMSC LAUNCHES INITIATIVE IN CHINA**—IMSC's Director, Prof. Ulrich Neumann (front left), and Prof. Guangyou Xu, Director of the Key Lab on Pervasive Computing of Tsinghua University in Beijing, sign a memorandum of understanding at the Key Lab to launch the USC-Tsinghua Multimedia Sciences Consortium. Standing are (from left to right) Prof. Shiqiang Yang, Secretary of the Computer Science Department, Tsinghua University; Prof. Suya You, IMSC key investigator; Prof. Ke Gong, Vice President, Tsinghua University; Prof. Yuanchun Shi, Computer Science Department, Tsinghua University; Hong Chen, Director, Division of International Relations, Tsinghua University; and Prof. Jianhua Lu, Electronic Engineering, Tsinghua University.

## Andrew & Erna Viterbi give \$52 million as naming gift for School of Engineering

IMSC is very pleased to inform our members that the USC School of Engineering has recently received a School naming gift of \$52 million from cell phone pioneer and alumnus Prof. Andrew Viterbi and his wife, Erna.

Prof. Viterbi, who received a Ph.D. in electrical engineering from USC in 1962, is a co-founder of Qualcomm and a major figure in the communications field.

The School's new name is the USC Andrew and Erna Viterbi School of Engineering. (See <http://www.usc.edu/dept/engineering> for additional information.)

## Prof. Elaine Chew receives NSF Early Career award

IMSC key investigator Prof. Elaine Chew, a specialist in computational music research, recently received a prestigious 2004 Early Career Award from the National Science Foundation (NSF).

Prof. Chew, an assistant professor in industrial and systems engineering, was awarded the five-year, \$500,000 grant for research, teaching and outreach activities in the development of computational music perception and cognition models for real-time interactive music systems.



**Prof. Elaine Chew**

She specializes in computational research in music cognition, music information categorization and retrieval, music visualization, music performance and performance rendering.

Prof. Chew is developing a system that would allow the user to add expressive flourishes to music by “driving” with a device based on a car’s steering wheel and pedals, instead of using the traditional mouse or joystick.

“Many musicians say that performing music is a lot like driving a car, so we are taking the analogy to the next level and developing a ‘driving’ interface for users,” she said.

She pointed out that the driving interface would allow musicians “to tinker with different expressive nuances” and would allow non-expert musicians “to experience the euphoria of driving through a piece.”

Prof. Chew also plans to create analysis tools for evaluating

musical synchronizations in collaborative environments, including the immersive environment being developed by IMSC’s Distributed Immersive Performance (DIP) project. This project is developing technology to allow musicians in different places to perform together over the Internet.

Other projects include “Music on the Spiral Array. Real Time” (MuSA.RT), a system for music analysis and visualization (See page 4 for separate article); music feature extraction; and music indexing and summarization for information retrieval.

Prof. Chew, who joined the IMSC faculty when she came to USC in 2001, praised the Center for its commitment to cross-disciplinary research. “At IMSC, this commitment to cross-disciplinary collaboration is more than lip service. The Center’s infrastructure encourages an adventurous spirit toward new research approaches,” she said.

Prof. Chew was an award-winning pianist by the time she was in her teens. She is a Fellow of Trinity College, London, in piano performance and specializes in contemporary classical music.

She was born in Buffalo, New York, and grew up in Singapore. She earned her Bachelor’s degree in Mathematical and Computational Sciences and in Music from Stanford University and holds a Master’s and Ph.D. in Operations Research from the Massachusetts Institute of Technology.

Prof. Chew’s Career award is from NSF’s Program in Human-Computer Interaction under the agency’s Information and Intelligent Systems Division.

## *Media outlets cover IMSC projects extensively*

Media outlets, including MSNBC and The New York Times, have covered IMSC extensively in the past few months.

Prof. Shri Narayanan, an associate professor of electrical engineering, computer science and linguistics, appeared on MSNBC’s “Countdown with Keith Olbermann” in February to discuss a system he and his team are developing to recognize frustration in the voice of callers when they use phone answering systems that respond to verbal input. (See page 5 for details on this voice recognition system.)

Other media coverage of the system included MIT Technology Review, February issue; Wired.com Web site; 94 KJY Radio, Providence, Rhode Island; Canadian Broadcast Corp. radio; and Le Show on National Public Radio.

### **Virtual environment projects covered**

IMSC’s virtual environment projects, headed by Prof. Skip Rizzo, also were covered by several media outlets. Prof. Rizzo, a clinical psychologist, and his team have developed several virtual reality environments, including IMSC’s Virtual Classroom for assisting children with attention deficit hyperactivity disorder. He was interviewed by Fox TV Channel 11 in San Diego at the Second Annual CyberTherapy Conference in January when he gave a demonstration of the Virtual Classroom.

In addition, he was featured by The New York Times in a February article on virtual reality in psychological therapy. The Science News for Kids Web site also covered the Virtual Classroom. For more information on IMSC’s Virtual Classroom and other virtual environments projects, visit <http://imsc.usc.edu/research/project/virtclass/index.html>.

### **ASEE Prism magazine features QuakeSim project**

The November issue of Prism magazine of the American Society for Engineering Education (ASEE) featured Prof. Dennis McLeod, IMSC’s Strategic Scientist and a key investigator, in an article on QuakeSim, a project on computer modeling for earthquake prediction. IMSC is working with the Jet Propulsion Laboratory and others on QuakeSim, which is funded by the National Aeronautics and Space Administration.

IMSC’s BioSIGHT project, directed by IMSC key investigator Wee Ling Wong, was cited in the December email newsletter of Eduventures, a Boston consulting firm in the education field. The BioSIGHT project focuses on interactive visualization for science education. The Eduventures article spotlighted BioSIGHT’s Interactive Streaming Storyboard, which assists teachers in creating visually compelling interac-

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## IMSC reaches Internet streaming milestone

IMSC reached a milestone in Internet application development in January with a teleconferencing demonstration of low-cost, live, two-way, high-definition video and two-channel audio streamed over the Internet between the University of Hawaii in Honolulu and an IMSC lab.



**Prof. Roger Zimmermann**

“Business teleconferencing can now potentially be much more affordable and flexible over the Internet,” according to Prof. Roger Zimmermann, who conducted the demonstration for researchers at a meeting of the Asia-Pacific Advanced Network Consortium in Hawaii.

“In the past, businesses have had to pay the extra cost of dedicated lines among company sites for teleconferencing. But now they will be able to use the Internet for extremely high-quality, low-cost teleconferencing and other applications,” he said. The equipment for the IMSC system costs less than one-tenth of comparable systems. In the demonstration, Prof. Zimmermann introduced the audience in Hawaii to two of his students, Dwipal Desai and Moses Pawar, who were at IMSC’s lab. The students then addressed the audience for about 10 minutes,



**MILESTONE IN INTERNET TELECONFERENCING**—In a milestone Internet streaming demonstration, IMSC students Dwipal Desai (left) and Moses Pawar in an IMSC lab watch Prof. Roger Zimmermann describe the project at a meeting of the Asia-Pacific Advanced Network Consortium in Hawaii. The students spoke for about 10 minutes on the technical details of the project after Prof. Zimmermann introduced them to the audience.

### Director’s Message . . .

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working in this area—the Key Lab has a “Smart Classroom” project, and we have a “2020 Classroom” project (See page 6 for an article on the latest developments with the 2020 Classroom project.) The technologies involved include Immersive Audio, video streaming, body tracking, avatar animation, speech and emotive processing, and content/media production and management.

We are also busy preparing for the next Scientific Advisory Board meeting on Monday, June 7, and the annual NSF site visit on Tuesday, June 8, and Wednesday, June 9.

explaining the technical details of the system.

The demonstration used the high-speed capabilities of the Internet, which are developed and used in research by universities and others and are available commercially to businesses in many areas. (The Internet’s high-speed capabilities have been developed by several research initiatives, using such names as Internet 2 and the Next Generation Internet.)

Prof. Zimmermann said that most traditional implementations of live media streaming suffer from a number of limitations. For example, he said, the picture resolution and quality are usually limited and do not convey a good sense of presence. He also said that, in the past, the few systems that have achieved HD media quality have required very costly equipment.

Prof. Zimmermann’s group integrated an MPEG-over-FireWire acquisition module, a low latency transmission protocol, and a high-speed software decoder in the new system.

This live streaming system is a component of the High Performance Data Recording Architecture (HYDRA) project. The goal of HYDRA is to improve current applications and enable new ones by acting as an efficient media stream coordinator that manages the transmission, recording and playback of many different data streams simultaneously. Go to <http://dmrl.usc.edu/hydra> for more information on HYDRA.



### Prof. Mendel honored

Prof. Jerry Mendel, IMSC’s Associate Director for Education and Outreach, was named a Life Fellow of the Institute of Electrical and Electronics Engineers (IEEE) in January.

Prof. Mendel, a professor of electrical engineering who specializes in uncertain rule-based systems and their applications, was also recently elected to the Administrative Committee of the IEEE Neural Networks Society. He is chairman of the Fuzzy Systems Technical Committee and a member of the Fellow Evaluations Committee and the Awards Committee of the Society.

## Tech Spotlight

A special feature on IMSC projects

# IMSC's goal: "Seeing" the music as you hear it

Imagine that you could "see" the music as well as hear it when you go to a symphony performance.

As the music plays, you watch colorful 3D animated patterns dance across two huge screens. And, the patterns are moving, not randomly, but according to a computer model that reflects the brain's perception of musical structure.



**Prof. Alexandre François**

That's the goal of IMSC researchers developing an interactive music system called "Music on the Spiral Array. Real Time." (MuSA.RT). The Spiral Array is a 3D model for tonality used for

analysis and graphical rendering.

Prof. Elaine Chew, an assistant professor of industrial and systems engineering, and Prof. Alexandre François, a research assistant professor of computer science, are designing MuSA.RT to capture a performance in real-time, analyze the musical content and render the internal structures of the music as a time-varying, 3D animation.

"Most systems for music visualization do not take into account how people perceive musical patterns," according to Prof. Chew, who developed the Spiral Array model.

"In particular, most of us are innately able to organize musical sounds into hierarchical structures. In MuSA.RT, we can make explicit this cognitive process of organizing musical sounds, as well as augment the listening experience by enabling listeners to see what they hear," she said.

Presently, the musical input comes from an electronic keyboard with the graphical rendering appearing on a



*Prof. Elaine Chew demonstrates how piano music is represented on a monitor as a colorful animated pattern based on a computer model that reflects the brain's perception of musical structure.*

computer monitor. A viewer can either navigate through the Spiral Array space using a gaming device or set the view to autopilot.

A prototype of the system was successfully demonstrated at the November 2003 Association for Computing Machinery International

ing distributed, asynchronous parallel processing of generic data streams.

Prof. François, who developed SAI, said the framework "provides the foundation for applying so-called lightweight or agile approaches to software engineering that are actually adapted to the research environment." In addition, he

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*"In MuSA.RT, we can make explicit (the) cognitive process of organizing musical sounds, as well as augment the listening experience by enabling listeners to see what they hear."—Prof. Elaine Chew*

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Conference on Multimedia in Berkeley.

In designing MuSA.RT, the researchers are using IMSC's SAI architecture framework, which is a model for designing, analyzing and implementing applications perform-

pointed out, SAI enables modular design and fast prototyping of real-time systems.

Prof. François also said that since MuSA.RT is an experiment in complex, cross-disciplinary, multi-modal and real-time system integration, it serves as a model for larger scale experiments.

## Tech Spotlight

A special feature on IMSC projects

# IMSC system recognizes frustration in caller's voice



*Prof. Shri Narayanan, IMSC's Research Area Director for the Application Research Projects area and co-leader of the Communication vision project. He also directs IMSC's Speech Analysis and Interpretation Laboratory.*

“Say or press 1 if you want . . .”

Frustrated trying to navigate through the instructions you get from those recorded phone answering systems?

Researchers at IMSC are trying to help.

They are developing a system that will recognize frustration in your voice—and then take action to help, such as providing a soothing response by the computer or immediately transferring the call to a human.

Presently, the system distinguishes irritated speech from normal speech with 85 percent accuracy, according to Prof. Shri Narayanan, associate professor of electrical engineering, computer science and linguistics.

Prof. Narayanan pointed out that companies would use the system to ensure callers do not hang up out of frustration and estimated that a commercially viable system could be available in about two years as the researchers continue to improve accuracy and add response capabilities.

He said he and his team have yet to decide on the kinds of response actions to implement.

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*“The underlying voice recognition technology we are developing for this application will be useful in many other areas, including automated training, education, and games. All this is part of socially cognizant technologies we are developing at IMSC.”*

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The system identifies frustration from such features as pitch, energy, duration of speech sounds, word content and contextual information.

The team used some 1,400 real calls recorded by a call center to “teach” the system to recognize frustration.

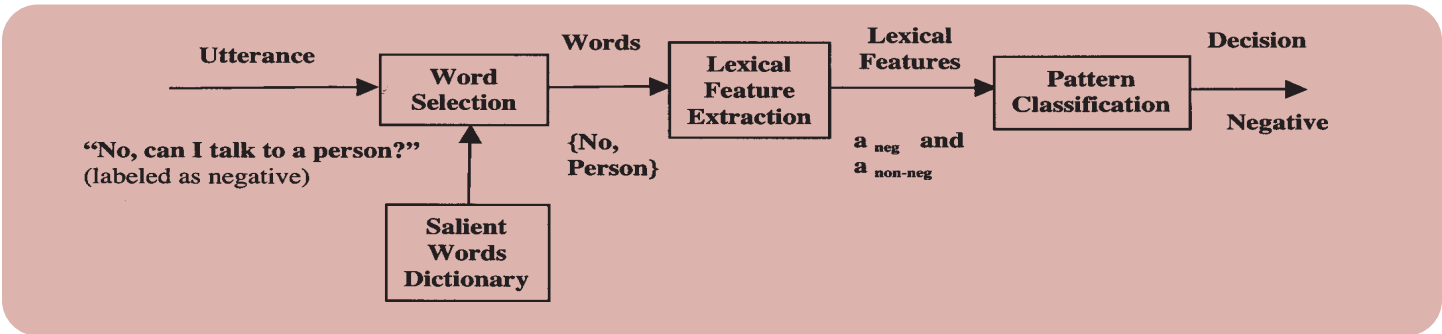
“The underlying voice recognition technology we are developing for this application will be useful in many other areas, including automated training, education, and games,” Prof. Narayanan said.

“All this is part of socially cognizant technologies we are developing at IMSC.”

He and Ph.D. student Chul Min Lee are reporting the research in an upcoming issue of the Institute of Electrical and Electronics Engineers Transactions in Speech and Audio Processing.

Lee is a recipient of a 2004 USC Communication Critical Pathway Dissertation Fellowship.

The project is receiving extensive media coverage. For details on the coverage, see an article on IMSC’s coverage of the past few months on page 2.



*A block diagram for the classification of negative and non-negative emotions using lexical information.*

## *New immersive technologies for education developed*

IMSC researchers are creating an immersive gaming architecture for the 2020 Classroom project that features 3D high-definition visuals, 10.2-channel Immersive Audio, and a customized “immersidata” management system.

They plan to conduct a study this spring to determine if learning can be enhanced by the integration of advanced video and audio technologies, new pedagogical techniques, a computer game-like environment, and tools for real-time and off-line analysis of participant interactions.

(The term, “immersidata,” is used by IMSC to describe data gathered by immersive technologies.)

“We plan to demonstrate that the application of immersive technologies combined with a compelling gaming concept can open new avenues for collaborative and distance learning,” according to Prof. Chris Kyriakakis, a co-director of the study and IMSC’s Research Area Director for Sensory Interfaces.

Prof. Cyrus Shahabi, IMSC’s Research Area Director for Information Management, is the other co-director.

The long-term 2020 Classroom project is integrating new information technologies and innovative pedagogy to develop a model for the classroom of the future.



**THE WORLD OF METALLO MAN**—IMSC’s imaginary Metallo Man immersive environment, a world existing far into the future where humans have merged with machines, is being developed as part of the 2020 Classroom project.

About 20 students will participate as subjects in the study. The students will navigate through IMSC’s imaginary “Metallo Man” immersive environment, a world existing 30,000 years into the future where humans have merged with machines.

Their task will be to solve a crisis in this future world by traveling back in time to address biological issues.

Researchers will use this imaginary scenario to teach real-world biology, with the students scoring points as they meet learning goals and gain specific knowledge of the subject.

Metallo Man will be a two-person game, with the two participants in different physical locations connected over the Internet. In addition to traditional keyboard, mouse and joystick interfaces, the participants will also use “data gloves” to navigate through the environment and use virtual tools with hand motions.

The novel 3D high-definition display developed for this project uses a combination of standard-definition and high-definition images and video to

provide the participants with convincing life-size visuals.

Students participating in the study will be using the new 2020 Classroom facility that is equipped with wide-field-of-view life-size displays and immersive audio rendering systems. In addition to looking at the value of this high-fidelity presence environment, the study will also examine the benefits of the gaming approach to learning when the students use traditional desktop computers.

An Immersidata Management System (AIMS), developed by IMSC, will track the actions of the participants as they navigate in the game. AIMS will gather and analyze the data streams both in real-time and off-line.

“The real-time analysis of these data streams is challenging due to the nature of the data as well as to the short time available to perform the analysis and respond to the user in real-time,” according to Prof. Shahabi, who leads the group handling this part of the study.

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### **IMSC News**

April 2004

**Integrated Media Systems Center  
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# Oil industry & airline projects move forward

Projects with three new IMSC sponsors, ChevronTexaco, Korean Air and Pratt & Whitney, are moving forward to introduce IMSC technologies into two major industries—oil and airlines.

IMSC researchers are assisting ChevronTexaco in developing the oilfield of the future through the Center's expertise in data management, data transmission and visualization.

This oilfield project is being developed under the auspices of the Center of Interactive Smart Oilfield Technologies (CiSoft), established by ChevronTexaco and USC. Three Viterbi School of Engineering organizations—IMSC, the Information Sciences Institute and the Petroleum Engineering Department—are working on the project.

Researchers from the three Viterbi SoE organizations have been visiting ChevronTexaco sites, including an offshore drilling platform and local oilfield operations.

They also attended a retreat with ChevronTexaco personnel to plan the project, and specific initiatives are now being developed.

Researchers are focusing on the integration of field automation, reservoir simulation technologies, new and emerging well technologies, and real-time reservoir management to help reduce field development costs, speed up the analysis of information, and enhance operational reliability.



ChevronTexaco photos

*ChevronTexaco offshore oil platforms.*



IMSC researchers provide expertise in data management and visualization for the development of instrumented, intelligent oil and gas fields. The Center's researchers will have access to drilling and production data from around the world.

IMSC's other two new sponsors, Korean Air and Pratt & Whitney, the airline's major jet engine supplier, are calling on IMSC's Remote Media Immersion (RMI) video and audio technology to develop a cutting-edge wireless Internet communications system that will dramatically cut costs and save time in the expensive area of engine maintenance.

The project is under the auspices of the Pratt & Whitney Institute for Collaborative Engineering (PWICE), established jointly at USC and Inha University in South Korea.

The RMI system is being integrated with other wireless communication tools to provide unprecedented interaction between Pratt & Whitney's engineers in the firm's East Hartford, Connecticut, headquarters and Korean Air mechanics working on the planes in the airline's maintenance facility in



Korean Air/Pratt & Whitney photo

*Korean Air technicians diagnose Pratt & Whitney engine, using wireless technology.*

Seoul, nearly 7,000 miles away. The engineers at the help-desk in Connecticut will work with the mechanics as if they were right next to them in the maintenance facility. They will not only view the engine and communicate in real time with the mechanics, but will get immediate data readings from diagnostic instruments.

As the project progresses, the engineers and mechanics will be able to monitor airplane conditions while the planes are still in the air.

Through PWICE, Korean Air and Pratt & Whitney have already been experimenting with wireless Internet technology. One demonstration last fall showed how P&W engineers and KAL mechanics could rely on the wireless Internet to transmit images from a borescope, a fiber-optic device with a tiny video camera able to peer deep inside an engine without disassembly. This year IMSC's RMI technology will be incorporated into the project to dramatically extend capabilities and improve performance.

Y.S. Kang, Managing Vice President of Korean Air, called the project an "outstanding" example of cooperation among Pratt & Whitney, Korean Air, USC and Inha University, pointing out that "we can potentially cut maintenance costs substantially while maintaining flight schedules."

Korean Air Chairman Y.H. Cho, the catalyst responsible for organizing the creation of PWICE, was similarly impressed with the project. He had previously commissioned an RMI installation at Inha University.

Bob Keady, Vice President, Asia/Pacific-Large Commercial Engines, for Pratt & Whitney, was also impressed, saying that RMI technology "will be key to the success of the project in a practical application."

For information on joining IMSC's sponsor program, go to <http://imsc.usc.edu/industry/categories.html>, or contact Dr. Isaac Maya, IMSC's Director of Industry and Technology Transfer Programs, at (213) 740-2592.

## Media coverage . . .

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tive lessons and supports users in telling stories with streaming media. For more information on the storyboard tool, go to <http://imsc.usc.edu/research/project/storyboard/index.html>.

IMSC Research Associate J.P. Lewis was cited in the October issue of the quarterly journal Cinefex for his graphics work on the "The Matrix Reloaded." He came up with a new approach to simulate skin translucency with digital techniques to make virtual characters look more real.

### IEEE Spectrum highlights degree programs

In February, IEEE (Institute of Electrical and Electronics Engineers) Spectrum magazine highlighted IMSC's degree programs in an article on where to go to study technology used in the entertainment industry.

Under "Entertainment & Engineering: Where to Study," the article listed the Master of Science in Integrated Media Systems; Master of Science in Electrical Engineering with a specialization in Multimedia and Creative Technologies; and Master of Science in Computer Science with a specialization in Multimedia and Creative Technologies. Programs at other Schools of Engineering were also cited.

IMSC has also developed other degree programs—two undergraduate minors in Multimedia and Creative Technologies (one for engineering students and the other for non-

engineering students) and a Bachelor of Science in Electrical Engineering with an emphasis in Integrated Media Systems.

Visit <http://imsc.usc.edu/education> for more information on IMSC's education program.

## Metallo Man . . .

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The real-time analysis will be used to answer such questions as:

- How long do the participants spend at various stages?
- Which path of exploration among several do they take?
- What patterns emerge when the two partners interact?

Prof. Shahabi said that "the off-line analysis is similar in concept to performing data-mining on multidimensional datasets."

"However, the off-line analysis of immersidata is distinguished from typical data-mining tasks by the nature of the data (e.g., noisy data) as well as by the application-specific complex assessment requirements resulting from the analysis," he said.

In a major component of the study, Prof. Albert "Skip" Rizzo, a clinical psychologist and key IMSC investigator, and his team are focusing on the value of the project from a user-centered point of view.

They will explore several issues, including whether gaming and immersion add to the learning experience, as well as what type of interfacing tools are most effective for naturalistically interacting with the 3D content.

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