



Message from the Chairs



Al Aho



Kathy McKeown

The Computer Science Department at Columbia University has grown tremendously in breadth and depth in the last few years.

Since 2002, we have added two new senior faculty, both stars in their fields.

Peter Belhumeur, a leading researcher in the area of visual appearance, left Yale University to join us in January 2002. Julia Hirschberg, known for her research in spoken dialog systems, came to us from AT&T Research Laboratories in September 2003.

In the last two years the department has hired eight new junior faculty: Steven Edwards from Berkeley, Tony Jebara from MIT, Angelos Keromytis from U. Penn, Tal Malkin from MIT, Vishal Misra from U. Mass, Ravi Ramamoorthi from Stanford, Rocco Servedio from Harvard, and Betsy Sklar from Brandeis.

These new faculty greatly strengthen the main themes of research in our department: interacting with the physical

world (graphics, vision, robotics), interacting with humans (user interfaces, natural language and speech, collaborative work, personalized agents), systems (networks, security, distributed systems, operating systems, compilers, programming languages, software engineering), designing digital systems (digital and VLSI design, CAD, asynchronous circuits, embedded systems), making sense of data (databases, data mining, Web search, machine learning applications) and computer science theory (cryptology, quantum computing, complexity, machine learning theory, graph theory, algorithms).

Our focus in hiring over the years has been to enlarge our impact in research areas that

we think are key to the future. Over the past decade our researchers have had demonstrated impact in several important areas of computer science including natural language processing, networking, security, computer vision and graphics. We have seen a dramatic increase in research spending, growing from \$5.5 million in 1998/99 to \$8.7 million in 2001/02.

Our new faculty also give us a better ability to address the educational needs of all our students. We have just instituted a new Masters program for Computer Engineering which provides the opportunity for advanced study in a combined program of Computer Science and Electrical Engineering.

(continued on page 6)



Shree Nayar

T.C. Chang Professor
of Computer Science

Professor Nayar heads the **Columbia Automated Vision Environment (CAVE)**, a research lab dedicated to the development of advanced computer vision systems.

Professor Nayar's research is focused on three areas: the creation of cameras that produce new forms of visual information; the modeling of the interaction of light with materials; and the design of algorithms that recognize objects from images.

This past spring Professor Nayar delivered Columbia's prestigious University Lecture to a packed audience in Low Library, marking the second time the University has honored a computer science faculty member with this distinction. In his lecture, Professor Nayar introduced the computational camera, a device that embodies the convergence of the camera and the computer.

The traditional notion of a camera is based on the concept of a pinhole (camera obscura). It produces an image by selecting rays of light from the scene in a specific manner; only those rays that pass through the iris of the camera's lens are captured. The computational camera uses unconventional optics to select light rays from a scene in

radically different ways and a suitable algorithm to manipulate the selected rays to produce new forms of visual information. Professor Nayar presented examples that demonstrate how the computational camera redefines the notion of an image, and hence has the potential to impact the very nature of visual communication.

Professor Nayar was born in Bangalore, India in 1963. In 1990, he received his PhD degree in Electrical and Computer Engineering from the Robotics Institute at Carnegie Mellon University. He has received the prestigious David Marr Prize twice (1990 and 1995), the David and Lucile Packard Fellowship (1992), the National Young Investigator Award (1993), the NTT Distinguished Scientific Achievement Award (1994), and the Keck Foundation Award for Excellence in Teaching (1995). He has published over 100 scientific papers and has over 30 awarded and pending patents on inventions related to imaging, vision, and robotics.

Faculty



Alfred Aho
Algorithms
& Compilers



Zeph Grunschlag
Algorithms



Kathy McKeown
Natural
Language
Processing



Rocco Servedio
Theory
& Learning



Peter Allen
Robotics
& Graphics



Julia Hirschberg
Speech
Processing



Vishal Misra
Networking
& Performance
Analysis



Edward Shortliffe
Joint with
Medical
Informatics



Peter Belhumeur
Computer
Vision
& Graphics



Tony Jebara
Machine
Learning



Shree Nayar
Computer
Vision



Elizabeth Sklar
Software
Agents



Adam Cannon
Machine
Learning



Gail Kaiser
Software
Systems



Jason Nieh
Operating
Systems



Clifford Stein
Joint with
I.E.O.R.



Stephen Edwards
Embedded
Systems



John Kender
Video
Processing



Steven Nowick
Asynchronous
Systems



Sal Stolfo
Security
& Systems



Steve Feiner
Computer
Graphics



Angelos Keromytis
Systems
Security



Ravi Ramamoorthi
Computer
Graphics
& Vision



Joseph Traub
Information
Based
Complexity



Zvi Galil
Algorithms
& Cryptography



Andrew Kosoresow
Artificial
Intelligence



Ken Ross
Database
Systems



Stephen Unger
Computer
Engineering



Luis Gravano
Information
Systems
& Databases



Christina Leslie
Computational
Biology



Dan Rubinstein
Joint with
Electrical
Engineering



Henryk Wozniakowski
Complexity
& Quantum
Computing



Jonathan Gross
Graph
Theory



Tal Malkin
Theory
& Security



Henning Schulzrinne
Networking



Yechiam Yemini
Networking

Congratulations to our 2003 CS & CE Graduates!

Undergraduate Degrees

Ayesha Abdul-Quader BA
Joseph Aghion BS
Shantanu Agrawal BS
Omar Ahmed BS
Kabir Ahuja BS
Kwamena Aidoo BA
Shuichi Aizawa BS
Andrew Arnold BA
Kierstan Bell BS
Vadim Belobrovka BS
Mark Benvenuto BS
William Bert BA
Ruby Bola BA
Rostislav Briskin BS
Andrew Brotzman BA
Robert Bruce BA
Daniel Burdeinick BS
Felix Candelario BA
Michael Castleman BS
Ye Chen BS
Michael Ching BS
Freddie Choi BS
Alfred Chung BA
Ketecia Clarke BA
Eric DeFriez BA

Vijay Dewan BS
Lukas Dudkowski BS
Charles Finkel BS
Gerardo Flores BS
Aner Fust BA
Mark Galagan BS
Jordan Genut BA
Meena George BS
Katrice Georges BS
Samuel Gordon BA
Elizabeth Gorinsky BA
Jeffrey Green BS
Brian Gruber BS
Zaheda Haidri BS
Andrew Han BS
David Hefter BS
David Hessing BA
Henry Ho BS
Matthew Hoffman BS
Yossi Horowitz BS
William Hu BA
Lin Jiang BS
Jeremiah Johnson BS
Calvert Jones BA
Yuan Kao BS
Olga Khaykina BA
Arseniy Khobotkov BS
Albert Kim BS
Kenneth Kim BS

Theodore Kim BS
Lawrence Kirschner BA
Dixon Koesdjojo BS
Isaac Krieger BS
Takahiro Kuba BS
Kristen Kupchik BS
William Kwok BS
Feng-Yin Lai BS
Benjamin Langmead BA
Julika Lartey BS
Don Lee BA
Lawrence Lee BS
Chang-Woo Lee BS
Johnie Lee BS
Micah Lemonik BS
Jeffrey Leung BS
Robyn Levinson BA
Ho-Cheung Li BS
Daniel Lichtenberg BA
Steven Ling BA
Alan Lue BA
Robbie Majzner BA
Igor Marfin BS
Eyal Mayer BA
Maxim Mayer-Cesiano BA
Edward Mezarina BA
Gregory Michalak BS
Shloke Mittal BS
Kaushik Mukherjee BS
Elizabeth Mutter BS
Justin Namolik BS
Michael Ockfen Metcalf BS
Charles O'Donnell BS
Adaku Ofoegbu BS
Rosauro Ola BS
Nicholas Orton BA
Peter Ottomanelli BS
James Pak BS
Tamar Palgon BA
EunSong Park BS
Sangdon Park BS
Ji-Soo Park BA
Christopher Pendleton BS
Sina Peyroviaan BS
Jeffrey Polanco BS
David Pollack BA
Scott Price BS
Amna Qaiser BS
Yong Man Ra BS
Min Jeong Ra BA
Vivek Ramdev BS
Shiva Ramudit BS
Sukumar Rao BS

Daniel Reed BA
John Rodriguez BA
John Rolston BS
Sajid Sadi BS
Jordan Salvit BS
Adam Schwartz BS
Andrei Scudder BS
Matthew Selsky BS
Gaurav Shah BA
Daniel Shamah BA
Max Shevyakov BS
Andrew Shin BS
Darrell Silver BA
Alvin So BS
Eva Soliz BA
Tenzin Sonam BS
Mu Lan Tan BS
Mark Tarnapol BA
Daniel Terry BS
Jonah Tower BS
Vikram Tuteja BS
Regina Udler BA
Noel Vega BS
Bill Wang BS
Jing Wang BS
Corey Wang BA
Marta Wojcik BA
Sau Man Wong BA
Jonathan Wu BA
Russell Yanofsky BS
Michael Youn BA
Olga Zaitseva BS
Eric Zhai BS
James Zheng BS

Masters Degrees

Genevive Alelis MS
George Atzemoglou MS
Jiangcheng Bao MS
Hrvoje Benko MS
Yuval Beres MS
Gabor Blasko MS
Aleksandr Bogomolov MS
Blaine Boman MS
Vlad Branzoi MS
Linh Bui MS
George Chang MS
Anurat Chapanod MS
Clayton Chen MS
Yu-Hua Chen MS
Helen Chen MS
Gyechul Cho MS
Paolo De Dios MS
Heba Elsayed MS
Gary Escola MS
Vanessa Frias-Martinez MS
Ravi Gadhia MS
Joseph Gagliano MS
Yong Gao MS
John Gassner MS
Xin Gong MS
Jean-Denis Greze MS
Rean Griffith MS
Alexander Haubold MS
Marshall Hayden MS
Ilana Hefter MS
Yu-Chi Hu Professional
Yu-Ling Huang MS
Edward Ishak MS
Stephen Jan MS
Angel Janevski Professional
Ganna Kozynenko MS
Nitya Krishnamoorthy MS
Bhaskar Krishnan MS
Shilpa Krishnappa MS
Lawrence Leftin Professional
Bo Li MS
Wei-Jen Li MS
Dongping Liang MS
Andrew Lih MS
Xiaohua Liu MS
Shahmil Merchant MS
Silvia Metodieva MS
Aparna Mohla MS
William Morein MS
Subroto Mukherjee MS

Smaranda Muresan MS
Ani Nenkova MS
Marcin Osiecki MS
Manishkumar Patel MS
Matias Pelenur MS
Samuel Popper MS
Raghav Ramesh MS
Andrew Shane MS
Sangho Shin MS
David Smilowitz MS
Viktoriya Sokolova MS
Srikrishna Sridhar MS
Dinesh Subhraveti MS
Serafina Sumargo MS
Nikhil Tiwari MS
Alejandro Troccoli MS
Akira Tsukamoto MS
Yen-Jong Tu MS
Aruchunan Vaseekaran MS
Shu-Chuan Wu MS
Xin Xie MS
Wang-Tso Yang MS
Wen-Hua Yu MS
Tiantian Zhou MS

Ph.D. Degrees

Aya Aner

Sponsor: John Kender
Video Summaries and Cross-Referencing

Regina Barzilay

Sponsor: Kathleen McKeown
Information for Multi-Document Summarization: Paraphrasing and Generation

Nicolas Bruno

Sponsor: Luis Gravano
Statistics on Query Expressions in Relational Database Management Systems

Sushil da Silva

Sponsor: Alfred Aho
Netscript: A Programming Language for Packet-Stream Processing

Eleazar Eskin

Sponsor: Salvatore Stolfo
Sparse Sequence Modeling with Applications to Computational Biology and Intrusion Detection

Atanas Georgiev

Sponsor: Peter Allen
Design, Implementation and Localization of a Mobile Robot for Urban Site Modeling

Efstathios Hadjidemetriou

Sponsor: Shree Nayar
Use of Histograms for Recognition

Tobias Höllerer

Sponsor: Steven Feiner
User Interfaces for Mobile Augmented Reality Systems

Wenyu Jiang

Sponsor: Henning Schulzrinne
QoS Measurement and Management for Internet Realtime Multimedia Services

Min-Yen Kan

Sponsors: Judith Klavans and Kathleen McKeown
Automatic Text Summarization as Applied to Information Retrieval: Using Indicative and Informative Summaries

Maria Papadopouli

Sponsor: Henning Schulzrinne
Resource Sharing in Mobile Wireless Networks

Carl Lewis Sable

Sponsor: Kathleen McKeown
Robust Statistical Techniques for the Categorization of Images Using Associated Text

Departmental Awards

Computer Science Department Award

Andrew Arnold (CC)

For scholastic achievements and contributions to the Computer Science Department, Columbia College, and the University as a whole

Computer Science Scholarship Award

Meena George (SEAS)

Joseph Aghion (SEAS)

For excellence in Computer Science

Theodore R. Bashkow Award

Charles O'Donnell (SEAS)

For excellence in independent projects

The Russell C. Mills Award

John Rolston (SEAS)

For excellence in the area of Computer Science

Paul Michelman Award

Phil Gross

For exemplary service to the Computer Science Department

Recognition of Excellence in TAing

Ayesha Abdul-Quader (CC)

Srikant Krishna

For excellence in TAing and substantial contribution to the sense of departmental community

PhD TA/Teaching Award of Excellence

Peter Davis

For excellence in TAing and substantial contribution to the sense of departmental community

Rocco Servedio and Ryan O'Donnell have won the Best Paper Award at the IEEE Conference on Computational Complexity for their paper "Extremal properties of polynomial threshold functions." (Ryan is Madhu Sudan's student at MIT.)

Luis Gravano's student, **Eugene Agichtein**, won the Best Student Paper award for their paper "Querying Text Databases for Efficient Information Extraction" presented at the 2003 IEEE ICDE database conference.

Angelos Keromytis, Sal Stolfo, Tal Malkin and **Vishal Misra** won a grant from the NSA for distributed intrusion detection.

The White House has announced the appointment of **Judith Klavans** to the President's Information Technology Advisory Committee. Judith is Director of the Center for Research on Information Access and a research scientist with the Natural Language Processing Group.

Stephen Edwards received a donation of hardware and software from Xilinx for his embedded systems research group.

Vishal Misra has won the NSF Career Award under the title "Expecting the Unexpected: A Study of Network Vulnerabilities." He also won the IBM faculty award, the DoE Career award and the NSF Career award.

Richard Feynman conjectured that many problems in quantum mechanics could never be solved on a classical computer. (All existing computers are classical.) He believed that quantum computers would be needed. Solving such problems is important because quantum mechanics governs the atomic and subatomic domains fundamental to chemistry and physics and is an essential key to understanding our universe.

One of the formulations of quantum mechanics is given by path integrals. "Path Integration on a Quantum Computer" by **Joe Traub** and **Henryk Wozniakowski** is the first paper to show that quantum computers provide a big win over classical computers for this problem. The paper has been accepted by the journal "Quantum Information Processing."

Joe Traub presented Distinguished Lectures to the School of Computer Science at Carnegie Mellon University, Peking University in Beijing and Fudan University in Shanghai.

Al Aho won the 2003 IEEE John von Neumann Medal for contributions to the foundations of computer science and to the fields of algorithms and software tools. He was also elected to the American Academy of Arts and Sciences.

Steven Feiner is program co-chair for ISWC 2003, the 7th IEEE International Symposium on Wearable Computers. He gave the keynote talk at IEEE Virtual Reality 2003, and will be giving invited talks at conferences in Japan and the UK over the next few months.

Jonathan Gross is editing of *The Handbook of Graph Theory* with Jay Yellen as co-editor. This 50-chapter encyclopedic volume will be published early in 2004. Columbia chapter authors include Professors Al Aho, Giuseppe Italiano, and Cliff Stein.

Adam Cannon won the 2002 SEAS Alumni Association Distinguished Faculty Teaching Award.

Julia Hirschberg gave a plenary talk at the ISCA & IEEE Workshop on Spontaneous Speech Recognition in Tokyo, entitled "Experiments in Emotional Speech." She also gave a talk at the University of Pittsburgh's CS Distinguished Lecture Series, entitled "Browsing and Searching Audio Data: SCANMail."

Jason Nieh was 1 of 5 professors across the nation to be awarded a 17" G4 PowerBook by Apple computers for use in operating systems research in a highly competitive competition.

Columbia's ACM Student Chapter won the Outstanding Chapter Community Service Award for 2002-03.

Gail Kaiser was asked to deliver an invited talk and paper on autonomic computing at the 5th Annual International Active Middleware Workshop in June. She has also been hired as a consultant by DARPA to "thoroughly integrate cognitive systems into the military's existing and future information infrastructures from tactical raw data to strategic vision."

(Message from the Chairs continued from page 1)

The department has also elected Al Aho as a new Vice Chair of Undergraduate Education. Under his purview, the department will be focusing on evolving the curriculum at both the undergraduate and graduate levels to meet the new challenges our graduates will face as citizens of the information age.

Our undergraduate programs are extremely popular with students, both undergraduate and graduate. We have 95 CS

majors per year, the largest in the Engineering School. We are also the only department in Columbia to offer both a BA and a BS and our majors come from Columbia College, General Studies, Barnard College, in addition to SEAS. We also offer a Computer Engineering degree, an interdisciplinary program similar in spirit to our MS program; it draws 35 majors per year.

At the graduate level, we have a total of 156 MS students and 102 PhD students. A key fea-

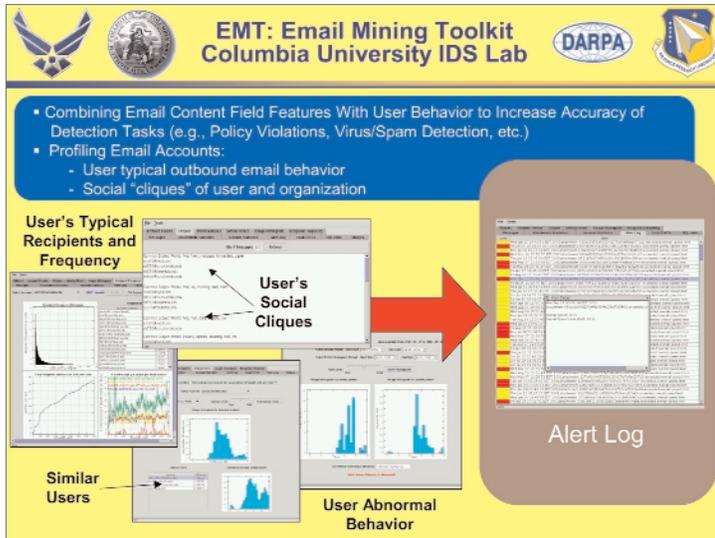
ture of our undergraduate programs is the ability to become involved in research. This happens through our Research Liaison program which holds a research fair mid-year to showcase student projects. For the graduate students, research starts early in the program and quickly becomes the main educational activity.

We should perhaps explain why the department has two chairs this year. Henning Schulzrinne was elected the chair of the Computer Science

Department, beginning in January 2004. Kathy McKeown finished her five-year term as chair in December 2002. Since Henning is on sabbatical, Al Aho (who was chair 1995-97) chaired the department in spring 2003, and Kathy McKeown will chair the department in fall 2003.

The department is clearly well positioned to meet the future.

Send comments, suggestions & news items to: chair@cs.columbia.edu



A Behavior-based Approach to Securing Email Systems

Professor Sal Stolfo and his IDS (Intrusion Detection Systems) research group have developed the Email Mining Toolkit (EMT), a system that implements behavior-based methods to improve security of email systems. Behavior models of email flows and email account usage may be used for a variety of detection tasks. Behavior-based

models are quite different from "content-based" models in common use today, such as virus scanners. The goal of these techniques is the detection of the onset of viral propagations. The results achieved for the detection of the onset of viral propagations suggest email delivery should be egress rate limited - stored for a while and then forwarded - or a record of recently delivered emails should be kept in order to develop sufficient statistics to verify a propagation is ongoing. EMT can form part of a larger security platform that deals with email security issues in general.

Visiting Committee

In January 2003, an External Visiting Committee consisting of twelve of the most distinguished scholars in Computer Science came to evaluate the Computer Science Department at Columbia. The members of the external committee were:

Jacob Abraham University of Texas, Austin
Steven Bellovin AT&T Laboratories
Robert Constable Cornell University
James Foley Georgia Tech
Jitendra Malik UC Berkeley
Christos Papadimitriou UC Berkeley
Fernando Pereira University of Pennsylvania
Tomaso Poggio MIT
Raghu Ramakrishnan University of Wisconsin
Alfred Spector IBM
Jon Turner Washington University
Jeannette Wing CMU

The Visiting Committee spent a day and a half examining the accomplishments and directions of the department. The meeting began with a departmental overview given by Kathy McKeown and Al Aho, followed by presentations from Dean Galil and President Bollinger. The Committee then heard from the research groups, PhD students, MS students and undergraduates. At the end of the review, the Committee issued its report. They gave us excellent marks on the progress we have made in advancing the department,

citing our strong research programs, excellence in hiring, and our focused strategic planning. The committee made suggestions on how we can improve our educational program and we have already instituted one of these recommendations by electing Al Aho to the position of Vice Chair of Undergraduate Education. We are actively working on implementing other suggestions such as curriculum reform.

Columbia Computer Science at the RoboCup American Open

Professor Elizabeth Sklar brought three teams to participate in the RoboCup American Open, held earlier this month at Carnegie Mellon University.

The "Metrobots" (shown on the right) entered the Four-Legged League, which is dedicated to programming a group of Sony AIBO robots to play soccer.

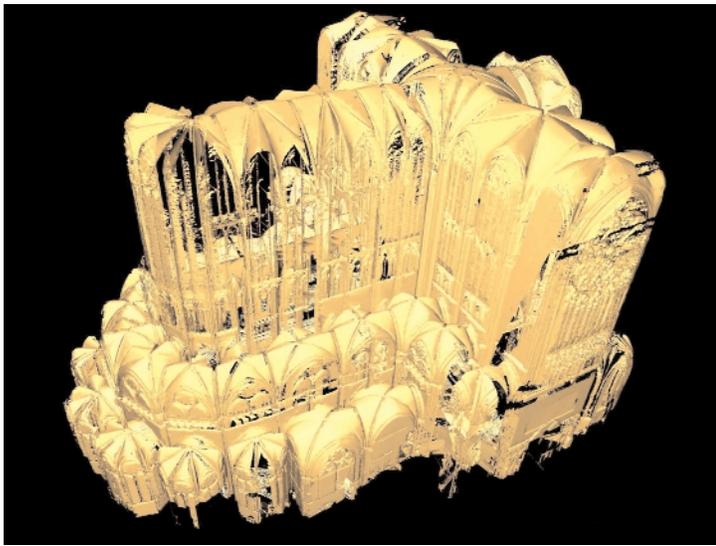
Professor Sklar and her students are using the Sony AIBO robots to experiment with embodied agents, multi-agent coordination and various forms of machine learning, including evolutionary computation. One of the biggest problems encountered for most teams in the Four-Legged League is calibration. The AIBO is equipped with a digital video camera in its head piece, which captures raw imaging data in YUV format. Algorithms which perform localization (knowing where the robot is on the soccer field) and object recognition (knowing which object is the ball) are highly sensitive to the accuracy

of the imaging information, which in turn is greatly affected by subtle changes in lighting conditions. Sklar and her students have been working on various ways to perform calibration quickly and easily before and during a soccer game.

Throughout the summer, the Metrobots will continue to work on the calibration and localization problems, integrating evolutionary learning to the manual methods they have developed this Spring. In July, all three Columbia-affiliated teams will participate in the Seventh International RoboCup, being held in Padova, Italy.

Metrobots is a joint effort with Professor Simon Parsons of the City University of New York (CUNY) and Professor Michael Littman of Rutgers University. The team includes CS PhD student Vannesa Frias-Martinez and CS alumnus Marek Marcinkiewicz ('02), currently a CUNY PhD student.





Professor Peter Allen's research team created this digital model of the Cathedral of Saint-Pierre

New Methods for Digital Modeling of Historic Sites Using Range and Image Data

Preserving cultural heritage and historic sites is an important problem. These sites are subject to erosion, vandalism, and as long-lived artifacts, they have gone through many phases of construction, damage and repair.

It is important to keep an accurate record of these sites using 3-D model building technology as they currently are, so preservationists can track changes, foresee structural problems, and allow a wider audience to "virtually" see and tour these sites. Due to the complexity of these sites, building 3-D models is time consuming and difficult, usually involving much manual effort. A research team headed by Professor Peter Allen and funded by the National

Science Foundation has begun to develop new tools to automate the modeling process. One of the testbeds for the research is the Cathedral of Saint-Pierre in Beauvais, France which is an endangered structure that is currently on the World Monuments Fund's Most Endangered List. Professor Allen's group has used laser range sensors to model the Cathedral, amassing over 100 million points of data. These new modeling methods utilize range image segmentation and feature extraction algorithms that can automatically register individual range scans, placing the scans in the same frame of reference. The methods can be extended to automate the texture mapping process as well, to create both geometric and photometric realistic models. The image to the left is a model generated from 120 range scans of the Cathedral's interior shell as seen from the outside.

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