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CMRR Report
Center for Magnetic Recording Research

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CMRR Welcomes New Faculty Member

Dr. Sungho Jin, a world-renowned researcher in the field of functional materials used in applications ranging from magnetic and electronic devices to optical telecommunications networks, has recently taken residence at CMRR. Dr. Jin's professional experience spans both industry and academia. He received his Ph.D. degree in materials science and engineering from the University of California, Berkeley in 1974. After two years of research at Lawrence Berkeley Laboratory, he joined Bell Laboratories at Murray Hill, New Jersey in 1976. He carried out research at Bell Labs for 26 years, first as a member of the technical staff, and later as a Technical Manager of the Applied Materials and Thin Film Metallurgy Research Group. He joined the University of California, San Diego in July 2002 as a Professor of Materials Science and is the first holder of the Kazuo Iwama Endowed Chair. He is currently serving as Director of the UCSD Materials Science and Engineering Program.

SUNGHO JIN

Dr. Jin's research interests include micro-electro-mechanical-system (MEMS) devices and materials; exploratory biomaterials and devices; carbon nanotube materials on which future nano-scale devices can be based; and sensor/actuator devices and technologies. Dr. Jin has also been a pioneer in the development of high-temperature superconductor materials, colossal magnetoresistance (CMR) materials, diamond film thinning techniques, and anisotropic conductive polymers. Dr. Jin has authored over 230 papers that have been cited over 5000 times in the SCI citation index. He has given more than 90 invited talks at various materials-related technical meetings, and has 180 U.S. patents issued or pending. In 1989, Business Week magazine selected him as one of the Top Ten Innovative Scientists in the country. He is a member of the U.S. National Academy of Engineering (elected in 1999), a Fellow of the American Physical Society (2003), and a Fellow of the American Society for Metals (1994). In 2000, he was elected to the

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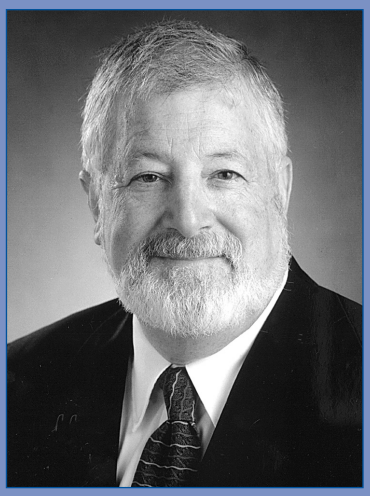
Professor Neal Bertram Retires

Having enjoyed a distinguished career in the private sector and twenty years as an Endowed Chair Professor at CMRR, Neal Bertram has announced his plans to retire following the Fall Quarter 2004. Fortunately, Neal will remain closely affiliated with CMRR as a UCSD Research Professor. He will continue to participate actively in CMRR research efforts and technical programs, spending a week or two each month at the Center.

Neal received his B.A. from Reed College in Portland, Oregon in 1963 and his Ph.D. in Physics in 1968 from Harvard University in Cambridge, Massachusetts. From 1968 to 1984, the Ampex Corporation in Redwood City, California employed him as a member of the research department. At first, his research focused on magnetization reversal and general properties of particulate magnetic media. He developed models of the AC-biased recording process, generalized reciprocity, and saturation in write-transducers. He engaged in a variety of experimental studies of magnetic tape recording, focusing on high-density signals and noise. Later he became involved in experimental studies of thin film disc media and the design of high frequency write pole tips.



In 2003, Neal Bertram was awarded the IEEE Reynold B. Johnson Information Storage Award.

In 1985, Neal joined the University of California at San Diego as an Endowed Chair Professor in the Electrical and Computer Engineering Department associated with the (then) newly created Center for Magnetic Recording Research. At UCSD, he directed a research program in the physics of magnetic recording, including studies of polycrystalline thin film media, write and read transducers, fine particle tape systems and general analyses of ultimate limits in ultra high density recording. Specific studies involved high-speed dynamic magnetization reversal, and effects of thermal excitation and fundamentals of dynamic relaxation. In these areas, his Ph.D. students engaged in both experimental and theoretical studies of basic issues in high-density magnetic recording, including noise phenomena, nonlinearities, dynamic processes, thermally induced relaxation and large-scale numerical simulations of high-density magnetic recording. Neal has created graduate courses in magnetic recording theory, analysis of recording materials, and magnetic recording measurements. As an Endowed Chair Professor at CMRR, he has been principle advisor to over twenty Ph.D. students.

During his career, Neal has received many awards and accolades. In 1986, he was an IEEE Distinguished Lecturer and in 1987 he was named an IEEE Fellow. In 1999, he received the annual technical achievement award from the Information Storage Industry Consortium (INSIC).

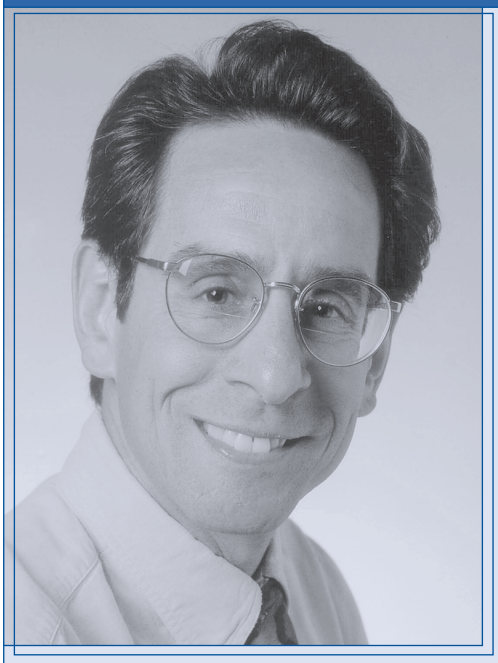
In 2003, Neal was awarded the IEEE Reynold B. Johnson Information Storage Award. This prize is awarded each year for outstanding contributions in the field of information storage, with emphasis on computer storage. Neal was commended "for fundamental and pioneering contributions to magnetic recording physics research, applications and education." In 1994, Neal published his widely acclaimed book entitled *Theory of Magnetic Recording* (Cambridge University Press, March 1994), which is used in graduate courses throughout the world.

New Faculty *continued from page 1*

rank of 100-living-member fellows of The Minerals, Metals and Materials Society (TMS). He is a member of the TMS Board of Directors, currently serving as the chair of the Electronic, Magnetic, and Photonic Materials Division. He is the current Principal Editor of Journal of Materials Research and Associate Editor of Materials Science and Engineering:B.

Dr. Jin can be reached at 858-534-6563 or via email at sujin@ucsd.edu

FROM THE DIRECTOR



These are exciting times for those of us working on advanced data storage technology and systems. The cycle of "revolution and evolution" continues in all of the component disciplines that are integrated into the remarkable magnetic recording devices that almost invisibly support the world's information infrastructure, and that lie at the heart of fascinating new consumer products and services such as the iPod® portable music system and the TiVo® home media system. These storage systems represent nanotechnology, brought to life. The same holds for optical recording and computer memory systems.

CMRR, renowned for its interdisciplinary approach to research and education, intends to remain a key contributor to this continuing miracle of progress in storage technology and its applications. The success of our approach is founded upon the technical strength and creativity of the Center's faculty, researchers, and students, qualities once again underscored in this issue of the CMRR Report.

CMRR and, more generally, the UCSD campus are committed to maintaining – indeed, expanding – our academic strength in areas vital to continued "revolution and evolution" in information storage. Prof. Sungho Jin has joined the CMRR faculty and will provide leadership for our magnetic materials and nanotechnology efforts (see article on page 1). Also, as one of our beloved and distinguished faculty members, Prof. Neal Bertram, transitions to the position of Research Professor (see article on page 2), the Center is undertaking an aggressive search for one or two new faculty members who, together with the other members of the "CMRR family," will preserve our tradition of excellence, relevance, and vision in data storage research.

Paul H. Siegel

— Paul H. Siegel, Director

Sheldon Schultz Prize Endowment

The Sheldon Schultz Prize for Excellence in Graduate Student Research was established in 2003 to recognize CMRR graduate students who have distinguished themselves through the creativity of their research and the impact of their publications.

The Prize is named in honor of former CMRR Director, Sheldon Schultz, who skillfully guided the Center from November 1990 through August 2000. The first Schultz Prizes were awarded at the 20th Anniversary Celebration dinner May 6, 2003.

The selection of the recipient is based upon the recommendation of a committee consisting of CMRR faculty members, with input from selected experts in information storage technology. CMRR's goal is to endow the Prize so it can be awarded annually and in perpetuity.

Those interested in making a donation of any amount to the Schultz Prize will help move us closer to the endowment target of $50,000. Checks should be made payable to "UC San Diego Foundation" with a notation on the check or a brief cover letter designating the contribution for the "Schultz Prize." Donations are100% tax-deductible, and an official acknowledgement of contributions will be provided. All correspondence pertaining to the Prize can be directed to:

Professor Paul H. Siegel, Director
Center for Magnetic
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University of California, San Diego
9500 Gilman Drive, 0401
La Jolla, CA 92093-0401

A Tensor-Product Parity Code for Magnetic Recording

I. Introduction

An error-correcting code is usually employed in magnetic recording to ensure data reliability. Reed-Solomon (RS) codes are, by far, the most commonly used for this purpose. Since the RS code is a symbol-based code, it is suitable to correct burst, but not random, errors. To help in correcting random errors, the RS code is often concatenated with an inner parity code.

To limit the rate penalty, practical applications often use high rate parity codes with a block length on the order of 30 to 100 bits. For such a large block length, there is a high probability that the code will miscorrect, and hence propagate, errors. It is also likely that multiple error events will occur within one block and therefore go undetected by the code.

In order to overcome these deficiencies, we propose the use of a "tensor-product parity code" whose parity-check matrix is the tensor-product of the parity-check matrices of a short parity code and a BCH code. This code achieves the same performance as the constituent parity code, but with higher rate.

II. Tensor-Product Parity Code System

Let C_1 be a single parity code with block length k_1+1 and let C_2 be an (n_2, k_2) binary linear code. Let $H_2 = [h_{i,j}]$ be a parity-check matrix of C_2. We define C to be the code with the following parity-check matrix:

$$H = \begin{bmatrix} h_{1,1}K & h_{1,2}K & \cdots & h_{1,n_2}K \\ h_{2,1}K & h_{2,2}K & \cdots & h_{2,n_2}K \\ \vdots & \vdots & \ddots & \vdots \\ h_{n_2-k_2,1}K & h_{n_2-k_2,2}K & \cdots & h_{n_2-k_2,n_2}K \end{bmatrix},$$

where $K = [1\ 1\ \ldots\ 1]$ is a row vector of size k_1. The code C has the following property. Suppose we divide a code word of C into disjoint blocks of length k_1, and compute the parity bits for each block using C_1. The parity bits of all blocks must form a valid code word of C_2.

The code C is a special case of a tensor-product code [1]. We therefore refer to C as a *tensor-product parity code*. This code can be easily generalized to the case where C_1 is a multiple parity code. The message length k_1 of C_1 is called the *block size* of C.

The tensor-product parity code can be concatenated with an RS code C_3, but we will, instead, combine the codes by taking their common subspace. In a slight abuse of terminology, we will call C_2 the *inner code* and C_3 the *outer code*.

An optimal sequence decoder for a parity-coded system is a Viterbi detector that combines channel states and code states [2]. The decoder ensures that the states at the parity block boundary satisfy the parity constraint. Since the correct parity is not known in advance, decoding of the tensor-product parity-coded system begins with detection of the recorded bits using the Viterbi algorithm matched to the channel only. Then, the detected word is divided into disjoint blocks of length k_1, and the parity of each block is computed to form a word w. From the property of C, the word w must be a code word of C_2. We decode w using C_2 and the corrected parity bits are provided to a Viterbi detector reflecting channel states and parity code states. Finally, the resulting sequence is decoded by the outer decoder.

III. Performance Comparison

Consider the (468,410) RS code over GF(1024). This code has 580-bit redundancy and can correct 29 symbol errors. To construct a tensor-product parity code system with a similar code rate, we choose the codes C_1, C_2, C_3 as follows. Fix C_1 to be the single parity code with $k_1 = 10$. Let C_3 be a $(468, k_3)$ RS code and choose C_2 to be a $(468, k_2)$ binary BCH code such that the total redundancy $10(468-k_3) + 468 - k_2$ is close to 580 bits. To find optimal values of k_2 and k_3, we simulate the tensor-product parity code system using the Lorentzian model with normalized pulse width PW50 = 3.0 and additive white Gaussian noise. The equalizer is a 12-tap finite-impulse-response filter with a length-5 partial response target. The sector error rate (SER) is estimated by an analytical method based on a block multinomial model [3]. At the signal-to-noise ratio (SNR) of 20 dB, optimal parameters are $k_2 = 225$ and $k_3 = 434$, which gives SER = 10^{-10}.

Next we vary the block size k_1 and find optimal code parameters using the same technique. The SER as a function of block size is plotted in Fig. 1. For comparison, we also plot the SER of the concatenation of a single parity code and an RS code, whose total redundancy is approximately 580 bits. For the concatenation system, a high-rate parity code is preferred since a low-rate parity code only allows a weak RS code. In contrast, the tensor-product parity code system gives lower SER when it has a smaller block size. When the block size is large, the SER is comparable to the concatenation system since the best inner code C_2 is the trivial code with one code word.

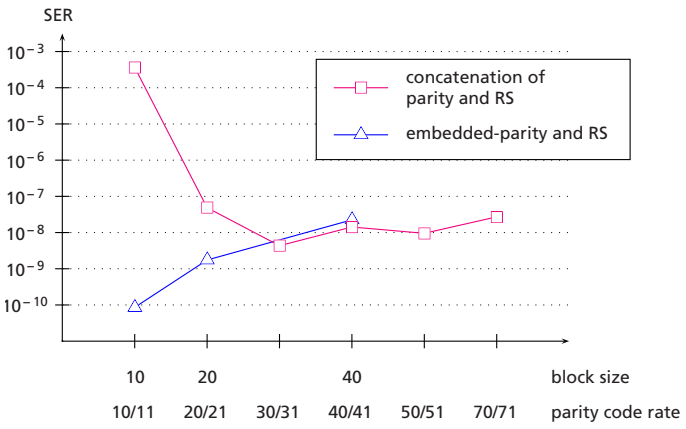


Fig. 1. Sector error rates at SNR = 20 dB of the tensor-product parity code system and the concatenation of a parity code with an RS code. The block size of the tensor-product parity code is varied from 10 to 40. For the concatenation system, the rate of the parity code is varied from 10/11 to 70/71.

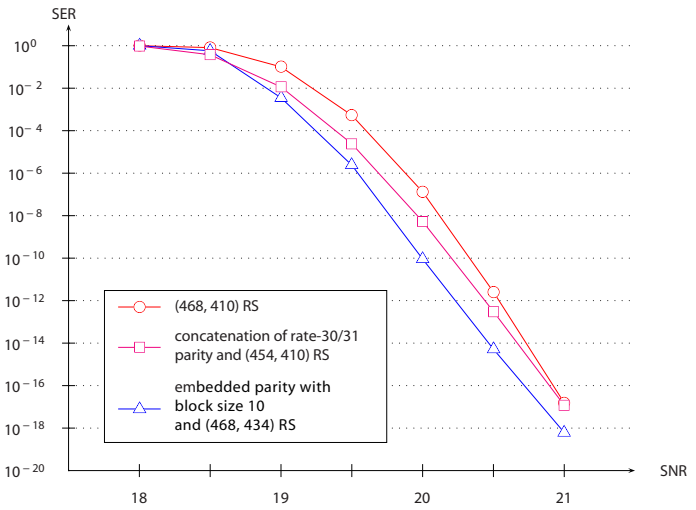


Fig. 2. Sector error rates of the (468,410) RS code, the concatenation of the rate-30/31 parity code and the (454,410) RS code, and the tensor-product parity code system with block size 10, (468,225) inner BCH code, and (468,434) outer RS code.

Finally, we select the best parameters for the concatenation system and the tensor-product parity code system and compare their performance to that of the (468,410) RS code. The SER of the three systems are shown in Fig. 2. We see that the tensor-product parity system has a gain of approximately 0.3 dB over the RS code and almost 0.2 dB over the concatenation system at SER = 10^{-10}.

[1] J. K. Wolf, "On codes derivable from the tensor product of check matrices," *IEEE Trans. Inform. Theory*, vol. IT-11, no. 2, pp. 281-284, Apr. 1965.
[2] Z. Wu, P. A. McEwen, K. K. Fitzpatrick, and J. M. Cioffi, "Interleaved parity check codes and reduced complexity detection," in *Proc. ICC 1999*, Vancouver, BC, pp. 1648-1652.
[3] Z. A. Keirn, V. Y. Krachkovsky, E. F. Haratsch, and H. Burger, "Use of redundant bits for magnetic recording: single-parity codes and Reed-Solomon error-correcting code," *IEEE Trans. Magn.*, vol. 40, no. 1, pp. 225-230, Jan. 2004.

For more information contact Panu Chaichanavong: pchaichanavong@ucsd.edu, Paul Siegel: psiegel@ucsd.edu

CMRR Research Reviews

CMRR hosted forty-five people from the CMRR Industrial Sponsor companies and other invited guests at the semi-annual Research Review and Advisory Council meeting on May 5-6, 2004. The two-day review highlighted the work of CMRR faculty, researchers, and graduate students. Professor Sungho Jin from the MAE Department at the University of California, San Diego gave a Special Session presentation entitled "Nano Materials and Structures for Potential Magnetic Applications."

CMRR Sponsor company employees may access the abstracts and viewgraphs of the Research Review presentations on the CMRR website in the Sponsor Resources section at http://cmrr.ucsd.edu/sponsors/subpgset.htm.

The Fall 2004 Research Review will be held on October 20-21, 2004. The special session on October 20th will feature a presentation by Professor Deli Wang entitled, "Semiconductor Nanostructures for Information Storage." For further information on the Fall Review please contact Betty Manoulian at 858-534-6707 or bmanoulian@ucsd.edu .

2004 Schultz Prize

On June 23, 2004, CMRR honored the recipients of the Annual Sheldon Schultz Prize for Excellence in Graduate Student Research. The Schultz Prize is presented in recognition of CMRR graduate students who have distinguished themselves through the creativity of their research and the impact of their publications. This was the second year the award, named in honor of former CMRR director Sheldon Schultz, was bestowed. CMRR students Brian Kurkoski and Marcus Marrow were chosen this year based upon recommendations from CMRR faculty members, Associate Director Gordon Hughes, and selected individuals from the storage technology sector.

The Schultz Prize is presented in recognition of CMRR graduate students who have distinguished themselves through the creativity of their research and the impact of their publications.

LEFT TO RIGHT: JACK WOLF, NEAL BERTRAM, MARCUS MARROW, BRIAN KURKOSKI, SHELDON SCHULTZ, PAUL SIEGEL

Brian Kurkoski, a graduate student of Professors Paul Siegel and Jack Wolf since 1999, received his Ph.D. in June 2004. His thesis entitled "Algorithms and Schedules for Turbo Equalization" considered algorithmic aspects of turbo equalization in magnetic recording. His dissertation also considered decoding on the erasure channel, which can be applied to hard disk systems such as RAID. After graduation, Brian will continue his work at the University of Electro-Communications in Tokyo as a postdoctoral fellow.

Marcus Marrow, a graduate student of Professor Jack Wolf's, was recently awarded a Ph.D. for his thesis entitled "Detection and Modeling of 2-dimensional Signals." As a CMRR student Marcus worked on five distinct topics. He created 2-dimensional data models for holographic storage. He worked on various kinds of codes, such as 2-dimensional constrained codes and error correction codes. He has submitted a patent application for his work to unscramble 2-dimenisonal intersymbol interference. He has also worked with CMRR graduate student Michael Cheng (Ph.D., 2004) on an INSIC project to implement an extremely fast computer simulation for high-density perpendicular magnetic recording. This past year Marcus worked with CMRR Professor Neal Bertram modeling DC noise in thin film media. Since graduation, Marcus has joined Link-A-Media Devices Corporation, in Santa Clara, California.

Lake Arrowhead Conference

The 24th Annual Information Storage Interactive Workshop will be held December 5-8, 2004 at the Lake Arrowhead Conference Center east of Los Angeles, chaired by Gordon Hughes, CMRR Associate Director. A small group of about twenty technologists is invited to discuss their current work.

The workshop opens with a tutorial talk on "Flying Below 7nm Magnetic Spacing - A Discussion On The Smallest Achievable Spacing And The Necessary Developments In Metrology, Sealed Drives, Ultra-Low-Mass Sliders, Vapor Phase Lubricants, And Contact Recording."

Workshop sessions are planned on high density recording issues, especially perpendicular, alternative recording technology, spin torque switching of magnetic materials, and new particulate recording materials

The 24th Annual Information Storage Interactive Workshop will be held December 5-8.

Recent Gifts, Grants, Awards, and Internships

The Information Storage Industry Consortium (INSIC) has recently funded the following CMRR projects under INSIC'S Program in Advanced Magnetic Tape Storage Technology.

Fred Spada received funding for the project "Contribution of Electrochemical Processes to Increased Head-Media Spacing in Tape Drives." This program explores the possibility that electrochemical mechanisms may play some role in producing undesired spacing loss between the tape and head in tape drive systems. The electrochemical focus is the primary feature of this program that distinguishes it from other studies of tape head wear and pole tip/shield recessing (PTR).

Professor Frank Talke will direct a project involving the "Investigation of High Frequency Lateral Tape Motion."

Ismail Demirkan, a doctoral student in Prof. Jack Wolf's group, reflected on his summer internship at Hitachi Global Storage Technologies, where he worked with Dr. Yuan Xing Lee on the design of modulation codes for perpendicular recording channels. Ismail stated: "This work was basically about combining multiple modulation constraints into one code in a practical way. We investigated the capacity of the combined constraints that would be implemented in the codes. A combined constraint inherits all properties from its constituent constraints. Because of this, the optimization of code parameters is a difficult problem. There was also the requirement that the coding rate should not be less than 0.95. This forced us to work on searching for good codes with rates in a small gap between 0.95 and the capacity of the constraint. Another design criterion was that the code should be block decodable and that the encoder should have only a few states. Fortunately, we developed a design strategy that let us achieve most of the requirements. This experience was very exciting and beneficial to me."

Maik Duwensee spent the summer as an intern at Hitachi Global Storage Technologies under the direction of Bernhard Knigge and Peter Baumgart in the Head/Disk Interface group. Maik programmed several data acquisition devices to investigate the effects of parameter changes on the dynamics of the HDI. The effect of different lubes, micro waviness, sliders and disks were investigated. He also focused on electrostatic and electrodynamic effects at the head/disk interface.

Aravind Murthy from Professor Frank Talke's group worked as a co-op at Hitachi Global Storage Technologies during the summer of 2004. He worked under the guidance of Dr. Bert Feliss, Dr. Donald Gillis and Dr. Reinhard Wolter. His research focused on various effects of shock in hard disk drives. He measured the out of plane motion of the actuator arm, head-suspension assembly and disk in various drives subject to linear shock. A Laser Doppler Vibrometer (LDV) was used to measure the displacement and frequencies of vibrations. Currently, he is working on finite element modeling to simulate shock in hard disk drives.

Graduate Degrees Awarded

Michael Cheng, a member of Professor Paul Siegel's group since the Fall of 1998, received his Ph.D. in June 2004. His thesis, entitled "Algebraic Soft-Decision Reed-Solomon Decoding Techniques for High-Density Magnetic Recording," explored modern algebraic decoding algorithms for error-correcting codes used in current read-channel architectures. He also worked together with Marcus Marrow on noise modeling for perpendicular recording. During his graduate studies, Mike has learned much from being around very knowledgeable people of all areas at CMRR and made many good friends at UCSD. He is also thankful for the financial support provided by INSIC. Mike has moved from one information and coding theory mecca to another by joining the Communications Systems and Research group at the Jet Propulsion Laboratory in Pasadena, California, where he is now working on high-speed laser communication from Mars.

Saurabh Deoras came to the United States after completing his bachelor's education at the Indian Institute of Technology, Bombay, India. He has been a graduate student at CMRR for the last five years in Professor Frank Talke's group. He recently completed his Ph.D. thesis entitled "Investigation of Slider Dynamics and Tribology of Head-Disk Interface." When not in the lab, Saurabh enjoys photography and traveling.

Prajakta Gudadhe joined Dr. Gordon Hughes' group in September 2002 after completing her bachelor's degree from Birla Institute of Technology and Science, Pilani, India. She recently completed her Master's thesis entitled "Analysis of Disk Drives and Storage Interfaces for Data Security and Performance of Disk Subsystems." She has enjoyed her two-year stay both at CMRR and La Jolla and has recently accepted a position at Maxtor in Milpitas, California.

Brian M. Kurkoski, a student of Professors Paul Siegel and Jack Wolf since 1999, received his Ph.D. in June 2004. His dissertation, entitled "Algorithms and Schedules for Turbo Equalization," considered algorithmic aspects of turbo equalization in magnetic recording and decoding of convolutional codes on the erasure channel. Brian was co-recipient of the 2004 Schultz Prize for Excellence in Graduate Student Research. Following graduation, Brian accepted a postdoctoral position at the University of Electro-Communications in Tokyo, working with Professor Kingo Kobayashi and Professor Kazuhiko Yamaguchi, under a postdoctoral fellowship from the Japan Society for the Promotion of Science (JSPS), in cooperation with the National Science Foundation.

Marcus Marrow, a student in Professor Jack Wolf's group since September 1999, received his Ph.D. in June 2004. His thesis was entitled "Detection and Modeling of 2-Dimensional Signals." In June 2004, he was awarded the Schultz Prize for Excellence in Graduate Student Research. Marcus's research interests are in digital communications, coding, and signal processing for communications and storage. Marcus is currently a systems architect at Link- A- Media Devices in Santa Clara.

Bogdan Valcu, a native of Romania, joined Neal Bertram's group in September 1999. He studied several aspects of the perpendicular magnetic recording system, leading to his Ph.D. in Physics in June 2004. Bogdan is currently working at Seagate in Fremont, California. Outside academia, Bogdan is interested in foreign languages. He speaks French and at UCSD he enjoyed taking Japanese classes. He is thankful to CMRR for the opportunity he had to visit Japan during an internship at Hitachi in 2001. In addition, Bogdan strives to become a better soccer player; he will always remember the Saturday afternoons at the on-campus Canyon Vista soccer field.

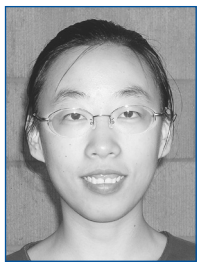
CMRR WELCOMES NEW RESEARCHERS

Ralf Brunner has returned to CMRR as a graduate student in Professor Frank Talke's lab. His research will focus on carbon nanotubes and nanotechnology. Ralf originally came to CMRR in March 2003 as a graduate student from the Technical University of Ilmena, Germany. Prior to that he held several internships at different companies and institutions to gain experience. He worked at Electro Optical Systems, in Munich, with laser sintering machines and CO_2 lasers. He has also worked at the Federal Institute for Materials Research and Testing in Berlin in Professor Santner's tribology group. During his free time, Ralf enjoys badminton, surfing, and playing the guitar.

Hamedtoolloei Hamidreza is an undergraduate student working on his B.S. in computer science and engineering. His research with Fred Spada focuses on erasing data on magnetic media. Hamed comes to us from Tehran, Iran by way of Berkeley, California where he attended community college before completing an internship at the Lawrence Berkeley National Laboratories. At LBNL he worked with Professor Paul Ridgeway on measuring physical properties of moving paper. Hamed enjoys tennis, swimming, and reading fiction.

Junsheng Han is a graduate student in Professor Paul Siegel's group. His research interests include network coding and fountain codes. Junsheng received his B.S. from Tsinghua University, Beijing, China, in automation, and his M.S. in electrical engineering from the Ohio State University, Columbus, Ohio. Before joining UCSD he was employed at Ericsson Wireless Communications, Inc. in San Diego. Outside of the lab, Junsheng has interests in many sports, such as badminton, tennis, soccer, volleyball, and ping-pong. He would like one day to ride a surfboard given he lives in San Diego but plans on enrolling in swim classes first. He also wishes he will be able to play his guitar soon.

Zeinab Taghavi-Nasrabadi began her Ph.D. at UCSD in September 2003 and has been co-advised by Professors Siegel and Wolf since July 2004. Her area of research is 2-dimensional constrained codes with applications in magnetic recording and holography. She received her B.S. and M.S. degrees at Sharif University of Technology, Tehran, Iran, in Electrical Engineering/Communications, in 2001 and 2003, respectively. In her spare time, she enjoys watching movies, reading, and sports.



Zheng Wu was born in Jiangsu Province in China. She has worked as a doctoral student of Professor Wolf and Professor Siegel since the Spring Quarter of 2004. Her current interest areas are LDPC codes and iterative decoding. Zheng received her B.S. and M.S. degrees in Electrical Engineering from Tsinghua University, Beijing, China. Outside of school Zheng enjoys badminton and traveling.

POSTDOCS

Kishore Sreenivasan has joined the laboratory of Professor Ami Berkowitz as a Postgraduate Researcher. His research activities at CMRR will focus on optimization of chemical synthesis routes for the preparation of pure metal oxide nanoparticles and coated metal nanoparticles and their characterization for fundamental studies as well as device applications. Dr. Sreenivasan holds a Doctorate degree in Physics from the Indian Institute of Technology, Madras, India, specializing in experimental magnetism and magnetic materials. Subsequent to completion of his Ph.D. in 1998, he served as Staff Scientist at the Electronic Materials Laboratories of the Ministry of Information Technology, Government of India. He was then associated with the Department of Physics, Pennsylvania State University as Postdoctoral Researcher. His fields of research interest include experimental magnetism and magnetic materials, magnetism in intermetallics and nanomaterials, crystalline electric field effects in intermetallics, hydrogen storage properties of intermetallics and nanomaterials, and effects of hydrogen on the magnetic properties of materials.

Lizhi Su joined Professor Talke's lab as a Postgraduate Researcher in April 2004. His research at CMRR will focus on magnetic recording tribology. Lizhi received his B.S. and M.S. degrees in Material Science and Engineering from Zhejiang University in Hangzhou, China. In 2003, Lizhi completed his Ph.D. in Mechanical Engineering at Tohoku University in Sendai, Japan, where he worked as a postdoctoral researcher for a year before coming to CMRR. His research interests are in the area of tribology and mechatronics of the head/disk interface of hard disk drives. Specifically, Lizhi is interested in the friction control between a head-slider and a disk using MEMS sensors and actuators. Out of the laboratory Lizhi enjoys listening to music and plans to earn his amateur ham radio license.

VISITING SCHOLARS

Mo Chung is a visiting scholar on a three-year sabbatical from Yeungnam University, Korea where he is a professor in the Department of Mechanical Engineering. Mo completed his B.S. and M.S. degrees from Seoul National University in 1980 and 1982. In 1990, he received his Ph.D. in mechanical engineering from UCLA. His major fields are heat and mass transfer, fluid mechanics, and applied mathematics. He worked several years as a researcher at Hyundai Motor Company and the Korean Institute of Energy Research. Mo is a part of Professor Talke's group where he is working on analytical and/or numerical solutions of partial differential equations involving lubrication and media dynamics and heat transfer related topics. Whenever he feels a headache coming on from these math problems, he likes to take a look at his colleague's experiments to satisfy his own curiosity on newly developing high-techs such as nanotechnology. Mo is joined by his wife, his daughter (who is a newly enrolled student at UCSD) and a son in high school. As a tennis buff he translated Vic Braden's "Tennis 2000," an international best selling instruction book, into Korean. He also enjoys traveling, especially to national parks in the West.

Graduate Students & Researchers Near Completion

STUDENT	LEVEL	ADVISOR	DEPT	RESEARCH INTEREST	COMPLETION DATE
Jiangxin Chen	Ph.D.	Siegel	ECE	Constrained codes, channel capacity bounds, two-dimensional channels	December 2004
Joseph Soriaga	Ph.D.	Siegel	ECE	Channel capacity calculation, graph-based codes, iterative decoding	December 2004
Marvin Balaoro	M.Sc.	Talke	MAE	Air bearing optimization using the genetic algorithm	December 2004
Ryan Taylor	Ph.D.	Talke	MAE	High frequency lateral tape motion in magnetic tape guiding systems	March 2005
Jason Wang	Ph.D.	Talke	MAE	Tape edge wear	March 2005
Jiadong Zhang	Ph.D.	Talke	MAE	Air bearing slider modeling simulation and optimization	December 2004

CMRR Information Center Offers Resources on Storage Technology

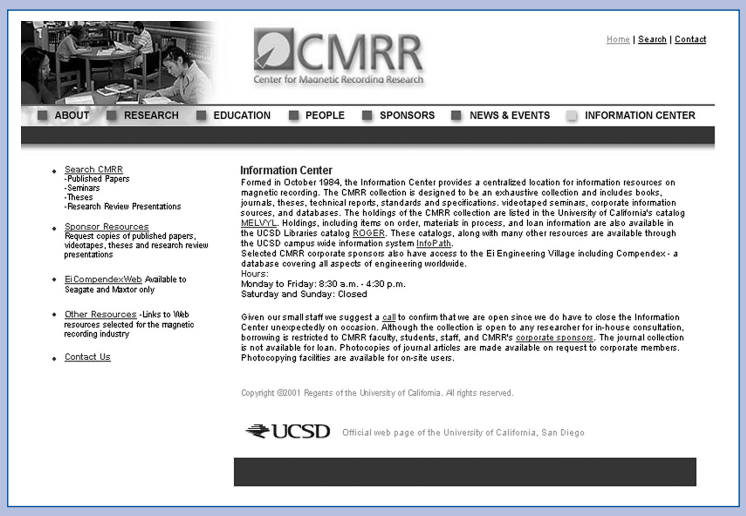
Many of you may not be aware that CMRR has an Information Center/ Library. Formed in October 1984, it provides a centralized location for information resources on storage technology. The collection includes books, journals, theses, technical reports, standards and specifications, and databases. While the collection is open to any researcher for in-house consultation, more specialized services are only available to members of the sponsoring companies of CMRR. These services include:

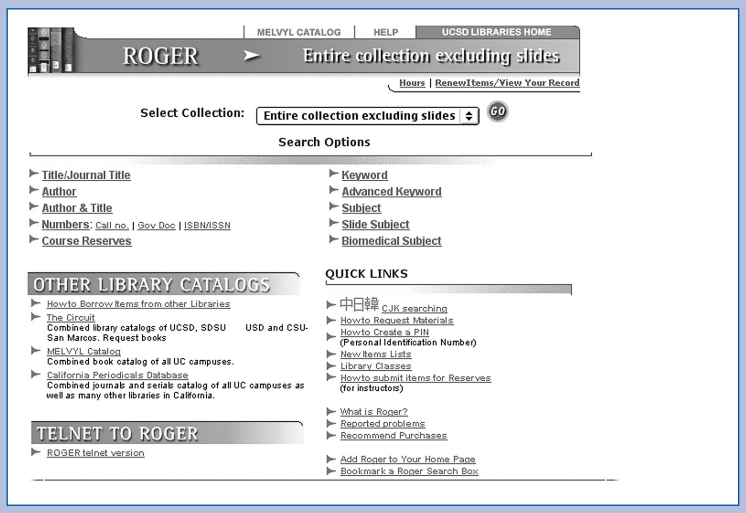
- Photocopies of journal articles
- Loan of books
- Loan or purchase of DVDs of the CMRR weekly seminar series and the monthly lecture series sponsored by the IEEE Magnetics Society.
- Copies of theses, from CMRR as well as from other institutions
- Copies of patents
- Copies of industry standards
- Searches of commercial databases such as INSPEC, Chemical Abstracts, Compendex, World Patents Index, etc. These searches can be done as a one-time retrospective search covering any period of time from approximately 1970 to date. A search profile can also be established to track an area of interest and results will be emailed on a monthly basis.

Requests can be made via telephone, fax, email, or via our Web site at **http://cmrr.ucsd.edu/icenter/**. Please note that while the searchable database of all CMRR seminars, Research Review presentations, and student theses is publicly accessible from our Web site, a more full-featured search including full abstracts and links to PowerPoint presentations and where available a link to a streaming video file is only available to members of CMRR sponsoring companies. An on-line ordering function is also available to members of CMRR sponsoring companies via the password-protected Web page. You can register to receive the password at the site.

The holdings of the CMRR collection are listed in the UCSD Libraries on-line catalog ROGER, **http://roger.ucsd.edu/** . After searching by any of the available indexes – author, title, keyword, subject, or call number, you can restrict your results with the "Limit this Search" function found at the bottom of the screen and then indicating "cmrr" in the "Where Item is located" search box, again located near the bottom of the screen.

The Information Center is open Monday to Friday: 8:30 a.m. - 4:30 p.m. and closed Saturday and Sunday. Given our small staff we suggest a call to confirm that staff are available to assist you, should you be planning to visit in person.





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DIMACS Workshop on Advances in Information Recording

A working group and a workshop on Advances in Information Recording were held this past March at the Center for Discrete Mathematics and Theoretical Computer Science (DIMACS) located at Rutgers University, Piscataway, New Jersey. Co-organizers of the meetings were Dr. Emina Soljanin and Dr. Adriaan van Wijngaarden of Bell Laboratories, Prof. Bane Vasic of the University of Arizona at Tucson, and CMRR Director Paul Siegel. The meetings were part of a series of workshops organized as part of a multi-year "Special Focus on Computational Information Theory and Coding" at DIMACS, a program funded by the National Science Foundation.

The meetings brought together experts from academia and industry with wide-ranging backgrounds and interests relevant to present and future information recording technologies. The sessions comprised 21 invited seminars on a variety of topics, including macro-molecular data storage, efficient storage of genomic data, highly-parallel scanning-probe storage technology, two-dimensional optical recording, information-theoretic limits on storage capacity, constrained coding techniques for one- and two-dimensional recording, and iterative algorithms for timing recovery and error-correction. The week-long meetings concluded with a very entertaining, but serious, presentation entitled "ET Might Write Not Radiate," which proposed that initial contact by extraterrestrial civilizations may be more likely to occur through information recorded on a physical storage device - sort of a space-age "message in a bottle" – rather than by means of electromagnetic communication!

More information on the meetings, including programs and seminar abstracts, can be found at http://dimacs.rutgers.edu/Workshops/Storage_WG/ and http://dimacs.rutgers.edu/Workshops/Storage. The viewgraphs of the presentations are available at http://cm.bell-labs.com/cm/ms/events/WGIR04 and http://cm.bell-labs.com/cm/ms/events/WSIR04, respectively. Proceedings of the workshop will be published as part of the American Mathematical Society (AMS) DIMACS Volumes.

CMRR Report
Center for Magnetic Recording Research

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