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CMRR Report
Center for Magnetic Recording Research

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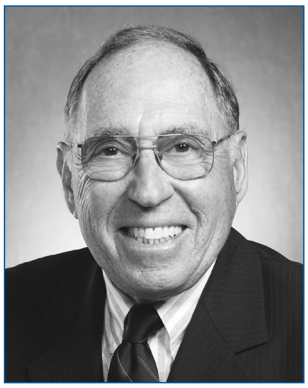
CMRR Professors Receive Awards



JACK WOLF

Jack Keil Wolf, the Stephen O. Rice Professor of Electrical and Computer Engineering at UCSD and CMRR endowed chair, has been selected by the Institute of Electrical and Electronics Engineers (IEEE) to receive the 2004 Richard W. Hamming Medal. This prestigious award is named in honor of Dr. Richard W. Hamming, who played a central role in the development of computers and computing science, and whose many significant contributions in the area of information science include the

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CMRR Welcomes New Sponsors

CMRR is pleased to welcome two new corporate sponsors, Toshiba Corporation and Marvell Semiconductor, Incorporated.

Toshiba, a leader in high-quality storage peripherals, joined the Center in October 2003. Toshiba is a pioneer in small form factor storage, and in January 2004 the company announced the development of a 0.85-inch hard disk drive. This is the first drive to deliver multi-gigabyte storage capacity in a sub-one-inch form factor. It is expected to find use in a range of applications, including mobile telephony and portable consumer electronics. Yoichiro Tanaka, Senior Manager in the Hard Disk Drive Development Department in Toshiba's Core Technology Center, will serve as the sponsor representative.

Marvell Semiconductor joined the Center in December 2003. The company provides high-performance read channel transceivers, system-on-chip solutions, and preamplifiers for disk drive and network storage applications. Toai Doan, Vice President of Read Channel Development in the Storage Business Group, will serve as the sponsor representative.

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error-correcting codes that bear his name. Sponsored by AT&T Labs, the Hamming Medal has been given annually since 1988 for exceptional contributions to information sciences, systems and technology.

Wolf was cited "for fundamental contributions to the theory and practice of information transmission and storage." He and his research group at CMRR have had an enormous impact on the technical advancement of signal processing and coding in storage devices. They have made fundamental contributions to channel characterization and modeling methods, equalization and detection techniques, modulation coding algorithms, and error-correcting codes. Their innovations include the so-called microtrack model, post-processing detection techniques for partial-response maximum-likelihood (PRML), runlength-limited coding algorithms, algebraic error-control coding methods, and graph-based iterative turbo-decoding architectures. Many of his students have gone on to become technical leaders in the storage industry, such as last year's CMRR Distinguished Alumna Kelly (Knudson) Fitzpatrick.

The Hamming Medal is Wolf's third major IEEE award in five years. He was the recipient of its Koji Kobayashi Computers and Communication Award in 1998, and the Information Theory Society's Claude E. Shannon Award in 2001. Wolf is a Fellow of the IEEE and a member of the National Academy of Engineering. He earned his Ph.D. in 1960 from Princeton University, and later taught at New York University, Polytechnic Institute of Brooklyn, and the University of Massachusetts at Amherst. Wolf joined the UCSD faculty in 1984 and was the first chaired professor in CMRR.

Distinguished Alumni

JIAN-GANG ZHU

Jian-Gang (Jimmy) Zhu, a Ph.D. graduate from CMRR and a current Professor of ECE, MSE, and Physics at Carnegie Mellon University was named the first ABB Professor of Engineering for his research in magnetic data storage technologies. His work on the microstructure of thin film recording media has been pivotal to hard disk drives reaching their current storage capacity. Pioneering the research on utilizing micromagnetic modeling for MRAM memory element design, Zhu has established some of the most fundamental design principles used today. Over the past 12 years as an educator, he has graduated 19 Ph.D. students and more than 20 M.S. students in either electrical engineering or physics.

Zhu co-invented the CPP/GMR read sensor patent, winning the 1996 R&D Top 100 Award. With more than 170 major technical journal publications, he has authored or co-authored five book chapters and has given over 40 invited papers at major international conferences.

A recipient of the 1993-1998 NSF Presidential Young Investigator Award, Zhu also received a McKnight Land Grant Professorship in 1992 from the Regents of the University of Minnesota. He is an IEEE Magnetics Society Distinguished Lecturer in 2004 and has been on the Advisory Editorial Board for the Journal of Magnetism and Magnetic Materials, North-Holland, Elsevier since 1998.

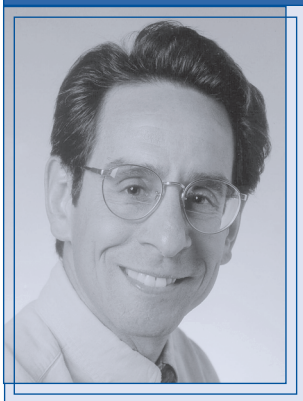
Receiving his B.S. degree in physics from Huazhong University of Science and Technology in China in 1982, he then earned his M.S. degree and Ph.D. degrees, both in physics, from the University of California at San Diego in 1983 and 1989, respectively. Before coming to Carnegie Mellon University, he was a faculty member in the Department of Electrical Engineering at the University of Minnesota from

FRANK TALKE

CMRR Professor, **Frank Talke**, has been nominated by the Fellows Committee and approved by the Board of Directors to be elevated to the grade of Fellow by the Society of Tribologists and Lubrication Engineers (STLE).

He will be presented with this award at the President's Luncheon on Tuesday, May 18, 2004 during the STLE Annual Meeting in Toronto.

FROM THE DIRECTOR



The articles and news items in this issue of CMRR Report reflect the culture of excellence and innovation that is the hallmark of our Center. Our programs of research and education produce a steady stream of technical ideas and trained graduates of the highest quality, and our faculty members, alumni, and staff members continue to receive the highest forms of professional recognition.

As the field of information storage continues to evolve, so does CMRR.

In addition to maintaining our focus on the advancement of hard disk and tape technology, CMRR faculty and a growing contingent of affiliated researchers are conducting pioneering research relevant to alternative storage approaches, such as patterned media, multidimensional optical recording, and nanowire arrays. And the Center's research program on "intelligent" storage systems continues to take shape.

We welcome our newest sponsors, Toshiba and Marvell Semiconductor, as well as the expansion of our collaborations with NSA and NIST. Contributing to the invention of storage systems and technologies that will meet the needs of the future is indeed exciting, and we sincerely thank those whose investments in the Center make it possible for us to do so.

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 selection of the recipient will be based upon the recommendation of a committee consisting of CMRR faculty members, with input from selected experts in information storage technology. The first Schultz Prize(s) were awarded at the 20th Anniversary Celebration dinner, May 6, 2003. CMRR's goal is to endow the Prize so that it can be awarded annually and in perpetuity.

If you are interested in making a donation of any amount to the Schultz Prize, you 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." Your donation is 100% tax-deductible, and an official acknowledgement of your contribution will be provided to you. All correspondence pertaining to the Prize can be directed to:

Prof. Paul H. Siegel, Director
UC San Diego
CMRR, 0401
9500 Gilman Drive
La Jolla, CA 92093-0401.

CMRR Shannon Memorial Lecture

Lloyd Welch, professor emeritus in the Electrical Engineering Department at the University of Southern California, will deliver the Second Annual Shannon Memorial Lecture at CMRR. The endowed lecture series, made possible by the generosity of CMRR Prof. Jack K. Wolf, commemorates the achievements of Claude E. Shannon, the acknowledged "father of information theory," whose revolutionary mathematical theory of communication has served as the foundation for the past half-century of progress in information storage and transmission technology. The lecture, entitled "Hidden Markov Models and the Baum-Welch Algorithm," will be held at 2:00 p.m. April 30, Shannon's birthday, in the CMRR Auditorium.

The lecture will be webcast live by Cal-$(IT)^2$ at http://www.calit2.net

Prof. Welch received the 2003 Claude E. Shannon Award, the highest honor bestowed by the IEEE Information Theory Society, for "consistent and profound contributions to the field of information theory."

Prof. Welch's research career has spanned more than forty years and has had a profound impact on digital communications, coding theory, and signal processing. The "Baum-Welch algorithm" for detecting and predicting the behavior of hidden Markov models has found widespread use in a variety of disciplines – most noticeably as one of the "engines" that powers the decoding of turbo codes. Dr. Welch has also established a fundamental bound, known as the "Welch Bound," on the cross-correlation values of a set of signals, and he is a co-discoverer of the tightest known upper bound on the rate of an error control code, the so-called "JPL bound."

Research Highlight — *Analysis of DC Noise in Thin Film Media*

I. Introduction

Thin film magnetic media utilized in high performance disk drives are comprised of fine grains. The granular structure gives rise to a stationary or DC noise in addition to transition noise. In particular, it is the variation in the mix of magnetic grains and non-magnetic intergranular spacing in regions along the recording track that causes a broadband stationary noise.

Historically, in contrast to magnetic tape, DC noise has been widely considered to be insignificant in comparison to transition noise and consequently the design of media has focused on shrinking the average grain size to minimize the negative influence of transition noise on system performance. For ultra high density applications (i.e. beyond 100 Gbit/sq.in.), the DC noise may increase relative to the transition noise since electron microscopy suggests that as the grain diameters are decreased, the intergrain boundary may not decrease in proportion [1].

To study this phenomenon, we built a numerical model of granular media which permits control of grain size variance σ_A, orientation distributions $F(\theta)$ and packing fraction p. Using this model, we determined by Monte Carlo simulation the DC noise 2-D spatial correlation function $R(x,y)$ for a range of media parameters $(\sigma_A, F(\theta), p)$. Of particular interest is the area under the correlation function which gives a measure of the noise spectral density near DC, the component remaining after filtering with the head response function. The total power at DC may be written in terms of the area under the normalized correlation function [2]

$$TP_{DC} = W_r M_g^2 A_{corr} p(\overline{\cos^2\theta} - p\overline{\cos\theta}^2) \int_{-\infty}^{\infty} dx' H^2(x').$$

II. Granular Medium Modeling

A Monte Carlo simulation was used to create 2-dimensional realizations of thin-film magnetic media by quantizing a large sample with square grids of pixel area chosen sufficiently small to make the quantization error negligible. A cellular automaton (CA) was used to simulate grain growth. This involves initializing an empty array with random seed locations and growing the seeds by iteratively applying an update rule to every empty pixel. In general it is difficult to achieve circular growth from a CA on a square grid. We obtained satisfactory results by alternating between 2 rules:

1. if any 4-neighbor of a pixel is magnetic and there are no other grains within a radius δ then that pixel becomes part of the grain.
2. if any 8-neighbor of a pixel is magnetic and there are no other grains within a radius δ then that pixel becomes part of the grain.

The rules are shown graphically in Fig. 1. Alternating between these rules will grow an isolated seed into an octagonal grain. A sample section of media with normalized grain area standard deviation $\sigma_A/\bar{A} = 0.4$ and packing fraction $p = 0.7$ is shown in Fig. 2. The advantages of using a CA to simulate the grain growth are that the simulation time increases only linearly with the number of grains simulated and the grain boundary width is easily controlled.

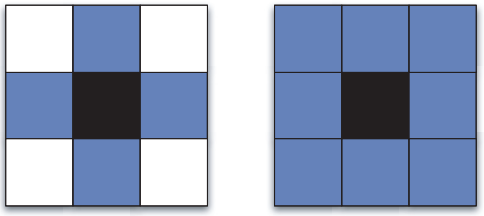


Fig. 1. A pixel has (a) four 4-neighbors and (b) eight 8-neighbors. A cellular automata growth rule corresponds to applying an OR operation to a set of neighbors to determine if a pixel should be magnetic.

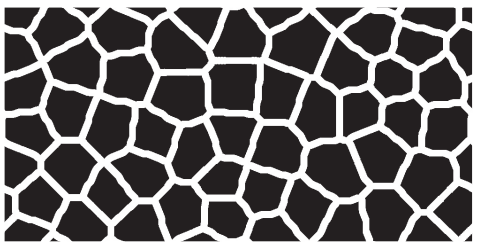


Fig. 2. A perfectly oriented media realization.

To control the packing fraction, the grain boundary was set to a constant width δ. Each seed location was generated from 2 random numbers (x_i, y_i) where x_i is uniformly distributed along the track and y_i is uniformly distributed across the track width. To control the grain area variance, (x_i, y_i) was repeatedly generated until its minimum distance to all previously generated seeds exceeded a given number.

III. Results

The statistics of the DC noise were estimated for $\sigma_A/\bar{A} = 0.4$ and $p = 0.7$. The spatial correlation function is shown in Fig. 3(a) for perfectly oriented media, where the correlation function decreases to near 0 at a radial distance equal to the intergranular spacing. We see a slight increase in the correlation function at a distance equal to the average grain diameter, an artifact that becomes more pronounced as the grain size variance is tightened and the grains becomes more regularly aligned. The main lobe of the correlation function broadens as the media is allowed

to become more randomly oriented (Fig. 3(b)) causing a significant increase in the area under the correlation function and hence the total power near DC. The radial cross-sections of the correlation function is plotted for a range of grain orientation distributions in Fig. 4.

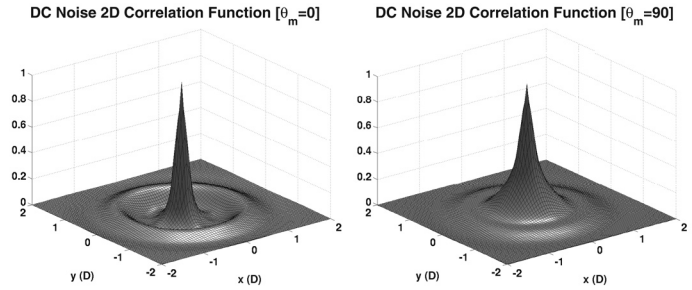


Fig. 3. Spatial correlation function cross section for $\Theta_M = 0, 52, 65, 90$.

In Fig. 5, the DC noise power relative to the transition noise power (in dB) is plotted for media with grain orientations uniformly distributed on $[-\Theta_M, \Theta_M]$ for 5 values of Θ_M .

The average grain diameter was fixed at 7 nm and the intergranular spacing varied from 0.5 nm to 2 nm. The squareness ratio (SR) is shown in the figure for the values $\Theta_M = 0, 52, 65, 90$ which are characteristic of very well oriented longitudinal media, current moderately oriented product media, and unoriented media with typical intergranular interactions, respectively. It can be seen from the plot that if the grain orientation is not tightly controlled, then even at modest intergranular spacing the DC noise power can exceed that of the transition noise.

References

[1] J. Wittig, MMM-INTERMAG Conference proceedings, Anaheim, CA, January 2004.

[2] H. N. Bertram, M. Marrow, J. Ohno and J.K. Wolf, ``Analysis of DC noise on thin film media", MMM-INTERMAG Conference proceedings, Anaheim, CA, January 2004.

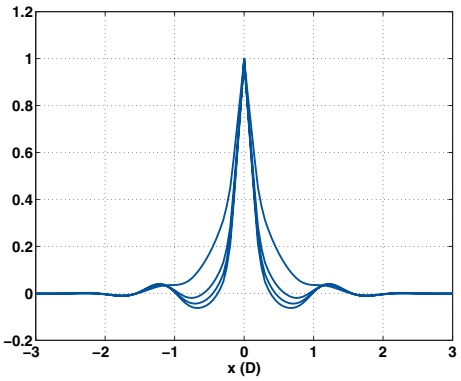


Fig. 4. Spatial correlation function cross section for $\Theta_M = 0, 52, 65, 90$

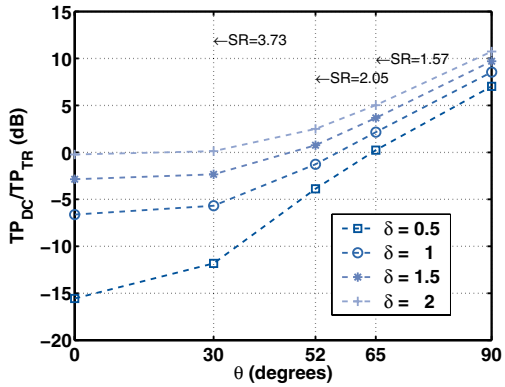


Fig. 5. DC noise power compared to transition noise power.

For more information contact Marcus Marrow at mmarrow@ucsd.edu or Neal Bertram at nbertram@ucsd.edu

CMRR Research Reviews

CMRR hosted 40 people from the CMRR Industrial Sponsor companies and other invited guests at the semi-annual Research Review and Advisory Council meeting on November 12-13, 2003. The two-day review highlighted the work of CMRR faculty, researchers and graduate students. Professor John Chapman of the University of Glasgow, Glasgow, UK gave a Special Session presentation entitled, "Wall Watching: the Progress of Domains in Small Elements".

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 Spring 2004 Research Review will be held on May 5-6, 2004. For further information on the Spring Review please contact Betty Manoulian at 858-534-6707 or bmanoulian@ucsd.edu.

CMRR WELCOMES NEW AFFILIATED FACULTY

Dr. Deli Wang received his Ph.D. degree in materials science from the University of California, Santa Barbara in 2001. Following two and a half years of postdoctoral research at Harvard University, he joined the University of California, San Diego in January of 2004 as an assistant professor of electrical and computer engineering, and is actively engaged in expanding both education and research into nanoelectronics and nanophotonics.

Dr. Wang's previous research activities include fabrication of biosensors from organic semiconductors, assembly of nanoscale transistors; light emitting diodes; bistable switches; decoders; nonvolatile memory cells; and computing systems based on semiconductor nanowires. His research interests/programs at UCSD related to the topic of magnetics will include the design and study of new one-dimensional magnetic materials and spin-related devices, in particular, magnetic oxide nanowires and dilute magnetic semiconductor nanowires. Other research programs in his group (three graduate and one undergraduate students, and one research scientist) involve the study of compound semiconductor nanowire based devices for optical and biological sensing and nanoscale computing.

"Let no foil go unchallenged"

Lake Arrowhead Conference

The 23rd CMRR Lake Arrowhead Interactive Workshop on Data Storage was held December 7-10, 2003. This workshop invites a small group of technologists to discuss topics of contemporary interest in magnetic recording and information storage in an open, interactive workshop setting. The workshop motto is "Let no foil go unchallenged."

Dr. Giora Tarnopolsky gave the Tutorial on "Hard Disk Drive Capacity at High Areal Density," proposing that the disk drive bit areal density curve will not continue the endless climb of the last half-century. Instead, an optimum areal bit density plateau will be reached, as determined by user needs, format efficiency, engineering, and physics limits.

The first workshop session was on "Head-Media Interface at Nanometer Spacings." Tribologists from several drive companies appeared confident about reaching 2 nm fly heights in 2009 for 1 Tbit per square inch (1000 Gbits per square inch) areal density. However, disk roughness may have to be eliminated. Roughness is necessary for tribological reasons, but it adds to the head-media spacing. One possible solution under study by Prof. Frank Talke at CMRR is texturing the slider air-bearing surfaces, rather than the disk. A second suggested solution is to exploit the inherent island and groove "roughness" found in patterned media.

In the second session on "Perpendicular Recording: Progress and Problems," a world record areal density demonstration based upon perpendicular recording was shown. In the third session on "Alternative Media," Komag showed patterned track media with as little as 127 nm track pitch, promising 240 GBytes per 3.5-inch disk. Results for patterned bit media with 50 nm features were also shown. In the final session on "The Future of Servos and Tracking," researchers from Carnegie Mellon University proposed new servo patterns for out-of-drive servo writing and also proposed changing read channel equalization to minimize error rate when the head is off-track.

Recent Gifts, Grants, Awards, and Internships

The Information Storage Industry Consortium (INSIC) has recently funded the following four CMRR projects under the Extremely High Density Recording (EHDR) Program.

Prof. Neal Bertram will direct a project on "Experimental and Theoretical Studies of Signals and Noise in Perpendicular (and Advanced Longitudinal) Recording Media." The project focuses on a detailed examination of signal and noise, primarily in perpendicular media, but also including advanced longitudinal media. The question to be answered is: do we understand current media in terms of SNR and what must be done to "scale" the media to high densities such as 200-1000 Gbit/in^2 ?

Prof. Paul Siegel received funding for the project "Error Control Coding for Terabit per Square Inch Recording." This project continues the INSIC-funded research on design and performance evaluation of error-control coding for magnetic recording applications. The focus will be on improved algorithms and architectures for high-speed soft-decision algebraic decoding of high-rate Reed-Solomon codes and other coding schemes. A key theme will be the incorporation of soft-decision decoding into more realistic channel designs using parity codes and post-processing.

Prof. Frank Talke was awarded a grant for a project entitled "Textured Sliders for Near-Contact Studies." The objective is to study the texture of pico- and femto-sliders and optimize the tribological behavior of textured sliders in near contact and contact recording applications. One topic of investigation will be the use of oxygenated plasma etching and other related methods, including ion beam etching, to fabricate sliders with varying amounts of texture depth. Another issue to be addressed is whether texturing can be restricted to the trailing edge area of the slider where the closest head disk spacing occurs, or whether the complete air bearing surface must be textured.

The research effort will also include a study of the texturing of alumina, since alumina is a material found in the immediate neighborhood of the read write element. The project also includes plans to examine the instabilities predicted due to adhesion and van der Waals forces for sub-3 nm flying height sliders, and to investigate the effect of these instabilities on the tribological performance of extremely low flying sliders in the sub-nm spacing range.

Associate Director Gordon Hughes received funding for a "Patterned Media Terabit/in^2 Fabrication and Recording Systems Study." Alternative patterning processes to fabricate patterned disks for Tbits/in^2 will be studied. Even with square bits, the feature size requirement is an extremely challenging 12 nm. E-beam lithography research projects reach 10 nm resolution, but only over mm size areas. Projection e-beam lithography production processes have been developed for 8-inch semiconductor wafers but their resolution over large areas is currently only 100 nm. Disk heads will have 100 nm feature size by 2003, matching semiconductor feature size by 2005 at 50 nm, even accounting for the current slowing of the areal density curve. Semiconductor feature size is currently at 90 nm (Intel production).
As alternatives, direct physical imprint projects will be surveyed and cooperative research projects for patterned media discussed with their research teams. These include nano imprint lithography (NIL), said to be capable of 10 nm features. Features smaller than 60 nm in size have been reliably produced by the Step and Flash Imprint Lithography project at the University of Texas at Austin. This process has promise to produce etch masks for patterning continuous film perpendicular media. Terabit/in^2 patterned media recording systems modeling work will continue with the inclusion of 3D bit switching and reading. CPP read heads will be added.

Profs. Paul Siegel and Jack Wolf are participants in a two-year **NIST Advanced Technology Program (ATP)** joint venture partnership project on "Technologies for Advanced Holographic Data Storage." In cooperation with academic participants from Carnegie Mellon University and researchers at **InPhase Technologies** and **DisplayTech**, the CMRR team will investigate holographic channel characterization, modeling, and equalization, along with two-dimensional modulation, coding, and detection techniques.

CMRR has received a gift from **STMicroelectronics** to support the research activities of **Prof. Jack Wolf.** This unrestricted research grant was one of three made to UCSD faculty members as part of a program in which STMicroelectronics recognizes the engineering contributions of its employees by providing research gifts on their behalf to academic researchers named by the employees.

The National Security Agency has renewed **Fred Spada's** contract to study "Secure Erasure of High Coercivity Magnetic Media." The purpose of the project is to perform erasure measurements on various commercial magnetic storage media and formats in order to determine the efficacy of both prototype and commercially available instruments for erasing all remnants of the recorded signal from media used by the U.S. government.

Fred Spada has accepted an equipment donation from **Hitachi Global Storage Technologies** for an upgraded PHI Auger 600 Spectrometer.

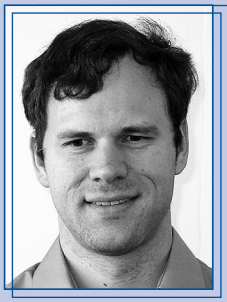
Ismail Demirkan, a doctoral student in Prof. Jack Wolf's group, received a Cal-(IT)^2 fellowship to continue his research on two-dimensional constrained modulation codes. The award represents a matching grant from Cal-(IT)^2 for a National Science Foundation project entitled "Information-Theoretic Limits in Data Storage Systems" on which Prof. Wolf and Prof. Paul Siegel are co-principal investigators.

Ph.D.'s Awarded

Geoff Beach, a member of Professor Ami Berkowitz's group since September 1998, received his Ph.D. in June 2003. His thesis, entitled "Magnetic Properties of Co_xFe_{100-x} Metal/Native Oxide Multilayers," detailed a promising new composite thin film material with applications in ultrahigh data rate magnetic recording. In May 2003, he received the first annual Schultz Prize for Excellence in Graduate Student Research for his work. Geoff's research interests lie broadly in thin film magnetism and magnetic materials. Geoff is now a postdoctoral fellow at The University of Texas at Austin, where he is studying magnetization dynamics with Professor James Erskine. When he is not in the lab, he enjoys landscaping with his wife in their new home.

Vladimir Dorfman, a part time member of Professor Jack Wolf's group since the fall of 1997, received his Ph.D. in December 2003. His thesis was entitled "Detection and Coding Techniques for Partial Response Channels." This research also resulted in several papers published in IEEE journals. Vladimir's research interests are in digital communications, coding, and signal processing for communications. He plans to continue his research in these areas. He has been employed at Conexant Systems, Inc. since May 2000. He is a Systems Engineer on the ADSL project (a form of the high speed telephone line digital communication system). Before his current position, Vladimir was a consultant for Pacific Communications Systems, Inc., ADC, and Wireless Data Services, working on various forms of digital communications devices.

Eric Jayson, a member of Professor Frank Talke's group since September 1999 was awarded his Ph.D. in June 2003. His thesis was entitled "Numerical and Experimental Investigations of a Hard Disk Drive Subject to Shock and Vibrations." As a graduate student at CMRR, Eric was honored as an Outstanding Teaching Assistant. During his tenure at CMRR he had the opportunity to intern at two sponsor companies, Seagate Technology and Quantum Corporation. Eric is currently a Project Engineer at ATA Engineering. He is responsible for the design modeling and analysis of mechanical devices and structures subjected to static and dynamic mechanical and thermal loads.



John Miller joined Professor Jack Wolf's group as a volunteer in the summer of 1997. In January 1999 he was accepted into the graduate program and was awarded his Ph.D. in May 2003. His thesis was entitled "High Code Rate, Low-Density Parity-Check Codes with Guaranteed Minimum Distance and Stopping Weight." John is the first blind student to earn a doctorate in electrical engineering from the Jacobs School of Engineering. He is also the president of the science and engineering division of the National Federation of the Blind and hopes to continue "breaking down some of the barriers that have made it almost impossible for young blind students to pursue careers in science and engineering." John is currently a postdoctoral fellow at Cal-$(IT)^2$ under Professor Ramesh Rao and is involved in a number of projects. He is a member of Rao's NSF grant for "Responding to Crises and Unexpected Events (RESCUE)." This grant explores the parallel between the needs of the blind and first responders. John has also created a program entitled "What's in the Neighborhood?" that enables blind people to virtually learn the lay of the land at UCSD on their PCs before venturing into the physical domain.

Xiaobin Wang, a member of Professor Neal Bertram's group since the spring of 1999, received his Ph.D. in the summer of 2003. His doctoral thesis was entitled "Studies on Dynamic Thermal Reversal and Transition Jitter in Magnetic Materials." In August of 2003 Xiaobin joined Seagate Technology and is currently working at the Bloomington, Minnesota facility. He is working on magnetic recording subsystem models. Xiaobin is thankful for the education he received at CMRR and especially thankful for the people at the Center who created an outstanding research environment.

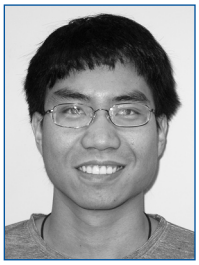
CMRR WELCOMES NEW RESEARCHERS

Marvin Balaoro was born in San Jose, California in 1980. He completed his B.S. in Mechanical Engineering at the University of California, San Diego in June 2002. He was admitted into the B.S./M.S. program and continues his graduate studies here at CMRR in Professor Talke's lab. His area of research is in air bearing simulation, design, and optimization. His current work uses the genetic algorithm to minimize the dynamic movement of a slider after it encounters a shock event. This is accomplished by altering the shape of the air bearing surfaces. For this optimization, he is using the resources available through the National Partnership for Advanced Computational Infrastructure, which includes the San Diego Supercomputer Center and the Texas Advanced Computing Center. In his spare time, Marvin enjoys seeing movies, going to the beach, and visiting friends.

John Xu was born in 1979 in the Hunan province of China. He joined Professor Talke's lab in August 2003 as a graduate student. His research is on the head disk interface for femto-sliders in very small form factor devices that require exceptional shock tolerance and tribological performance. Previously, John worked in Dr. Bo's lab in Singapore at the Data Storage Institute, as a research engineer from July 2002 to August 2003. He participated in slider air bearing surface design, fabrication and characterization. He received his M.S. in high performance computing for engineered systems at the Singapore-MIT Alliance in July 2002. He earned his B. Eng in mechanical engineering at Huazhong University of Science and Technology in July 2001. Outside of work and study, John is very fond of traveling and hopes to tour around the world someday. He likes to play chess and go and his favorite sports are tennis, badminton, and table tennis.

Yeoung Chin (Paul) Yoon arrived at CMRR from South Korea in August 2003. He is a first year graduate student in Professor Talke's lab. He is interested in MEMS and nanotribology, optimization design and precision engineering. Paul earned his undergraduate degree in Mechanical Engineering at Dankook University. He also served in the Korean Air Force from 1995 to 1998 as an engineer. Paul's hobbies include soccer, Jok-Gu and basketball. His favorite activity is Tae-Kwon-Do, a martial art from Korea. He is currently enrolled in lessons twice a week.

POSTDOCS

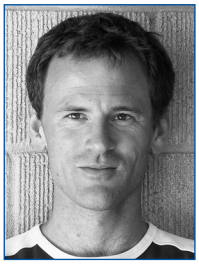


Panu Chaichanavong became a Postgraduate Researcher in September 2003 working with Professor Siegel in coding theory and design. He received a bachelor's degree from Chulalongkorn University, Bangkok, Thailand. Then he continued his studies at Stanford University under the guidance of Professor Brian Marcus. He received his Ph.D. in June 2003 with the dissertation entitled "Block-Type-Decodable Encoders for Constrained Systems." He had two opportunities, summers 2001 and 2002, to work at the IBM Almaden Research Center on timing recovery for magnetic recording. At Stanford, he engaged in many cultural activities and was the President of Thai Student Association. His favorite hobbies include tennis, soccer, pool and snooker, video games, and cards.

Jung-Il Hong has joined Professor Berkowitz's lab as a Visiting Postgraduate Researcher. He was a Postdoctoral Fellow since 2000 at the Rensselaer Polytechnic Institute in the Rensselaer Nanotechnology Center. Dr. Hong's work at CMRR will focus on investigating the optimization of Co-Pd multilayers for perpendicular recording and the Lawrence Livermore National Laboratory (LLNL) program on producing and characterizing the properties of spark-eroded particles of giant magnetostrictive materials such as Terfenol and Fe-Ga. Jung received his Ph.D. in Materials Science and Engineering from Northwestern University in 1999 and his B.S. in Physics from Korea Advanced Institute of Science and Technology in 1992.

Sandra Sankar, a CMRR graduate, returned last summer to the Berkowitz lab as a Postgraduate Researcher. Sandra was a graduate student in Professor Berkowitz's lab from 1994-2000. Her Ph.D. dissertation was entitled "Correlation of Microstructural, Magnetic and Transport Properties of Composite Metal-Insulator Films." After her graduation from CMRR she joined Read-Rite Corporation as a Staff Engineer until June 2003. Sandra has recently accepted a position at Western Digital in San Jose.

VISITING SCHOLARS

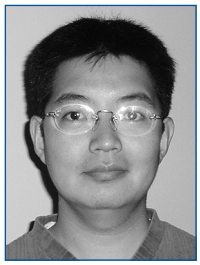


Pål Ellingsen came to CMRR in late August 2003 as a visiting graduate student. During his 10-month stay, he is working with both Professor Siegel's and Professor Wolf's groups. His visit to CMRR was made possible by a grant from the NFR (the Norwegian Research Foundation) under their research exchange program. Normally, Pål is at the Selmer Center for Coding and Cryptography at the University of Bergen in Norway, and is working with Professor Øyvind Ytrehus on different aspects of asymmetric channels and nonlinear codes. Other interests are Bayesian networks and information theory. He has a background in mathematics and statistics, and has a master's degree in algebraic geometry from the University of Tromsø, the world's northernmost university, also in Norway. When not in the office, he thrives best with a board of some kind under his feet. This happens mostly on snow, but during the last few months, surfing has also become a favorite pastime.

CMRR welcomes the return of **Dr. Ho-Jong Kang**, a Professor from Dankook University, Korea. Dr. Kang was at CMRR from March 1997 to December 1999. He will be working in Professor Talke's lab on new disk lubricants, lubricant systems with X1-P additive and novel high temperature lubricant systems.

Torben V. Laursen received his M.Sc. in mathematics and computer science from the University of Copenhagen in 2001. The subject of his thesis was "Symbolic Dynamics and Coding for Digital Recording Devices." After graduation he worked as a high school teacher until he began as a Ph.D. student at the Technical University of Denmark under the supervision of Søren Forchhammer. He visited Professor Paul Siegel's group at CMRR in the fall of 2003 where he worked on methods for lower bounding the capacity of certain two-dimensional constrained systems. His research interests include image compression and two-dimensional constrained systems, especially estimating the capacity of and designing coding schemes for such systems. When not at work, he enjoys reading, hiking and playing the piano besides spending time with his wife and two sons.

Yusuke Matsuda has joined the Talke group as a visiting scholar and he will work in the lab until September 2004. Yusuke was born in Nagano, Japan, the host city for the Winter Olympics in 1998. He completed his B.S. degree in Mechanical Engineering at Tohoku University, Japan in 2002. He is currently a graduate student in Professor Kato and Associate Professor Adachi's group at Tohoku University. His area of research is the tribology of a precise positioning stage driven by an ultrasonic motor. Outside of school, Yusuke likes to play archery and table tennis. He also enjoys traveling and plans to tour around the United States during his stay.



Akihiko Takeo is a visiting scholar from Toshiba Corporation in Professor Bertram's group. He received his B.S. and M.S. of engineering from Tohoku University in 1993 and 1995 respectively. In 1995 he received the Annual Paper Award of the Magnetic Society of Japan. His current research areas are advanced recording systems over 300 Gbit/in^2 and micromagnetic simulations. Outside the lab Akihiko has many other interests. He enjoys skiing, playing rock music on his guitar, traveling, and driving.

Graduate Students & Researchers Near Completion

STUDENT	LEVEL	ADVISOR	DEPT	RESEARCH INTEREST	COMPLETION DATE
Bogdan Valcu	Ph.D.	Bertram	Physics	Perpendicular magnetic recording	Spring 2004
Jiangxin Chen	Ph.D.	Siegel	ECE	Constrained codes, channel capacity bounds, two-dimensional channels	June 2004
Michael Cheng	Ph.D.	Siegel	ECE	Algebraic codes, soft-decision decoding, perpendicular recording models	June 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	April 2004
Saurabh Deoras	Ph.D.	Talke	MAE	Tribology and mechanics of computer hard-disk drives	September 2004
Tathagata Mitra	M.Sc.	Talke	MAE	Surface characterization of textured sliders using the CSS tester to measure the stiction for textured sliders	April 2004
Aravind Murthy	M.Sc.	Talke	MAE	Investigation of the shock response in a hard disk drive	April 2004
Ryan Taylor	Ph.D.	Talke	MAE	High frequency lateral tape motion in magnetic tape guiding systems	December 2004
Jiadong Zhang	Ph.D.	Talke	MAE	A comparison of the genetic algorithm and the subregion approach in the optimization of slider air bearings for sub-7 nm flying height	December 2004
Brian Kurkoski	Ph.D.	Wolf/Siegel	ECE	Message-passing algorithms, LDPC codes, erasure channels	June 2004
Marcus Marrow	Ph.D.	Wolf	ECE	Signal processing for digital recording	June 2004

Staff Changes

CHERYL HACKER CUTS HER RETIREMENT CAKE

In December 2003 over 100 people gathered in the CMRR auditorium to celebrate the retirement of **Cheryl Hacker**, the Center's Management Service Officer. Cheryl came to the University in 1989 and worked in several departments before coming to CMRR in 1994. At the Center, she served as the liaison with our sponsors, organized the semi-annual Research Reviews and Lake Arrowhead Conference, and edited the *CMRR Report*. In 2003 Cheryl was nominated by the Center for the Betsy Faught Award and the Academic Affairs Employee of the Year Award. These awards recognize outstanding work performance by employees at UCSD. In retirement, Cheryl and her husband Joe are enjoying their grandchildren, their dogs and building a home in Julian.

CMRR is pleased to announce that **Iris Villanueva**, the Center's financial analyst, has accepted the position of Management Service Officer at CMRR. Iris brings a wealth of experience to this position. She came to the Center in 1991 and has worked closely with the Center's professors, students and staff. She has also been a liaison with our sponsoring companies over the years. Congratulations Iris!

CMRR Report
Center for Magnetic Recording Research

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