

**VIJAYAKUMAR BHAGAVATULA**  
(B.V.K. Vijaya Kumar)

Professor of ECE  
Electrical and Computer Engineering  
Carnegie Mellon University  
Pittsburgh, Pennsylvania 15213-3890  
(412) 268-3026 (Voice), (412) 268-6345 (FAX)  
[kumar@ece.cmu.edu](mailto:kumar@ece.cmu.edu)  
<http://www.ece.cmu.edu/~kumar/>

**EDUCATION**

- Ph.D. (Electrical Engineering) from Carnegie Mellon University, February 1980.
- M.Tech. (Electrical Engineering) from Indian Institute of Technology, Kanpur, India, June 1977.
- B.Tech. (Electrical Engineering) from Indian Institute of Technology, Kanpur, India, May 1975.

**EMPLOYMENT**

- Acting Head of the Department, Electrical and Computer Engineering (ECE) Department, CMU, July 2004-February 2005.
- Professor of ECE, CMU since September 1991.
- Associate Department Head of ECE, CMU from July 1994 to June 1996.
- Associate Professor of ECE, CMU from September 1987 to August 1991.
- Assistant Professor of ECE, CMU from September 1982 to August 1987.
- Research Associate in ECE, CMU from March 1980 to August 1982.

**TECHNICAL CONSULTING**

- Lockheed Missiles and Space Company, Palo Alto, CA.
- General Dynamics, Pomona, CA.
- Unicorn Systems Inc., Pittsburgh, PA.
- Westinghouse Electric Corp., Pittsburgh, PA.
- Two-Six Inc., Saxonburg, PA.
- Carnegie Mellon Research Institute, Pittsburgh, PA.
- Teledyne Brown Engineering, Huntsville, AL.
- Dynetics Inc., Huntsville, AL.
- US Army Missile Command Laboratories, Huntsville, AL.
- Rosemount Analytical, Inc., Pittsburgh, PA.
- Martin Marietta Company, Orlando, FL.
- Hughes Missile Systems Company, Tucson AZ.
- Southwest Intelligent Systems Inc., Tucson, AZ.
- Hughes Research Laboratories, Malibu, CA.
- Mytec Technologies Inc., Toronto, Canada
- Raytheon Systems Company, Tucson, AZ.
- ADC Communications, Pittsburgh, PA.
- Litton TASC Institute, VA.
- Maxoptix Corp., Fremont, CA
- Northrop Grumman, Pittsburgh, PA.
- Lockheed Martin, Orlando, FL.
- Lucent Technologies, NJ.
- Mine Safety Appliances, Pittsburgh, PA.
- Media Balance, East Lansing, Michigan.

- Pukoa Scientific, Hawaii.
- Utopia Compression, CA.

#### **LEGAL CONSULTING**

- Morgan, Lewis and Bockius, Washington, DC.
- Baker and McKenzie, San Francisco, CA.
- Finnegan, Henderson, Farabow, Garrett and Dunner, Washington, DC.
- McAndrews, Held & Malloy, Chicago, Illinois.
- Weil, Gotshal & Manges, Redwood Shores, CA.

#### **TEACHING**

##### **Carnegie Mellon Courses**

- Mathematical Foundations of Electrical Engineering
- Signals and Systems
- Digital Communications
- Applied Stochastic Processes
- Digital Signal Processing
- Advanced Digital Signal Processing
- Pattern Recognition Theory
- Error Control Coding
- Detection and Estimation Theory
- Linear IC Applications
- Special Topics in Signal processing: Biometrics

##### **Short Courses**

- Algorithms for Biometric Recognition (Intl. Conf. on Image Processing, Singapore; SPIE Defense & Security Symposium)
- Statistical Pattern Recognition (SPIE Aerosense Symposium)
- Advanced Correlation Filters (SPIE Aerosense Symposium)
- Partial response Maximum Likelihood (PRML) methods for Optical Data Storage (Optical Data Storage conference)
- MATLAB for Signal Processing (TASC Institute)
- Coding for Data Storage (StorageTek Inc.)
- Low Density Parity Check (LDPC) Codes (Data Storage Institute, Singapore)
- Correlation Filters for Biometric Recognition (Indian National Academy of Engineer's Workshop on Image and Speech processing, IIT/Madras, Chennai, India)
- Frequency-domain methods for biometric recognition (ICASSP 2007)

#### **INVITED TALKS**

1. "Performance of synthetic discriminant functions for distortion-invariant pattern recognition," **Jet Propulsion Laboratories**, Pasadena, California, March 1987.
2. "Optimal detection of digital information on particulate magnetic recording media," **Hewlett-Packard Laboratories**, Palo Alto, California, March 1987.
3. "Detection of digital signals on particulate media in non-stationary noise," **Control Data**, Minneapolis, Minnesota, May 1987.
4. "Optical correlators for pattern recognition," **IEEE ASSP Society and IEEE Controls Society Chapter meeting**, Pittsburgh, Pennsylvania, October 1987.
5. "Associative Memory from Neural Networks," Joint Seminar, **Department of Electrical Engineering and Division of Imaging Science**, Yale University, New Haven, Connecticut, November 1987.

6. "Input-output characterization of laterally inhibited networks," **Electrical and Computer Engineering**, University of Missouri, Columbia, Missouri, February 1988.
7. "Optical Pattern Recognition," **Defense Research and Development Laboratories**, Hyderabad, India, June 1988.
8. "Image Reconstruction from Partial Fourier Information," **Center for Fluorescence Research**, Carnegie Mellon University, Pittsburgh, Pennsylvania, October 1988.
9. "Noise Modeling in Magnetic Recording," **Magnetics Technology Center**, Carnegie Mellon University, Pittsburgh, Pennsylvania, November 1988.
10. "Input-Output characteristics of a class of Laterally Inhibited Neural Networks," **Jet Propulsion Laboratories**, Pasadena, California, January 1989.
11. "Input-output characterization of a class of laterally inhibited neural networks," **US West Advanced Technologies**, Englewood, Colorado, February 1989.
12. "Phase-only and binary phase-only filters for optical pattern recognition," **NSF Center for Opto-Electric Computing Systems**, University of Colorado, Boulder, Colorado, February 1989.
13. "Optical Data Processing Research at CMU," **ECE Graduate Seminar**, Carnegie Mellon University, Pittsburgh, Pennsylvania, September 1989.
14. "Partial-Information Correlator Systems," **Litton Data Systems**, Van Nuys, California, January 1990.
15. "Design of phase-only and binary phase-only correlation filters," **Rockwell International Sciences Center**, Los Angeles, California, July 1990.
16. "Binary phase-only filter design," **Litton Data Systems**, Van Nuys, California, July 1990.
17. "Partial-information correlation filter design," **Sandia National Laboratories**, Albuquerque, New Mexico, July 1990.
18. "Three-level composite filters for optical pattern recognition," **Litton Data Systems**, Van Nuys, California, March 1991.
19. "Advances in correlation filter design," **U.S. Army Night Vision Laboratories**, April 1991.
20. "Trade-off in the design of correlation filters," **SPIE Critical Reviews**, San Jose, California, November 1991.
21. "Filter design for optical correlators," **Martin-Marietta Company**, Orlando, Florida, April 1992.
22. "Design of Filters for Optical Correlators," **Sandia National Laboratories**, Albuquerque, New Mexico, January 1993.
23. "Application of Differential Learning to Pattern Recognition," **Indian Institute of Technology**, Madras, India, June 1993.
24. "Efficient statistical pattern recognition through differential learning," **Indian Statistical Institute**, Calcutta, India, July 1993.
25. "Applications of Signal Processing in Data Storage Systems," **KODAK**, Rochester, New York, September 1993.

26. "Differential learning approaches," **Hughes Missile Systems Company**, Canoga Park, California, March 1994.
27. "Neural networks for Pattern Recognition," **NASA Johnson Space Center**, Houston, Texas, May 1994.
28. "Correlation filters for Automatic Target Recognition," **Westinghouse Science & Technology Center**, Pittsburgh, PA, September 1994.
29. "Correlation Filters for Pattern Recognition," **Hughes Research Labs**, Malibu, California, October 1994.
30. "Equalization for Holographic Data Storage," **University of Arizona**, Tucson, AZ, January 1996.
31. "Correlation Filters for Automatic Target Recognition," **Northrop Grumman Norden Systems**, Norwalk, CT, July 1996.
32. "Coding for Data Storage," **Storage Technologies Inc.**, Boulder, CO, December 1996.
33. "Coding for High-density Data Storage," Computational Sciences Center, **University of Kentucky**, Lexington, KY, March 1997.
34. "Advanced correlation filters for pattern recognition," **Indian Statistical Institute**, New Delhi, India, May 1997.
35. "Run-length limited Codes for high-density data storage," **Hughes Missile Systems Company**, Tucson, AZ, October 1997.
36. "Partial response methods for high density data storage," **Raytheon Missile Systems Company**, Tucson, AZ, March 1998.
37. "Equalization methods for optical data storage," **Calimetrics Inc.**, Oakland, CA, June 1998.
38. "Equalization methods for optical data storage," **Quantum Electronics**, Shrewesbury, MA, July 24, 1998.
39. "Advanced optical correlation methods," **Raytheon Missile Systems Company**, Tucson, AZ, August 1998.
40. "Coding and Signal processing for high-density data storage systems," **Indiana University of Pennsylvania**, Indiana, PA, September 1998.
41. "Equalization for holographic data storage," **International Workshop for Holographic Data Storage**, Nice, France, March 1999.
42. "Clutter rejection methods for automatic target recognition," **Northrop Grumman Science and Technology Center**, Pittsburgh, PA, October 1999.
43. "Optical data storage research at DSSC," **Optical Data Storage Center, University of Arizona**, Tucson, AZ, October 1999.
44. "Signal Processing for Optical Data Storage," **NSIC Optical Data Storage Road Map Workshop**, Los Gatos, CA, November 1999.
45. "Timing recovery for data storage," **Seagate**, Minneapolis, MN, December 14, 1999.

46. "Turbo codes for data storage," **IEEE Magnetics Society Seminar**, Minneapolis, MN, December 14, 1999.
47. "Characterization and equalization of tape dropouts," **Imation**, Minneapolis, MN, December 15, 1999.
48. "Turbo coding for optical data storage," **Infineon Technologies**, Santa Cruz, CA, May 5, 2000.
49. "Turbo codes for data storage," **Quantum Inc.**, Milpitas, CA, May 5, 2000.
50. "Eigen and non-linear for improved clutter rejection in correlation-based automatic target recognition," **Northrop Grumman Science and Technology Center**, Pittsburgh, PA, September 29, 2000.
51. "Coding and Signal Processing for Data Storage," **Lucent Technologies**, Allentown, PA October 13, 2000.
52. "Correlation Filters: State of the Art," **Raytheon Systems Company**, Tucson, AZ, March 2001.
53. "Low Density Parity Check (LDPC) Codes for Data Storage," **Samsung Information Systems of America**, San Jose, CA, March 2001.
54. "Advanced correlation filters for Automatic Target Recognition," **Lockheed Martin**, Orlando, FL, April 2001.
55. "Coding and Signal Processing for Optical Data Storage," **Philips Laboratories**, Eindhoven, Netherlands, June 2001.
56. "Role of Coding and Signal Processing for Digital Data Preservation," **NIST**, Gaithersburg, MD, August 2001.
57. "Biometric verification algorithms," **Lockheed Martin**, Orlando, Florida, March 2002.
58. "Coding and Signal Processing Research at Data Storage Systems Center," **Data Storage Institute**, Singapore, December 2002.
59. "Advanced timing recovery methods for low-SNR data storage channels," Coding and Signal Processing Group, **Data Storage Institute**, Singapore, December 2002.
60. "Correlation filter methods for face verification," ECE Dept., **Natl. Univ. of Singapore**, Singapore, December 2002.
61. "Biometric verification using correlation filters," Computer Science Department, **IIT/Madras**, Madras, India, December 2002.
62. "Biometric recognition using correlation filters," Cal-IT2 seminar, **University of California at San Diego**, CA, October 2003.
63. "Biometrics for Security," **IEEE Erie Section New Members Dinner Meeting**, Erie, PA, November 2003.
64. "Correlation Pattern Recognition," Dowd Fellowship Seminar, **Carnegie Institute of Technology**, CMU, Pittsburgh, PA, December 2003.
65. "Biometrics for Human Identification," **Indian National Academy of Sciences (INSA) Chennai Chapter**, Chennai, India, January 9, 2004.

66. "Correlation filters for biometric authentication," **Siemens Corporate Research Center**, Princeton, NJ, March 19, 2004.
67. "Biometrics research at Carnegie Mellon's CyLab," **West Virginia University**, Morgantown, WV, September 29, 2004.
68. "Biometrics Research at Carnegie Mellon's Cylab," **IEEE Communications Society Queensland Chapter**, Brisbane, Australia, December 7, 2004.
69. "Biometric Authentication using Correlation Filters," **Michigan State University**, February 8, 2005.
70. "DSSC Coding and Signal Processing Research," **Broadcom**, Longmont, Colorado, July 28, 2005.
71. "Frequency-domain Biometric Authentication," **North Carolina State University**, Raleigh, NC, August 30, 2005.
72. "Correlation Filters for Face Recognition," **Face Recognition Advanced Study Workshop**, Morgantown, WV, November 2005.
73. "DSSC Channels research," **LSI Logic**, Fort Collins, CO, December 2005.
74. "Frequency-domain approach to Image Biometric Authentication," Invited talk, **IAPR International Conference on Biometrics (ICB)**, Hong Kong, January 5, 2006.
75. "Introduction to Correlation Filters for Biometric Recognition," **IIT**, Hyderabad, January 12, 2006.
76. "Iris verification," **IIT/Madras**, Chennai, India, February 27, 2006.
77. "Spatial-frequency domain methods for face recognition and iris recognition," **Booz Allen Hamilton**, McLean, VA, May 2, 2006.
78. "Spatial-frequency domain techniques for face recognition grand challenge (FRGC)," **CyLab**, Carnegie Mellon university, Pittsburgh, June 5, 2006.
79. "FPGA-based evaluation of LDPC codes," **Sabanci University**, Istanbul, Turkey, September 14, 2006.
80. "Correlation filters for ATR & Biometrics," **General Dynamics Robotic Systems**, Pittsburgh, September 25, 2006.
81. "Image biometric verification in spatial frequency domain," **Royal Melbourne Institute of Technology (RMIT) University**, Melbourne, Australia, October 6, 2006.
82. "Coding and signal processing for holographic data storage," **Data Storage Institute (DSI)**, Singapore, June 20, 2007.
83. "Biometric recognition in spatial frequency domain," **University of Gottingen**, Germany, September 8, 2007.
84. "Spatial frequency domain biometric recognition," **Air Force Institute of Technology**, Dayton, Ohio, November 9, 2007.
85. "Image biometric recognition via spatial frequency domain," Keynote speech, **3<sup>rd</sup> Indian International Conference on Artificial Intelligence**, Pune, India, December 17, 2007.
86. "Iris verification," Invited talk, **Workshop on Image and Signal Processing**, Guwahati, India, December 28, 2007.

87. "Face recognition," Invited talk, **Workshop on Image and Signal Processing**, Guwahati, India, December 29, 2007.
88. "Signal processing approaches for face and iris recognition," **Syracuse University**, Syracuse, NY, February 13, 2008.
89. "Coding and signal processing for bit-patterned media," **LSI**, Milpitas, CA, December 12, 2008.

## **STUDENT SUPERVISION**

### **Visiting Faculty**

- Prof. Fei Su, Beijing Univ. of Posts & Telecommunications, China (Feb. 2008-Jan. 2009)

### **Post-Docs**

- Dr. Hyungshin Kim, Ph.D. from KAIST, Korea (May 2003-Feb. 2004)
- Dr. Zongwang Li (January 2004-October 2005)

### **Industry Visitors**

- Toshihiro Horigome, Sony, Japan (July 2002-February 2004)

### **Ph.D. Students**

1. Christopher Carroll, "Application of Optical Signal Processing to Adaptive Phased Array Radar," May 1987.
2. Bruce Montgomery, "On decoding algorithms for linear binary block codes," July 1987.
3. Zouhir Bahri, "Phase-only and binary phase-only filters in optical correlators," September 1989.
4. Michael Lemmon, "Parameter Estimation using competitively inhibited neural networks," April 1990.
5. Laurence Hassebrook, "Linear phase filters and filter banks for distortion-invariant optical pattern recognition," July 1990.
6. James Connelly, "Two-dimensional correlation using one-dimensional acousto-optic devices," October 1990.
7. Ashraf Ali Kassim, "A neural network architecture for generating potential fields," March 1993.
8. Charles Hendrix, "Two-level and three-level filter design for distortion-invariant pattern recognition," August 1993.
9. John Hampshire, "A differential theory of learning for efficient statistical pattern recognition," September 1993.
10. Inci Ozgunes, "Modeling Magneto-Optic Read Channels," December 1995.
11. Khaled Al-Ghoneim, "Learning ranks for pattern recognition," April 1996.
12. Srinivasan Gopalswamy, "Multi-channel signal processing for high track density optical recording systems," May 1996.
13. Daniel Carlson, "Optimal tradeoff composite filters," August 1996.
14. Greg Silvus, "Detection of ultra-high-density magnetic tape signals in the presence of nonlinearities," September 1996.

15. Usha Pillai, "Readback signal simulation and development of data detection techniques for a scanner-based multi-channel optical tape system," January 1999.
16. Venkatesh Vadde, "2-Dimensional equalization, detection and coding for volume holographic data storage," August 1999.
17. Mohamed Alkanhal, "Eigen and nonlinear correlation filters for automatic target recognition," September 2000.
18. Yifei Yuan, "Timing recovery for data storage," December 2000.
19. Mehmet Keskinöz, "Two-dimensional equalization and detection for quadratic storage channels," July 2001.
20. Fatih Sarigoz, "Characterization and mitigation of dropouts in magnetic tape recording: A read channel perspective," September 2001. (co-advisor: Dr. James Bain)
21. Hongwei Song, "Iterative soft detection/decoding for data storage channels," December 2002.
22. Jingfeng Liu, "Timing recovery for low-SNR data storage channels," April 2003.
23. Marios Savvides, "Reduced-Complexity Face Recognition using Advanced Correlation Filters and Fourier subspace Methods for Biometric Applications," April 2004 (co-advisor: Prof. Pradeep Khosla).
24. Xiaoming Liu, "Pose-robust video-based face recognition," October 2004 (co-advisor: Prof. Tsuhan Chen).
25. Lingyan Sun, "Implementation and evaluation of iterative soft detection/decoding using field programmable gate array," August 2005 (Recipient of the Milnes Award for the best Ph.D. thesis in ECE Department, CMU, 2005-2006).
26. Jin Xie, "Timing recovery for data storage using Kalman filters," July 2006.
27. Chunyan Xie, "Class-dependence feature analysis for large population face recognition," August 2006.
28. Krithika Venkataramani, "Optimal classifier ensembles for improved biometric verification," January 2007.
29. Jason Thornton, "Iris pattern matching: a probabilistic model based on discriminative cues," April 2007 (co-advisor: Marios Savvides, Recipient of the Milnes Award for the best Ph.D. thesis in ECE Department, CMU, 2006-2007).
30. Ryan Kerekes, "Combining correlation outputs for enhanced distortion-tolerant target recognition," May 2007.
31. Lakshmi Ramamoorthy, "Advanced coding and signal processing for holographic data storage," February 2008.
32. Xinde Hu, "Low density parity check (LDPC) codes for magnetic recording systems," March 2008.
33. Pablo Hennings, "Simultaneous Super-resolution and recognition," October 2008.
34. Sheida Nabavi, "Signal processing for bit-patterned media channels with inter-track interference," December 2008.

35. Soowoong Lee, "Soft-Decision Decoding of Reed-Solomon Codes Using Successive Algebraic Decoding Algorithm for Magnetic Recording Channels," expected to complete by August 2009.
36. Seungjune Jeon, expected to complete by December 2009.
37. Euseok Hwang, started in June 2007 (co-advisor: Rohit Negi)
38. Vishnu Naresh Boddeti, started in September 2007.
39. Kathy Brigham, started in September 2008.
40. Yibin Ng, started in September 2008.
41. Andres Rodriguez, started in September 2008.

### **Master's Students**

1. Christopher Carroll, October 1983.
2. Craig Rahenkamp, July 1985.
3. Keith DeVos, October 1985.
4. Zouhir Bahri, October 1986.
5. Venugopal Veeravalli, October 1986.
6. Michael Lemmon, December 1987.
7. James Connelly, February 1988.
8. Dean Hering, December 1989 (joint advisor: Prof. P. Khosla)
9. Phillip Wong, May 1990.
10. Wei Shi, August 1990.
11. Charles Hendrix, December 1990.
12. Greg Silvus, November 1991.
13. Daniel Carlson, May 1992.
14. Chu-Lung Chen, August 1993.
15. Hooman Yaghoobi, May 1994.
16. Aida Ibrahim, September 1995.
17. Fatih Sarigoz, May 1996.
18. Magdalena Wong, August 1996.
19. Glen Clark, May 1997.
20. Mehmet Keskinoz, December 1997.
21. Reese Bovard, December 1999.
22. Siriluck Tipmongkonsilp, May 2000.
23. Rajan Singh, May 2002.
24. Krithika Venkataramani, December 2002.
25. Shilpi Sahu, December 2002.

26. Jason Thornton, December 2003.
27. Mike Beattie, December 2004.
28. Sheida Nabavi, May 2005.
29. Ryan Kerekes, May 2005.
30. Euseok Hwang, May 2008.
31. She-Hwan Jung, expected completion December 2009.

## MAJOR RESEARCH CONTRIBUTIONS

### Correlation Filters

- Developed the concept of **composite correlation filters**, designed to handle the lack of tolerance of matched filters to common image distortions such as rotations and scale changes.
- Introduced the use of constrained optimization methods in the design of **minimum variance synthetic discriminant function (MVSDF) filters** that have maximum tolerance to input noise
- With Abhijit Mahalanobis and Dave Casasent, developed the **minimum average correlation energy (MACE) filters** designed to produce sharp correlation peaks and achieve very good discrimination; this ground-breaking work was the first to approach correlation filter design in the spatial frequency domain, leading to a computationally-friendly, closed form filter solution.
- With graduate students and colleagues, introduced several other advanced composite correlation filter designs including **unconstrained filters** (to improve their generalization capability), **distance classifier correlation filters** (to make use of the entire correlation output rather than just the peak value), **polynomial correlation filters** (to increase the versatility of correlation filters by allowing point nonlinearities of input images), **optimal trade-off circular harmonic function filters** (to achieve desired filter response to in-plane rotations) and **Mellin radial harmonic (MRH) filters** (to achieve desired filter response to in-plane scale changes).
- Developed algorithms to design optimal correlation filters that can be implemented on optical processors that use **limited-modulation devices** in the filter plane; this work resulted in several advances to **phase-only, binary phase-only, complex ternary and cross-coupled correlation filters**.
- With colleagues from industry and government labs, demonstrated the application of correlation filters for several **automatic target recognition** tasks based on images collected using optical, synthetic aperture radar, infrared and LADAR sensors.
- Developed the **statistical modeling** to quantify the relationships between the number of training images used and the resulting performance from correlation filters.
- Developed **correlation filter performance metrics** such as signal-to-noise ratio (SNR), peak-to-correlation energy (PCE) and light throughput efficiency.
- Extended the correlation filters to **multi-frame, multi-view and multi-filter processing**. This offers us the ability to extract maximum detection information in situations involving video sequences, multiple cameras and multiple correlation filters.

### Biometrics (much of this, jointly with Marios Savvides)

- Developed and demonstrated **correlation filters for biometric recognition**; introduced the face recognition research community to the advantages of using frequency domain methods; developed a **correlation-filter based face verification demo** to illustrate the approach.
- Developed **reduced-complexity correlation filters**, suitable for implementation on limited-capability platforms.
- Developed **Eigenphase** method, an improvement over the Eigenface method introduced for face recognition; Eigenphases is built on the understanding that phase is more important than the magnitude in the Fourier transform of face images.
- Combined the best features of the correlation filters and Eigenfaces methods to introduce a new shift-invariant approach called **CoreFaces** for face recognition.

- With colleagues from Mytec (now BioScript), developed a method for **encryption using biometric signatures** such as fingerprint.
- Demonstrated the use of correlation filters for other biometric modalities such as **palmprint** recognition.
- Developed **cancelable biometrics**, which allow us to reuse the same biometric signature (e.g., same face image) even when the smart card with the template is lost or stolen.
- Developed **face authentication from cell phone camera images** containing illumination and pose variations.
- Developed a new approach called **class-dependence feature analysis (CFA)** that extends the correlation filter approach to take advantage of the availability of generic training sets; using CFA, **achieved excellent performance in the face recognition grand challenge (FRGC)**.
- Developed a new **probabilistic framework for correlation filters** to take into account spatially-varying deformations in iris imagery; using this new approach, achieved **outstanding verification results in the iris challenge evaluation (ICE)**.

#### **Low-Density Parity Check (LDPC) Codes**

- Developed **structured LDPC codes** of potential use in magnetic recording systems; structured LDPC codes have parity check matrices with nonzero elements in well-defined locations, making their implementation easier than LDPC codes with random parity check matrices.
- Showed that use of LDPC codes can lead to **increased storage density** (for a given target bit error rate) using real signals from magnetic tape recording test stand.
- Developed a **field programmable gate array (FPGA) platform** for the evaluation of channels employing generalized structured LDPC codes; using this platform, demonstrated bit error rates down to  $10^{-12}$ .
- Developed methods to **combine the run-length constraints with LDPC codes**; run-length constraints are needed in magnetic and optical data storage systems to reduce inter-symbol interference and improve timing recovery.
- **Extended the FPGA LDPC code evaluation platform to longitudinal and perpendicular magnetic recording channels with realistic impairments** such as transition noise, nonlinear transition shift, partial erasure and transition percolation.

#### **Timing Recovery for Data Storage**

- Introduced a new timing recovery method (called the **Dual-segmented Kalman Filter-based Timing Recovery or DSKSTR**), that reduces the loss of lock (also called cycle slip, leading to mis-indexing of detected bits which lead to the entire sectors failing) rate at low signal-to-noise ratios by almost three orders of magnitude in magnetic recording simulations.
- Introduced new acquisition (i.e., the early stage of timing recovery, based on a known preamble pattern) methods, called extended digital zero-phase start (**EDZPS**) and digital zero frequency/phase start (**DZF/PS**) to cope with low SNRs and higher timing disturbances in future high-density magnetic recording systems.
- Developed **Kalman filter-based timing recovery methods to deal with low SNR**; showed that these approaches can handle large frequency offset in zero-phase start, provide optimal loop gains as a function of loop delay and improved loss of lock rates in the presence of dropouts.

#### **Equalization/Detection for Data storage**

- Developed **channel models** and analyzed equalization/detection methods for magneto-optic recording systems exhibiting **transition noise**.
- Developed **nonlinear channel identification** methods for magnetic tape recording systems exhibiting nonlinear effects such as nonlinear transition shift, partial erasure, etc.
- Developed and analyzed **multi-track equalization/detection** methods for data storage systems reading multiple adjacent tracks in parallel.
- Developed **channel models for page-oriented holographic data storage** systems exhibiting complicated noise sources (electronic noise as well as complex light field noise) as well as nonlinearity induced by intensity detection by the output camera.
- Developed novel **2-D equalization and detection** methods suitable for page-oriented holographic data storage.

- Developed a **model for dropouts** in magnetic tape recording systems and proposed a **dropout-compensation** method.
- Developing **coding and signal processing methods for bit-patterned media**.

#### Artificial Neural Networks

- Developed the mathematical models for **competitively inhibited neural networks**.
- Developed a planar neural network architecture called **wave expansion neural network**, useful for problems involving shortest path selection.
- Showed that the conventional artificial neural network training methods based on minimum squared error are suboptimal for pattern recognition applications and proposed a new metric called the **Classification Figure of Merit (CFM)**, better suited for pattern recognition.
- Extended the CFM metric to **ranking figure of merit**, to accommodate the case where individual classifiers provide relative rankings of the input pattern into multiple classes.

#### Others

- Developed and evaluated **optical processing architectures to generate ambiguity functions of sonar signals**
- Developed and analyzed methods to **process signals using their Wigner distributions**; Wigner distribution is one example of a joint time-frequency representation of signals
- Investigated methods to implement **adaptive radar array computations using optical processors**.
- Developed improved methods for **minimum distance decoding** of error correcting codes.
- Developed an **acousto-optic correlator** for achieving 2-D correlations using 1-D processors.
- Developed channel models and equalization/detection methods for an **optical tape recording system employing a sinusoidal scanner**, where the relationship between space on the tape and time in the readback is sinusoidal and hence nonlinear.
- Developed **image processing and pattern recognition methods for disk forensics**.
- Showed that composite correlation filters can be used to achieve **rotation-tolerant watermark detection**.

#### BOOKS

1. B.V.K. Vijaya Kumar, A. Mahalanobis and Richard Juday, **Correlation Pattern Recognition**, Cambridge University Press, United Kingdom, November 2005.
2. B.V.K. Vijaya Kumar and H. Kobori, editors, **Proc. of Optical Data Storage 2004**, SPIE, October 2004.
3. V. Bhagavatula, V. Govindaraju, editors, **Proc. of the Fourth IEEE Workshop on Automatic Identification Advanced Technologies**, Buffalo, NY, October 17-18, 2005.
4. B.V.K. Vijaya Kumar, S. Prabhakar and A. Ross, editors, **Proc. of Biometric Technology for Human Identification V**, vol. 6944, SPIE, March 2008.

#### BOOK CHAPTERS

1. D. Casasent and B.V.K. Vijaya Kumar, "Optical linear algebra processors," Chapter 6.1, *Optical Signal Processing* (edited by J.L. Horner), Academic Press, 389-407, 1987.
2. M. Lemmon and B.V.K. Vijaya Kumar, "Competitively Inhibited Neural Networks: Analysis and Applications," Chapter 3 in *Neural Networks: Concepts, Applications and Implementations, Vol. III*, 48-83, Prentice-Hall, 1991.
3. B.V.K. Vijaya Kumar and P. Wong, "Optical Associative Memories," Chapter in *Artificial Neural Networks and Statistical Pattern Recognition: Old and New Connections*, 219-241, North-Holland, 1991.

4. B.V.K. Vijaya Kumar, "Optical Pattern Recognition," Chapter in *Optical Signal Processing*, 39-88, Academic Press, 1994.
5. A. Kassim and B.V.K. Vijaya Kumar, "Artificial potential fields and neural networks," Chapter in *The Handbook of Brain Theory and Neural Networks*, edited by Michael Arbib, 749-753, Bradford Books, 1995.
6. C. Soutar, D. Roberge, A. Stoianov, R. Gilroy and B.V.K. Vijaya Kumar, "Biometric Encryption™," Chapter 22 in *ICSA Guide to Cryptography*, edited by Randall K. Nicholls, 649-675, 1999.
7. B.V.K. Vijaya Kumar, V. Vadde and M. Keskinöz, "Equalization for volume holographic data storage systems," chapter in *Holographic Data Storage* (editors: H. Coufal, D. Psaltis and G. T. Sincerbox), 309-317, Springer, Heidelberg, Germany 2000.
8. J. Liu and B.V.K. Vijaya Kumar, "Modulation and Coding," chapter in *Encyclopedia of Optical Engineering* (eds. R.B. Johnson and E. Lichtenstein), online supplement, Marcel Dekker, New York, NY, 2003.
9. H. Song and B.V.K. Vijaya Kumar, "Iterative codes in magnetic storage systems," chapter in *Turbo Codes Applications: a journey from a paper to realizations* (ed: Keattisak Sripimanwat), 17-44, Springer, Netherlands, 2005.
10. M. Savvides, B.V.K. Vijaya Kumar and P. Khosla, "COREFACES: A shift-invariant principal component analysis (PCA) correlation filter bank for illumination-tolerant face recognition," Chapter 5, *Face Biometrics for Personal Identification* (eds: R. Hammoud, B.R. Abidi and M.A. Abidi), 61-71, Springer, 2007.
11. J. Thornton, M. Savvides and B.V.K. Vijaya Kumar, "Improved iris verification using probabilistic information from correlation filters," chapter in *Advances in Biometrics: Sensors, Systems and Algorithms* (eds: N. Ratha and V. Govindaraju), 265-285, Springer, 2008.
12. C. Xie and B.V.K. Vijaya Kumar, "Large population face recognition (LPFR) using correlation filters," chapter in *Advances in Biometrics: Sensors, Systems and Algorithms* (eds: N. Ratha and V. Govindaraju), 363-382, Springer, 2008.
13. K. Venkataramani and B.V.K. Vijaya Kumar, "Designing classifiers for fusion-based biometric verification," chapter in *Biometrics: Theory, Methods and Applications*, Wiley/IEEE, 2008.

#### **PUBLICATIONS IN CONFERENCE PROCEEDINGS**

1. D. Casasent, B.V.K. Vijaya Kumar, and T. Tullia "A coherent optical signal processor for passive ambiguity function generation," *Proc. of 8th IOCC*, IEEE Computer Society Press, 96-100, 1979.
2. D. Casasent and B.V.K. Vijaya Kumar, "Optical passive ambiguity surface computation for sonar signal processing," *Proc. of EASCON 79*, IEEE Press, 595-601, 1979.
3. D. Casasent, D. Psaltis, B.V.K. Vijaya Kumar and M. Carlotto, "Optical processors for adaptive phased array radars," *Proc. of SPIE*, vol. 209, 47-52, 1979.
4. D. Casasent and B.V.K. Vijaya Kumar, "Processing flexibility by hybrid optical/digital techniques," *Proc. of the Workshop on Future Directions of Optical Data Processing*, Texas Tech. University, Lubbock, 17-25, 1980.
5. D. Casasent, S. Eiva and B.V.K. Vijaya Kumar, "Image quality effects in optical correlators," *Proc. of SPIE*, vol. 310, 183-92, 1981.

6. D. Casasent, B.V.K. Vijaya Kumar and H. Murakami, "A correlator for optimum 2-class discrimination," *Proc. of EOSD Conference*, Anaheim, California, 321-30, 1981.
7. D. Casasent, B.V.K. Vijaya Kumar, and V. Sharma, "Synthetic discriminant functions for 3-D object recognition," *Proc. of SPIE*, vol. 360, 136-42, 1982.
8. B.V.K. Vijaya Kumar and C. Carroll, "Pattern Recognition using Wigner distribution function," *Proc. of 10th IOCC*, IEEE Computer Society Press, 130-36, 1983.
9. B.V.K. Vijaya Kumar, E. Pochapsky and D. Casasent, "Optimality considerations in modified matched spatial filters," *Proc. of SPIE*, vol. 519, 85-93, 1984.
10. B.V.K. Vijaya Kumar, "Role of Wigner distribution function in pattern recognition," *Proc. of SPIE*, vol. 521, 44-52, 1984.
11. B.V.K. Vijaya Kumar and C. Rahenkamp, "An optical/digital hybrid system for calculating geometric moments," *Proc. of SPIE*, vol. 579, 215-224, 1985.
12. B.V.K. Vijaya Kumar, "Optimality of projection synthetic discriminant functions," *Proc. of SPIE*, vol. 579, 86-95, 1985.
13. B.V.K. Vijaya Kumar and C. Rahenkamp "Performance of a hybrid processor to compute geometric moments," *Proc. of SPIE*, vol. 638, 32-40, 1986.
14. B.V.K. Vijaya Kumar "Geometric moments from Hartley transform intensities," *Proc. of SPIE*, vol. 639, 253-59, 1986.
15. B. Montgomery and B.V.K. Vijaya Kumar "Nearest neighbor non-iterative error-correcting optical associative processor," *Proc. of SPIE*, vol. 638, 83-90, 1986.
16. B.V.K. Vijaya Kumar and S. Rajan, "Subpixel delay estimation using group delay functions," *Proc. of SPIE*, vol. 697, 187-196, Aug. 1986.
17. B. Montgomery and B.V.K. Vijaya Kumar, "A general minimum distance decoding procedure for binary linear block codes," *Digest of Abstracts, International Symposium on Information Theory*, Ann Arbor, Michigan, 1986.
18. B. Montgomery, B.V.K. Vijaya Kumar and H. Diamond "On the average codeword length of optimal binary codes for extended sources," *Digest of Abstracts, International Symposium on Information Theory*, Ann Arbor, Michigan, 1986.
19. Z. Bahri and B.V.K. Vijaya Kumar "Computational considerations in the determination of synthetic discriminant functions," *Proc. of SPIE*, vol. 726, 46-55, 1986.
20. D. Casasent, B.V.K. Vijaya Kumar and Y. Lin, "Subpixel target detection and tracking," *Proc. of SPIE*, vol. 726, 206-220, 1986.
21. B.V.K. Vijaya Kumar and C. Carroll, "Variable accuracy optical matrix/vector processors - Speed/Accuracy tradeoffs," *Proc. of SPIE*, vol. 752, 179-186, 1987.
22. B.V.K. Vijaya Kumar, Z. Bahri and A. Mahalanobis, "Optimal synthetic discriminant functions based on intensity constraints," *Technical Digest of OSA Topical Meeting on Machine Vision*, vol. 12, 54-57, 1987.

23. M. Lemmon and B.V.K. Vijaya Kumar, "Representing lattice-ordered associative memories with artificial neural networks," *Proc. IEEE International Symposium on Circuits and Systems*, 362-365, 1987.
24. M. Lemmon and B.V.K. Vijaya Kumar, "Neural Networks as Associative Mappings," *Proc. of IEEE First Annual International Conference on Neural Networks*, vol. II, 213-222, 1987.
25. B.V.K. Vijaya Kumar and K. DeVos, "Linear system description using Wigner Distribution functions," *Proc. of SPIE*, vol. 826, 115-124, 1987.
26. C. Carroll and B.V.K. Vijaya Kumar, "Iterative Fourier transform phased array Radar pattern synthesis," *Proc. of SPIE*, vol. 827, 73-84, 1987.
27. B.V.K. Vijaya Kumar and Z. Bahri, "Frequency domain characterization of synthetic discriminant functions," *Proc. of SPIE*, vol. 848, 56-62, 1987.
28. B.V.K. Vijaya Kumar and Z. Bahri, "Optimality of phase-only filters," *Proc. of SPIE*, vol. 884, 146-152, 1988.
29. C. Carroll and B.V.K. Vijaya Kumar, "Adaptive phased-array radar processing on a multi-channel, acousto-optic linear algebra system: experimental results," *Proc. of SPIE*, vol. 886, 203-212, 1988.
30. C. Carroll and B.V.K. Vijaya Kumar, "Application of optical processing to adaptive phased array radar," *Proc. of SPIE*, vol. 936, 142-151, 1988.
31. B.V.K. Vijaya Kumar, A. Lee and J. Connelly, "Correlation filters for orientation estimation," *Proc. of SPIE*, vol. 938, 190-197, 1988.
32. B.V.K. Vijaya Kumar, "Hybrid methods to compute image moments," *Proc. of SPIE*, vol. 939, 121-126, 1988.
33. A. Rakes, C. Hester, R. Inguva and B.V.K. Vijaya Kumar, "Wigner distribution function/ambiguity function processor," *Proc. of SPIE*, vol. 936, 260-269, April 1988.
34. B.V.K. Vijaya Kumar, Z. Bahri and L. Hassebrook, "Review of Synthetic Discriminant Function algorithms," *Proc. of SPIE*, vol. 960, 18-28, 1988.
35. Z. Bahri and B.V.K. Vijaya Kumar, "Performance of optimal phase-only filters," *Proc. of SPIE*, vol. 1005, 58-63, 1988.
36. L. Hassebrook, B.V.K. Vijaya Kumar and L. Hostetler, "Linear Phase Coefficient Composite Filters for Optical Pattern Recognition," *Proc. of SPIE*, vol. 1053, 218-226, 1989.
37. B.V.K. Vijaya Kumar and Z. Bahri, "Selection of optimum pass band for binary phase-only filters," *Proc. of SPIE*, vol. 1053, 227-232, 1989.
38. M. Lemmon and B.V.K. Vijaya Kumar, "Competitively Inhibited Optical Neural Networks using Two Step Holographic Materials," *OSA Technical Digest on Optical Computing*, 36-39, 1989.
39. M. Lemmon and B.V.K. Vijaya Kumar, "A Model for Self-organization in WTA Networks and its application to MAP Prediction Problems," *Proc. of IJCNN*, vol. II, 509-516, 1989.
40. B.V.K. Vijaya Kumar and J. Connelly, "Effects of Quantizing the Phase in Correlation Filters," *Proc. of SPIE*, vol. 1151, 166-173, 1989.
41. B.V.K. Vijaya Kumar and M. Lemmon, "Efficient algorithm for predicting the response of a laterally inhibited neural network," *Proc. of SPIE*, vol. 1154, 63-70, 1989.

42. Z. Bahri and B.V.K. Vijaya Kumar, "Algorithms for Designing Phase-only Synthetic Discriminant Functions," *Proc. of SPIE*, vol. 1151, 138-147, 1989.
43. Z. Bahri and B.V.K. Vijaya Kumar, "Design of Partial Information Filters for Optical Correlators," *Proc. of IEEE Intl. Conf. on Sys. Man and Cybernetics*, 421-426, 1989.
44. D. Hering, P. Khosla and B.V.K. Vijaya Kumar, "The use of Modular Neural Networks in Tactile Sensing," *Proc. of IJCNN*, vol. II, 355-358, 1990.
45. B.V.K. Vijaya Kumar and L. Hassebrook, "Trade-offs in nonlinearly recorded matched filters," *Proc. of SPIE*, vol. 1296, 54-60, 1990.
46. B.V.K. Vijaya Kumar, C. Hendrix and W. Shi, "An algorithm for designing phase-only filters with maximally sharp correlation peaks," *Proc. of SPIE*, vol. 1296, 132-139, 1990.
47. Z. Bahri and B.V.K. Vijaya Kumar, "Binary Phase-Only Synthetic Discriminant Function (BPOSDF) designed using the Successive Forcing Algorithm," *Proc. of SPIE*, vol. 1297, 188-193, 1990.
48. M. Lemmon and B.V.K. Vijaya Kumar, "Competitive Learning's Global Search Property," *Proc. of IJCNN*, vol. III, 837-842, 1990.
49. M. Lemmon and B.V.K. Vijaya Kumar, "Learning in Competitively Inhibited Neural Nets," *Proc. of IJCNN*, vol. III, 477-482, 1990.
50. B.V.K. Vijaya Kumar and J. Connelly, "Binarization effects in acousto-optic correlators," *Proc. of SPIE*, vol. 1347, 112-122, 1990.
51. B.V.K. Vijaya Kumar, R. Juday and S. Rajan, "Maximization of SNR of filters for optical pattern recognition under the condition of input and detector noise," *Proc. of IEEE International Symposium on Circuits and Systems*, 2637-2640, 1991.
52. B.V.K. Vijaya Kumar, V. Liang and R. Juday, "Optimal phase-only correlation filters in colored scene noise," *Proc. of SPIE*, vol. 1555, 138-145, 1991.
53. B.V.K. Vijaya Kumar and D. Carlson, "Optimal correlation filters for implementation on deformable mirror devices," *Proc. of SPIE*, vol. 1558, 476-486, 1991.
54. C. Hendrix, B.V.K. Vijaya Kumar, T. Stalker, B. Kast and R. Shori "Design and testing of 3-level optimal correlation filters," *Proc. of SPIE*, vol. 1564, 2-13, 1991.
55. J. Connelly, B.V.K. Vijaya Kumar, P. Molley, T. Stalker and B. Kast, "Design and experimental testing of minimum average correlation energy filters on acousto-optic 2-D correlators," *Proc. of SPIE*, vol. 1564, 572-592, 1991.
56. B.V.K. Vijaya Kumar, C. Hendrix and D. Carlson, "Tradeoff in the design of correlation filters," *Proc. of SPIE*, vol. CR-40, 191-215, 1991.
57. B.V.K. Vijaya Kumar and C. Hendrix, "Phase-only and binary phase-only filters that best approximate the classical matched filters," *Proc. of SPIE*, vol. 1701, 112-120, 1992.
58. B.V.K. Vijaya Kumar, R. Juday and D. Carlson, "Bias in correlation peak location," *Proc. of SPIE*, vol. 1701, 149-158, 1992.
59. S.R.F. Sims, J. Epperson, B.V.K. Vijaya Kumar and A. Mahalanobis, "Synthetic discriminant function (SDF) filter performance evaluations," *Proc. of SPIE*, vol. 1701, 169-177, 1992.

60. L. Hassebrook, M. Rahmati and B.V.K. Vijaya Kumar, "Hybrid composite filter banks for optical pattern recognition," *Proc. of SPIE*, vol. 1701, 217-228, 1992.
61. J. Hampshire and B.V.K. Vijaya Kumar, "Shooting craps in search of an optimal strategy for training connectionist pattern classifiers," *Advances in Neural Information Processing Systems*, vol. 4, 1125-1132, Morgan Kaufman, 1992.
62. J. Hampshire and B.V.K. Vijaya Kumar, "Why error measures are sub-optimal for training neural network pattern classifiers," *Proc. of IJCNN*, vol. IV, 220-227, 1992.
63. A. Kassim and B.V.K. Vijaya Kumar, "A neural network architecture for path planning," *Proc. of IJCNN*, vol. II, 787-792, 1992.
64. A. Kassim and B.V.K. Vijaya Kumar, "Neural network architecture for generating potential fields for motion planning," *Proc. of SPIE*, vol. 1766, 94-105, 1992.
65. D. Carlson and B.V.K. Vijaya Kumar, "Optimal synthetic discriminant functions for implementation on arbitrarily constrained devices," *Proc. of SPIE*, vol. 1772, 10-20, 1992.
66. C. Hendrix and B.V.K. Vijaya Kumar, "Iterative algorithm for designing binary phase-only composite filters," *Proc. of SPIE*, vol. 1772, 184-191, 1992.
67. C. Chen and B.V.K. Vijaya Kumar, "Improved distortion-invariant pattern recognition through synthesizing similar training images into a composite image," *Proc. of SPIE*, vol. 1812, 219-226, 1992.
68. J. Brasher, J. Kinser, B.V.K. Vijaya Kumar and C. Chen, "Correlation filters assessed in terms of probability of detection and probability of false alarm," *Proc. of SPIE*, vol. 1959, 12-22, 1993.
69. B.V.K. Vijaya Kumar, J. Brasher, C. Hester, G. Srinivasan and S. Bollapragada, "Role of the constraint values in synthetic discriminant function (SDF) filter design," *Proc. of SPIE*, vol. 1959, 23-31, 1993.
70. M. Rahmati, L. Hassebrook and B.V.K. Vijaya Kumar, "Automatic target recognition with intensity and distortion-invariant hybrid composite filters," *Proc. of SPIE*, vol. 1959, 133-145, 1993.
71. S.R.F. Sims, J. Epperson, B.V.K. Vijaya Kumar and A. Mahalanobis, "Synthetic discriminant function using relaxed constraints," *Proc. of SPIE*, vol. 1959, 146-157, 1993.
72. B.V.K. Vijaya Kumar and C. Hendrix, "Choice of threshold line angle for binary phase-only filters," *Proc. of SPIE*, vol. 1959, 170-177, 1993.
73. J. Hampshire and B.V.K. Vijaya Kumar, "Differential theory of learning for efficient neural network pattern recognition," *Proc. of SPIE*, vol. 1966, 76-95, 1993.
74. J. Hampshire and B.V.K. Vijaya Kumar, "Differential learning leads to efficient neural network classifiers," *Proc. of ICASSP*, vol. I, 613-616, 1993.
75. J. Hampshire and B.V.K. Vijaya Kumar, "Differentially generated neural network classifiers are efficient," *Neural Networks for Signal Processing III: Proceedings of the 1993 IEEE Workshop*, 151-160, 1993.
76. B.V.K. Vijaya Kumar, J. Brasher and C. Hester, "Nonlinear decision boundaries using complex constraints in synthetic discriminant function filters," *Proc. of SPIE*, vol. 2026, 88-99, 1993.
77. A. Mahalanobis, B.V.K. Vijaya Kumar and S.R.F. Sims, "Distance classifier correlation filters for distortion tolerance, discrimination, and clutter rejection," *Proc. of SPIE*, vol. 2026, 325-335, 1993.

78. B.V.K. Vijaya Kumar and S. Bollapragada, "Pruning of the training sets used for synthetic discriminant function filter design," *Proc. of SPIE*, vol. 2237, 14-18, 1994.
79. C. Hendrix and B.V.K. Vijaya Kumar, "Comparative evaluation of binary phase-only synthetic discriminant function filters," *Proc. of SPIE*, vol. 2237, 102-113, 1994.
80. R. Juday, S. Monroe and B.V.K. Vijaya Kumar, "Correlation peak shifts between phase-matched and maximum-intensity correlation," *Proc. of SPIE*, vol. 2237, 114-123, 1994.
81. A. Mahalanobis, D. Carlson, B.V.K. Vijaya Kumar and S.R.F. Sims, "Distance classifier correlation filters," *Proc. of SPIE*, vol. 2238, 2-13, 1994.
82. J. Hampshire and B.V.K. Vijaya Kumar, "Efficient autonomous learning for statistical pattern recognition," *Proc. of SPIE*, vol. 2243, 90-110, 1994.
83. A. Kassim and B.V.K. Vijaya Kumar, "Application of the wave expansion neural network (WENN) to path planning problems," *Proc. of SPIE*, vol. 2243, 406-419, 1994.
84. B.V.K. Vijaya Kumar and C. Hendrix, "Two or three levels? A comparison of the two level and three level filters for optical pattern recognition," *Proc. of Euro-American Optical Pattern Recognition Workshop*, 1994.
85. I. Ozgunes and B.V.K. Vijaya Kumar, "Signal-to-noise ratio performance of Magneto-Optic read channels in the presence of bloom," *Proc. of SPIE*, vol. 2338, 319-327, 1994.
86. S. Gopaldaswamy and B.V.K. Vijaya Kumar, "Channel model for an optical tape system," *Proc. of SPIE*, vol. 2338, 222-229, 1994.
87. S. Gopaldaswamy and B.V.K. Vijaya Kumar, "Multi-channel Readback Model for an Optical Tape System," *Proc. of Globecom '94*, 1472-1476, 1994.
88. B.V.K. Vijaya Kumar and A. Mahalanobis, "Recent advances in distortion-invariant correlation filter design," *Proc. of SPIE*, vol. 2490, 2-13, 1995.
89. B.V.K. Vijaya Kumar, D. Carlson, W. Friday, G. Davenport and A. Mahalanobis "Design and testing of correlation filters for cross-coupled devices," *Proc. of SPIE*, vol. 2490, 194-205, 1995.
90. K. Al-Ghoneim and B.V.K. Vijaya Kumar, "Learning ranks with neural networks," *Proc. of SPIE*, vol. 2492, 446-464, 1995.
91. S.R.F. Sims, A. Mahalanobis and B.V.K. Vijaya Kumar, "Evaluation of generalized distance classifier filters for multi-class automatic target recognition," *Proc. of SPIE*, vol. 2485, 238-248, 1995.
92. A. Mahalanobis, B.V.K. Vijaya Kumar and S.R.F. Sims, "Distance classifier correlation filters using multiple eigenvectors for enhanced class separation," *Proc. of SPIE*, vol. 2565, 50-61, 1995.
93. B.V.K. Vijaya Kumar, D. Carlson and A. Mahalanobis, "Efficient computation of optimum gain and angle in the design of filters for cross-coupled devices," *Proc. of SPIE*, vol. 2565, 166-174, 1995.
94. R. Juday and B.V.K. Vijaya Kumar, "Balancing among filtering objectives in coupled SDFS," *Proc. of SPIE*, vol. 2565, 175-178, 1995.
95. G. Silvas and B.V.K. Vijaya Kumar, "A simple two-dimensional run-length-limited code for ultra-high-density magnetic tape recording," *Proc. of ICC*, 633-637, 1995.

96. G. Silvus and B.V.K. Vijaya Kumar, "A non-linear signal model for magnetic-tape recording channels utilizing magneto-resistive heads," *Proc. of SPIE*, vol. 2604, 192-199, 1995.
97. G. Silvus and B.V.K. Vijaya Kumar, "Convergence times of timing-recovery schemes for magneto-resistive magnetic-recording channels," *Proc. of SPIE*, vol. 2604, 246-255, 1995.
98. A. Ibrahim, F. Sarigoz and B.V.K. Vijaya Kumar, "Equalization of magnetic recording signals using Artificial Neural Networks," *Proc. of SPIE*, vol. 2605, 58-64, 1995.
99. S. Gopaldaswamy and B.V.K. Vijaya Kumar, "Decision feedback equalization with multi-channel readback in high density optical recording," *Proc. of SPIE*, vol. 2605, 65-76, 1995.
100. I. Ozgunes and B.V.K. Vijaya Kumar, "Adaptive partial response (PR) signaling for magneto-optic read channels in the presence of transition noise," *Proc. of SPIE*, vol. 2605, 77-83, 1995.
101. D. Carlson, B.V.K. Vijaya Kumar, R. Juday and A. Mahalanobis, "MEDOF 3.0: Optimizing composite filters in the presence of device constraints and systems noise" *Proc. of SPIE*, vol. 2752, 31-38, 1996.
102. T. Ng and B.V.K. Vijaya Kumar, "MACE-type correlation filter with controlled in-plane rotation response," *Proc. of SPIE*, vol. 2752, 57-68, 1996.
103. A. Mahalanobis and B.V.K. Vijaya Kumar, "Prediction and comparison of performance of correlation filters," *Proc. of SPIE*, vol. 2754, 136-141, 1996.
104. D. Carlson, B.V.K. Vijaya Kumar, R. Mitchell and M. Hoffelder, "Composite correlation filters for SAR image recognition," *Proc. of SPIE*, vol. 2757, 338-349, 1996.
105. K. Al-Ghoneim and B.V.K. Vijaya Kumar, "Combining neural networks using the ranking figure of merit," *Proc. of SPIE*, vol. 2760, 2-13, 1996.
106. M. Alkanhal, B.V.K. Vijaya Kumar and A. Mahalanobis, "Combining multiple correlators using neural networks," *Proc. of SPIE*, vol. 3073, 398-403, 1997.
107. D. Carlson, B.V.K. Vijaya Kumar, R. Mitchell and M. Hoffelder, "Optimal trade-off distance classifier correlation filters (OTDCCFs) for SAR ATR," *Proc. of SPIE*, vol. 3070, 110-120, 1997.
108. A. Mahalanobis and B.V.K. Vijaya Kumar, "Polynomial filters for higher-order correlation and multi-input information fusion" *Proc. of Euro-American Optoelectronic Information Processing workshop*, 221-231, 1997.
109. V. Vadde and B.V.K. Vijaya Kumar, "Channel Estimation and Intra-page Equalization for Digital Volume Holographic Data Storage," *Proc. SPIE, Optical Data Storage*, vol. 3109, 250-255, 1997.
110. G. Silvus and B.V.K. Vijaya Kumar, "Synchronization Timing Recovery for Magneto-resistive-head Magnetic-recording Channels," *Digest of INTERMAG*, 1997, BS-16 -BS-16.
111. S. Gopaldaswamy and B.V.K. Vijaya Kumar, "Multi channel Equalization for MO PWM Channels," *Digest of INTERMAG*, 1997, FQ-13 -FQ-13.
112. C. Soutar, D. Roberge, A. Stoianov, R. Gilroy and B.V.K. Vijaya Kumar, "Biometric encryption using image processing," *Proc. of SPIE*, vol. 3314, 178-188, 1998.
113. A. Mahalanobis, B.V.K. Vijaya Kumar and D. Carlson, "Evaluation of MACH and DCCF correlation filters for SAR ATR using the MSTAR public database," *Proc. of SPIE*, vol. 3370, 460-468, 1998.

114. K. Al-Ghoneim and B.V.K. Vijaya Kumar, "Combining focused MACE filters for target detection," *Proc. of SPIE*, vol. 3371, 242-252, 1998.
115. B.V.K. Vijaya Kumar, A. Mahalanobis and A. Takessian, "Optimal trade-off correlation filter with controlled in-plane rotation response for target recognition," *Proc. of SPIE*, vol. 3371, 253-262, 1998.
116. A. Mahalanobis and B.V.K. Vijaya Kumar, "Important differences between distance classifier correlation filters (DCCFs) and Fisher linear discriminant functions (LDFs)," *Proc. of SPIE*, vol. 3371, 263-274, 1998.
117. C. Soutar, D. Roberge, A. Stoianov, R. Gilroy and B.V.K. Vijaya Kumar, "Biometric encryption - Enrollment and Verification Procedures," *Proc. of SPIE*, vol. 3386, 24-35, 1998.
118. D. Roberge, C. Soutar and B.V.K. Vijaya Kumar, "Optimal correlation filter for fingerprint identification," *Proc. of SPIE*, vol. 3386, 123-133, 1998.
119. K. Al-Ghoneim and B.V.K. Vijaya Kumar, "Combining focused MACE filters for pose estimation," *Proc. of SPIE*, vol. 3386, 260-271, 1998.
120. V. Vadde, B.V.K. Vijaya Kumar, G. Burr, H. Coufal, J. Hoffnagle and R. Jefferson "A figure of merit for the optical aperture used in digital volume holographic data storage," *Proc. of SPIE*, vol. 3401, 194-200, 1998.
121. F. Sarigoz, B.V.K. Vijaya Kumar, and M. Kowarz, "Tilt analysis of readback signals from DVD-ROM media," *Proc. of SPIE*, vol. 3401, 232-241, 1998.
122. "A simple nonlinear channel model for phase change optical recording media," *Proc. of SPIE*, Vol. 3401, 187-193, 1998 (Yuan and Kumar)
123. U. Pillai and B.V.K. Vijaya Kumar, "Channel simulation and development of signal processing techniques for a scanner based optical storage system," *Proc. of SPIE*, vol. 3401, 170-176, 1998.
124. I. Ozgunes, K. Hacioglu and B.V.K. Vijaya Kumar, "Recurrent neural network equalization (RNNE) for partial response (PR) shaping of Magneto-Optical (MO) readback signals," *Proc. of SPIE*, vol. 3401, 159-167, 1998.
125. V. Vadde and B.V.K. Vijaya Kumar, "Digital equalization for optical distortions in volume holographic data storage systems," *Technical Digest of Optics in Computing*, 84-88, 1999, Optical Society of America.
126. K. Al-Mashouq, M. Alkanhal and B.V.K. Vijaya Kumar, "Analysis of signal-to-noise ratio at the output of polynomial correlation filters," *Proc. Of SPIE*, vol. 3715, 407-413, 1999.
127. M. Alkanhal, B.V.K. Vijaya Kumar and A. Mahalanobis, "Improving the false alarm capabilities of composite correlation filters," *Proc. Of SPIE*, vol. 3718, 358-367, 1999.
128. B.V.K. Vijaya Kumar, M. Alkanhal and A. Mahalanobis, "Effect of constraint phases on the clutter rejection performance of SDF filters," *Proc. Of SPIE*, vol. 3718, 368-375, 1999.
129. A. Mahalanobis, L. Ortiz and B.V.K. Vijaya Kumar, "Performance of the MACH/DCCF algorithms on the 10-class public release MSTAR data set," *Proc. Of SPIE*, vol. 3721, 285-291, 1999.
130. M. Keskinoz and B.V.K. Vijaya Kumar, "Linear minimum mean squared error (LMMSE) equalization for holographic data storage," *Proc. Of ICC*, 1957-1961, 1999.

131. V. Vadde and B.V.K. Vijaya Kumar, "Partial response equalization for grayscale volume holographic data storage," *Technical Digest, Joint ISOM/ODS*, 97-99, 1999.
132. Y. Yuan and B.V.K. Vijaya Kumar, "A comparison of timing recovery schemes for optical storage systems," *Technical Digest, Joint ISOM/ODS*, 267-269, 1999.
133. B.V.K. Vijaya Kumar, V. Vadde and M. Keskinöz, "2D equalization for page-oriented data storage systems," *Proc. of the thirty seventh annual Allerton conference on communication, control and computing*, pp. 1294-1303, 1999.
134. S. Tipmongkonsilp, B.V.K. Vijaya Kumar and J. Kokaj, "Equivalence of two approaches for the design of optically realizable correlation filters," *Proc. of SPIE*, vol. 4043, 158-165, 2000.
135. M. Alkanhal, B.V.K. Vijaya Kumar and A. Mahalanobis, "Improved clutter rejection in synthetic aperture radar (SAR) imagery using the extended maximum average correlation height (EMACH) filter," *Proc. of SPIE*, vol. 4053, 332-339, 2000.
136. A. Mahalanobis, L. Ortiz, B.V.K. Vijaya Kumar, and A. Ezekiel, "ATR performance using Xpatch (synthetic) training data," *Proc. of SPIE*, vol. 4053, 340-343, 2000.
137. F. Sarigoz, G. Li, B.V.K. Vijaya Kumar, J. Bain and J. Zhu, "Analysis of dropout peak shift in magnetic tape recording," *Digest of InterMag*, 39, 2000.
138. Y. Yuan and B.V.K. Vijaya Kumar, "Effect of timing recovery methods on turbo coded and turbo equalized magnetic recording channels," *Digest of InterMag*, 524, 2000.
139. V. Vadde and B.V.K. Vijaya Kumar, "Performance comparison of equalization and low-pass coding for holographic storage," *Optical Data Storage Conference Digest*, 113 –115, 2000.
140. D. Karns, J. Zhai, H. Song, A. Gamble, D. Stancil, B.V.K. Vijaya Kumar and E. Schlesinger, "To 100 Gb/in<sup>2</sup> and beyond in magneto-optic recording," *Optical Data Storage Conference Digest*, 176 –178, 2000.
141. M. Keskinöz and B.V.K. Vijaya Kumar, "Efficient modeling of volume holographic storage channels (VHSC)," *Optical Data Storage Conference Digest*, 116 –118, 2000.
142. H. Song, B.V.K. Vijaya Kumar and E. Kurtas, "Effect of transition noise on turbo decoding for optical data storage," *Optical Data Storage Conference Digest*, 188 –190, 2000.
143. H. Song, B.V.K. Vijaya Kumar and E. Kurtas, "Effect of transition noise on Turbo coding in optical data storage" *Proc. of SPIE*, vol. 4090, 283-288, 2000.
144. M. Keskinöz and B.V.K. Vijaya Kumar, "Efficient modeling of volume holographic storage channel (VHSC)" *Proc. of SPIE*, vol. 4090, 205-210, 2000.
145. V. Vadde and B.V.K. Vijaya Kumar, "Performance comparison of equalization and low-pass coding for holographic data storage" *Proc. of SPIE*, vol. 4090, 197-204, 2000
146. D. Karns, J. Zhai, H. Song, A. Gamble, D. Stancil, B.V.K. Vijaya Kumar and E. Schlesinger, "To 100 Gb/in<sup>2</sup> and beyond in magneto-optical recording" *Proc. of SPIE*, vol. 4090, 238-245, 2000.
147. V. Vadde and B.V.K. Vijaya Kumar, "Fixed-delay tree search based detection for volume holographic data storage" *Proc. of SPIE*, vol. 4090, 216-224, 2000.
148. J. Liu, H. Song, B.V.K. Vijaya Kumar and D. Shieh, "Channel modeling for hybrid magneto-optical recording," *Proc. of SPIE*, vol. 4090, 292-299, 2000.

149. F. Sarigoz, B.V.K. Vijaya Kumar and J. Bain, "Characterization and equalization of dropouts in the magnetic tape recording channel," *Proc. ICASSP*, 3554-3557, 2000.
150. Y. Yuan and B.V.K. Vijaya Kumar, "Use of adaptive filter for timing recovery for data storage channels," *Proc. ICC*, 94-98, 2000.
151. H. Song, B.V.K. Vijaya Kumar, E. Kurtas and Y. Yuan, "Turbo decoding for optical data storage," *Proc. ICC*, 104-108, 2000.
152. A. Mahalanobis and B.V.K. Vijaya Kumar, "Separable correlation filters," *Proc. of SPIE*, vol. 4113, 2000.
153. F. Sarigoz, J. Bain and B.V.K. Vijaya Kumar, "Mitigating the effects of dropouts in magnetic tape recording: A read channel perspective," *Digest of TMRC*, 2000.
154. H. Song and B.V.K. Vijaya Kumar, "Performance of partial response iterative decoded channels for optical data storage," *Digest of TMRC*, 2000.
155. Y. Yuan and B.V.K. Vijaya Kumar, "Advanced timing recovery for data storage systems," *Digest of TMRC*, 2000.
156. J. Liu, H. Song, B.V.K. Vijaya Kumar, and D. Shieh, "Fly Height Margin of Hybrid MO and Near Field Recording," *Technical Digest of ISOM*, 34-35, 2000.
157. H. Song, J. Liu, B.V.K. Vijaya Kumar, and D. Shieh, "Effects of nonlinearities on partial response equalized hybrid MO recording channel," *Technical Digest of ISOM*, 164-165, 2000.
158. H. Song, J. Liu, B.V.K. Vijaya Kumar, and Y. Yuan, "Application of Soft Output Viterbi Algorithm (SOVA) in Timing Recovery for Iterative Soft Decoded Magnetic Recording Channels," *Digest of InterMag*, 2001.
159. J. Liu, H. Song and B.V.K. Vijaya Kumar, "Effect of a differentiator in partial response maximum likelihood (PRML) detection schemes for optical recording," *Proc. of SPIE*, vol. 4342, 409-417, 2001.
160. M. Keskinöz and B.V.K. Vijaya Kumar, "Method for amplitude response estimation in quadratic channels," *Proc. of SPIE*, vol. 4342, 574-579, 2001.
161. D. Karns, D. Stancil, B.V.K. Vijaya Kumar and E. Schlesinger, "High-density substrate incident magneto-optic recording using a solid immersion lens," *Proc. of SPIE*, vol. 4342, 213-219, 2001..
162. B.V.K. Vijaya Kumar and M. Alkanhal, "Eigen-extended maximum average correlation height (EEMACH) correlation filters for automatic target recognition," *Proc. of SPIE*, vol. 4379, 424-431, 2001.
163. A. Mahalanobis, B.V.K. Vijaya Kumar and A. Van Nevel, "Three-dimensional correlation filters for orientation-invariant recognition," *Proc. Of SPIE*, vol. 4379, 51-58, 2001.
164. M. Keskinöz and B.V.K. Vijaya Kumar, "Efficient modeling and iterative magnitude-squared decision feedback equalization (DFE) for volume holographic storage channels," *Proc. of ICC*, vol. 9, 2696-2700, 2001.
165. H. Song, J. Liu, B.V.K. Vijaya Kumar, A. Inaba, A. Shimazaki and N. Ota, "Low density parity check (LDPC) codes for partial response equalized CAD-MO recording," *Technical Digest of ISOM*, 14-15, 2001.

166. J. Liu, H. Song and B.V.K. Vijaya Kumar, "Fast timing acquisition for high density optical recording," *Technical Digest of ISOM*, 150-151, 2001.
167. D. Karns, D. Stencil, B.V.K. Vijaya Kumar and E. Schlesinger, "Thermal aging of very small domains in TbFeCo," *Technical Digest of ISOM*, 166-167, 2001.
168. A. Mahalanobis, B.V.K. Vijaya Kumar, and A. Van Nevel, "Volume correlations for recognizing patterns in 3D data," *Proc. Of SPIE*, vol. 4471, 51-58, July 2001.
169. M. Savvides, B.V.K. Vijaya Kumar and P. Khosla, "Face verification using correlation filters," *Proc. Of the Third IEEE Automatic Identification Advanced Technologies*, 56-61, Tarrytown, NY, 2002.
170. B.V.K. Vijaya Kumar, K. Venkataramani and M. Savvides, "Efficient methods for correlation-based automatic target recognition," *Proc. Of SPIE*, vol. 4726, 183-192, 2002.
171. R. Singh and B.V.K. Vijaya Kumar, "Performance of the extended maximum average correlation height (EMACH) filter and the polynomial distance classifier correlation filter (PDCCF) for multiclass SAR detection and classification," *Proc. Of SPIE*, vol. 4727, 265-276, 2002.
172. X. Liu, T. Chen and B.V.K. Vijaya Kumar, "On modeling variations for face authentication," *Proc. of Intl. Conf. on Face and Gesture Recognition*, Washington, D.C., 2002.
173. B.V.K. Vijaya Kumar, H. Song and J. Liu "Low density parity check codes for optical data storage," *ISOM/ODS joint meeting Technical Digest*, 371-373, Waikoloa, Hawaii, 2002.
174. H. Song, J. Liu and B.V.K. Vijaya Kumar, "LDPC codes with run length constraints," *ISOM/ODS joint meeting Technical Digest*, 377-379, Waikoloa, Hawaii, July 2002.
175. J. Liu, H. Song and B.V.K. Vijaya Kumar, "Timing recovery for MAMMOS," *ISOM/ODS joint meeting Technical Digest*, 347-349, Waikoloa, Hawaii, July 2002.
176. B.V.K. Vijaya Kumar, M. Savvides, K. Venkataramani and C. Xie, "Spatial frequency domain image processing for biometric recognition," *Proc. of Intl. Conf. on Image Processing (ICIP)*, vol. I, 53-56, 2002.
177. H. Song, J. Liu and B.V.K. Vijaya Kumar, "Low complexity LDPC codes for partial response channels," *Proc. of Globecom*, 1294-99, 2002.
178. J. Liu, H. Song, and B.V.K. Vijaya Kumar, "Symbol timing recovery for low-SNR partial response channels," *Proc. of Globecom*, 1129-1136, 2002.
179. H. Song, J. Liu and B.V.K. Vijaya Kumar, "Convergence analysis of iterative soft decoded magnetic recording," *InterMag Technical Digest*, DT-02, 2003.
180. J. Liu, H. Song and B.V.K. Vijaya Kumar, "Timing acquisition for low-SNR data storage channels," *InterMag Technical Digest*, DT-04, 2003.
181. S. Sahu, H. Song and B.V.K. Vijaya Kumar, "Performance of low density parity check (LDPC) codes on high-density magnetic tape recording signals," *InterMag Technical Digest*, DT-10, 2003.
182. H. Song, J. Liu and B.V.K. Vijaya Kumar, "Concatenated low density parity check (LDPC) codes for magnetic recording channels," *InterMag Technical Digest*, DT-12, 2003.
183. B.V.K. Vijaya Kumar, M. Savvides, C. Xie, K. Venkataramani and J. Thornton, "Using composite correlation filters for biometric verification," *Proc. of SPIE*, vol. 5106, 13-21, 2003.

184. B.V.K. Vijaya Kumar, C. Xie and A. Mahalanobis, "Optimal tradeoff circular harmonic function filters for 3-D target recognition," *Proc. of SPIE*, vol. 5094, 18-28, 2003.
185. A. Mahalanobis, R. Muise and B.V.K. Vijaya Kumar, "Quadratic correlation filters for optical correlators," *Proc. of SPIE*, vol. 5106, 53-63, 2003.
186. J. Liu, H. Song and B.V.K. Vijaya Kumar, "Parity-check error event post-processor for optical data storage," *Optical Data Storage (ODS), Technical Digest*, 99-101, 2003.
187. T. Horigome, H. Song, L. Sun and B.V.K. Vijaya Kumar, "High-speed simulation of partial response channels employing low density parity check (LDPC) codes," *Optical Data Storage (ODS) Conference, post-deadline papers*, 34-36, 2003.
188. B.V.K. Vijaya Kumar, C. Xie and J. Thornton, "Iris verification using correlation filters," *Proc. of 4<sup>th</sup> Intl. Conf. on Audio- and Video-Based Biometric Person Authentication (AVBPA)*, LCNS 2688, pp. 697-705, Springer-Verlag, Berlin Heidelberg, 2003.
189. M. Savvides and B.V.K. Vijaya Kumar, "Quad-phase minimum average correlation energy filters for reduced-memory illumination-tolerant face authentication," *Proc. of 4<sup>th</sup> Intl. Conf. on Audio- and Video-Based Biometric Person Authentication (AVBPA)*, LCNS 2688, pp. 19-26, Springer-Verlag, Berlin Heidelberg, 2003.
190. K. Venkataramani and B.V.K. Vijaya Kumar, "Fingerprint verification using correlation filters," *Proc. of 4<sup>th</sup> Intl. Conf. on Audio- and Video-Based Biometric Person Authentication (AVBPA)*, LCNS 2688, pp. 886-894, Springer-Verlag, Berlin Heidelberg, 2003.
191. M. Savvides and B.V.K. Vijaya Kumar, "Illumination normalization using logarithm transforms for face authentication," *Proc. of 4<sup>th</sup> Intl. Conf. on Audio- and Video-Based Biometric Person Authentication (AVBPA)*, LCNS 2688, pp. 549-556, Springer-Verlag, Berlin Heidelberg, 2003.
192. M. Savvides and B.V.K. Vijaya Kumar, "Efficient Design of Advanced Correlation Filters for Robust Distortion-Tolerant Face Identification", *Proc. of IEEE International Conference on Advanced Video and Signal Based Surveillance (AVSS)*, 45-52, 2003.
193. M. Savvides, K. Venkataramani and B.V.K. Vijaya Kumar, "Incremental updating of advanced correlation filters for biometric authentication systems," *Proc. of International Conference on MultiMedia (ICME)*, vol. 3, 229-232, 2003.
194. J. Liu, H. Song and B.V.K. Vijaya Kumar, "Dual-segmented Kalman filters based symbol timing recovery for low-SNR partial response data storage channels," *Proc. of Globecom*, 4084-4090, 2003.
195. H. Song, J. Liu and B.V.K. Vijaya Kumar, "Large-girth cycle codes for partial response channels," *InterMag Technical Digest*, 2004.
196. T. Horigome, H. Song, L. Sun and B.V.K. Vijaya Kumar, "Software simulations of very low bit error rates in partial response channels employing low density parity check (LDPC) codes," *InterMag Technical Digest*, 2004.
197. L. Sun, T. Horigome and B.V.K. Vijaya Kumar, "A high-throughput field-programmable gate array implementation of soft output Viterbi algorithm for magnetic recording," *InterMag Technical Digest*, 2004.
198. T. Horigome, H. Song, L. Sun and B.V.K. Vijaya Kumar, "High-speed simulation of partial response channels employing low density parity check (LDPC) codes," *Proc. of SPIE*, vol. 5069, 215-222, 2003.

199. H. Kim and B.V.K. Vijaya Kumar, "Rotation-Tolerant Watermark Detection using Circular Harmonic Function Correlation Filter," *Digital Watermarking* (eds: Kalker, Cox and Ro), LNCS 2939, 263-276, Springer, Heidelberg, 2004.
200. S. Palanivel, B. Yegnanarayana, C. Xie and B.V.K. Vijaya Kumar, "Towards still to video based face recognition," *Proc. of Multi-Modal User Authentication (MMUA) Workshop*, 41-47, 2003.
201. B.V.K. Vijaya Kumar and J. Thornton, "Distortion-tolerant iris recognition using advanced correlation filters," *Proc. of Multi-Modal User Authentication (MMUA) Workshop*, 173-180, 2003.
202. B. Yegnanarayana, A. Sao, B.V.K. Vijaya Kumar and M. Savvides, "Determination of pose angle of face using dynamic space warping (DSW)," *International Conference for Information Technology*, 661-664, 2004.
203. B.V.K. Vijaya Kumar and J. Thornton, "Efficient methods for extracting performance metrics from correlation filter outputs," *Proc. of SPIE, Optical Pattern Recognition*, Vol. 5437, 27-37, 2004.
204. C. Xie, S. Palanivel, B. Yegnanarayana, and B.V.K. Vijaya Kumar, "An optimal tradeoff synthetic discriminant function filter-based still reference to video sequence face verification system," *Proc. of SPIE, Biometric Technology for Human Identification*, vol. 5404, 106-113, 2004.
205. K. Venkataramani, A. Sao, B. Yegnanarayana and B.V.K. Vijaya Kumar, "Face authentication using one-dimensional processing," *Proc. of SPIE, Biometric Technology for Human Identification*, vol. 5404, 76-86, 2004.
206. M. Savvides, B.V.K. Vijaya Kumar and P. Khosla, "Robust Shift-invariant Biometric Identification from Partial Faces," *Proc. of SPIE, Biometric Technology for Human Identification*, vol. 5404, 124-135, 2004.
207. M. Savvides, B.V.K. Vijaya Kumar and P. Khosla, "Authentication Invariant Cancelable Correlation Filters for Illumination Tolerant Face Recognition," *Proc. of SPIE, Biometric Technology for Human Identification*, vol. 5404, 156-163, 2004.
208. M. Keskinöz and B.V.K. Vijaya Kumar, "Performance comparison of equalization/detection schemes for magnification error-dominated volume holographic storage channel," *Technical Digest of Optical Data Storage Conference*, 131-133, 2004.
209. M. Savvides, B.V.K. Vijaya Kumar and P. Khosla, "Corefaces – Robust Shift Invariant PCA based Correlation Filter for Illumination Tolerant Face Recognition," *Computer Vision and Pattern Recognition (CVPR)*, vol. II, 834-841, 2004.
210. S. Qidwai, K. Venkataramani, and B.V.K. Vijaya Kumar, "Face Authentication from Cell Phone Camera images with Illumination and Temporal Variations," *Biometric Authentication* (eds: Zhang and Jain), LNCS 3072, 74-80, Springer, Heidelberg, 2004.
211. C. Xie, B.V.K. Vijaya Kumar, S. Palanivel and B. Yegnanarayana, "A Still-to-Video Face Verification System using Advanced Correlation Filters," *Biometric Authentication* (eds: Zhang and Jain), LNCS 3072, 102-108, Springer, Heidelberg, 2004.
212. M. Keskinöz and B.V.K. Vijaya Kumar, "Performance comparison of equalization/detection schemes for magnification error-dominated volume holographic storage channel," *Proc. Of SPIE, Optical Data Storage*, vol. 5380, 602-609, 2004.
213. M. Savvides and B.V.K. Vijaya Kumar, "Cancelable biometric filters for face recognition," *Intl. Conf. on Pattern Recognition (ICPR)*, 922-925, 2004.

214. M. Savvides and B.V.K. Vijaya Kumar, "Eigenphases vs. Eigenfaces," Intl. Conf. on Pattern Recognition (ICPR), 810-813, 2004.
215. M. Beattie, S. Lucey, B.V.K. Vijaya Kumar and O. Tonguz, "Building access control using coordinated biometric verification," *BCTP Workshop, Intl. Conf. on Pattern Recognition*, 2004.
216. J. Thornton and B.V.K. Vijaya Kumar, "Reduced-complexity biometric recognition using 1-D cross-sections of correlation filters," *International Conference on Image Processing (ICIP)*, 897-900, 2004.
217. J. Xie and B.V.K. Vijaya Kumar, "Performance analysis and simplification of digital zero phase start (DZPS) employed in data storage timing recovery systems," *Proc. of Globecom*, 1118-1122, 2004.
218. P. Hennings and B.V.K. Vijaya Kumar, "Fingerprint recognition using correlation filter classifiers," Conference Record of 38<sup>th</sup> *Asilomar Conference on Signals, Systems and Computers*, 567-571, 2004.
219. Z. Li and B.V.K. Vijaya Kumar, "A class of good quasi-cyclic low density parity check codes based on progressive edge growth graph," Conference Record of 38<sup>th</sup> *Asilomar Conference on Signals, Systems and Computers*, 1990-94, 2004.
220. M. Savvides, B.V.K. Vijaya Kumar and P. Khosla, "Efficient boosting for synthesizing a minimally compact reduced complexity correlation filter bank for face identification in biometric applications," Conference Record of 38<sup>th</sup> *Asilomar Conference on Signals, Systems and Computers*, 587-591, 2004.
221. S. Wijaya, M. Savvides and B.V.K. Vijaya Kumar, "Face Authentication of Variable Illumination Low-Bitrate JPEG2000 Wavelet Face Images using Advanced Correlation Filters for mobile devices," Conference Record of 38<sup>th</sup> *Asilomar Conference on Signals, Systems and Computers*, 592-596, 2004.
222. L. Sun and B.V.K. Vijaya Kumar, "Field Programmable Gate Array Implementation of a Generalized Decoder for Structured Low-Density Parity Check Codes," *International Conference on Field-Programmable Technology*, 17-24, Brisbane, Australia, 2004.
223. L. Ramamoorthy, S. Nabavi and B.V.K. Vijaya Kumar, "Physical Channel Model for Holographic Data Storage Systems," *Annual Lasers and Electro-Optics Society (LEOS) Meeting*, 997-998, 2004.
224. J. Thornton, M. Savvides and B.V.K. Vijaya Kumar, "Linear Shift-Invariant Maximum Margin SVM Correlation Filter," *Proc. of Intl. Conf. on Intelligent Sensors, Sensor Networks, and Information Processing (ISSNIP)*, 183-188, 2004.
225. C. Xie and B.V.K. Vijaya Kumar, "Quaternion correlation filters for color face recognition," *SPIE Conference on Security, Steganography and Watermarking of Multimedia Contents*, vol. 5681, 486-494, 2005.
226. P. Hennings, M. Savvides and B.V.K. Vijaya Kumar, "Hiding phase-quantized biometrics: A case of steganography for reduced-complexity correlation filter classifiers," *SPIE Conference on Security, Steganography and Watermarking of Multimedia Contents*, vol. 5681, 465-473, 2005.
227. L. Sun, H. Song and B.V.K. Vijaya Kumar, "Error floor investigation and girth optimization for certain types of low density parity check codes," *ICASSP*, 1101-1104, 2005.
228. J. Thornton, P. Hennings, J. Kovacevic and B.V.K. Vijaya Kumar, "Wavelet packet correlation methods," *ICASSP*, 18-23, 2005.
229. C. Xie, M. Savvides and B.V.K. Vijaya Kumar, "Quaternion Correlation Filters for face Recognition in Wavelet domain," *ICASSP*, 85-88, 2005.

230. L. Ramamoorthy, M. Keskinöz and B.V.K. Vijaya Kumar, "Support vector machines based data detection for holographic data storage," *ICASSP*, 969-972, 2005.
231. C. Xie, M. Savvides and B.V.K. Vijaya Kumar, "Improved Face Recognition using multi-band Gabor quaternion filters," *SPIE Conference on Biometric Technologies for Human Identification*, vol. 5779, 418-425, 2005.
232. S. Mitra, M. Savvides and B.V.K. Vijaya Kumar, "Biometric authentication based on novel frequency-domain facial asymmetry measures," *SPIE Conference on Biometric Technologies for Human Identification*, vol. 5779, 409-417, 2005.
233. R. Kerekes, M. Savvides, B.V.K. Vijaya Kumar and S.R.F. Sims, "Fractional power scale-tolerant correlation filters for enhanced automatic target recognition performance," *SPIE Conference on Automatic Target Recognition*, vol. 5807, 317-328, 2005.
234. K. Venkataramani, M. Keskinöz and B.V.K. Vijaya Kumar, "Soft information fusion of correlation filter plane outputs using support vector machine (SVM) for fingerprint verification," *SPIE Conference on Biometric Technologies for Human Identification*, vol. 5779, 184-195, 2005.
235. P. Hennings, M. Savvides and B.V.K. Vijaya Kumar, "Robust multi-biometric verification using jointly optimized multi-biometric fusion correlation filter classifiers," *SPIE Conference on Biometric Technologies for Human Identification*, vol. 5779, 205-213, 2005.
236. R. Kerekes, B.V.K. Vijaya Kumar and S.R.F. Sims, "Estimating performance limits for automatic target recognition in compressed video," *SPIE Conference on Automatic Target Recognition*, vol. 5807, 296-307, 2005.
237. L. Sun, H. Song, B.V.K. Vijaya Kumar and Z. Keirn, "Field programmable gate array (FPGA)-based investigation of the error floor of LDPC codes for magnetic recording channels," *Technical Digest of InterMag*, 1605-1606, 2005.
238. Z. Li, J. Xie and B.V.K. Vijaya Kumar, "Low density parity check codes with variable rate and randomized constraints for advanced magnetic tape recording," *Technical Digest of InterMag*, 1611-1612, 2005.
239. J. Xie and B.V.K. Vijaya Kumar, "Dropout compensation by equalizer selection and timing recovery hang-up for magnetic tape systems," *Technical Digest of InterMag*, 1693-1694, 2005.
240. M. Savvides, C. Xie, N. Chu, B.V.K. Vijaya Kumar, C. Podilchuk, A. Patel, A. Harthattu and R. Mammone "Face recognition using advanced correlation filters with bijective-mapping preprocessing," *Audio-Video Biometrics Based Person Authentication (AVBPA) Conference* (eds: Kanade, Jain and Ratha), *Lecture Notes in Computer Science*, LNCS 3546, 607-616, Springer, Heidelberg, 2005.
241. S. Mitra, M. Savvides, and B.V.K. Vijaya Kumar, "A one bit facial asymmetry code (FAC) in Fourier domain for human recognition," *Audio-Video Biometrics Based Person Authentication (AVBPA) Conference* (eds: Kanade, Jain and Ratha), LNCS 3546, 61-70, Springer, Heidelberg, 2005.
242. M. Beattie, B.V.K. Vijaya Kumar, O. Tonguz and S. Lucey, "Combining verification decisions in a multi-vendor environment," *Audio-Video Biometrics Based Person Authentication (AVBPA) Conference* (eds: Kanade, Jain and Ratha), LNCS 3546, 406-415, Springer, Heidelberg, 2005.
243. L. Sun, H. Song, B.V.K. Vijaya Kumar and Z. Keirn, "Iterative decoder in FPGA," *The Magnetic Recording Conference (TMRC)*, Stanford, Technical Digest, E2, 2005.

244. J. Heo, M. Savvides, and B.V.K. Vijaya Kumar, "Illumination tolerant face recognition using phase-only support vector machines in the frequency domain," *Pattern Recognition and Image Analysis*, LNCS 3687, 66-73, 2005.
245. K. Venkataramani and B.V.K. Vijaya Kumar, "Conditionally dependent classifier fusion using AND rule for improved biometric verification," *Pattern Recognition and Image Analysis*, LNCS 3687, 277-286, 2005.
246. J. Xie, A. Kaya, J. Bain and B.V.K. Vijaya Kumar, "Shallow arc detection in disk surface images for disk forensics," *International Conference on Image Processing (ICIP)*, vol. 3, 81-84, 2005.
247. J. Xie, Z. Li and B.V.K. Vijaya Kumar, "Maximum likelihood estimation of phase from preambles with harmonics," *ISOM/ODS Technical Digest*, 2005.
248. J. Xie, Z. Li and B.V.K. Vijaya Kumar, "Low-density parity check codes with DC control," *ISOM/ODS Technical Digest*, 2005.
249. L. Ramamoorthy and B.V.K. Vijaya Kumar, "2-D equalization and error correction using low density parity check (LDPC) codes for holographic data storage," *ISOM/ODS Technical Digest*, 2005.
250. S. Nabavi and B.V.K. Vijay Kumar, "Comparative evaluation of equalization methods for holographic data storage channels," *ISOM/ODS Technical Digest*, 2005.
251. S. Mitra, M. Savvides, and B.V.K. Vijaya Kumar, "Facial asymmetry: a new robust biometric in the frequency domain," *International Conference on Image Analysis and Recognition (ICIAR)*, LNCS 3656, 1065-1072, 2005.
252. P. Hennings, M. Savvides, and B.V.K. Vijaya Kumar, "Verification of biometric palmprint patterns using optimal trade-off filter classifiers," *International Conference on Image Analysis and Recognition (ICIAR)*, LNCS 3656, 1081-1088, 2005.
253. J. Heo, M. Savvides, and B.V.K. Vijaya Kumar, "Advanced correlation filters for face recognition using low-resolution visual and thermal imagery," *International Conference on Image Analysis and Recognition (ICIAR)*, LNCS 3656, 1089-1097, 2005.
254. J. Thornton, M. Savvides, and B.V.K. Vijaya Kumar, "Robust iris recognition using advanced correlation techniques," *International Conference on Image Analysis and Recognition (ICIAR)*, LNCS 3656, 1098-1105, 2005.
255. J. Heo, M. Savvides, and B.V.K. Vijaya Kumar, "Performance evaluation of face recognition using visual and thermal imagery with advanced correlation filters," *IEEE International Workshop on object tracking and classification beyond the visible spectrum*, June 2005.
256. C. Xie, M. Savvides and B.V.K. Vijaya Kumar, "Redundant Class-Dependence Feature Analysis Based on Correlation Filters Using FRGC2.0 Data," *IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR)*, 153-158, 2005.
257. F. De la Torre, R. Gross, S. Baker and B.V.K. Vijaya Kumar, "Representational oriented component analysis (ROCA) for face recognition with one sample image per training class," *IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR)*, vol. 2, 266-273, 2005.
258. C. Xie and B.V.K. Vijaya Kumar, "Face class code based feature extraction for face recognition," *Fourth IEEE Workshop on Automatic Identification advanced Technologies*, 257-262, 2005.

259. M. Beattie, B.V.K. Vijaya Kumar, S. Lucey and O. Tonguz, "Automatic configuration for a biometrics-based physical access control system," *Advances in Biometric Authentication, LNCS 3781*, 241-248, 2005.
260. C. Xie, M. Savvides and B.V.K. Vijaya Kumar, "Kernel correlation filter based redundant class-dependence feature analysis (KCFA) on FRGC2.0 Data," *Analysis and Modeling of Faces and Gestures, LNCS 3723*, 32-43, 2005.
261. J. Xie, L. Sun and B.V.K. Vijaya Kumar, "Analysis of Kalman Filter in Timing Acquisition in Data Storage Read Channels," *Proc. GlobeCom*, 2364-68, 2005.
262. S. Mitra, M. Savvides and B.V.K. Vijaya Kumar, "Facial Asymmetry in the Frequency Domain: The "Phase" Connection," *Proceedings of First International Conference on Pattern Recognition and Machine Intelligence (PReMI)*, Kolkata, India, LNCS 3776, pp. 422-427, Springer, New York, 2005.
263. J. Xie, A. Kaya, B.V.K. Vijaya Kumar, and J. Bain, "Forensics for floppy disks and recordable compact discs," *AAFS*, abstract, 2006.
264. M. Savvides, J. Heo, R. Abiantun, C. Xie, S. Park and B.V.K. Vijaya Kumar, "Using kernel correlation filters and class redundant feature analysis (CFA) with support vector machines on face recognition grand challenge (FRGC) phase-2 data for enhanced holistic face recognition," *Proc. of SPIE on Biometric Technology for Human Identification III*, vol. 6202, 48-57, 2006.
265. J. Thornton, M. Savvides and B.V.K. Vijaya Kumar, "Enhanced iris matching using estimation of in-plane nonlinear deformations," *Proc. of SPIE on Biometric Technology for Human Identification III*, vol. 6202, 135-145, 2006.
266. R. Kerekes, B. Narayanaswamy, M. Beattie, B.V.K. Vijaya Kumar and M. Savvides, "Multiframe distortion-tolerant correlation filtering for video sequences," *Proc. of SPIE on Optical Pattern Recognition XVII*, vol. 6245, 93-104, 2006.
267. K. Venkataramani and B.V.K. Vijaya Kumar, "Fusion of conditionally dependent correlation filter-based classifiers using OR rule for improved biometric verification," *Proc. of SPIE on Optical Pattern Recognition XVII*, vol. 6245, 105-116, 2006.
268. J. Xie and B.V.K. Vijaya Kumar, "Baseline wander compensation by Per-Survivor processing," GQ-09, *InterMag*, 2006.)
269. X. Hu, L. Sun and B.V.K. Vijaya Kumar, "FPGA-based LDPC code evaluation using an advanced magnetic recording channel model," GQ-07, *InterMag*, 2006.
270. Y. Li, M. Savvides and B.V.K. Vijaya Kumar, "Illumination-tolerant face recognition using a novel face from sketch synthesis approach and advanced correlation filters," *Proc. of ICASSP*, vol. II, 357-360, 2006.
271. J. Heo, M. Savvides, R. Abiantun, C. Xie and B.V.K. Vijaya Kumar, "Face recognition with kernel correlation filters on a large scale database," *Proc. of ICASSP*, vol. II, 181-184, 2006.
272. M. Savvides, J. Heo, R. Abiantun, C. Xie and B.V.K. Vijaya Kumar, "Class-dependent kernel discrete cosine transform features for enhanced holistic face recognition in FRGC-II," *Proc. of ICASSP*, vol. II, 185-188, 2006.

273. S. Nabavi and B.V.K. Vijaya Kumar, "Detection methods for holographic data storage," *Digest of Optical Data Storage*, 156-158, 2006.
274. J. Heo, R. Abiantun, C. Xie, M. Savvides and B.V.K. Vijaya Kumar, "Large scale face recognition with Kernel correlation feature analysis with support vector machine distance measure," 8th *International Conference on Enterprise Information Systems (ICEIS)*, Cyprus, 2006.
275. Y. Li, M. Savvides, and V. Bhagavatula "Face recognition from sketches using advanced correlation filters using hybrid eigenanalysis for face synthesis," 8th *International Conference on Enterprise Information Systems (ICEIS)*, Cyprus, 2006.
276. J. Xie and B.V.K. Vijaya Kumar, "Timing recovery loop delay compensation by optimal loop gains," *Proc. of International Communications Conference*, 3229-3234, 2006.
277. C. Xie, M. Savvides and B.V.K. Vijaya Kumar, "Comparison of feature space methods for face recognition," *CVPR Biometrics Workshop*, p. 46, New York, 2006.
278. M. Savvides, R. Abiantun, J. Heo, S. Park, C. Xie and B.V.K. Vijaya Kumar, "Partial and holistic face recognition on FRGC-II data using support vector machine kernel correlation feature analysis," *CVPR Biometrics Workshop*, p. 48, New York, 2006.
279. S. Nabavi and B.V.K. Vijaya Kumar, "Iterative decision feedback equalizer detector for holographic data storage systems," *Proc. of SPIE*, vol. 6282, OT1-OT8, 2006.
280. S. Mitra, M. Savvides and B.V.K. Vijaya Kumar, "Human face identification from video based on frequency domain asymmetry representation using hidden Markov models," *Proc. Multimedia Content Representation, Classification and Security, LNCS 4105*, 26-33, Springer, 2006.
281. K. Venkataramani and B.V.K. Vijaya Kumar, "Role of statistical dependence between classifier scores in determining the best decision fusion rule for improved biometric verification," *Proc. Multimedia Content Representation, Classification and Security, LNCS 4105*, 489-496, Springer, 2006.
282. X. Hu and B.V.K. Vijaya Kumar, "Improved run-length control with low density parity check codes," *GlobeCom 2006*, San Francisco, CA, November 2006.
283. S. Jeon, X. Hu, L. Sun and B.V.K. Vijaya Kumar, "Performance evaluation of partial response targets for perpendicular recording using field programmable gate arrays," *InterMag*, 2007.
284. S. Nabavi, B.V.K. Vijaya Kumar and J. Zhu, "Modifying Viterbi algorithm to mitigate inter-track interference in patterned media," *InterMag*, 2007.
285. J. Xie and B.V.K. Vijaya Kumar, "Kalman filter timing acquisition for large frequency drift," *InterMag*, 2007.
286. R. Abiantun, M. Savvides and B.V.K. Vijaya Kumar, "Robust low-dimensional kernel correlation feature spaces that generalize to unseen data sets," *SPIE Conf. on Biometric Technology for Human Identification IV*, vol. 6539, Orlando, 2007.
287. C. Xie, M. Savvides and B.V.K. Vijaya Kumar, "Correlation filters for large population face recognition," *SPIE Conf. on Biometric Technology for Human Identification IV*, vol. 6539, Orlando, 2007.
288. R. Abiantun, M. Savvides and B.V.K. Vijaya Kumar, "Generalized low-dimensional feature subspace for robust face recognition on unseen datasets using kernel correlation feature analysis," *ICASSP*, 2007.

289. B.V.K. Vijaya Kumar, L. D. Ramamoorthy and S. Nabavi, "Channels strategies for handling low signal-to-noise ratios in holographic data storage systems," Technical Digest, WB1, *Optical Data Storage (ODS)*, May 2007.
290. L. D. Ramamoorthy and B.V.K. Vijaya Kumar, "Effect of 2-D interleaving and low density parity check (LDPC) codes on burst errors," *Proc. SPIE Optical Data Storage (ODS)*, vol. 6620, no. 72, 2007.
291. S. Nabavi, B.V.K. Vijaya Kumar and J. Zhu, "Two-dimensional generalized partial response equalizer with conventional Viterbi detector for patterned media," *International Communications Conference (ICC)*, June 2007.
292. S. Lee and B.V.K. Vijaya Kumar, "Application of soft-decision decoders to non narrow-sense Reed-Solomon codes," *International Communications Conference (ICC)*, June 2007.
293. R. Kerekes, B. Narayanaswamy, J. Thornton, M. Savvides and B.V.K. Vijaya Kumar, "Graphical model approach to iris matching under deformation and occlusion," *Computer Vision and Pattern Recognition (CVPR)*, 1-6, June 2007.
294. P. Hennings, M. Savvides and B.V.K. Vijaya Kumar, "Palmpoint recognition with multiple correlation filters using edge detection for class-specific segmentation," *Proc. 5<sup>th</sup> IEEE Workshop on Advanced Automatic Identification Technologies*, 214-219, 2007.
295. Y. Wang, J. Hu, K. Xi and B.V.K. Vijaya Kumar, "Investigating correlation-based fingerprint authentication schemes for mobile devices using the J2ME technology," *Proc. 5<sup>th</sup> IEEE Workshop on Advanced Automatic Identification Technologies*, 35-40, 2007.
296. X. Hu, Z. Li and B.V.K. Vijaya Kumar, "Error Floor Estimation of Long LDPC Codes on Partial Response Channels," *Globecom*, Washington, DC, November 2007.
297. S. Jeon and B.V.K. Vijaya Kumar, "Error Event Analysis of Partial Response Targets for Perpendicular Magnetic Recording," *Globecom*, Washington, DC, November 2007.
298. J. Thornton, M. Savvides and B.V.K. Vijaya Kumar, "An evaluation of iris representations," *Biometrics: Theory, Applications & Systems (BTAS)*, September 2007.
299. C. Xie and B.V.K. Vijaya Kumar, "Comparison of kernel class-dependence feature analysis (KCFA) with kernel discriminant analysis (KDA) for face recognition," *Biometrics: Theory, Applications & Systems (BTAS)*, September 2007.
300. A. Mahalanobis, C. Reyner, H. Patel, T. Haberfelde, D. Brady, M. Neifeld, B.V.K. Vijaya Kumar and S. Rogers, "IR performance study of fan adaptive coded aperture diffractive Imaging system employing MEMS eyelid shutter technologies," *Proc. of SPIE on Adaptive Coded Aperture Imaging and Non-Imaging Sensors*, vol. 6714, 2007.
301. A. Mahalanobis and B.V.K. Vijaya Kumar, "Multi-frame filtering techniques for the detection and recognition of moving objects," *Proc. SPIE on Unmanned/Unattended Sensors and Sensor Networks IV*, vol. 6736, September 2007.
302. R. Kerekes and B.V.K. Vijaya Kumar, "Multiple target detection in video using quadratic multi-frame correlation filtering," *Proc. SPIE on Optical Pattern Recognition*, vol. 6977, March 2008.
303. A. Mahalanobis, C. Reyner, T. Haberfelde, M. Neifeld and B.V.K. Vijaya Kumar, "Recent developments in coded aperture multiplexed imaging systems," *Proc. SPIE on Visual Information Processing XVII*, vol. 6978, March 2008.

304. S. Nabavi and B.V.K. Vijaya Kumar, "Mitigating the Effects of Track Mis-Registration in Bit-Patterned Media," *Intl. Communications Conference (ICC)*, Beijing, May 2008.
305. E. Hwang, R. Negi and B.V.K. Vijaya Kumar, "Extended Kalman Filter based Acquisition Timing Recovery for Magnetic Recording Read Channels," *Intl. Communications Conference (ICC)*, Beijing, May 2008.
306. S. Nabavi, B.V.K. Vijaya Kumar and J. Bain, "Two-dimensional pulse response and media noise modeling for bit-patterned media channels," *IEEE Intern. Magnetics Conference*, Madrid, Spain, May 2008.
307. P. H. Hennings-Yeomans, S. Baker and B.V.K. Vijaya Kumar, "Simultaneous Super Resolution for Face Recognition," *Computer Vision and Pattern Recognition (CVPR)*, Anchorage, Alaska, June 2008.
308. L. Ramamoorthy and B.V.K. Vijaya Kumar, "Sparse modulation codes for channel with media saturation," *Joint ISOM/ODS conference*, Hawaii, July 2008.
309. P.H. Hennings-Yeomans, S. Baker and B.V.K. Vijaya Kumar, "Recognition of low-resolution face images using multiple still images and multiple cameras," *Biometrics: Theory, Applications and Systems*, Crystal City, VA, September 2008.
310. Vishnu Naresh Boddeti and B.V.K. Vijaya Kumar, "Extended depth of field iris recognition with correlation filters," *Biometrics: Theory, Applications and Systems*, Crystal City, VA, September 2008.
311. S. Jeon, X. Hu and B.V.K. Vijaya Kumar, "Evaluation of the concatenation of LDPC and RS codes in magnetic recording channels using field programmable gate arrays," *Globecom*, New Orleans, November 2008.
312. S. Lee and B.V.K. Vijaya Kumar, "Soft-decision decoding of Reed-Solomon codes using successive error-and-erasure decoding," *Globecom*, New Orleans, November 2008.
313. Vishnu Naresh Boddeti, F. Su and B.V.K. Vijaya Kumar, "A biometric key-binding and template protection framework using correlation filters," accepted, *Intl. Conf. on Biometrics (ICB)*, Alghero, Italy, June 2009.

## **JOURNAL PUBLICATIONS**

1. B.V.K. Vijaya Kumar and S.K. Mullick, "Power spectrum estimation using maximum entropy methods," *JIETE*, vol. 25, 181-94, 1979.
2. D. Casasent and B.V.K. Vijaya Kumar, "Optical image plane correlator for ambiguity surface computation," *Applied Optics*, vol. 18, 1673-78, 1979.
3. B.V.K. Vijaya Kumar and D. Casasent, "Space blur bandwidth product in correlator performance evaluation," *JOSA*, vol. 70, 103-10, 1980; *Reprinted in SPIE Milestone Series, Vol. MS76, "Selected Papers on Optical Correlators," 1993.*
4. B.V.K. Vijaya Kumar and D. Casasent, "Non-linear t-E curve effects in an optical correlator," *Optics Communications*, vol. 34, 4-6, 1980.
5. D. Psaltis and B.V.K. Vijaya Kumar, "Acousto-optic spectral estimation: a statistical analysis," *Applied Optics*, vol. 20, 601-05, 1981.
6. B.V.K. Vijaya Kumar and D. Casasent, "Binarization effects in a correlator with noisy input data," *Applied Optics*, vol. 20, 1433-37, 1981.

7. B.V.K. Vijaya Kumar and D. Casasent, "Eigenvector determination by iterative optical methods," *Applied Optics*, vol. 20, 3707-10, 1981.
8. B.V.K. Vijaya Kumar, "A modified hyperplane method for null synthesis in an array pattern," *IEEE Trans. Ant. Prop.*, vol. 30, 512-16, 1982.
9. B.V.K. Vijaya Kumar, D. Casasent and H. Murakami, "Principal component imagery for statistical pattern recognition correlators," *Optical Engineering*, vol. 21, 43-47, 1982.
10. H. Murakami and B.V.K. Vijaya Kumar, "Efficient calculation of primary images from a set of images," *IEEE Trans. Patt. Ana. Mach. Intell.*, vol. 4, 511-15, 1982.
11. D. Casasent, G. Silbershatz and B.V.K. Vijaya Kumar, "Acousto-optic matched filter correlator," *Applied Optics*, vol. 21, 2356-64, 1982.
12. B.V.K. Vijaya Kumar, D. Casasent and A. Goutzoulis, "Fine delay estimation in time integrating correlators," *Applied Optics*, vol. 21, 3855-63, 1982.
13. H. Murakami and B.V.K. Vijaya Kumar, "Correlation of binarized images," *IEEE Trans. Aerosp. Electr. Sys.*, vol. 19, 322-28, 1983.
14. B.V.K. Vijaya Kumar, "Errors in optical computation of correlation coefficients," *Applied Optics*, vol. 22, 209-11, 1983.
15. B.V.K. Vijaya Kumar, "Singular value estimation using iterative optical processors," *Applied Optics*, vol. 22, 962-63, 1983.
16. B.V.K. Vijaya Kumar, "Efficient approach for designing linear combination filters," *Applied Optics*, vol. 22, 1445-48, 1983.
17. A. Goutzoulis and B.V.K. Vijaya Kumar, "Optimum time integrating acousto-optic correlator for binary codes," *Optics Communications*, vol. 48, 393-97, 1984.
18. A. Goutzoulis and B.V.K. Vijaya Kumar, "Squared signal correlation and its acousto-optic implementation," *Applied Optics*, vol. 23, 798-802, 1984.
19. B.V.K. Vijaya Kumar and C. Carroll, "Loss of optimality in cross-correlators," *JOSA-A*, vol. 1, 392-97, 1984.
20. B.V.K. Vijaya Kumar, "Lower bound for the suboptimality of cross-correlators," *Applied Optics*, vol. 23, 2048-49, 1984.
21. D. Casasent, A. Goutzoulis and B.V.K. Vijaya Kumar, "Time integrating acousto-optic correlator error source modeling," *Applied Optics*, vol. 23, 3130-37, 1984.
22. B.V.K. Vijaya Kumar and C. Carroll, "Performance of Wigner distribution function based detection methods," *Optical Engineering*, vol. 23, 732-37, 1984.
23. B.V.K. Vijaya Kumar and C. Carroll, "Effects of sampling on signal detection using the cross Wigner distribution function," *Applied Optics*, vol. 23, 4090-94, 1984.
24. A. Goutzoulis, D. Casasent and B.V.K. Vijaya Kumar, "Acousto-optic processor for adaptive radar noise environment characterization," *Applied Optics*, vol. 23, 4303-08, 1984..

25. B.V.K. Vijaya Kumar, "Effect of signal bandwidth on the accuracy of signal reconstruction from its phase," *IEEE Trans. ASSP*, vol. 32, 1238-39, 1984.
26. A. Goutzoulis, D. Casasent and B.V.K. Vijaya Kumar, "Detector effects on time integrating correlators," *Applied Optics*, vol. 24, 1224-33, 1985.
27. A. Goutzoulis and B.V.K. Vijaya Kumar, "Detector size effects on peak-to-sidelobe ratio in bulk Acousto-Optic spectrum analyzer," *Optical Engineering*, vol. 24, 908-12, 1985.
28. A. Chakrabarti, D. Shaw, P. Stephenson and B.V.K. Vijaya Kumar, "Digital signal processing of geotechnical data," *Journal of Engineering Mechanics*, American Society of Civil Engineers, vol. 112, 70-83, 1986.
29. B.V.K. Vijaya Kumar and C. Rahenkamp, "Calculation of geometric moments using Fourier plane intensities," *Applied Optics*, vol. 25, 997-1007, 1986.
30. B.V.K. Vijaya Kumar and E. Pochapsky, "Signal-to-Noise Ratio considerations in modified matched spatial filters," *JOSA-A*, vol. 3, 777-786, 1986.
31. B.V.K. Vijaya Kumar and A. Mahalanobis, "Alternate interpretation for minimum variance synthetic discriminant functions," *Applied Optics*, vol. 25, 2484-85, 1986.
32. B.V.K. Vijaya Kumar, C.P. Neuman and K. DeVos, "Discrete Wigner synthesis," *Signal Processing*, vol. 11, 277-304, 1986).
33. B.V.K. Vijaya Kumar, "Minimum variance synthetic discriminant functions," *JOSA-A*, vol. 3, 1579-84, 1986; *Reprinted in the SPIE Milestone Series, "Selected Papers on Optical Pattern Recognition," 1999.*
34. B. Montgomery and B.V.K. Vijaya Kumar, "Evaluation of the use of the Hopfield neural net model as a nearest-neighbor algorithm," *Applied Optics*, vol. 25, 3759-66, 1986; *Reprinted in the SPIE Milestone Series, "Selected Papers on Neural Networks," 1994.*
35. C. Rahenkamp and B.V.K. Vijaya Kumar, "Modifications to the McClellan, Parks and Rabiner computer program for designing higher order differentiating FIR filters," *IEEE Trans. ASSP*, vol. 34, 1671-74, 1986.
36. A. Mahalanobis, B.V.K. Vijaya Kumar and D. Casasent, "Spatial-temporal correlation filter for in-plane distortion invariance," *Applied Optics*, vol. 25, 4466-72, 1986.
37. B.V.K. Vijaya Kumar, "Geometric moments computed from the Hartley transform," *Optical Engineering*, vol. 25, 1327-32, 1986.
38. B. Montgomery and B.V.K. Vijaya Kumar, "On the average codeword length of optimal binary codes for extended sources," *IEEE Trans. Information Theory*, vol. IT-33, 293-296, 1987.
39. V. Veeravalli, R. Katti, B.V.K. Vijaya Kumar and M. Kryder, "Time-domain model for noise from particulate recording media," *Journal of Applied Physics*, vol. 61, 4034-36, 1987.
40. M. Zinnikas and B.V.K. Vijaya Kumar, "Geometric moments from optical cosinusoidal transform," *Optics Communications*, vol. 62, 237-242, 1987.
41. A. Mahalanobis, B.V.K. Vijaya Kumar and D. Casasent, "Minimum average correlation energy filters," *Applied Optics*, vol. 26, 3633-3640, 1987; *Reprinted in SPIE Milestone Series, "Selected Papers on Optical Pattern Recognition," 1999.*

42. B.V.K. Vijaya Kumar and V. Veeravalli, "Approximate lower bound for the SNR of matched filters," *Journal of the Franklin Institute*, vol. 324, 139-147, 1987.
43. B. Montgomery and B.V.K. Vijaya Kumar, "On decoding rules to minimize the probability of information bit errors," *IEEE Trans. Information Theory*, vol. IT-34, 880-881, 1988.
44. B.V.K. Vijaya Kumar, Z. Bahri and A. Mahalanobis, "Constraint phase optimization in minimum variance synthetic discriminant functions," *Applied Optics*, vol. 27, 409-413, 1988.
45. Z. Bahri and B.V.K. Vijaya Kumar, "Generalized synthetic discriminant functions," *JOSA-A*, vol. 5, 562-571, 1988.
46. B.V.K. Vijaya Kumar and C. Fitzpatrick, "Performance of an algorithm that computes geometric moments from optical Hartley transform intensities," *Optical Engineering*, vol. 27, 280-288, 1988.
47. R. Katti, V. Veeravalli, M. Kryder and B.V.K. Vijaya Kumar, "Model for Demagnetization-induced noise in thin film magnetic recording media," *IEEE Trans. Magnetism*, vol. 24, 2150-2158, 1988.
48. B.V.K. Vijaya Kumar and Z. Bahri, "Phase-only filters with improved signal-to-noise ratio," *Applied Optics*, vol. 28, 250-257, 1989.
49. M. Lemmon and B.V.K. Vijaya Kumar, "Emulating the dynamics for a class of laterally inhibited neural networks," *Neural Networks*, vol. 2, 193-214, 1989.
50. B.V.K. Vijaya Kumar and Z. Bahri, "Efficient algorithm for designing a ternary-valued filter yielding maximum Signal-to-noise Ratio," *Applied Optics*, vol. 28, 1919-1925, 1989; *Reprinted in the SPIE Milestone Series, "Fourier Optics," 1994.*
51. B.V.K. Vijaya Kumar, A. Lee and J. Connelly, "Estimating object rotation and scale using correlation filters," *Optical Engineering*, vol. 28, 474-481, 1989.
52. B.V.K. Vijaya Kumar, D. Casasent and A. Mahalanobis, "Correlation filters for target detection in a Markov model background clutter," *Applied Optics*, vol. 28, 3112-3119, 1989.
53. C. Carroll and B.V.K. Vijaya Kumar, "Pattern synthesis using Fourier Transforms," *Optical Engineering*, vol. 28, 1203-1210, 1989.
54. B.V.K. Vijaya Kumar, Z. Bahri and L. Hasebrook, "Correlation Filters for Optical Pattern Recognition," *JIETE*, vol. 35, 105-113, 1989.
55. B.V.K. Vijaya Kumar, "Signal-to-Noise Ratio (SNR) Loss in Correlators Using Real Filters," *Applied Optics*, vol. 28, 3287-88, 1989.
56. B. Montgomery, H. Diamond and B.V.K. Vijaya Kumar, "Bit probabilities of optimal binary source codes," *IEEE Trans. Information Theory*, vol. 36, 1446-1450, 1990.
57. B. Montgomery and B.V.K. Vijaya Kumar, "Systematic random error correcting and all unidirectional error detecting codes," *IEEE Trans. Computers*, vol. 39, 836-840, 1990.
58. F. Dickey, B.V.K. Vijaya Kumar, L. Romero and J. Connelly, "Complex Ternary Matched Filters yielding high Signal-to-Noise Ratios," *Optical Engineering*, vol. 29, 994-1001, 1990.
59. Z. Bahri and B.V.K. Vijaya Kumar, "Fast Algorithms for the design of optimal phase-only filters (POFs) and binary phase-only filters (BPOFs)," *Applied Optics*, vol. 29, 2992-2996, 1990.

60. B.V.K. Vijaya Kumar and L. Hassebrook, "Performance Measures for Correlation Filters," *Applied Optics*, vol. 29, 2997-3006, 1990; Reprinted in *SPIE Milestone Series, Vol. MS76, "Selected Papers on Optical Correlators," 1993*.
61. L. Hassebrook, B.V.K. Vijaya Kumar and L. Hostetler, "Linear Phase Coefficient Composite Filter Banks for Distortion-Invariant Optical Pattern Recognition," *Optical Engineering*, vol. 29, 1033-1043, 1990.
62. B.V.K. Vijaya Kumar, W. Shi and C. Hendrix, "Phase-only filters with maximally sharp correlation peaks," *Optics Letters*, vol. 15, 807-809, 1990.
63. B.V.K. Vijaya Kumar, W. Shi and C. Hendrix, "Partial-Information Filters Yielding Maximally Sharp Correlation Peaks," *Optical Computing and Processing*, vol. 1, 29-46, 1991.
64. R. Juday, B.V.K. Vijaya Kumar and S. Rajan, "Optimal Real Correlation Filters," *Applied Optics*, vol. 30, 520-522, 1991.
65. B.V.K. Vijaya Kumar and R. Juday, "Design of phase-only, binary phase-only and complex ternary matched filters with increased signal-to-noise ratios for colored noise," *Optics Letters*, vol. 16, 1025-1027, 1991; Reprinted in the *SPIE Milestone Series, "Selected Papers on Optical Pattern Recognition", 1999*.
66. M. Lemmon and B.V.K. Vijaya Kumar, "Competitive Learning with Generalized Winner Take All Activation," *IEEE Trans. on Neural Networks*, vol. 3, 167-175, 1992.
67. B.V.K. Vijaya Kumar, R. Juday and S. Rajan, "Saturated filters," *JOSA-A*, vol. 9, 405-412, 1992; errata in *JOSA-A*, vol. 10, 191, 1993.
68. B.V.K. Vijaya Kumar, F. Dickey and J. DeLaurentis, "Correlation filters minimizing peak location errors," *JOSA-A*, vol. 9, 678-682, 1992.
69. B.V.K. Vijaya Kumar, A. Mahalanobis, S. Song, S.R.F. Sims and J. Epperson, "Minimum squared error synthetic discriminant functions," *Optical Engineering*, vol. 31, 915-922, 1992.
70. L. Hassebrook, M. Rahmati and B.V.K. Vijaya Kumar, "Hybrid composite filter banks for distortion-invariant optical pattern recognition," *Optical Engineering*, vol. 31, 922-933, 1992.
71. B.V.K. Vijaya Kumar, "Tutorial survey of composite filter designs for optical correlators," *Applied Optics*, vol. 31, 4773-4801, 1992; Reprinted in the *SPIE Milestone Series, "Fourier Optics," 1994*.
72. P. Refregier, B.V.K. Vijaya Kumar and C. Hendrix, "Multi-criteria optimal binary amplitude phase-only filters," *JOSA-A*, vol. 9, 2118-2125, 1992.
73. B.V.K. Vijaya Kumar and J. Brasher, "Relationship between maximizing signal-to-noise ratio and minimizing classification error probability for correlation filters," *Optics Letters*, vol. 17, 940-942, 1992.
74. B.V.K. Vijaya Kumar, "A tutorial review of partial-information filter designs for optical correlators," *Asia-Pacific Engineering Journal*, (Part A), vol. 2, 203-215, 1992.
75. P. Refregier and B.V.K. Vijaya Kumar, "Introduction of detector noise and optimal filters," *JOSA-A*, vol. 9, 2089-90, 1992.
76. A. Kassim and B.V.K. Vijaya Kumar, "Neural Networks and the Potential Field Approach to Path Planning," *Asia Pacific Engineering Journal*, vol. 3, 283-295, 1993.

77. B.V.K. Vijaya Kumar, J. Brasher, C. Hester, G. Srinivasan and S. Bollapragada, "Synthetic discriminant functions for recognition of images on the boundary of the convex hull of the training set," *Pattern Recognition*, vol. 27, 543-548, 1994.
78. A. Mahalanobis, B.V.K. Vijaya Kumar, S. Song, S.R.F. Sims and J. Epperson, "Unconstrained correlation filters," *Applied Optics*, vol. 33, 3751-3759, 1994.
79. C. Hendrix and B.V.K. Vijaya Kumar, "Design and evaluation of three level composite filters obtained by optimizing an average compromise performance measure," *Optical Engineering*, vol. 33, 1767-1773, 1994.
80. B.V.K. Vijaya Kumar, "Partial information filters," *Digital Signal Processing*, vol. 4, 147-153, 1994.
81. B.V.K. Vijaya Kumar, D. Carlson and A. Mahalanobis, "Optimal tradeoff synthetic discriminant function (OTSDF) filters for arbitrary devices," *Optics Letters*, vol. 19, 1556-1558, 1994.
82. I. Ozgunes and B.V.K. Vijaya Kumar, "Magneto-optic read channel modeling in the presence of bloom," *IEEE Transactions Magnetics*, vol. 30, 4410-4412, 1994.
83. I. Ozgunes, B.V.K. Vijaya Kumar and M. Kryder, "Effect of transition noise on the signal-to-noise ratio of magneto-optic read channels," *IEEE Transactions Magnetics*, vol. 32, 3291-3304, 1996.
84. B.V.K. Vijaya Kumar and T.K. Ng, "Multiple circular harmonic function correlation filter providing specified response to in-plane rotation," *Applied Optics*, vol. 35, 1871-1878, 1996.
85. A. Mahalanobis, B.V.K. Vijaya Kumar and S.R.F. Sims, "Distance classifier correlation filters for multi-class target recognition," *Applied Optics*, vol. 35, 3127-3133, 1996.
86. S. Gopaldaswamy and B.V.K. Vijaya Kumar, "Multi-channel decision feedback equalizer for high track density in optical recording," *Optical Engineering*, vol. 35, 2386-2395, 1996.
87. A. Kassim and B.V.K. Vijaya Kumar, "Path planning for autonomous robots using neural networks," *Journal of Intelligent Systems*, vol. 7, 33-55, 1997.
88. A. Kassim and B.V.K. Vijaya Kumar, "The wave expansion neural network," *Neuro Computing*, vol. 16, 237-258, 1997.
89. S. Gopaldaswamy and B.V.K. Vijaya Kumar, "Multi-channel equalization for PWM channels in magneto-optical recording," *IEEE Trans. Magnetics*, vol. 33, 3265-67, 1997.
90. A. Mahalanobis and B.V.K. Vijaya Kumar, "Optimality of the MACH filters," *Optical Engineering*, vol. 36, 2642-2648, 1997.
91. B.V.K. Vijaya Kumar, D. Carlson and A. Mahalanobis, "Efficient determination of the optimum gain and angle in the design of optical correlation filters," *Optical Engineering*, vol. 37, 132-137, 1998.
92. G. Silvus and B.V.K. Vijaya Kumar, "A comparison of detection methods in the presence of nonlinearities," *IEEE Trans. Magnetics*, vol. 34, 98-103, 1998.
93. K. Al-Ghoneim and B.V.K. Vijaya Kumar, "Unified decision combination framework," *Pattern Recognition*, vol. 31, 2077-2086, 1998.
94. C. Soutar, D. Roberge, A. Stoianov, R. Gilroy and B.V.K. Vijaya Kumar, "Optimal trade-off filter for the correlation of fingerprints," *Optical Engineering*, vol. 38, 108-113, 1999.

95. A. Kassim and B.V.K. Vijaya Kumar, "Path planners based on the wave expansion neural network," *Robotics and Autonomous Systems*, vol. 26, 1-22, 1999.
96. V. Vadde and B.V.K. Vijaya Kumar, "Parity coding for page-oriented optical memories with intra-page intensity variations," *Optics Letters*, vol. 24, 546-548, 1999.
97. M. Keskinöz and B.V.K. Vijaya Kumar, "Application of linear minimum mean squared error equalization for volume holographic data storage," *Applied Optics*, vol. 38, 4387-4393, 1999.
98. V. Vadde and B.V.K. Vijaya Kumar, "Channel modeling and estimation for intrapage equalization in pixel-matched volume holographic data storage," *Applied Optics*, vol. 38, 4374-4386, 1999.
99. B.V.K. Vijaya Kumar and A. Mahalanobis, "Recent advances in composite correlation filter design," *Asian Journal of Physics*, vol. 8, No. 4, 407-420, 1999.
100. B.V.K. Vijaya Kumar, A. Mahalanobis and A. Takessian, "Optimal tradeoff circular harmonic function (OTCHF) correlation filter methods providing controlled in-plane rotation response," *IEEE Trans. Image Processing*, vol. 9, 1025-1034, 2000.
101. M. Alkanhal, B.V.K. Vijaya Kumar and A. Mahalanobis, "Improving the false alarm capabilities of the maximum average correlation height (MACH) correlation filter," *Optical Engineering*, vol. 39, 1133-1141, 2000.
102. A. Mahalanobis, B.V.K. Vijaya Kumar and R. Frankot, "Optimization of Intra-class and between class registration for correlation filter synthesis," *Applied Optics*, vol. 39, 2918-2924, 2000.
103. Y. Yuan, E. Kurtas and B.V.K. Vijaya Kumar, "Performance of timing recovery methods in Turbo coded magnetic recording channels," *IEEE Trans. Magnetics*, vol. 36, 2187-2189, 2000.
104. F. Sarigoz, B.V.K. Vijaya Kumar and J. Bain, "Performance of dropout correction on real magnetic waveforms with dropouts," *IEEE Trans. Magnetics*, vol. 37, 639-645, 2001.
105. H. Song, J. Liu, B.V.K. Vijaya Kumar and E. Kurtas, "Iterative soft-decoded partial response channels for hybrid magneto-optical recording," *IEEE Trans. Magnetics*, vol. 37, 676-681, 2001.
106. F. Sarigoz, H. Song, B.V.K. Vijaya Kumar and J. Bain, "Dropout tolerant read channels," *IEEE Journal on Selected Areas of Communications*, vol. 19, 744-755, 2001.
107. H. Song, B.V.K. Vijaya Kumar, E. Kurtas, Y. Yuan, L. McPheters and S. McLaughlin, "Iterative decoding for partial response (PR), equalized, magneto-optical data storage channels," *IEEE Journal on Selected Areas of Communications*, vol. 19, 774-782, 2001.
108. J. Moon, H. Thapar, B.V.K. Vijaya Kumar, and K. Immink, "Editorial: Signal Processing for High Density Storage Channels," *IEEE Journal on Selected Areas of Communications*, vol. 19, 577-581, 2001.
109. H. Song, J. Liu, B.V.K. Vijaya Kumar, A. Inaba, K. Shimazaki and N. Ota, "Low Density Parity Check (LDPC) Code Concatenated with Generalized Partial Response (GPR) Target for High-Capacity Magneto-Optic (MO) Recording Channels," *Japanese Journal of Applied Physics*, vol. 41, 1749-1752, 2002.
110. J. Liu, H. Song and B.V.K. Vijaya Kumar, "Fast timing acquisition for low-SNR, high-density optical recording," *Japanese Journal of Applied Physics*, vol. 41, 1772-1776, 2002.
111. M. Savvides, B.V.K. Vijaya Kumar and P. Khosla, "Two-class minimax distance transform correlation filter," *Applied Optics*, vol. 41, 6829-6840, 2002.

112. J. Liu, H. Song and B.V.K. Vijaya Kumar, "Bound for loss of lock rate in partial response channels," *Electronics Letters*, vol. 38, 928-930, 2002.
113. X Liu, T. Chen and B.V.K. Vijaya Kumar, "Face authentication of multiple subjects using eigenflow," *Pattern Recognition*, vol. 36, 313-328, 2003.
114. M. Alkanhal and B.V.K. Vijaya Kumar, "Polynomial distance classifier correlation filter for pattern recognition," *Applied Optics*, vol. 42, 4688-4708, 2003.
115. J. Liu, H. Song and B.V.K. Vijaya Kumar, "Timing acquisition for low-SNR data storage channels," *IEEE Trans. Magnetics*, vol. 39, 2558-60, 2003.
116. H. Song, J. Liu and B.V.K. Vijaya Kumar, "Convergence analysis of iterative soft decoding in partial response channels," *IEEE Trans. Magnetics*, vol. 39, 2552-54, 2003.
117. B.V.K. Vijaya Kumar, M. Savvides, K. Venkataramani, C. Xie, J. Thornton and A. Mahalanobis "Biometric verification using advanced correlation filters," *Applied Optics*, vol. 43, 391-402, 2004.
118. M. Keskinoz and B.V.K. Vijaya Kumar, "Discrete magnitude-square channel modeling, equalization and detection for volume holographic storage channel," *Applied Optics*, vol. 43, 1368-1378, 2004.
119. A. Kavcic, J. Moura and B.V.K. Vijaya Kumar, "Iterative, soft signal processing for digital communications," *IEEE Signal Processing Magazine*, Guest Editorial, 26, January 2004.
120. H. Song and B.V.K. Vijaya Kumar, "Low-density parity check codes for partial response channels," *IEEE Signal Processing Magazine*, 56-66, January 2004.
121. H. Song, J. Liu and B.V.K. Vijaya Kumar, "Large-girth cycle codes for partial response channels," *IEEE Trans. Magnetics*, vol. 40, 3084-3086, 2004.
122. L. Sun, T. Horigome and B.V.K. Vijaya Kumar, "A high-throughput field-programmable gate array implementation of soft output Viterbi algorithm for magnetic recording," *IEEE Trans. Magnetics*, vol. 40, 3081-3083, 2004.
123. K. Venkataramani and B.V.K. Vijaya Kumar, "Performance of composite correlation filters for fingerprint verification," *Optical Engineering*, vol. 43, 1820-27, 2004.
124. P. Hennings, J. Thornton, J. Kovacevic and B.V.K. Vijaya Kumar, "Wavelet packet correlation methods in biometrics," *Applied Optics*, vol. 44, 637-646, 2005.
125. S. Wijaya, M. Savvides and B.V.K. Vijaya Kumar, "Illumination-tolerant face verification of low bit rate JPEG2000 wavelet images using advanced correlation filters for handheld devices," *Applied Optics*, vol. 44, 655-665, 2005.
126. K. Venkataramani, S. Qidwai and B.V.K. Vijaya Kumar, "Face authentication from cell phone camera images with illumination and temporal variations," *IEEE Trans. on Systems, Man and Cybernetics – Part C: Applications and Reviews*, vol. 35, 411-418, 2005.
127. Z. Li, J. Xie and B.V.K. Vijaya Kumar, "An improved bit-flipping scheme to achieve run length control in coded systems," *IEEE Trans. Magnetics*, vol. 41, 2980-82, 2005.
128. L. Sun, H. Song, B.V.K. Vijaya Kumar and Z. Keirn, "Field-programmable gate-array based investigation of the error floor of low-density parity check codes for magnetic recording channels," *IEEE Trans. Magnetics*, vol. 41, 2983-85, 2005.

129. L. Sun, H. Song, Z. Keirn and B.V.K. Vijaya Kumar, "Field programmable gate array (FPGA) for iterative code evaluation," *IEEE Trans. Magnetics*, vol. 42, 226-231, 2006.
130. Z. Li and B.V.K. Vijaya Kumar, "Low density parity check codes with run length limited modulation constraints," *IEEE Trans. Magnetics*, vol. 42, 344-349, 2006.
131. S. Nabavi and B.V.K. Vijaya Kumar, "Application of linear and nonlinear equalization methods for holographic data storage," *Japanese Journal of Applied Physics*, vol. 45, 1079-1083, 2006.
132. L. Ramamoorthy and B.V.K. Vijaya Kumar, "Two-dimensional equalization and error correction using low density parity check codes for holographic data storage," *Japanese Journal of Applied Physics*, vol. 45, 1305-1310, 2006.
133. R. Kerekes and B.V.K. Vijaya Kumar, "Correlation filters with controlled scale response," *IEEE Trans. Image Processing*, vol. 15, 1794-1802, 2006.
134. S. Mitra, M. Savvides and B.V.K. Vijaya Kumar, "Face identification using novel frequency domain representation of facial asymmetry," *IEEE Trans. Information Forensics and Security*, vol. 1, 350-359, 2006.
135. J. Xie, B.V.K. Vijaya Kumar and X. Hu, "Baseline wander compensation by per-survivor processing," *IEEE Trans. Magnetics*, vol. 42, 2609-2611, 2006.
136. X. Hu, B.V.K. Vijaya Kumar, L. Sun and J. Xie "Decoding behavior study of LDPC codes under a realistic magnetic recording channel model," *IEEE Trans. Magnetics*, vol. 42, 2606-2608, 2006.
137. B.V.K. Vijaya Kumar, M. Savvides and C. Xie, "Correlation pattern recognition for face recognition," *Proc. IEEE*, vol. 94, 1963-1976, 2006.
138. X. Hu and B.V.K. Vijaya Kumar, "Evaluation of low density parity check (LDPC) codes on perpendicular magnetic recording model," *IEEE Trans. Magnetics*, vol. 43, 727-732, 2007.
139. J. Thornton, M. Savvides and B.V.K. Vijaya Kumar, "A unified Bayesian approach to deformed pattern matching of iris images," *IEEE Trans. Patt. Anal. Mach. Intell.*, vol. 29, 596-606, 2007.
140. J. Xie and B.V.K. Vijaya Kumar, "Dropout compensation by equalizer selection and Kalman filter-based timing recovery," *IEEE Trans. Magnetics*, vol. 43, 2045-2053, 2007.
141. S. Jeon, X. Hu, L. Sun and B.V.K. Vijaya Kumar, "Performance evaluation of partial response targets for perpendicular recording using field programmable gate arrays," *IEEE Trans. Magnetics*, vol. 43, 2259-2261, 2007.
142. S. Nabavi, B.V.K. Vijaya Kumar and J. Zhu, "Modifying Viterbi algorithm to mitigate inter-track interference for bit-patterned media," *IEEE Trans. Magnetics*, vol. 43, 2274-2276, 2007.
143. A.K. Sao, B. Yegnanarayana and B.V.K. Vijaya Kumar, "Significance of image representation for face verification," *Signal, Image and Video Processing*, vol. 1, 225-237, 2007.
144. P. Hennings, B.V.K. Vijaya Kumar and M. Savvides, "Palmprint classification using multiple advanced correlation filters and palm-specific segmentation," *IEEE Trans. Information Forensics and Security*, vol. 2, 613-622, 2007.

145. B. Bhanu, N.K. Ratha, B.V.K. Vijaya Kumar, R. Chellappa and J. Bigun, "Guest editorial: Special issue on human detection and recognition," *IEEE Trans. Information Forensics and Security*, vol. 2, 489-490, 2007.
146. J. Xie, L. Sun and B.V.K. Vijaya Kumar, "An implementation-friendly constraint for FIR filters for equalization," *IEEE Trans. Magnetics*, vol. 44, 315-319, 2008.
147. R. Kerekes and B.V.K. Vijaya Kumar, "Selecting a composite correlation filter design: a survey and comparative study," *Optical Engineering*, vol. 47, no.6, 067202, June 2008.
148. J. Xie and B.V.K. Vijaya Kumar, "Timing recovery in data storage systems: framework and approach of Kalman filtering" special issue on advances in data storage systems and technology, *International J. Product Development*, vol. 5, no. 3/4, 430-446, 2008.
149. S. Nabavi, B.V.K. Vijaya Kumar and J. Bain, "Media noise modeling for bit-patterned media," to appear, *IEEE Trans. Magnetics*, September 2008.
150. R. Kerekes and B.V.K. Vijaya Kumar, "Enhanced video-based target detection using correlation filters," to appear, *IEEE Trans. Aerospace Electronic Systems*, 2009.
151. Vishnu Naresh Boddeti and B.V.K. Vijaya Kumar, "Performance evaluation of wavefront coding for iris recognition," submitted, *IEEE Trans. Systems, Man and Cybernetics A*, December 2008.
152. P. Campisi, E. Kelkboom, B.V.K. Vijaya Kumar, N. Ratha and Y. Sutcu, "Privacy and Biometrics: Why and How?," submitted, *IEEE Trans. Systems, Man and Cybernetics A*, December 2008.

#### **OTHER PUBLICATIONS**

1. B.V.K. Vijaya Kumar, Review of the book, "Principles of Communication Systems" by H. Taub and D. Schilling (McGraw-Hill, 1986), *IEEE Communications Magazine*, vol. 25, No. 10, pp. 63, 77, October 1987; Also reprinted in *Proc. of IEEE*, vol. 77, No. 4, pp. 625-626, April 1989.
2. B.V.K. Vijaya Kumar, Foreword to the book, *Competitively Inhibited Neural Networks for Adaptive Parameter Estimation* by M. Lemmon, Kluwer Academic Publishers, 1991.
3. B.V.K. Vijaya Kumar, *Electrical and Computer Engineering at Carnegie Mellon - a New Curriculum*, contributor, Dept. of ECE, Carnegie Mellon University, 1995.
4. D. Casasent, B.V.K. Vijaya Kumar, J. Moura and R. Stern, "Signal Processing," part of the book *Our Vision: Frontiers in Electrical and Computer Engineering*, edited by Robert M. White, Dept. of Electrical and Computer Engineering, Carnegie Mellon university, Pittsburgh, 1997.
5. B.V.K. Vijaya Kumar, "Channels and ECC", Section 7 of the Executive Report of the *NSIC International Workshop on Holographic Data Storage*, Nice, France, March 8-11, 1999.
6. B.V.K. Vijaya Kumar, "Coding and Signal Processing for Optical Storage Systems," section in *NSIC Optical Storage Road Map*, January 2000.
7. R. Barndt, B.V.K. Vijaya Kumar, G. Jacqueline, N. Koren, R. Molstadt and A. Roesler, "Recording Channel Electronics Technology," section in *NSIC Tape Road Map*, 2002.

8. B.V.K. Vijaya Kumar, "Coding and signal processing for optical storage," section in *INSIC Optical Storage Road Map*, February 2003 (member of the team).
9. B.V.K. Vijaya Kumar, "Signal processing for optical data storage," section in *INSIC Optical Storage Road Map*, June 2006 (member of the team).

#### **PATENTS**

- C. Soutar, D. Roberge, A. Stoianov, R. Gilroy and B.V.K. Vijaya Kumar, "Method for secure key management using a biometric," US patent # 6219794.
- A. Mahalanobis and B.V.K. Vijaya Kumar, "Polynomial filters for higher order correlation and multi-input information fusion," US patent # 6295373.
- H. Song, J. Liu and B.V.K. Vijaya Kumar, "Encoding method using a low density parity check code with a column weight of two," US patent # 7058873.
- J. Liu, H. Song and B.V.K. Vijaya Kumar, "Timing recovery system and method," US patent # 7239682.

#### **MEDIA COVERAGE**

- "Riconoscere un naso da pochi pixel un software ricrea i volti nascosti," *La Repubblica*, September 19, 2008 ([http://www.repubblica.it/2008/09/sezioni/scienza\\_e\\_tecnologia/software-volti-nascosti/software-volti-nascosti/software-volti-nascosti.html](http://www.repubblica.it/2008/09/sezioni/scienza_e_tecnologia/software-volti-nascosti/software-volti-nascosti/software-volti-nascosti.html))
- "A face-finding search engine," *MIT Technology Review*, September 17, 2008 (<http://www.technologyreview.com/Infotech/21384/page1/>)
- "Private eyes are watching you," *ABCNews.com* article, May 19, 2008 (<http://abcnews.go.com/Technology/GadgetGuide/Story?id=4872498&page=1>)
- "Integrating correlation filtering and tracking for better target detection," *SPIE Newsroom* article, April 2008 (<http://spie.org/x23184.xml>)
- "Tech lets you pay with your finger," *Discovery channel news* article, August 16, 2007 ([http://dsc.discovery.com/news/2007/08/16/fingerpay\\_tec.html?category=technology&guid=20070816101500](http://dsc.discovery.com/news/2007/08/16/fingerpay_tec.html?category=technology&guid=20070816101500))
- "Dotting the eyes on terror," *RMIT Openline*, the online magazine of RMIT University, Melbourne, Australia, October 02, 2006 (<http://www.rmit.edu.au/browse;ID=t5rq11xgdeby>)
- "Correlation pattern recognition for biometrics," *SPIE Newsroom* article, June 2006 (<http://newsroom.spie.org/x3165.xml?highlight=x535>)
- "Airport security becomes high-tech," *Beaver County Times* (PA), February 21, 2006 (<http://www.tmcnet.com/usubmit/2006/02/21/1390479.htm>)
- Our biometrics research was featured in *Currents*, ECE Department's news magazine.
- Our face verification demo was one of the demonstration items at the OSA Annual meeting (in Tucson) and was featured on local TV in Tucson, Arizona (October 2003).
- January 2004 newsletter of the International Association of Pattern Recognition (IAPR) devoted two pages (including the cover page) to discuss our correlation filters research.
- Our face recognition demo was featured on local TV in Pittsburgh (October 2002) during the C3S (predecessor to CyLab) inauguration events.
- Our biometrics work was featured in the May 2003 *Pittsburgher* monthly magazine.

#### **HONORS AND AWARDS**

- Recipient, Government of India Merit Scholarship (1970-75).
- Fellow, Optical Society of America (1993).
- Fellow, SPIE, the International Society of Optical Engineering (1991).
- Fellow, IAPR, the International Association of Pattern Recognition (2006)
- Listed in *Who's Who Among Asian Americans*.
- Listed in *Marquis Who's Who in Optical Sciences and Engineering*.
- Listed in *American Men and Women of Science*.
- Listed in *Marquis Who's Who in Sciences and Engineering*.
- Listed in *Marquis Who's Who in Education*.

- Listed in Marquis *Who's Who in Finance and Business*
- Listed in Marquis *Who's Who in America*
- Listed in Marquis *Who's Who in the World*.
- Recipient of Carnegie Institute of Technology's Philip Dowd Fellowship (2003)
- Recipient of Eta Kappa Nu award for Outstanding Faculty in the Electrical and Computer Engineering (ECE) Department at CMU, May 2003.

#### **PROFESSIONAL SOCIETY ACTIVITIES**

- Member, Sigma Xi
- Senior Member, IEEE
- Fellow, Optical Society of America
- Fellow, Society of Photo-optical Instrumentation Engineers
- Fellow, Intl. Assoc. of Pattern Recognition
- President, Pittsburgh section of OSA (1982)
- Chairman, 1988 Max Born award committee for OSA
- Vice President, Pittsburgh Chapter of Sigma Xi (1992-93)
- Vice Chair, IEEE Signal Processing for Storage Technical Committee, IEEE Communications Society (1998-2000)
- Chair, IEEE Signal Processing for Storage Technical Committee, IEEE Communications Society (2000-2002)
- Member, IEEE Biometrics Council (2008)
- Member, IEEE Technical Committee on Information Forensics and Security (IFS) (2008)

#### **PROFESSIONAL CONFERENCE ACTIVITIES**

- Program Committee for the SPIE Conference on Optical Information Processing, San Diego (1990 - 1994).
- Program Committee for the 1990 IEEE International Conference on Systems Engineering, Pittsburgh.
- Program Committee for the 1991 SPIE Conference on Emerging Optoelectronic Technologies in Bangalore, India.
- Poster Chairman, The Magnetic Recording Conference (TMRC), Hidden Valley, Pennsylvania, June 1991.
- Program Committees of the SPIE Conference on Optical Pattern Recognition in Orlando, Florida (1992-).
- Program Committee, Florida Artificial Intelligence Research Symposium (FLAIRS), Orlando, (1997-2000).
- International Program Committee, IASTED International Conference on Neural Networks (NN'2000), Pittsburgh, PA, May 2000.
- Co-organizer (with Dr. Mike Melas of IBM Almaden Research Center), Workshop on Data Storage in the Third Millennium, International Communications Conference, New Orleans, LA, June 2000.
- Program Committee, Optical Data Storage conference (2001-)
- Member, Technical Program Committee, International Symposium on Optical memories (ISOM) (2001-2005).
- Co-chair, Technical Program Committee, Optical Data Storage (ODS) conference, Vancouver, BC, Canada, May 2003.
- Program Committee, Globecom (2004-2007).
- General co-chair, Optical Data Storage (ODS) Conference, Monterey, CA, April 2004.
- Program Committee, Biometric Authentication Workshop, Prague, May 2004.
- Program Committee, International Communications Conference (ICC), (2005, 2006).
- Co-General chair, Advisory Committee, Optical Data Storage (ODS) conference, Hawaii, July 2005.
- Program Committee, Audio, Video-based Person Authentication (AVBPA) conference, New York, July 2005.
- Program Committee, SPIE Conference on Biometric Technology for Human Identification (2005-)

- Co-General chair, 4<sup>th</sup> IEEE workshop on Automatic Identification Advanced Technologies, Buffalo, October 2005.
- Program Committee, International Association of Pattern Recognition International Conference on Biometrics (IAPR ICB), Hong Kong, January 2006.
- Program Committee, Biometrics Symposium Technical Session (2005-).
- Program committee, International Conference on Pattern Recognition (ICPR), Hong Kong, August 2006.
- Program Committee, CVPR Biometrics Workshop, New York City, June 2006.
- Chair, *Biometrics* special session, Intl. Workshop on Multimedia Content Representation, Classification and Security (MRCS 2006), Istanbul, Turkey, September 2006.
- Program Committee, 5<sup>th</sup> IEEE workshop on Automatic Identification Advanced Technologies, Italy, June 2007.
- Program Committee, Intl. Conf. on Image Analysis and Recognition (ICIAR) (2005-2007)
- Program Committee, Biometrics Symposium (2006-)
- Program Committee, Intl. Conf. on Computer Vision (ICCV), 2007-.
- Co-chair, SPIE Conference on Biometric Technology for Human Identification (2008)
- Program Committee, International Conference on Pattern Recognition (ICPR), 2008.
- Program Committee, Face & Gesture conference, 2008.
- Advisory Committee, Intl. Conference on Biometrics, Italy (2008)

#### **PROFESSIONAL JOURNAL ACTIVITIES**

- Reviewer for many journals (including *Applied Optics*, *Optics Letters*, *Optical Engineering*, *Optics Communications*, *JOSA-A*, *IEEE Trans. on Magnetics*, *IEEE Trans. on Signal Processing*, *IEEE Trans. on Vehicular Technology*, *IEEE Trans. on Sys. Man and Cybernetics*, *IEEE Trans. on Image Processing* and *IEEE Trans. on Pattern Analysis, Machine Intelligence*)
- Topical Editor for Pattern Recognition, *Applied Optics* (1990-1996)
- Member, Editorial panel of *Asia-Pacific Engineering Journal* (1991-93)
- Guest Editor, September 1990 Special Issue of *Optical Engineering* on Optical Pattern Recognition
- Co-Guest Editor, April 2001 special issue of the *IEEE Journal of Special Areas of Communications (JSAC)* on *Signal Processing for High-Density Storage Channels*.
- Editorial Board member, *IEEE Surveys and Tutorials in communications* (2001-2007)
- Co-Guest Editor, *IEEE Signal Processing Magazine* special issue on soft algorithms for communications, January 2004.
- Associate Editor, *IEEE Transactions on Information Forensics and Security* (2005-)
- Co-Guest Editor, special issue of *IEEE Trans. Information Forensics and Security* devoted to *Human Detection and Recognition* (September 2007)

#### **OTHER COMMITTEE ACTIVITIES**

- Member, Wipe the Slate Clean Committee, ECE Department, CMU: This committee developed the current ECE undergraduate curriculum at CMU.
- Chairman, ECE Head Search Committee (1992)
- Member, ECE Head Search Committee (1998)
- Member, Tri-Service Automatic Target Recognition Technology Assessment Plan (ATR-TAP) for Conventional Weapon Committee (1995)
- Member, Enrollment Process Reengineering Committee, CMU (1995)
- Member, Continuing Education Committee, Carnegie Institute of Technology, CMU (1994-95)
- Member, CIT Faculty Awards Committee: this committee developed the current CIT Faculty Awards process.
- Faculty Senate, Carnegie Mellon University (2000-2002)
- Chairman, Graduate Studies Committee, ECE Dept., CMU (2003-2004)
- Member, Undergraduate Studies Committee, ECE Dept., CMU (2005-2006)
- Member, Undergraduate Advising Committee (2008-2009)
- Member, NSF Electrical Engineering Panel for Graduate Research Fellowship Program (2008, 2009)

- Panel member, Jack Kent Cooke Foundation Fellowship Program (2008)

**VOLUNTEER ACTIVITIES**

- Member of the Executive Committee, S.V. Temple, Pittsburgh, PA (1990-92)
- President, Executive Committee, S.V. Temple, Pittsburgh, PA (1991-92)
- Member of the Board of Directors, S.V. Temple, Pittsburgh, PA (1992-94)
- Secretary, Board of Directors, S.V. Temple, Pittsburgh, PA (1993-94).
- Executive Committee, Pittsburgh Area Telugu Association (1999-2002).