



The Peter T. Flawn Distinguished Professor Electrical and Computer Engineering

Sos S. Agaian

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Education

Ph.D., Mathematics and Physics
Steklov Institute of Mathematics
Academy of Sciences of the USSR

Doctor of Engineering Sciences
Computer Center
Academy of Sciences of the USSR

Honors and Awards

Selected as an Influential Member of
the School of Engineering, Tufts
University, who Contributed
Significantly to Student Intellectual
and Personal Development, 2005

MAESTro Educator of the Year
Award (2004), Society of Mexican
American Engineers and Scientists

President's Annual Special Research
Award, The College of Staten Island
2001

Professional Editorship

Associate Editor

- Real-Time Imaging
- Electronic Imaging

Editorial Board Member

Pattern Recognition and Image
Analysis, USA-Russia

Research Interests

Fundamental

- Signal Processing and Systems
- Information Assurance
- Discrete Mathematics and
Computation

Applications

- Secure Multimedia & Cellular
Communications
- Steganography and
Watermarking
- Information Assurance
- Multimedia & Mobile Signal
Processing
- Pattern Recognition and
Machine Vision

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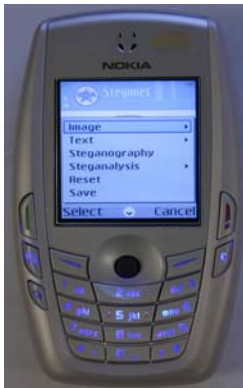
Research Summary

Dr. Agaian's research over the past several years has been devoted to such areas as Intelligent Signal Processing and Systems. He is particularly interested in development of scientific computing applicable to the theory and practice of engineering science. He explored the future of multi-discipline engineering applications such as target detection and recognition, computer engineering (faults detection), and multimedia security (steganography and watermarking and authentication). Dr. Agaian's research is of an interdisciplinary nature that has evolved from industrial mathematics to computer science, from applied signal/image processing, computer vision to target detection and recognition systems. It is this multidisciplinary experience that allows him to investigate these research areas thoroughly, and teach technical courses in an efficient manner. After September 11th he extended his research area to the fields of information assurance, multimedia and mobile secure communication.

Dr. Agaian's research projects, supported by the U.S. Department of Energy, DARPA, U.S. Army, Center for Infrastructure Assurance and Security and Air Force Information Warfare Center, include wavelet based target detection and recognition systems, theoretic development and application of Boolean functions and logical transforms, predictive transform-compression architecture and methodology for knowledge aided sensor signal processing and expert systems, blind detection of the localization hidden data in multimedia data, compact and fast representation multimedia signal and systems, adaptive linear and nonlinear filtering systems, and communication networks. As the PI, his current research projects are funded by Air Force Information Warfare Center and CIAS and include design of steganographical detection tools, secure cellular communications systems, multimedia database security, computational intelligent systems, and visual communications. Steganography is the hiding of a message within another message so that the presence of the hidden message is indiscernible. Practically, it is the art of secret communication. Digital data can be hidden in pictures, videos, music, text, binary files, cipher text or source code. The key concept behind steganography is that the message to be transmitted is not visible to the informal eye. Recently USA Today reported that Bin Laden was using steganography to disguise his communications. The Internet has become a new form of cold war era "dead drop". Steganalysis is to discover the presence of hidden messages in digital media. Steganography and steganalysis have not been completely examined in detail by the scientific community outside of the military. It is a relatively new and fast growing field. This area is now closely related to the security of our nation. Major work is being done in this area, and Agaian and his students haven developed very unique, proficient stego detection, localization and hidden algorithms, which differ from the traditional approaches. Dr. Agaian and Dr. Akopian also implemented a pioneered cellophane steganographic system. In addition, Dr. Agaian and Dr.Wang have discovered novel network components from temporal expressional profiles of malaria parasite.

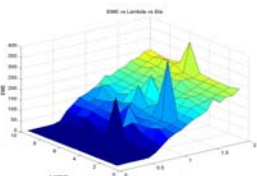
Dr. Agaian has been working at Aware as a senior research fellow sponsored by the US Army where he with his colleague, Dr.Del-Marko, have developed the wavelet transform based automatic target detection, segmentation, and recognition system. While teaching at Tufts University as a visiting professor, Dr. Agaian and Dr. Panetta have developed the image enhancement evaluation measure, and several elegant image enhancement and denosing algorithms based on the human visual system. These techniques had been employed on NASA's Earth Observing System satellite data for the purpose of anomaly detection and visualization.

- Bioinformatics
- Medical and Mobile Imaging
- Genomic Signal Processing



Areas of Expertise and Keywords

- Intelligent Systems
- Fast Transforms and Fractals
- Wavelets and Multiscale Methods
- Multimedia Signal Processing Enhancement, Analysis, Representation, Modeling, Filtering and Compression
- Measures (Image Enhancement, Stego Sensitivity, Image Similarity)
- Fast and Parallel Computation
- Data Hiding and Detection
- Monitoring, Diagnosis, and Forecasting
- Target Detection and Recognition
- Multimedia Security
- Quantum Computation



This collaborating work was awarded the Best Research and Presentation Diploma, NASA Annual Conference, (Fl.1998). When Dr. Agaian was a Guest Professor at the Tampere University of Technology, his colleagues, Dr. Astola and Dr.Egiazarian, and he have developed a theory of the Binary Polynomial Transforms with application. In particular, they have introduced a concept of construction of a class of logical systems (such as binary polynomial transforms, logical wavelets, and logical/fuzzy subband decompositions) for binary signals and for analyzing and minimizing Boolean functions. The polynomial transforms share many of the important properties of the discrete orthogonal and wavelet transform for graylevel or color images, which are impractical for representation binary signals. In addition, they have developed Fibonacci recursion based subband decomposition techniques and a class of linear and nonlinear filters. During this time, Dr. Agaian and his colleagues have also developed a new class (pipeline-parallel, parallel thresholding) architecture for nonlinear filtering, and proposed several series of application specific parallel discrete orthogonal processors combining the high speed and a high reliability, universality (ability to handle a family of basis), in a unified architecture. While teaching at New York City University Dr.Agaian and Dr.Feria have developed Accelerated Predictive-Transform, fast KLT algorithms.

Significant work is being done in multimedia signal representation areas. Agaian and his students have been developed very efficient, fast orthogonal, linear, non-linear, parametric, custom need, and fuzzy/wavelets transforms such as Fourier (FFT), slant, cosine, Hartely, Haar, Hadamard, KLT, SVD, and Fibonacci. They also derived lower and upper bounds for the complexity logical and linear transforms for MISD, SIMD, and MIMD systems, and gave a unified statistical method for estimation of round-off and overflow error in fixed-point arithmetic. They look at FFT algorithms from graph theory point of view and investigate optimality and isomorphism of these FFT-graph models. These works involve creative theory, resourceful practical implementations, and several military and industrial applications. Major work is also being done in construction of combinatorial configurations: he constructed class of Hadamard matrices, built an example which confirms that Plotkin's conjectures are not correct and he solved the Slichta problem. Dr. Agaian also introduces a visual morphology concept, which is remarkably capable of being a substitute (for many real-life problems) to the commonly used morphological methods. The results of Dr. Agaian's research in DSP are described in one of his several books on multidimensional discrete unitary and logical transforms, Hadamard matrices, logical transform with applications and articles. Many of his results are internationally known (Agaian's Theorems, Agaian's Bound, and Agaian's Family (see for examples, "Contemporary Design Theory", edited by J.H. Dinitz and D.R. Stinson, John Wiley & Sons, Inc. 1992, or visit the website at <http://www.cs.uow.edu.au/people/jennie/lifework.html>).

Selected Publications: He has written over 300 scientific papers (more than 100 refereed journal papers), four books, six book chapters, and has 12 patents)

- (Invited Paper) S.Agaian, "Steganography & Steganalysis An Overview of Research & Challenges", *Network Security and Intrusion Detection*, NATO Proceedings, 29 pages, 2005.
- (Invited Paper) S. Agaian et al. "Image Enhancement", *Advances in Imaging and Electron Physic*, 2004, pp.165-243
- S.Agaian, J. Astola and K.Egiazarian, "Binary Polynomial Transforms and Nonlinear Digital Filters," Marcel Dekker INC, New York, 1995, 308 pages.
- A.M. Grigoryan, and S.S.Agaian, "Multidimensional Discrete Unitary Transformations: Representation, Partitioning, and Algorithms", Marcel Dekker INC, New York, 2003, 521 pages.
- S. Agaian et al., "Transform Based Image Enhancement Algorithms with Performance Measure", *IEEE Transaction on Image Processing*, Volume 10, No.3.March, 2001, pp. 367-380.
- B.Rodriguez, S.Agaian, and G.Dietrich, "Steganalysis Using Modified Pixel Comparison and Complexity Measure", *IS&T/SPIE's Security, Steganography, and Watermarking of Multimedia Contents VI*, Jan. 2004, pp.46-58. San Jose
- D. Gevorkian, S.Agaian, and J.Astola, "Lower and Upper Bounds of Complexity of a Family of Fourier-Like Transforms with Respect to a Model of Linear SIMD-Computations" *Proceedings, 11th IASTED International Conference on Parallel and Distributed Computing and Systems*, MIT, vol. 1, 1999.
- US Patent, E. Feria and S.Agaian, "Accelerated Predictive-Transform," Nov. 2003
- S.Agaian, "Hadamard Matrices and Their Applications", *Lecture Notes of Mathematics*. No 1168, Springer-Verlag, 1985, 227 pages
- S.Agaian, and B.Rodriguez, "Basic Steganalysis Techniques for the Digital Media Forensics Examiner", book chapter, *Digital Crime and Forensic Science in Cyberspace*, 2006