PRECISE expects to significantly strengthen the current environment in Computing and Information Sciences and Engineering (CISE) at UPR through more diverse, competitive, and sustainable research. The award contributed to implement the multi-campus Ph.D. CISE. While increasing the participation of women and minorities in graduate education, the project facilitated, enhanced, and intensified research in CISE areas. The project enforced and supported the following research areas: Scientific Computing, Computing Systems, and Automated Information Processing & Digital Systems Implementation.

These areas constitute the core of the CISE multidisciplinary research environment, fostering the formation of multidisciplinary groups and partnerships with industry, government, and other universities in research projects of mutual interest. Four research groups have been created out of these areas: Advanced Data Management (ADM), Automated Information Processing & Digital Systems Implementation (AIP-DSI), Computational Statistics and Data Analysis (CSDA), and Parallel and Distributed Computing (PDC). A Computing Research Seminar and a biweekly CISE Technical Lecture Series have been established as a formal forum for the discussion of common grounds of CISE areas and the presentation of frontier research. A Computer Research Laboratory was established to support the proposed research and to serve as a location for student training activities. New research laboratories are being developed to support the research groups.

Through these efforts, the University of Puerto Rico at Mayagüez has further developed its computing science and engineering research capabilities involving minority students in greater number, paving the way for the conferring of more doctoral degrees to under-represented groups, particularly Hispanic and women in Computer Science and Engineering. It is hoped that through these efforts, the nation might find a successful model that will help in building a better racially and ethically balanced technological enterprise for the benefit of its present and future generations.

Currently, there are a total of sixteen (16) professors active in the PRECISE Project who come together into four research groups, each group with no more than four (4) professors: Advanced Data Management (ADM), Computational Statistics and Data Analysis (CSDA), Automated Information Processing &
& Digital Systems Implementation (AIP-DSI), and Parallel and Distributed Computing (PDC). In addition, there is a group composed of two professors whose main emphasis is research and development efforts for industrial software production. Finally, there are a total of three professors who are part of the PRECISE Project and are conducting research on an individual basis.

The Ph.D. Program in Computing and Information Sciences and Engineering (CISE) has been a central theme of the PRECISE Project. It is expected through this program to contribute to an increase in the participation of women and minorities in graduate education. The Ph.D. in CISE officially started in the Spring 2001 Semester. At the present time the program has eighteen (18) active students, a 50% increase over last year. Four students are female. A total of five (5) students are currently being fully supported by the PRECISE Project. An additional six (6) students will be admitted to the program in August 2003.

In the pages below we present our accomplishments for this fourth year of the PRECISE Project, starting with the figure below depicting the conformation of our research groups into a cohesive, integrated, and interacting strategic unit.

Our Vision

PRECISE will significantly strengthen the current research environment in Computing and Information Sciences and Engineering (CISE) at the UPR, making it more diverse, competitive, and sustainable. It will help in implementing the Ph.D. CISE model as an academic program.
Our Mission

To facilitate, enhance and strengthen research in Computing and Information Sciences and Engineering (CISE) while increasing the participation of women and minorities through a program that could become a national model.

Our Objectives for the Coming Fifth Year

Create and develop three new research laboratories to support the ADM, AIP-DSI, and PDC research groups. Contribute in the development of new laboratory to support the CSDA research group. Establish an Institute for Computing and Information Studies (ICIS) to integrate and structure all the resources harnessed by PRECISE into a unique focal entity in order to continue on a steady and well determined path to research excellence in selected CISE areas. Foster the advancement of the Ph.D. CISE Program into a strategic consortium. Maintain commitment to produce top quality graduate students at the MS and Ph.D. levels.
Our Management Structure

PRECISE’s Management Structure

ECE & Math Chairs

Ph.D. CISE Program

R&D Center

Dr. Domingo Rodriguez
Director

Project Assistant
Miss. Carmen V. Santiago

Dr. Néstor Rodríguez
Project Manager

Dr. Edgar Acuña
CSDA

Dr. Domingo Rodriguez
AIP-DSI

Dr. Wilson Rivera
PDC

Dr. Manuel Rodriguez-Martinez
ADM

External Evaluation Committee

Academia, Industry, and Government

Research Group Coordinators

Administrative Personnel
CECOR

From left: Profs. P. Rivera, J. Seguel, D. Rodriguez, W. Rivera, and M. Rodriguez

PRECISE’s Professors at the R&D CISE Conference Room
Part B: Accomplishments - PRECISE’s SUCCESS STORIES

1.0 Thesis Produced since April 2000 to present

On Kronecher Products Signal Processing Algorithms and FPGA Computational Structure
Student: Ivonne Avilés (May 2000)
Dr. Domingo Rodríguez

El Uso de Marcos de Referencia en la Teoría de Ondulaciones
Student: Amaldo Cohen May 2000
Dr. Jaime Seguel

A Java Based Tool Environment FFT Code Generation
Student: Maritza Rodríguez (May 2000)
Dr. Domingo Rodríguez

Fast Multidimensional Convolutions and SAR Image Formations in a MatLab Environment
Student: Dilia Rueda (May 2000)
Dr. Domingo Rodríguez

Time-Frequency Tools for Signal Analysis and Real-Time Applications
Student: Marlene Vargas (May 2000)
Dr. Domingo Rodríguez

Evolutionary System: “An Artificial System for Manufacturing Cell Design
Student: Yolanda Peña (July 2000)
Dr. Ramón Vásquez

Genetically Found Neurally Computed Artificial Features with Applications to Epileptic Seizure Detection and Prediction
Student: Hiriam Firpi (May 2001)
Dr. Javier Echauz

A Rule Based Intelligent Event Service
Edwin Moulier (May 2002)
Advisor: Dr. Javier Arroyo

A Framework for Generating a New Class of Numerical Integration Methods
Student: Amando Vega (May 2002)
Advisor: Dr. Jaime Seguel

Development of a Database for a Computer-Based Patient Record System
Juan P. J. Carvajal (Summer 2002)
Advisor: Dr. Néstor Rodríguez
Implementation of the Unsupervised Possibility Fuzzy C-means Algorithm for Classification of Hyperspectral Data
Student: Fernando Gallo (Summer 2002)
Advisor: Dr. Luis O. Jiménez

A Hierarchical Hybrid Approach to Cell Loading Manpower Allocation and Job Sequencing in Cellular Manufacturing
Student: Alejandro Mosquera (December 2002)
Advisor: Dr. Güer Süer

Un Método Eficiente para el Cómputo de Transformadas Trigonométricas
Student: Daniza Morales (December 2002)
Advisor: Dr. Jaime Seguel

Computational Modeling Simulation and Comparison Study of Cirrus Clouds Ice Crystals
Student: Jorge M. Villa (December 2002)
Advisor: Dr. Sandra Cruz-Pol

Stellar Imaging Interferometry
Student: Armando Yance (December 2002)
Advisor: Dr. Mark Chang

Comparación entre el Lenguaje de Especificación de reglas y el Lenguaje Orientado a objetos Java para el Desarrollo de Sistemas Distribuidos
Student: Amarillis Cuaresma (December 2002)
Advisor: Dr. Néstor Rodríguez

An Object-Oriented Framework for Parallel Incompressible Flow Simulations
Student: Freddy Perez (May 2003)
Advisor: Dr. Wilson Rivera

Multisensor Fusion Algorithms for Object Detection Using Subsurface Data
Student: Leonid Tolstoy (May 2003)
Advisor: Hamed Parsiani

Students at the PRECISE’s Computing Research Laboratory
The PRECISE Project donated a few C6711 DSP Development Systems to the Digital signal Processing Project Design Laboratory of the ECE Dept. where Prof. Domingo Rodríguez started to teach a capstone course in Digital Signal Processing.

2.0 Publications

Journals


Conferences (with proceedings)


Solá, Juan and I. Couvertier, A Parallel TCP/IP Offloading Framework for a TCP/IP Offloading Implementation, to appear in the IP Based SoC Design Workshop’02, October 30-31, 2002, Grenoble, France


**Book Chapters/Articles in Collections**


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**3.0 CISE-Technical Lecture Series**

**August—December 2002**

**Information Management Research @ UPRM**
CISE TLS I - Dr. Bienvenido Vélez
Department of Electrical and Computer Engineering
UPR-Mayagüez
August 29, 2002

**Simulation of Biomedical Fluid Flows**
CISE TLS II - Dr. Wilson Rivera
Department of Electrical and Computer Engineering
UPR-Mayagüez
September 12, 2002

**FTIS in Computational X-Ray Crystallography**
CISE TLS III - Dr. Jaime Seguel
Ph.D. CISE Program Director
UPR-Mayagüez
September 26, 2002
Modernización Curso de Compiladores
CISE TLS IV - Dr. Manuel E. Bermúdez
Department of CISE
University of Florida at Gainesville
October 10, 2002

Knowledge Management: An Information Nightmare or a Constructivist Dream
CISE TLS V - Dr. J. Fernando Vega-Riveros
Associate Director for Academic Affairs—ECE Department
UPR-Mayagüez
October 24, 2002

Feature Selection for Supervised Classification
CISE TLS VI - Dr. Edgar Acuña
Department of Mathematics
UPR-Mayagüez
November 7, 2002

CPS Methods for Signal Representation in Radar Imaging and MIMO Wireless Systems
CISE TLS VII - Dr. Domingo Rodríguez
Department of Electrical and Computer Engineering
UPR-Mayagüez
November 29, 2002

Structural Subband Decomposition: A New Concept in Digital Signal Processing
CISE TLS VIII - Dr. Sanjit K. Mitra
Department of Electrical and Computer Engineering
University of California at Santa Barbara
December 5, 2002

Prof. Sanjit K. Mitra, of UCSB, at a CISE Lecture at UPRM
Special Editions: August - December 2002

Paradigmas y Perspectivas Futuras en Computación
CISE Lecture Special Edition I - Dr. Manuel E. Bermúdez
Department of CISE
University of Florida at Gainesville
October 10, 2002

Overview of Computational Biology
CISE Lecture Special Edition II - Dr. David W. Deerfield II
Biomedical Initiative Director
Pittsburgh Super Computer Center
October 29, 2002

Resource Management and QOS Control for Next Generation Wireless Networks and High Speed Networks
CISE Lecture I - Dr. Yi Qian
CISE Distinguished Lecturer
January 10, 2003

Unsupervised Feature Subset Selection using Matrix Factorization Methods with Applications to Hyperspectral Imagery Band Subset Selection
CISE Lecture II - Dr. Miguel Vélez
Department of Electrical and Computer Engineering
UPR-Mayagüez
January 30, 2002
Unsupervised Feature Extraction Techniques for Hyperspectral Data and its Effects on Unsupervised Classification
CISE Lecture II - Dr. Luis O. Jiménez
Department of Electrical and Computer Engineering
UPR-Mayagüez
February 13, 2003

An Overview of the “System Security” Problem
CISE Lecture III - Dr. Fernando Colon-Osorio
Worcester Polytechnic Institute
February 27, 2002

Terrascope: A Database Middleware System to Support Wide-Area Scientific Applications
CISE Lecture IV - Dr. Manuel Rodríguez-Martínez
Department of Electrical and Computer Engineering
UPR-Mayagüez
March 13, 2003

Turbo Encoders with Interleavers Constructed using Permutation Monomials
CISE Lecture V - Dr. Ivelisse M. Rubio Canabal
Department of Mathematics
UPR-Humacao
March 27, 2003

High-Tech Entrepreneurship Adventures of an Academic Scientist
CISE Lecture VII - Dr. Jaime Ramirez-Vick
Department of General Engineering
UPR-Mayagüez
April 10, 2003

On the Use and Architecture of Knowledge Management Systems in High Education
CISE Lecture VIII - Dr. J. Fernando Vega-Riveros
Associate Director for Academic Affairs—ECE Department
UPR-Mayagüez
May 8, 2003

Prof. Fernando Colon-Osorio, of WPI, at a CISE Lecture
Identifying Determinants of Biological Specificity among Protein Families: A Case Study of Aldehyde Dehydrogenases and Glutathione S-Transferases
CISE-TLS Special Edition 7 Doctoral CISE Seminar - Dr. Hugh B. Nicholas Jr.
Pittsburgh Super Computing Center
February 26, 2003

The Mattson-Solomon Polynomial: An Elementary Introduction
CISE Lecture Special Edition II - Dr. H. F. Mattson Jr.
March 20, 2003

A New Approach to 2D/3D Interleaving and its Application to Digital Image and Video Watermarking
CISE Lecture Special Edition III - Dr. Yun Qing Shi
New Jersey Institute of Technology
Distinguished IEEE Lecturer
April 1, 2003

4.0 PRECISE Students

PRECISE Research Assistantships

<table>
<thead>
<tr>
<th>Ph.D. Student</th>
<th>Advisor</th>
<th>Research Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maria del Mar Alvarez</td>
<td>Dr. Jaime Seguel</td>
<td>Implementation of a Method for Compact Symmetric FFT Code Generation</td>
</tr>
<tr>
<td>Rafael Arce</td>
<td>Dr. Manuel Jiménez</td>
<td>Integer Pair Representation for Multiple-Output Logic</td>
</tr>
<tr>
<td>Vidya Manian</td>
<td>Dr. Ramón E. Vásquez</td>
<td>Texture Discrimination</td>
</tr>
<tr>
<td>Edusmildo Orozco</td>
<td>Dr. Dorothy Bollman</td>
<td>On the Structure ofFinite Dynamical Systems</td>
</tr>
<tr>
<td>Juan M. Solá</td>
<td>Dr. Isidoro Couvertier</td>
<td>UDP, TCP, and IP Fragmentation Analysis and its Importance in TOW Devices</td>
</tr>
</tbody>
</table>

Dr. Jaime Seguel in the PRECISE Students Meeting on February 20, 2003
<table>
<thead>
<tr>
<th>MS Student</th>
<th>Advisor</th>
<th>Research Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naomi Acosta</td>
<td>Dr. Jose Borges</td>
<td>Development of Efficient Data Input Techniques for Clinical Applications on PDAs.</td>
</tr>
<tr>
<td>Daniel Burbano</td>
<td>Dr. Jaime Seguel</td>
<td>A Self-Adaptive MPI Program</td>
</tr>
<tr>
<td>José F. Enseñat</td>
<td>Dr. Manuel Rodríguez</td>
<td>Design, Development and Implementation of a Registration Server for the NetTraveler Middleware System</td>
</tr>
<tr>
<td>Maria I. Diaz</td>
<td>Dr. Domingo Rodríguez</td>
<td>Java-Based Environment for the Implementation of Kronecker Mask Imaging Filters</td>
</tr>
<tr>
<td>Elisa Maldonado</td>
<td>Dr. Daniel Mcgee</td>
<td>The Use of Backpropagating Neural Networks in Coordination with Logistic Spline Coefficients to Obtain the Change Point</td>
</tr>
<tr>
<td>Viviam Murillo</td>
<td>Dr. Néstor J. Rodríguez</td>
<td>Usability Study of a Computer-Based Patient Record</td>
</tr>
<tr>
<td>Hilaura Nava</td>
<td>Dr. Domingo Rodríguez</td>
<td>Modeling and Simulation of Point Spread Functions for Advanced SAR Systems</td>
</tr>
<tr>
<td>Irvin Ortiz</td>
<td>Dr. Manuel Jiménez</td>
<td>Scalable Pipeline Insertion in Floating-Point Units for FPGA Synthesis</td>
</tr>
<tr>
<td>Freddy Perez</td>
<td>Dr. Wilson Rivera</td>
<td>An Object-Oriented Framework for Parallel Incompressible Flow Simulations</td>
</tr>
<tr>
<td>Roberto Piñero</td>
<td>Dr. Jorge Ortiz</td>
<td>Evolutionary Training of Morphological Neural Networks</td>
</tr>
<tr>
<td>Alberto Quinchanegua</td>
<td>Dr. Domingo Rodríguez</td>
<td>Computing Methods for Signal Algebra Operators: A DSP Core Implementations Approach</td>
</tr>
<tr>
<td>Yeida Rodríguez</td>
<td>Dr. Néstor J. Rodríguez</td>
<td>A Study of the State of the Art of Medical Informatics in Hospitals in Puerto Rico</td>
</tr>
<tr>
<td>Yajaira Soler</td>
<td>Dr. Néstor J. Rodríguez</td>
<td>Development of User Interfaces for Accessing Electronic Patient Record Systems with Hand Held Devices</td>
</tr>
<tr>
<td>Leonid Tolstoy</td>
<td>Dr. Hamed Parsiani</td>
<td>Multisensor Fusion Algorithms for Object Detection, Using Subsurface Data</td>
</tr>
<tr>
<td>José Torres</td>
<td>Dr. Bienvenido Vélez</td>
<td>Elastically Replicated Information Services</td>
</tr>
<tr>
<td>Jairo Valiente</td>
<td>Dr. Bienvenido Vélez</td>
<td>INFORADAR_ML: A Multi-Lingual Information Discovery Tool Exploiting Automatic Document Categorization</td>
</tr>
<tr>
<td>Ivan A. David</td>
<td>Dr. Jaime Seguel</td>
<td>Behavioral Analysis of Cilk Multithreading Programs Running on Multiprocessor Computer Systems</td>
</tr>
</tbody>
</table>

**PRECISE Infrastructure Assistantships**

<table>
<thead>
<tr>
<th>Name</th>
<th>Advisor</th>
<th>Research Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carlos Huallparimachi</td>
<td>Dr. Domingo Rodríguez</td>
<td>Java-Based Tool for Synthetic Aperture Radar Image Analysis</td>
</tr>
<tr>
<td>Ana M. Molina,</td>
<td>Dr. Manuel Rodríguez</td>
<td>XRoaster: A Tool for Catalog Management on Middleware</td>
</tr>
<tr>
<td>Alejandra Umaña</td>
<td>Dr. Miguel Vélez</td>
<td>Unsupervised Band Selection Algorithm for Hyperspectral Imagery</td>
</tr>
</tbody>
</table>
Part C: Accomplishments - PRECISE’s SUCCESS STORIES

Research Groups

1.0 COMPUTATIONAL STATISTICS AND DATA ANALYSIS GROUP

Edgar Acuña, edgar@math.uprm.edu, Coordinador
Daniel McGee, mcgee@cs.uprm.edu

1.1 Description

This group is dealing with research work in two areas:

Computational Statistics: where we look for the explicit impact of computers on statistical methodology, such as: algorithms, computer graphics, computer intensive inferential methods, expert systems, neural networks, parallel computing and statistical databases.

Statistical Methodology for data analysis, where we explore for new data analysis strategies and methodologies such as: classification, data exploration, density estimation, design of experiments, pattern recognition/image analysis and robust procedures, comparison of statistical methodology and simulation of experiments.

1.2 Current Participation in Competitive Research Grants

“Combining Classifiers Involving Kernel Density Estimates and Gaussian Mixtures”, Sponsored by Office of Naval Research (Edgar Acuña)

“Visualization Tools for 3d,” Sponsored by NSF (D. McGee, Martinez-Planell (Co-PI)

“Water Quality and Marine System Indicators: Development of a Statistical Model for an Integral Assessment,” Sponsored by NOAA (J. González, D. McGee (Co-PI), and A. San-Juan (Co-PI))

“Web Based Technology for Calculus,” Sponsored by Dept. of Education (D. McGee, Vazquez (Co-PI), Cáreres (Co-PI), Martinez Planel (Co-PI))

1.3 Strategic R&D with other Institutions

Medical University of South Carolina: Barbara Tilley, Zhen Zhang
Navy Laboratory at Virginia: David Marchette and Jeffrey Solka.

1.4 Research Summaries

1.4.1 Improvement of Supervised Pattern Recognition Techniques - Dr. Edgar Acuña

The research deals with the use of computer intensive methods in statistics to improve supervised pattern recognition techniques. Computer intensive methods involve three aspects: First, the use of powerful computers including parallel computers. Second, the development of efficient algorithms to carry
out the procedures, and, Third, the programming to perform the algorithms with accuracy and minimizing the running time. Supervised pattern recognition has plenty of applications, but we are more interested in engineering and biomedical (Bioinformatics) applications. The expected research outcomes are:

- Feature selection for classifiers based on Kernel density estimation. This part will be the master thesis of my student Zoraida Morales and it started in August 2001.

- Improvement of classifiers based on Gaussian Mixtures through the use of bagging and boosting. This kind of classifiers has a lot of applications even in unsupervised pattern recognition and involves parallel computation. This part will be the master thesis of my student Luis Daza and it started in August 2001. This work will be extended by my doctoral student Jose Vega in his thesis.

- Applications to genomics of improved classifiers based on Kernel density estimators and Gaussian mixtures. This will be the master thesis of my student Adriana Lopez and started in August 2001.

- Improvement of Support Vector Machine through the use of bagging and boosting. This new kind of classifiers but has gained a lot of attention very quickly. I am planning to use two students for this part. My students Frida Coaquira and Elio Lozano will be working during the year 2002 in this project and it will be their master thesis. Both of them are planning to continue doctoral studies in CISE.

1.4.2 Bioinformatics—Dr. Daniel McGee

The research is conducted in coordination with the Bioinformatics Department of the Medical University of South Carolina and concentrates on the application and development of Bioinformatics techniques when applied to medical and educational databases. In particular, neural networks, cluster analysis, genetic algorithms, principal component analysis, and normal statistical methodologies will be used and improved upon in these environments.

Goals:

- Make significant improvements to the training process for neural networks when used on medical and educational databases
- Compare the effectiveness of neural networks with traditional methods when applied to medical databases
- Establish the degree to which and the method by which the dimensionality of large records in medical or educational databases may be reduced
- Obtain clusters within medical and educational fields to identify endpoints or classes with which records may be associated
- Create an overall system to analyze medical and educational databases that will obtain the minimum necessary dimensionality per record, will obtain appropriate endpoints with which records may be associated, will train in a considerably expedited fashion neural networks that will obtain the probability that a record should be associated with a given endpoint.
2.0 AUTOMATED INFORMATION PROCESSING & DIGITAL SYSTEMS IMPLEMENTATION GROUP

Domingo Rodríguez, domingo@ece.uprm.edu, Coordinator
Manuel Jiménez, mjimenez@ece.uprm.edu
Isidoro Couvertier, icouver@ece.uprm.edu

2.1 Description

The Digital Systems Implementation (DSI) Group has as main objective to conduct basic and applied research in the design and development of efficient rapid systems prototypes for digital electronics applications. Special attention is given to prototypes for digital vector testability for large scale digital designs, FPGA development for emulation and simulation of signal processing computing methods, and the development of Integer Representation-based CAD tools. Target applications include remote sense imaging circuits, coding and cryptography systems, wavelength division multiple-access (WDM) communications circuits, and other large scale computing applications in Signal Processing and Communications. This research group is associated with newly created RASP Laboratory. A main mission of the RASP Laboratory is to enable graduate students acquire the necessary training, skills, expertise, and capabilities to conduct academic and industrial research work in the field of rapid prototyping digital-based systems, in general, and digital signal processing systems, in particular.

2.2 Current Participation in Competitive Research Grants

- “Continuation of the TI Analog, Digital, and Mixed-signal Electronics Program at the UPRM” Researchers: Rogelio Palomera (PI), Manuel Jiménez (Co-PI), Manuel Toledo Quiñones (Co-PI). Sponsor: Texas Instruments

2.3 Strategic R&D Alliances with other Institutions

- Texas Instruments, Inc.

2.4 Research Summaries

2.4.1 The Integer-Pair Representation: A Suitable Format for the Parallel Manipulation of Boolean Algebra — Dr. Manuel Jimenez

This work deals with the creation of a new format to represent binary terms in Boolean functions, called the Integer Pair Representation (IPR). This novel format uses an ordered pair of integers to compactly represent each cube of a Boolean function written as a sum-of-products in either canonical or non-canonical form. Properties of the representation have been formally established unveiling its advantages for developing algorithms enabling the concurrent processing of Boolean variables on SISD machines. In the current stage of development, these properties and algorithms have been combined to develop a prototype program for minimizing single-output binary valued Boolean functions.

2.4.2 Scalable Computing Methods for Signal Processing Systems — Dr. Domingo Rodriguez

This work deals with the analysis, design, and implementation of communications signals and circuits for signal processing systems. In particular, the work concentrates on developing scalable computing methods in signal processing for various stages of transmitter and receiver circuits and systems in digital radar systems, and digital communications systems in general. New hardware development strategies for signal synthesis, digital modulation, and channel coding techniques are being studied for signal transmission and reception efforts in multi-input multi-output (MIMO) adaptive sensor array radar systems. Special attention is being given to time-frequency representation techniques for the firmware implementation of surface point target response functions for synthetic aperture radar (SAR) processing operations. Kronecker signal algebra is being used for the study of structured multirate array sensor signal processing systems.
2.4.3 TCP/IP Offloading for Multi-Homed Servers — Dr. Isidoro Couvertier

This work is focused on TCP/IP (Transport Control Protocol/Internet Protocol) offloading based on frame carrier protocols, especially Ethernet. Studying Ethernet offloading as a frame carrier protocol is a feasible way to manage parallelism for multi-homed servers. The first stage of TCP/IP offloading begins with frame carrier offloading as a stepping-stone for higher offload layers of TCP/IP. The first stage of this project is based on frame carrier protocol. Overall concepts of computer networks, programming languages and compilers, operating systems, and application development will be used for the completion of this work. In addition, this work will address the subject of offloading onto an intelligent network card and the real time operating systems issues in relation to the TCP/IP offloading itself.

3.0 PARALLEL AND DISTRIBUTED COMPUTING GROUP

Wilson Rivera, wrivera@ece.uprm.edu, Coordinator
Jaime Seguel, jaime.seguel@ece.uprm.edu

3.1 Description

The Parallel and Distributed Computing Group performs research in the design, implementation, and efficiency measurements of parallel algorithms. It also addresses research issues related to parallel and distributed computing systems with an emphasis in high-performance cluster computing and Grid computing. Our work includes a wide spectrum of experiences from computing systems (e.g., self-optimizing software, hybrid multithreaded-distributed computing environments, performance testing, etc), to mathematical modeling and simulation of physical and biological phenomena, and the mathematics of algorithm design and optimization. [http://www.ece.uprm.edu/PDC](http://www.ece.uprm.edu/PDC)

3.2 Current Participation in Competitive Research Grants

3.2.1 Pending Proposals

- NSF-ITR proposal: “BTeV Breaking Down Barriers.” (Collaboration with FermiLab)

3.3 Strategic R&D Alliances with other Institutions

- Pittsburgh Supercomputing Center (Dr. David Deerfield, Biomedical Division)
- Mississippi State University (Dr. Ioana Banicescu, Computer Science)
- University of Akron (Dr. Jianping Zhu, Applied Mathematics)
- Northeastern University (Dr. David Kaeli, Electrical and Computer Eng.)

3.4 Research Summaries

3.4.1 Domain Decomposition Methods – Dr. Wilson Rivera

A new method based on explicit predictor and implicit corrector (EPIC) for generating numerical interface boundary conditions between subdomains has been proposed. We have applied the EPIC method to the solution of nonlinear equations on structured grids. The numerical results have shown that for transient problems the boundary treatment performed using the EPIC method yields significant improvement in accuracy.
compared to the traditional time-lagging (TL) method. The EPIC method showed better accuracy than time-lagging for detecting unsteady shocks. Also, the EPIC method demonstrated high quality solution at high CFL conditions, while the TL method demonstrated a reduction in quality as the CFL number was increased. In addition, the results showed that the new parallel algorithm is scalable as the number of processors increases. We plan to extend the EPIC methodology to unstructured grids. Unstructured grids offer a means to easily generate grids around very complex configurations since no predefined connectivity must be maintained, therefore, providing more flexibility and more optimal meshing point distribution. Strategies of treating subdomain interface connectivity and coupling in the parallel unstructured solution algorithm are being investigated.

3.4.2 Special Purpose Fast Fourier Transform (FFT) Algorithm - Dr. Jaime Seguel

The FFT is crucial to scientific computation. In several of these instances, the data to be transformed possesses special features such as symmetries, irregular shapes, or, as in physics, some degree of accuracy is demanded. The proposed research is intended to design and test algorithms for applications such as Volterra filters, Poisson solvers, and Crystallographic FFTs. This work concentrates on the use of mathematical properties for improving the computation of multidimensional FFTs of data sets endowed with special features such as symmetries or irregular shape, and improving the precision of FFT computations. The work contemplates implementations on parallel computing environments as well as the design of special purpose compilers for the efficient production of performance critical code segments.

3.4.3 Self-optimization Methodologies for Local Area Networks and the Grid – Dr. Jaime Seguel & Dr. Wilson Rivera

Currently, one of our major research efforts focuses on the design of self-optimizing software systems. Real-world computer systems are never completely described by any theory. Because of this lack of theoretical understanding it is not possible to design high-performance algorithms that are oblivious to the network architecture and its underlying system software. Self-adaptive software attains high performance by allowing an application to adapt the computation to the significant details of the computing system, automatically. Successful experiences have shown the validity of using meta-programming for automatic performance optimization. The meta-program collects significant information on the performance of the application on a particular system and modifies it, accordingly. These experiences have been mainly carried out on shared memory parallel computers. We propose to extend this approach to local area networks (LANs) and the Grid.

The Advanced Technology Platforms - Itanium 2 Academic Grant Initiative Program of Hewlett-Packard has awarded a $151k grant to the Parallel and Distributed Computing Group. The title of the proposal submitted by Dr. Wilson Rivera and Dr. Jaime Seguel was “Enhancing high performance computing research and education at UPRM.” This award has been matched with $126k by Hewlett-Packard Puerto Rico committed to foster computing research at UPRM.
4.0 ADVANCE DATA MANAGEMENT GROUP

Manuel Rodríguez-Martínez, manuelr@acm.org, Coordinator
Bienvenido Vélez, bvelez@acm.org
Pedro I. Rivera Vega, pedro.rivera@ece.uprm.edu
Fernando Vega, fvega@ece.uprm.edu

4.1 Description

Our research will focus on the design and implementation of next generation database and information retrieval systems with emphasis on Web information systems, handheld devices, reliability and fault tolerance, multimedia databases and cluster computing.

4.1.1 Vision

Establish a premier Research and Development Center dedicated to the advancement of Information Management Technologies, including: Database Management, Information Discovery, Network Middleware, and Database-Enabled Web Applications.

4.1.2 Mission

- The ADM Group is committed to conduct both theoretical and practical research aimed at the discovery of new theories and the development of new systems with particular emphasis on technologies with the potential for deep impact on the improvement of the quality of life in our society.

- The ADM group is committed to the advancement of Data Management technologies. Specific areas of emphasis include: Database Management, Information Retrieval and Discovery, Fault-tolerant Systems, Integrating Systems, Interoperability, and reliable Information Storage and Dissemination.

- The ADM group is committed to the integration of research and education through the rapid transfer of discoveries to the classroom. The group will be one of the main driving forces behind the development of the curriculum pertaining to Data Management at the University of Puerto Rico.

4.1.3 The ADM group is currently working on the following projects:

- Data Service Composition in Peer-to-Peer Architectures (P2P)
- Verizon Intelligent Home (iHome)
- Dynamic Image Retrieval and Composition Services in Distributed Information Systems
- Adaptively Replicated Information Services (ARIS)
- Inforadar: Document Classification using Query Lookahead
- Open Source Operating Systems (collaboration with IBM)

4.2 Current Participation in Competitive Research Grants

- O2S2 Sponsored by IBM (B. Velez and J. Arroyo (Co-PI)
4.3 Strategic R&D Alliances with other Academic and Industrial Institutions

- IBM - Open Source Operating Systems Project
- Tren Urbano - Passenger Information System
- CenSSIS Engineering Research Center - Dynamic Image Retrieval and Composition Services in Distributed Information Systems

4.4 Research Summaries

4.4.1 Interactive Queries Hierarchies for Effective Information Discovery at UPR-Mayagüez - Dr. Bienvenido Vélez

Advances in processor technologies suggest that future search engines will be capable of spending orders of magnitude more processing capacity per user request without inducing noticeably larger response times. A new information discovery technique called query lookahead invests additional computation on the eager evaluation of multiple queries automatically generated from an initial user query.

Query lookahead has the potential of improving search systems in at least two novel ways. First, it enables the deployment of anticipatory user interfaces capable of presenting the result sets of automatically generated refined queries ahead of time. Refined queries serve as categories upon which a large and imprecise result set can be organized. Second, query lookahead has the potential of improving the effectiveness of feature (e.g. term) selection algorithms. These algorithms can be improved by exploiting information about the result set induced by each potential feature when combined with the user query. This research focus on a new network search system, InfoRadar, exploiting query lookahead along these two lines. In response to a user query, InfoRadar displays a hierarchically organized selection of refined queries that we call an interactive query hierarchy. We have developed InfoRadar as a vehicle for testing our hypothesis that interactive query hierarchies can improve information discovery effectiveness. InfoRadar has three main software components: a multi-threaded Java applet, a server module and an indexing module. InfoRadar supports boolean queries using a syntax borrowed from the popular Altavista (www.altavista.com) search engine. In response to a query request from the applet, the InfoRadar server returns a hierarchy of queries together with their individual result set.

4.4.2 Data Composition Services in Peer-to-Peer Architecture - Dr. Manuel Rodríguez-Martínez

Next-generation Distributed Information Systems will consist of hundreds of thousands, perhaps millions, of diverse data sources located on geographically distributed networks like the Internet. In these types of large-scale distributed environments, heterogeneity in terms of hardware devices, software components, network connectivity and system configuration will be a fundamental characteristic of the data sources. In fact, these data sources might reside on high-end servers, desktop computers, mobile laptop computers, hand-held devices, intelligent sensors and appliances, or embedded computer systems.

Data integration and interoperation between these data sources will be a critical requirement to harvest the vast amounts of valuable information stored and maintained by the data sources. Information could be extracted from any available data source, whether it is a satellite image from an Earth Science database, or a phone book list, encoded in XML, that is extracted from a Palm-Pilot. Therefore, a data source site cannot be defined based on the size of stored data sets, or on the software environment being run, but rather, on whether other sites in the system retrieve the information held by the data source. In the other words, a data source is any site that provides a service to access some kind of data. Clearly, the distinction between what constitutes a client site and what constitutes a server site will be blurred, since any site can act as a client or as a service provider to another site in the system. Moreover, the sheer number and diversity of data sources implies that there cannot be a single authority that effectively coordinates and controls the access to data, or to the computational services in the system. These observations motivate us to conduct research and point us in the direction of a peer-to-peer dynamic environment [6,26] in which any
site can request or serve data, and must engage in a cooperative effort aimed at satisfying the requests for data and services associated with the queries posed by interested end-users.

We envision a decentralized Peer-to-Peer software framework in which user-defined code and control is released to the local executing sites (client or data sources), which will decide which are the sites that will supply data, computational services, and the aggregation of results. The receiving site may partially execute its code on its local environment, and pass it along with partial results to next peer site, or coalition of peer sites that will continue with the computational process. This framework is based on a model for composition of data services, where one site performs a given task and ships its results, plus some control information, to another site that will continue with the computational process.

4.4.3 Implementation of a Prototype for Knowledge Management in Higher Education – Dr. J. Fernando Vega-Riveros

The research consists in the implementation of a prototype of a knowledge system. The implementation includes two classes of distributed agents, one denoted user agent which acts as a knowledge broker for the user; the other denoted service agent receives queries to a knowledge repository from the user agents. The knowledge-base may be distributed and conformed by several knowledge repositories. In addition, the user client includes an expert system which assists in the construction of queries making inferences on the ontology or ontologies defined for the knowledge domain or domains present in the knowledge-base using a dialog-like or conversational interaction. It is important to highlight that in this proposal we refer not only to queries for information retrieval but for information storage as well. This is based on the highly interactive model for knowledge-management that has been devised and which assumes that users generate knowledge which becomes explicit through information resources and that are produced and analyzed in the source, i.e., by the user.

4.4.4 The Smart Mirrors Project - Dr. Pedro I. Rivera-Vega

We consider the problem of serving data being requested through the Internet, with the goal of completing the service in minimum time (turnaround time). We are working on a distributed peer-to-peer mirror system, the Smart Mirrors System that continuously collects information from peers, in order to decide the best approach to follow in serving each request. The information being interchanged describes two important factors that need to be taken into consideration by the system: the work load of each server and the network bandwidth. When a request is received the system uses this information, and further collaborates with the client site, in order to finally assign the task to the most appropriate server. The different research issues being considered are: architecture of the system, cost model to estimate service time of each particular server, interchange of information and service requests among peers, and real experimentation. We discuss these research issues under consideration and present preliminary results.

At this stage of the project, we are considering only static data requests, and a system in which each of the servers (peers) have the same data. We are in the process of real experimentation of our approach. We plan to further expand this project to the case in which a more dynamic environment exists in terms of data available in each of the servers.
The CRC 2003 conference was celebrated on April 5 of this year. This year, six papers were selected for oral presentation and 29 for poster presentation (see list below). All the papers were included in the proceeding of the conference and were presented by graduated as a result of their research effort. This year we had the participation of Aldo E. Briano from Southwestern Educational Society High School. The papers as well as other information about the conference is available on the conference website at:

http://ece.uprm.edu/crc/crc2003

The keynote address were given by Eng. Raymond Laureano, President of the Institute of Computer Engineers, College of Engineers and Land Surveyors of Puerto Rico, and Eng Neymar Maldonado, Information Technology Advisor of the Office of Management and Budget, Commonwealth of Puerto Rico.

The chairman of the conference were Nestor J. Rodríguez and Domingo Rodríguez. The Organizing Committee was formed by Carmen V. Santiago, Waleska Campos and Nestor J. Rodríguez.

**Oral Presentations**

**An Efficient Implementation of the Parallel Prime Edge-Length Crystallographic FFT**
Student: Daniel A. Burbano
Advisor: Dr. Jaime Seguel

**Signal Processing Implementations Using Simulink®**
Student: Alberto Quinchanegua & William Sánchez
Advisor: Domingo Rodríguez

**Integer Pair Representation for Multiple-Output Logic**
Student: Rafael A. Arce Nazario
Advisor: Dr. Manuel Jiménez

**Behavioral Modeling of Sigma-Delta Modulators Based on Symbolic Admittance Matrix**
Student: Félix O. Femández
Advisor: Dr. Manuel A. Jiménez

**Finite Fields are Better Booleans**
Student: Humberto Ortiz-Arzuga
Advisor: Dr. Oscar Moreno

**UDP, TCP, and IP Fragmentation Analysis and its Importance in TOE Devices**
Student: Juan M. Solá-Sloan
Advisor: Dr. Isidoro Couvertier
Analyzing the Parts Behavior in a Vibratory Bowl Feeder to Predict the Dynamic Probability Profile
Student: Abigail Santos
Advisor: Dr. Lourdes M. Rosario

Extended Java-FFT Environment
Student: Alberto Quinchanegua & Iván García
Advisor: Dr. Domingo Rodríguez

Development of a Database Middleware System to Support Remote Sensing Analysis over Distributed Data Sources
Student: Alcides Alvear
Advisor: Dr. Manuel Rodríguez-Martínez

A Comparison of A Rule Definition Language (RDL) and the JAVA Object Oriented Language for Implementing a Distributed System
Student: Amarilis Cuaresma
Advisor: Dr. Néstor Rodríguez

A Musical Signal Analyst
Student: Aldo E. Briano
Advisor: Dr. Domingo Rodríguez

TERRASCOPE CLIENT: An Interactive Image Browser for an Earth Science Information System
Student: Amaury Cabarcas
Advisor: Dr. Bienvenido Vélez

Xroaster: A Tool for Catalog Management on Middleware Databases Systems
Student: Ana M. Molina
Advisor: Manuel Rodríguez-Martínez

A Java-Based Tool for Image Analysis over Distributed Networks
Student: Carlos Huallparimachi
Advisor: Dr. Domingo Rodríguez

Experimental Validation of Bulk Synchronous Parallel on Origin 2000
Student: Elio Lozano
Advisor: Dr. Edgar Acuña

The Use of Backpropagating Neural Networks in Coordination with Logistic Spline Coefficients to Obtain the Change Point
Student: Elisa M. Maldonado
Advisor: Dr. Daniel McGee

TERRASCOPE SRE: Search and Retrieval Engine of Earth Science Information System
Student: Enna Z. Coronado
Advisor: Dr. Manuel Rodríguez-Martínez
An Object Oriented Framework for Computational Fluid Dynamics Simulations
Student: Freddy Pérez
Advisor: Dr. Wilson Rivera

Modeling and Simulation of Point Spread Functions for Advanced SAR Systems
Student: Hilaura Nava
Advisor: Dr. Domingo Rodríguez

Scalable Pipeline Insertion in Floating Point Units for FPGA Synthesis
Student: Irvin Ortíz
Advisor: Dr. Manuel Jiménez

Behavioral Analysis of Cilk Multithreading Programs Running in Multiprocessor Computer Systems
Student: Iván A. David
Advisor: Dr. Jaime Seguel

Mapping and Characterization of Applications in Heterogeneous Distributed Systems
Student: Jaime Yeckle
Advisor: Dr. Wilson Rivera

Design, Development and Implementation of a Registration Server for the NetTraveler Middleware System
Student: Jose F. Enseñat
Advisor: Dr. Manuel Rodríguez-Martínez

A Case for Elastic Replication Information Services
Student: Jose E. Torres
Advisor: Dr. Bienvenido Vélez

Supporting Multimedia Applications with NetTraveler
Student: Juan P. Carvajal Barreto
Advisor: Dr. Manuel Rodríguez-Martínez

Comparison of Neural Network Classification Methods Applied to Subsurface Radar Images Based on Single Echo and Hyperbolic Signature
Student: Leonid Tolstoy
Advisor: Dr. Hamed Parsiani

Combining Classifiers Based on Gaussian Mixtures
Student: Luis Daza
Advisor: Dr. Edgar Acuña

Towards the Development of a Learning Management System: A Case Study of Students’ use of Information
Student: Manuel G. Millán & Sharissa Kamer
Advisor: Dr. J. Fernando Vega

Instruction Level Power Profile for the Power PC Microprocessor
Student: Oscar Acevedo
Advisor: Dr. Manuel Jimenez
Evolutionary Training of Morphological Neural Networks
Student: Roberto C. Piñeiro
Advisor: Dr. Jorge L. López

Pixel Unmixing using Positive Matrix Factorization
Student: Samuel Rosario
Advisor: Dr. Miguel Vélez-Reyes

Classification by Support Vector Machines
Student: Santiago Velasco
Advisor: Dr. Edgar Acuña

Texture Synthesis using Reaction-Diffusion
Student: Vidya Manian
Dr. Ramon Vásquez

Order Entry Interface for a Computer-Based Patient Record System
Student: Viviam Murillo
Advisor: Dr. Néstor Rodríguez

A Comparison of a Nursing Documentation Application for PDAs and Laptops
Student: Yajaira Soler
Advisor: Dr. Néstor Rodríguez

Participants at the PRECISE’s Sponsored 2003 Computing Research Conference
Participants at the PRECISE's Sponsored 2003 Computing Research Conference

Part E: Assessment Activities

This section provides various graphics that show the performance in publication efforts as well as the degree of student participation.
Publications by Year

<table>
<thead>
<tr>
<th></th>
<th>April 00 to March 01</th>
<th>April 01 to March 02</th>
<th>April 02 to present</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>20</td>
<td>23</td>
<td>41</td>
</tr>
<tr>
<td>Journal</td>
<td>6</td>
<td>11</td>
<td>8</td>
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</table>

Journals Publications by Research Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>April 00 to March 01</th>
<th>April 01 to March 02</th>
<th>April 02 to present</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSDA</td>
<td>4</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>ADM</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>PDC</td>
<td>6</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>AIP-DSI</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>
Part F: Budget: Funds Distributions

Budget

This year’s NSF and UPR contributed budgets were distributed as shown in the charts that follow.
The portions of the budget used and available as of April 30th are presented in the table below.

### Fourth Year Budget

<table>
<thead>
<tr>
<th>NSF Contribution</th>
<th>Original</th>
<th>Used</th>
<th>Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Personnel</td>
<td>10,553</td>
<td>0</td>
<td>10,553</td>
</tr>
<tr>
<td>Graduate Stipends</td>
<td>76,050</td>
<td>73,315</td>
<td>2,735</td>
</tr>
<tr>
<td>Equipment</td>
<td>10,000</td>
<td>0</td>
<td>10,000</td>
</tr>
<tr>
<td>Travel</td>
<td>60,000</td>
<td>46,848</td>
<td>13,152</td>
</tr>
<tr>
<td>Participant Support</td>
<td>6,000</td>
<td>4,598</td>
<td>1,402</td>
</tr>
<tr>
<td>Other Costs</td>
<td>8,000</td>
<td>7,999</td>
<td>1</td>
</tr>
<tr>
<td>Consulting</td>
<td>15,000</td>
<td>9,463</td>
<td>5,537</td>
</tr>
<tr>
<td>Indirect Cost</td>
<td>45,654</td>
<td>45,654</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UPR Contribution</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduate Stipends</td>
<td>96,375</td>
<td>94,045</td>
<td>2,330</td>
</tr>
<tr>
<td>Personnel</td>
<td>97,356</td>
<td>39,608</td>
<td>57,748</td>
</tr>
<tr>
<td>Equipment &amp; Maintenance</td>
<td>46,745</td>
<td>30,783</td>
<td>15,962</td>
</tr>
<tr>
<td>Release Time</td>
<td>61,510</td>
<td>61,510</td>
<td>0</td>
</tr>
</tbody>
</table>
The following chart shows the relationship between the used and available NSF funds for this fourth year.

![Chart showing NSF funds distribution]

The chart below shows the distribution of the funds contributed for research assistantships by NSF and UPR from last summer.

![Chart showing NSF and UPR contributions by quarter]

The following chart shows the distribution of the funds awarded for PhD and MS research assistantships.

The following chart shows the relationship between the used and available UPR funds for this year.
Part F: Budget: Funds Distributions

Concluding Remarks

A principal objective of the PRECISE Project is to demonstrate a sustained commitment of integrating research and education by incorporating technology into the curriculum, generating new knowledge, skills, scientific and engineering talent, and innovative research ideas. It is our hope to enhance with this action the research culture in CISE areas at UPRM and Puerto Rico in general. It is our deep belief that a science and engineering infrastructure is paramount to a nation’s world competitiveness. Towards this end, we find as a barrier the lack of sustained coupled interaction between academia, local government, and local industry to carry out a concerted effort to meet this principal objective. We see as an opportunity the emerging realization of local industry and government that this interaction is necessary and very much needed for the technological and economic development of Puerto Rico.
Outreach

UNIVERSITY OF PUERTO RICO AT MAYAGÜEZ CAMPUS
BOX 9038 Mayagüez, P.R. 00680-9038

Phone: (787) 834-7620 ext. 2294
Fax: (787) 834-7620 ext. 2295
E-mail: precise@ece.uprm.edu

Prepared by: Ms. Carmen V. Santiago
Edited by: Dr. Domingo Rodríguez

For more information
www.precise@ece.uprm.edu