Networking and High Performance Computing Group (GRyCAP)

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Talk Outline

• Introduction
• Research Lines and Technological Capabilities
• Research Projects
• Software Tools Used
GRyCAP

Networking and High Performance Computing Group

- [http://www.grycap.upv.es](http://www.grycap.upv.es)
- Created in 1986
- Responsible: Vicente Hernández García (vhernand@dsic.upv.es)
- 20 members
- Developed Doctoral Dissertations: 15
- Ongoing Doctoral Dissertations: 12
- European Projects: 14
- Journal Articles: ~120
- International Congresses: ~220
Our Group is a Member of the ITACA Institute
Innovation and Technology Transfer to Society
Composed of
- Research Groups in the Valencia University of Technology
- Private Companies
- Public Administration Bodies
- Professional Associations

http://www.itaca.upv.es
Research Lines

- Structured Matrices
- Solution of Sparse Large-Scale Systems of Linear Equations
- Eigenvalues and Singular Values Computation for Sparse Large-Scale Problems
- Systems of Non-linear Equations and Optimization
- Partial Differential Equations and Finite Elements
- Numeric Algorithms for Process Control
- Networked Computer Systems
- Image Graphics Processing
Technological Capabilities

• **Advanced Software**
  - Optimization of Industrial Codes and Software Migration
  - Development of Numerical Computing Software
  - Generation of Highly Realistic Images
  - Internet-based High Performance Computing and E-Commerce Systems
  - Development of Distributed Applications
  - Development of User Interfaces

• **Software applied to Engineering**
  - Development of Environments for Industrial Processes
    High Performance Simulation
  - Robust Efficient Accurate Software Tools for Control Engineering
Technological Capabilities

• **Medical Images**
  - High Performance Processing of Medical Images
  - Development of Surgical Simulation Systems

• **Technology Transfer**
  - Hipercosme, Hiperttn, Eutist-m

• **Services and Consultancy**
  - High Performance Computing Platforms
  - High Performance Computing Software
Research Projects

• **Simulation for Engineering**
  - **Construction**: Hipercosme-cs1, Vasses, Gasses, Masses, Easses, Padem, Hiperbuild, Calma3D
  - **Water Supply**: Hiperwater, Powadima, Calnet
  - **Electromagnetic Field**: Fed-com
  - **Plastic Injection**: Hiperplast
  - **Nuclear Energy**: Atrapas, Lambda Modes
  - **Bioelectric**: Camaec, Camav
  - **Ports and Coasts**: Neurebata

• **Medical Sector**: Hipercir, Dismedi, Petri-med, Fed-med, Vrsur

• **Image Visualisation**: Fed-RV, Vre-commerce

• **Control Applications**: Niconet
Construction Simulation

“High Performance Computing for 3D Analysis of Building Structures”

(HIPERBUILD)

- Objectives:
  - Structural Analysis of Large Buildings
  - High Capacity Visualization
  - Static and Dynamic 3D, Realistic and Rigorous Analysis (6 Degrees of Freedom), Without Simplifications
Hydraulic Simulation

“High Performance Computing in Water Distribution Simulation” (HI PERWATER)

- Objectives:
  - A Tool for the Hydraulic and Water Quality Simulation of Supply Networks
  - A Tool for Leakage Simulation and Minimization
  - A Powerful Tool that Provides the Quickest Response by Using HPCN Technology
Hydraulic Simulation

“Potable Water Distribution Management”

(POWADI MA)

• Objectives:
  - Establish the Feasibility and Efficacy of Introducing Real-time Optimal-control for Water Distribution Networks
  - Reducing Operating Costs, Ensuring Service
  - Efficient Tools for Simulation and Optimization
Hydraulic Simulation

“Calibration and Exploitation of Hydraulic Models for Water Distribution Networks by means of GIS and SCADA Systems Connection”

(CALNET)

• Objectives:
  - To Connect GIS and SCADA Systems With Hydraulic Simulator (EPANET)
  - To Make Progress in the Field of the Hydraulic Model Calibration. (Optimization Problem)
Electromagnetism Simulation

“Simulation of Electromagnetic Wave Propagation in Cavities”

Applications:
- Microwave Oven Design
  - Domestic Scope
  - Industrial Scope
- Anecoic Chamber Design
  - Electromagnetic Compatibility
  - Pre-certification
“HPCN Reinforced Plastic Injection Simulation” (HIPERPLAST)

- Objectives:
  - Simulation for Short Fiber Reinforced Thermoplastics Injection Processes
  - Toy Industry
  - Designing More Easily Plastic Pieces
  - Replacing Stainless Steel or Aluminum Pieces by Plastic Ones
**Nuclear Engineering Simulation**

- **ATRAPAS**
  - TRAC-BF1 Code Parallelization
  - TRAC is a 3D simulator for the analysis of nuclear thermo-hydraulic Transients
  - TRAC Simulates the behavior of a nuclear plant model.
  - TRAC is commonly used for Accident analysis, Transient Analysis, Licensing or Fuel recharge
• **Lambda Modes Calculation**
  - Analysis of Neutrons Diffusion Within a Reactor Core
  - Reactor 3D Model
    • Axial Levels
    • Cells
  - Discretization: Eigenvalue Problem
  - Analysis of Control Bars Insertion
    • Homotopy Techniques

• **Mammography**
  - Early Diagnostic of Breast Tumors
Other Simulations

- Advanced Computation of Electrical Heart Activity (CAMAEC)
- Analysis of Runup, Overtopping and Optimal Crest Freeboard of Mound Breakwaters Using Neural Network Models (NEUREBATA)
- Computational Fluid Dynamics for Airflow Between Turbine Blades (ATHENA)
“High Performance Medical Image Diagnosis in Cluster of PCs”
(HIPERCIR)

- Objectives:
  - Medical Image Diagnosis in PCs
  - Images From TAC, Magnetic Resonance, etc.
  - Cost Reduction With Regard to Commercial Equipment
  - Oriented to Small Hospitals
  - Needed Parallelism to Obtain Similar Performance (Better in Many Cases)
Medical Area

“Distributed High Performance Processing of Medical Images. A New Component in Advanced PACS”

(DISMEDI)

- Objectives:
  - Distributed System Development for Computer-Aided Image Diagnosis
Medical Area

“Virtual Reality Surgery Training System” (VRSUR)

- Objective:
  - Design and Implementation of a Laparoscopic Surgery Training System
Realistic Synthetic Images Generation

“High Performance Virtual Reality Distributed Electronic Commerce: Application for the Furniture and Ceramics Industries”

(VRE-Commerce)

- Objectives:
  - Realistic Synthetic Images Generation for Furniture and Ceramics Industries
  - Used Technologies:
    - Parallel Computing
    - Lighting Algorithms
    - Network Computation
“Numerics In COntrol NETwork”

(NI CONET)

• Objectives:
  - Coordination of all European Initiatives on Numerical Control Software Development. (Network with 17 Partners)
  - Development of the SLICOT Software Library for Control Problems (Software Library In Control Theory)
Software Tools Used

- Dense linear algebra
  - ScaLAPACK
- Solution of sparse linear systems of equations
  - (Direct Methods) SuperLU, PSPASES
  - (Iterative Methods) PETSc, AZTEC, SPARSKIT, P-SPARSELIB
- Solution of nonlinear systems of equations
  - SUNDIALS
- Optimization
  - FSQP
- Eigenvalue problems
  - ARPACK, BLZPACK, PLANSO, TRLAN
Software Tools Used

• Simulation of ODE and DAE systems
  – SUNDIALS, COLNEW, TWPBVP, ODEPACK, DASSL, DASPK, GELDA, RADAU5

• Communication libraries
  – MPI, PVM