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## GRUPO DE INVESTIGACIÓN EN MECÁNICA APLICADA

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### PUBLICACIÓN INTERNACIONAL

**GARCÍA, Manuel Julio; GARCÍA, Alvin; García, Bernardo; GÓMEZ, Sebastian; GUTIÉRREZ, Jorge; MONTOYA, Edwin; Peláez, Alejandro; Peláez, Gustavo; RAMIREZ, Juan; RUÍZ, Carlos; VALENCIA, Edison.**

**MantisGRID: A Grid Platform for DICOM Medical Images Management in Colombia and Latin America.**

En: Journal of Digital Imaging. Para PUBLICACIÓN en Febrero 03 de 2010.

ISSN: 1794-9165

Datos de indexación: SCOPUS

#### Abstract

This paper presents the mantisGRID project, an interinstitutional initiative from Colombian medical and academic centers aiming to provide medical grid services for Colombia and Latin America. The mantisGRID is a GRID platform, based on open source grid infrastructure that provides the necessary services to access and exchange medical images and associated information following digital imaging and communications in medicine (DICOM) and health level 7 standards. The paper focuses first on the data abstraction architecture, which is achieved via Open Grid Services Architecture Data Access and Integration (OGSA-DAI) services and supported by the Globus Toolkit. The grid currently uses a 30-Mb bandwidth of the Colombian High Technology Academic Network, RENATA, connected to Internet 2. It also includes a discussion on the relational database created to handle the DICOM objects that were represented using Extensible Markup Language Schema documents, as well as other features implemented such as data security, user authentication, and patient

confidentiality. Grid performance was tested using the three current operative nodes and the results demonstrated comparable query times between the mantisGRID (OGSA-DAI) and Distributed MySQL databases, especially for a large number of records.

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### PUBLICACIÓN NACIONAL

**García, Manuel Julio; LAIN, Santiago; ORREGO, Santiago ; QUINTERO, Brian.**

**CFD Numerical simulations of Francis turbines.**

En: Revista Facultad de Ingeniería Universidad de Antioquia. No. 51 pag. 24-33.

ISSN: 0120-6230

Datos de indexación. SCOPUS.

#### Abstract

In this paper the description of the internal flow in a Francis turbine is addressed from a numerical point of view. The simulation methodology depends on the objectives. On the one hand, steady simulations are able to provide the hill chart of the turbine and energetic losses in its components. On the other hand, unsteady simulations are required to investigate the fluctuating pressure dynamics and the rotor-stator interaction. Both strategies are applied in this paper to a working Francis turbine in Colombia. The employed CFD package is ANSYS-CFX v. 11. The obtained results are in good agreement with the in site experiments, especially for the characteristic curve.

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## PONENCIA INTERNACIONAL

**ARELLANO GUZMÁN, Mauricio; CHAILLAT, Stephanie; GÓMEZ, Juan David; ITURRARAN VIVEROS, Úrsula; JARAMILLO, Juan Diego; MARENGO, Humberto; PEREZ GAVILÁN, Juan J.; RODRÍGUEZ CASTELLANOS, Alejandro; SÁNCHEZ SESMA, Francisco; SUÁREZ, Martha.**

**Seismic Response of Three-Dimensional Rockfill Dams Using the Indirect Boundary Element Method.**

En: 9th World Congress on Computational Mechanics. Sydney, Australia. Julio 19 a 23 de 2010.

ISBN: 978-0-9808244-0-7

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### Abstract

The Indirect Boundary Element Method (IBEM) is used to compute the seismic response of a three-dimensional rockfill dam model. The IBEM is based on a single layer integral representation of elastic fields in terms of the full-space Green function, or fundamental solution of the equations of dynamic elasticity, and the associated force densities along the boundaries. The method has been applied to simulate the ground motion in several configurations of surface geology. Moreover, the IBEM has been used as benchmark to test other procedures. We compute the seismic response of a three-dimensional rockfill dam model placed within a canyon that constitutes an irregularity on the surface of an elastic half-space. The rockfill is also assumed elastic with hysteretic damping to account for energy dissipation. Various types of incident waves are considered to analyze the physical characteristics of the response: symmetries, amplifications, impulse response and the like. Computations are performed in the frequency domain and lead to time response using Fourier analysis. In the present implementation a symmetrical model is used to test symmetries. The boundaries of each region are discretized into boundary elements whose size depends on the shortest wavelength, typically, six boundary segments

per wavelength. Usually, the seismic response of rockfill dams is simulated using either finite elements (FEM) or finite differences (FDM). In most applications, commercial tools that combine features of these methods are used to assess the seismic response of the system for a given motion at the base of model. However, in order to consider realistic excitation of seismic waves with different incidence angles and azimuth we explore the IBEM.

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## PONENCIA INTERNACIONAL

**GARCÍA, Manuel Julio; BOULANGER, Pierre; GUTIÉRREZ, Jorge.**

**Fluid-Structure Coupling Using the Lattice-Boltzman Method and Fixed Grid FEM.**

En: 9th World Congress on Computational Mechanics. Sydney, Australia. Julio 19 a 23 de 2010.

ISBN: 978-0-9808244-0-7

### Abstract

This paper presents a method for the solid-structure interaction by a hybrid approach that uses lattice-Boltzmann method (LBM) for the fluid phase and Fixed Grid FEM (FGFEM) for the structure part. The method is implemented in a high performance platform using GPUs to provide a high level of interactivity with the simulation. It is also presented a way to solve both methods using the same grid, due that the LBM grid covers the entire domain, the LBM grid was chosen as the default, therefore the FGFEM will use the outer box of the LBM lattice to solve the equations for the solid object. The coupling between both methods is accomplished by mapping the macroscopic pressure, velocity or momentum values from the LBM simulation into the coinciding nodes for the FGFEM values. Therefore, the model is simplified to only one mesh. It is well known that LBM as FGFEM are

good candidates for computing parallelism, for this reason a hyper parallel architecture as a GPU was chosen for the implementation, also the squareness of the LBM mesh fits naturally into the GPU's memory architecture which simplifies the overall implementation. Preliminary results from this work show that the accuracy of the solution is as expected taking into account the discretisation of the domain and the interpolation needed to calculate forces at a solid frontier that does not match the grid. Also the GPU and the inherent velocity of LBM and FGFEM is giving us near real-time interactivity with the simulation.

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3. Lattice Boltzmann Modeling: An Introduction for Geoscientists and Engineers, Michael C. Sukop and Daniel T. Jr Thorne, Springer, 2009.
4. The Lattice Boltzmann Equation for Fluid Dynamics and Beyond, Sauro Succi. Oxford University Press USA, 2001.

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## **PONENCIA INTERNACIONAL**

**GÓMEZ, Juan David; JARAMILLO, Juan Diego; RESTREPO, Doriam.**

### **Evaluation of Numerical Alternatives for the Simulation of Wave Scattering Problems in a Unified Computational Framework.**

En: 9th World Congress on Computational Mechanics. Sydney, Australia. Julio 19 a 23 de 2010.

ISBN: 978-0-9808244-0-7

#### **Introduction**

Several numerical techniques for the simulation of wave scattering problems in semi-infinite domains are implemented in a unified framework and critically evaluated.

#### **Method**

Finite Element (FEM) and different Boundary Element (BEM) formulations, including direct and indirect methods are implemented into a unified computational framework to test their performance in the simulation of P-SV and Rayleigh wave scattering problems. Particular interest is placed on understanding the performance of the different formulations in approximating the radiation and regularity conditions of the semi-infinite half-space. Parallelization issues are discussed and the methods are compared in terms of computational efficiency, accuracy and ease of implementation.

#### **Results**

The numerical implementations are first validated against reported results for a semi-circular and a spherical canyon under incident P-SV and Rayleigh waves. In order to impose stronger demands on the approximation of the radiation condition a rectangular canyon with four sources of diffraction is studied. The canyon is later filled with a softer material to form a sedimentary basin resting on a half-space. The presence of the softer material traps energy

and the demands on the radiation condition approximation is relaxed. The solutions are calculated in the frequency domain and synthetic seismograms are obtained via Fourier transform along the surface and inside the domain of several formations allowing the identification of scattered surface waves generated as a result of diffraction.

### **Conclusion**

Several numerical techniques to simulate wave scattering problems are available in the literature. However and although the main challenge is the proper way of satisfying the radiation and regularity conditions, the found methods lack a strong conceptual basis leading to uncertainties on the validity of the results in complex problems. Here it is shown that the performance of the different techniques is associated with the generation of surface waves in the scattered field.

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## **PONENCIA INTERNACIONAL**

**HASMATUCHI, Vlad; ROTH, Steven; BOTERO, Francisco; TINGUELY, Marc; FARHAT, Mohamed; MARUZEWSKI, Pierre; and AVELLAN, François**

**Hydrodynamics of a Pump-Turbine at Off-Design Operating Conditions: Experimental and Numerical Investigations.**

En: 25th IAHR Symposium on Hydraulic Machinery and Systems

### **Abstract**

In the present work, the hydrodynamics of a low specific speed radial pump-turbine reduced scale model is experimentally and numerically investigated under off-design operating conditions. The aim is to identify the onset and development of flow instabilities outside the normal operating range in generating mode involving runaway and “S-shape”. Three operating points at 10° guide vanes opening angle are selected for advanced investigations, as follows: in the normal operating range, at runaway and at very low positive discharge. Wall pressure measurements, in the stator, are performed with the help of miniature piezoresistive sensors synchronized with high speed flow visualizations in the vaneless space between the runner and the guide vanes by air bubbles injection. The unsteady incompressible numerical simulation is performed using Ansys CFX code. The computational domain includes the full reduced model water passage from the spiral casing inlet to the draft tube outlet. Ansys ICEM is employed to generate the structured and unstructured meshes. Then a comparison between the experimental and numerical results is quantitatively and qualitatively performed. The detailed analysis is focused on the onset of the flow instabilities when the machine is brought from a calm operating condition to runaway and turbine break mode. At these severe operating points a rotating stall arises at runaway and increases in amplitude with the discharge decreasing, reaching its maximum value near zero discharge. Containing one stall cell, the instability rotates with the runner at subsynchronous speed in the vaneless space between the runner and the guide vanes. It is the effect of rotating flow separations developed in several consecutive runner channels which lead to their blockage.

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## **PONENCIA INTERNACIONAL**

**ROTH, Steven; HASMATUCHI, Vlad; BOTERO, Francisco; FARHAT, Mohamed; y AVELLAN, François**

**Fluid-Structure Interaction in the Guide Vanes of a Pump-Turbine Scale Model.**

En: 25th IAHR Symposium on Hydraulic Machinery and Systems

### **Abstract**

In the present study, fluid-structure coupling is investigated in the guide vanes of a pump-turbine scale model placed in one of the test rigs of the Laboratory for Hydraulic Machines (EPFL) in Lausanne. The fluctuating bending and torsion loads experienced by the guide vanes are surveyed for various operating conditions. The fluctuating pressure between guide vanes is simultaneously measured and, thereby, all information for a complete fluid-structure coupling survey is made available. A new method is used to excite and identify the eigen modes of vibrations for both a single guide vane and all the guide vanes cascade. Therefore, the influence of neighboring vibrating guide vanes and the influence of the surrounding water on the vibrations of a given guide vane can be distinguished. In air, the impulse response is also obtained and information on added mass and hydrodynamic damping can, thus, be deduced from the impulse response in water. Forced response due to the rotor-stator interaction is also studied. Several resonance cases are reached in order to better understand the interaction between neighboring vibrating guide vanes. The hydrodynamic damping and the added mass for the first bending and torsion eigen modes are obtained for several operating points of interest.

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## **GRUPO DE INVESTIGACIÓN EN MECATRÓNICA Y DISEÑO DE MÁQUINAS**

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### **PUBLICACIÓN NACIONAL**

**ARANGO, Ivan; y PINEDA Fabio**

**Desarrollo de tecnología apropiada para la fabricación de máquinas CNC para corte de tendidos de tela para pequeños talleres de confección.**

En: Tecnológicas. Edición especial julio 2010. 11-30 Instituto Tecnológico Metropolitano (ITM).

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### **Resumen**

Este artículo presenta el resultado de varias investigaciones relacionadas con el desarrollo de tecnología aplicada al diseño y la fabricación de máquinas CNC (control numérico por computador) para corte de tendidos de tela, destinadas a pequeños talleres de confección. El desarrollo responde a la necesidad de la industria de acceder a máquinas de producción fraccionada de bajos costos de operación. Desde diversos puntos de vista la solución encontrada presenta factores novedosos. El primero de ellos, la inversión de la dinámica de los tendidos de tela. Otro involucra el actuador de corte, el cual no se construyó a la medida de la máquina, sino que fue el resultado de un diseño para habilitar actuadores comerciales utilizados en el proceso manual. El equipo recibió el software CAD/CAM de otras investigaciones del mismo grupo. La máquina, por sus innovaciones, recibió derechos de la oficina de patentes de Colombia.

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