Geophysical Research Abstracts
Vol. 13, EGU2011-13533-4, 2011
EGU General Assembly 2011

Automated Model-driven Simulation and Visualization of Field Sensor Data

Thanasis Papaioannou (1), Sofiane Sarni (1), Karl Aberer (1), Mathias Bavay (2), Michael Lehning (2), Silvia Simoni (3), and Marc Parlange (3)

(1) Distributed Information Systems Lab (LSIR), EPFL, Switzerland (thanasis.papaioannou@epfl.ch, sofiane.sarni@epfl.ch, karl.aberer@epfl.ch), (2) WSL, Swiss Federal Institute for Forest, Snow and Landscape Research, SLF, Davos, Switzerland (bavay@slf.ch, lehning@slf.ch), (3) Laboratory of Environmental Fluid Mechanics and Hydrology, EPFL, Lausanne, Switzerland (silvia.simoni@epfl.ch, marc.parlange@epfl.ch)

Environmental models (e.g. GEOtop, Alpine3D, etc.) are very useful for understanding complex physical processes and predict potential natural hazards. However, running a model-driven simulation based on field sensor data needs several steps, namely data sensing, aggregation, retrieval, cleaning, interpolation, formatting, model execution and model output visualization. This process is time-consuming (e.g. only the data preparation for a single simulation typically takes 3-4 days) and highly error-prone, as it involves many manual or semi-automated steps. Furthermore, the scientists need to employ many different software tools for the various data processing steps, and often manually import data and export the results from the tools.

In the EU project Hydrosys (http://www.hydrosysonline.eu), we have defined and implemented a data processing pipeline that makes simulation process completely automated, fast and transparent to the scientist. Furthermore, our automated simulation tool is fault-tolerance and limits the space for introducing errors. A scientist can visualize or download sensor data, or run a simulation and obtain the results in the same web-based GUI. The environmental model employed is GEOtop (http://www.geotop.org), which is a distributed model of the mass and energy balance of the hydrological cycle for simulations in continuum in small catchments. However, our approach is generic-enough to include arbitrary environmental models.

The basic framework for the implementation of our tool is provided by the Global Sensor Networks platform (GSN, http://sourceforge.net/apps/trac/gsn/). GSN is an open-source, sensor data aggregation and processing middleware. Its key abstraction is called "virtual sensor" (VS), which is an atomic processing operation applied to one or more input historical/real-time sensor data streams and provides one output stream. Our simulation tool pipelines several ordinary VSs with special-purpose ones. Specifically, we developed a "GEOtop VS" for GSN interaction with the specific environmental model and a "R VS" for GSN interaction with an R server (http://www.r-project.org/). Moreover, we enhanced GSN functionality with two new web services interfaces, one for fast, concurrent access to sensor data, and another for the remote control of the simulation process. Also, a web-based front-end simulation GUI was included in the GSN portal.

The simulation process happens as follows: Initially, the scientist selects the sensors over a geographical region, sets their sensing period and defines the most important simulation parameters of the model (the rest of the parameters have their default values). Then, GEOtopVS starts the execution of the simulation at a remote server where the physical model resides. The environmental model employs MeteoIO library (http://slfsmm.indefero.net/p/meteoio/) to retrieve sensor data from GSN, filter and complete a certain segment of the sensor data of interest. When the simulation is completed, GEOtop VS retrieves the simulation results, stores them at GSN and forwards them to R VS that interacts with a R server to execute a visualization R script for producing graphs of the simulation output. These graphs are then stored at GSN, and finally, the graphs of the simulation output appear in the web-based GUI of the scientist.

The aforementioned functionality is contributed to the GSN open-source project and it is currently accessible online (http://lsir-hydrosys01.epfl.ch:22006/) for GEOtop simulations with data obtained from a sensor deployment in La Fouly catchment in Switzerland (Valais) established by Hydrosys. Finally, note that the architecture is fully distributed and the locations of GSN, model and R servers are totally flexible.