Floreon – the System for an Emergent Flood Prediction

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Abstract. The main goal of our developed system is to bring the information about the approaching disaster to the end user. The idea is that all types of users, including citizens, mayors, governments, or specialists, can find the proper information within the system. It is obvious that there is a knowledge gap between the uninformed user and specialist. Therefore the system must be able to provide the information for the ordinary people in the simple form and provide the complex information and possibility of the computations adjustment and parameterization for the more qualified users.

1 Introduction

There are many types of nature disasters in the world. Many of them depend especially on the geographical location. The one of the worst nature disasters in our region is the flood. Local governments claim for the reliable models for the floods simulations and predictions to save a lot of funds that must be otherwise invested to the post-flood renovation of the impacted region. Therefore, the problem of flood prediction and simulation was chosen as the use case for the experimental development of the sophisticated system that should combine all knowledge from the existing models and system and bring the results to the wide range of people that are not experts in this particular domain. The name of the system that is being developed is FLOREON (FLOods REcognition on the Net).

The main concern of our project is to proof that the combination of newest information technologies and results from the disciplines that are somehow connected to the solving of floods simulations and predictions can be very helpful. The list of the disciplines whose results must be combined comprises hydrology, meteorology, integration of prediction models, development of new models, etc. The information system itself is focused on the development of the reliable architecture and is also concerned of the graphical user interface (2D, 3D) that should be able to satisfy all types of users that can interact with the system.

Technological integration of the necessary system modules is provided by the usage of the modern internet technologies that enable dynamic configuration and building of the open architecture [4]. The communication of modules within the system and communication with the other systems can be based on the Web Services or other modern technologies.

Although, the primary goal of this system is flood prediction, simulation and presentation, it is possible to extend this system by other modules that can represent wide range of other disasters. For example the modules that can be added to the system are the modules that simulate and predict the air and water pollution, advective-dispersion processes, forest fire spreading etc. The addition and removal of the system modules (including alternative models for simulations and predictions) is based on the principle of plug and play. All of these system futures should establish the base for the complex and unique system that enable to use its potential for observing and controlling of various types of disasters.

2 System Architecture

At the beginning of the development of all information systems, the interaction scenarios between the system and user must be defined.

The main modules of the present system are core, data warehouse, meteorological data module, hydrology module, geographic module, alternate numeric method module, visualization module, and web server module.

All these modules must be connected somehow and communicate. The best technology that is available just now seems to be a Web Services. Web Services technology ensures implementation independence, simple maintenance of connections, standardized form of communication, and simple module exchange. This technology allows us to build a flexible and independent system.

Coordinator: Core module is responsible for the coordination of the system scenarios and controls all modules that are plugged in the system.

Warehouse: Data warehouse stores all necessary data that are provided by the wide range of sources (geological data, meteorological data, etc) or serve as a proxy to the remote resources. There are used these technologies:

- PostgreSql database and its spatial extension PostGis
- Microsoft SQL Server
- Raster Provider - was published as open source project [8]

Hydrometeorology: Meteorological module is provider of the meteorological data and predictions of weather. We use variety sources:

- CHMU - Czech Hydrometeorological Institute provides measurement of hydrometeorological data (precipitation, temperature, water level stages, discharges, snow cover) obtained both from the station net and the remote sensing methods (e.g. radar estimations of the precipitation rates) [3]

- ALADIN - numerical weather forecasting system engaged by CHMU [1]
- Medard - weather forecast system [6] engaged by Institute of Computer Science on Academy of Sciences of the Czech Republic [5]
- Povodi Odry - company established by government provides measured discharge volumes in rivers and information about the water reservoirs balance and operations [10].

Flood Calculation Model from Third Party: Hydrology module is especially responsible for the computation of the floods. There are used more independent applications in our computation chain. These programs are connected to provide fully automated execution. There are involved these applications:

- HEC-HMS (USACE) -Rainfall-runoff model
- MIKE 11 (DHI) - 1D hydrodynamic model
- MIKE 11 GIS (DHI) - GIS postprocessing software, which inspects and provides measures of the flood occurrence and extent in the terrain
- ArcGIS (ESRI) - another platform for the post-processing of results

Geograph: Geographical module is responsible for the providing of the all actual terrain data, maps, etc. It is group of standalone tools used for the data pre and post processing:

- SharpMap for shapefile parsing [9]
- Quantum GIS [7] for data import and management

Alternate Flood Calculation Mode: Alternate numeric method module is the experimental module that encapsulates new flood prediction methods that are developed by the mathematical group that cooperates on our project. There are 1D numerical approach but also more complicated 2D approach. 2D numerical approach is based on Finite volume method [2].

Map Server: Visualization module is the module that combines all the information that are stored and created by the system and prepares them for the presentation to the users. This module uses 2D, 3D techniques to show the results.

WEB: Web server module communicates with users and transfers the visualization data to the user. User can be equipped by any type of device. This module adapts the information to the user type of device. Our implementation use ASP.NET technology.

3 Future Work

The main goal for the informatics group of this project is the systematic development of the architecture. The other main task is continuous enhancement of the 2D and 3D visualization to bring the best possible visualized information to the user based on the open source and commercial technologies.

Another issue is a coordination of the system communication with the external subjects; the main concern is on the usage of standardized interface and security.

Information system without actual data is practically useless. Therefore, the data for the simulations and predictions must be systematically and periodically updated. Some of these data are stored in the data warehouse - schematizations of the river basins, terrains etc. Coordination of the data sources, selection of the data and actualization are long term tasks that must be carefully planned.

4 Acknowledgement

This project has been supported by the research grant of Moravian-Silesian Region: 01562/2006/RER. Project is managed on VŠB-TU Ostrava by prof. Ing. Ivo Vondrák, CSc.

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