CONTRIBUTIONS TO THE DEVELOPMENT OF INTELLIGENT ALGORITHMS FOR MONITORING AND ANALYSIS OF THE HYDROLOGICAL PROCESSES

ABSTRACT

PhD Supervisor
Prof. Dr. Eng. Mihaela Oprea

PhD Candidate
Eng. Alexandra Maria (Matei) Stoica

The last decade was characterized by an unprecedented growth in frequency or magnitude of the damages caused by floods in all their forms. Thus, in our country, the implementation of new projects for the modernization of the hydrological activity and water management started by installing automatic gauges with sensors for water levels, rainfall, air's and water's temperature measuring.

The complex motivation of this study is described by the next aspects:

- The monitoring and analysis of the hydrological processes are still present in most applications based on the hydrological engineering's experience, rather than systematically methodology;
- It is necessary broadening experience in the design of monitoring systems, analysis and forecasting floods and warning in real time of the population in case of flood;
- It is considered useful to establish clear and systematic algorithms for monitoring and analysis of hydrological processes;
- Modeling hydrological processes (which are complex processes) by using artificial intelligence techniques is an interesting problem, but a very difficult one.

The main objective of the PhD research is to develop algorithms for monitoring and analysis of the hydrographical basin, which allow more efficient solutions of current problem – prevention of flood waves.

Also, this thesis describes the opportunity of using artificial intelligence techniques such as neural networks, fuzzy logic and intelligent systems based on artificial intelligence techniques such as multi-agent systems, knowledge-based system.

The thesis is organized into seven chapters.

The first chapter entitled, ***Introduction***, presents the motivation of the research and describes the main objectives addressed in each chapter of this paper.

The second chapter of the thesis entitled, ***Theoretical aspects of the monitoring and analysis of hydrological processes***, presents the modeling of hydrological processes aspects.

In the second part of the chapter it is proposed by the author the structure of an automatic monitoring and analysis system of a hydrographical basin and the general algorithm on which it operates. Also, a number of methods for measuring the specific parameters of the studied catchment are presented.

Chapter 3 entitled, ***The current state and trends in monitoring and analysis of the hydrological processes from a hydrographical basin***, describes the current state of research and nationally and internationally achievements, from systems based on conventional methods and ending with advanced systems, based on artificial intelligence techniques. At the end of the chapter, an analysis of the main features of the presented systems is described.

Chapter 4 entitled, ***Contributions to the development of intelligent algorithms for the hydrographical basin monitoring***, provides the main algorithms for monitoring of the specific parameters of the catchment, algorithms based on techniques and monitoring methods that allow observation and measurement of specific parameters of a river and follow-up their real progress on the development of accurate predictions. Also, in this section the author presents ways of applying artificial intelligence techniques such as rule-based systems and multi-agent systems.

Chapter 5 entitled, ***Contributions to the development of intelligent algorithms for the hydrological processes analysis***, provides the algorithms for analysis of hydrological processes in a hydrographical basin, algorithms based on traditional methods and requires close cooperation between specialists in hydrology and engineers specializing in the artificial intelligence to achieve high performance in the knowledge of hydrological processes. Thus, it is proposed to implement the following techniques of artificial intelligence: neural networks and fuzzy techniques.

Chapter 6 entitled, ***Contributions to the integration and validation of the algorithms proposed in the flood monitoring, analysis and prediction systems*** integrates and validates the algorithms proposed in previous chapters. The main prototype systems based on artificial intelligence that had been developed are the following:

- an expert system for monitoring and analysis, named EXPERT_Hidro;
- a multi-agent system for monitoring and analysis of a catchment, named SMA_Hidro, which is a distributed system that meets the monitoring and the prediction of floods, river flow analysis functions;
- a neuro-fuzzy system for the analysis and prediction of floods, named FUZZY_Hidro;
- an intelligent flood monitoring, analysis and prediction system, named SM_INT_MAPI, that combines artificial intelligence techniques (knowledge-based systems and neural networks) with the classical methods for flood waves prediction.

At the end of the chapter there is a comparative analysis of the proposed systems and their results. Also, the main conclusions of the applicability of the systems in hydrology are highlighted.

The last chapter entitled, ***Final conclusions, contributions and the future research,*** presents the main conclusions and the contributions of the thesis, and an evaluation of some future developments.