Numerical algorithms and mathematical models supporting the management of communal water networks

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Outline

- Introduction
- Institute, Department, University
- Goals of the algorithms
- Hard management
- Soft management
- Summary
One of the **leading institutes** of technology in Poland, and one of the **largest in Central Europe**. It employs 2,453 teaching faculty, with 357 professors (including 145 titular professors).

R&D at WUT is:

- Participation in national and European research projects.
- Well-functioning Centre for Technology Transfer and Entrepreneurship Development.
- Coordination and activity within the framework of 8 research centres:
  - Academic Research Centre for Power Engineering and Environment Protection,
  - Academic Research Centre for Sustainable Energy Systems,
  - Research Centre for Business of the Faculty of Mathematics and Information Science.
Scientific profile

• Research and development of new automatic control, decision support and diagnostic systems;
• Application of artificial intelligence and neural networks in automation, robotics and diagnostics;
• Control engineering theory: optimal and predictive control;
• Construction and development of electric and hydraulic drives;
• Construction and development of mobile robots;
Important projects funded by NCBiR

- Intelligent system of diagnostics and industrial process control "DIASTER"
- Interactive environment for solving optimal control problems – IDOS
- Research on detection and location of leaks in pipelines

Experience with EU projects

- Advanced Decision Support System for Chemical/Petrochemical Manufacturing Processes – CHEM 5FP
- Development and Application of Methods for Actuator Diagnosis in Industrial Control Systems – DAMADICS 5FP
- Intelligent Controls for High Speed Inkection Moulding Machines – ICON HiSim 6FP.
Introduction – Goals of our activities

Goals of a waste and waste water companies

- Modern water and waste water company has a number of goals. The main aspects of its activity are:
  - Serving to the local community
  - Taking care about natural environment, water resources etc.
- Such companies can use integrated technical and computer aided tools to meet these requirements.

Supply → Distribution system → Sewage system → WWTP
Introduction – Goals of our activities

Our goals

• The main goal of our activities is an integrated approach to improve the complex management of municipal water supply and distribution systems.

• To realize this goal an integrated IT system is under development. The system will support the complex management, planning and operational control of communal water networks.

• The IT system is destined to computer aided and automated management of communal waterworks, based on the numerical algorithms and mathematical models.
Introduction – state of art

State of art

- The IT system planned in frame of our activities is not used in Poland.
- The **innovative feature** of the IT system are the simultaneous solutions of problems concerning the soft and hard management of communal water supply systems.
- The **soft management** means the solution of the tasks like financial planning of the water net expansion or revitalization or the human capital development.
- The **hard management** means the solution of the tasks like modelling, optimization and control of water nets.
The results in general

- The implementation of the IT system will help to solve the problems concerning the production and distribution of drink water and the improvement of water quality.
- The implementation of the IT system in waterworks will lead to the better management and utilization of available water resources and to energy saving water net operation.
Planned results

The results in details

• reduction of the **water losses** in the water networks
• **energy saving** control of the water nets
• improvement of the **drink water quality** supplied for the city
• increase of the **quality of services** executed for local communities
• reduction of the **money costs** while operating the water nets
Planning a monitoring system:
1. Planning algorithm is based on a mathematical model.
2. Mathematical model is based on a monitoring system.
3. Thus, process is iterative.
Hard management – leakage detection

Leakage detection:
1. Off-line: comparing measured flows with registered demands
2. On-line compare model output with measured demands

- Data Base
- Monitoring
- Water network
- Hydraulic model
- Planning
- Leakage info

Leakage detection

Brussels 18.10.2012
Hard management – Forecasting a net load

Control

Forecasting

Data Base

Monitoring

Hydraulic model

Planning

Leakage info

Energy savings

Water network

Leakage detection

Brussels 18.10.2012
Hard management – water quality

- Control
- Water quality (age)
- Leakage detection
- Forecasting
- Hydraulic model
- Planning
- Leakage info
- Data Base
- Monitoring
- Water network
- Better water quality
- Energy savings

Better water quality

Brussels 18.10.2012
Hard management

- Better water quality
- Energy savings
- Control
- Water quality (age)
- Leakage detection
- Forecasting
- Hydraulic model
- Planning
- Water network
- Data Base
- Monitoring
- Leak info

Better water quality

Energy savings

Water network

Data Base

Monitoring

Hydraulic model

Planning

Leakage info
Soft management

- Forecasting the possible damages
- Planning the water net revitalization
- Planning water price for the network
Soft management

Hydraulic model

Forecasting possible damages

Data Base

Planning water net revitalization

Monitoring

Water network
Summary

Future plans

- Development of presented algorithms
- Integration of all algorithms into united IT System
- Testing the system under real conditions

Future plans

- The diversity of problems to be solved makes the project complicated and very interesting from the scientific point of view.
- This will have an essential and positive impact on the environment regarding the reduction of water losses
- This will also influence positively the standard of life of human communities in the cities in which the system will be implemented.
Thank you for your attention