# Context-adaptive Mobile Visualization and Information Management

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**ABSTRACT**

This poster abstract presents a scalable information visualization system for mobile devices and desktop systems. It is designed to support the operation and the workflow of wastewater systems. The regarded information data includes general information about buildings and units, process data, occupational safety regulations, work directions and first aid instructions in case of an accident. Technically, the presented framework combines visualization with agent technology in order to automatically scale various visualization types to fit on different platforms like PDAs (Personal Digital Assistants) or Tablet PCs. The implementation is based on but not limited to SQL, JSP, HTML and VRML.

**CR Categories:** H.4 Information Systems Applications, J.7 Computers in Other Systems — Process Control.

**Additional Keywords:** Mobile Visualization, Multi Agent Technology, Environmental Engineering.

## 1 INTRODUCTION

The operation of urban wastewater treatment plants has become a very complex task. A drainage system consists of many spatial distributed parts which act separately but are connected together and thus have effect on the whole system. This situation often results in a suboptimal operation state and a suboptimal workflow. New ways must be found to visualize different processes, to help making decisions and to give efficient repair and maintenance instructions.

We have developed a demonstrator to visualize the information on small mobile devices like mobile phones, PDAs or Tablet PCs. These instruments can be easily carried along by the staff of a wastewater treatment plant (WWTP). The system has been evaluated on the municipal WWTP in Meisenheim (Germany) with 14.600 population equivalents (p.e.).

## 2 RELATED WORK

There are many other projects that investigate the potentialities of mobile devices. The TellMaris project [4] proposes the use of interactive three-dimensional maps on mobile devices. The IMoViS project demonstrates how mobile devices can be used in security systems. This project uses PDAs to visualize intrusion detection data [3]. A framework for mobile 3-D visualization and interaction in an industrial environment is presented in [2]. This project deals with the seamless navigation and provision of multimodal, context-sensitive speech-enabled augmented reality interfaces for mobile maintenance.

## 3 SCALABLE INFORMATION VISUALIZATION

### 3.1 System Framework

Our system framework has been designed to adapt various information types to different clients. The system can serve standard desktop systems as well as low-resource PDAs. The adaptation process can modify the layout of groups of information elements (e.g., the layout of a set of pictures) as well as the appearance of a single element (e.g., the size of a picture or table). Much research has been done in the area of 3-D visualization: Two new concepts have been implemented and tested to enable the visualization of complex 3-D scenes on devices without 3-D hardware.

The framework consists of two main parts: a data layer and a presentation layer. The data layer is realized as a relational database. It contains all information about the WWTP and references to external media files like images and videos. The presentation layer generates dynamic pages that fit to the screen size of the client device. This layer is realized with JSP (Java Server Pages) technology. The resulting pages are encoded in HTML, so any standard-conforming browser can display the pages. In addition we use external helper applications to display media files.

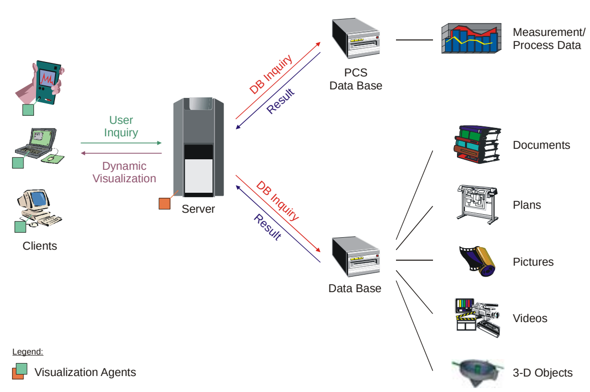


Figure 1: The system framework.

The automatic adaptation to the client device is done by a multi-agent-driven visualization system [1]: When the client accesses the server for the first time, the controlling pro-active agents collect information about the technical capabilities of the

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device and define the current system- and interaction context as well as the device context. Based on those contexts the pro-active agents define the control range in which the reactive agents can tune the actual session parameters. This agent-based solution enables us to automatically compute device-adjusted adequate visualizations. Figure 1 gives an overview of our framework.

### 3.2 System Components

Our developed demonstration application contains the following main items: “overall view WWTP”, “occupational safety”, “maintenance and repair”, “process monitoring, process visualization and process optimization”, “controlling”, “further training” and “first aid”. The main components have been developed according to the requirements of the WWTP operators.

### 3.3 3-D Visualization

In order to provide a flexible way for a client-independent 3-D visualization, we have implemented three different solutions. During runtime, the visualization agents choose the most appropriate solution for the client. The different requirements of the approaches are displayed in the following table:

Table 1: 3-D visualization possibilities

| | VRML | 3-D server | 3-D servlet |
|---|---|---|---|
| Server Requirements | low | high | medium |
| Client requirements | high | medium | low |
| Network requirements | low | high | low |
| Degree of interactivity | high | medium | low |

The VRML approach simply transfers the VRML world to the client which then renders the scene. This requires a powerful client with hardware 3D acceleration. In the other two approaches, the server is used to render the scene. Then, only the rendered image is sent to the client, so even complex 3-D models can be visualized on clients with limited technical resources. In the 3-D server approach the client uses a Java applet to communicate with the server, the 3-D servlet method uses standard HTTP requests.

## 4 System Evaluation

Our system has been evaluated on a convertible notebook (Toshiba Portegé 3500) and a Pocket PC (Compaq iPaq H5550). The devices were connected to the server via WLAN (802.11b). Figure 2 shows one of the pages rendered on the two devices.

Tests on the iPaq Pocket PC showed that the automatic adaptation to small screen sizes works very well. In most cases the relevant information can be viewed without scrolling or using special browser resizing features. Tests with different 3-D models showed that all approaches described in chapter 3.3 perform satisfying. For the notebook, the visualization agent chooses the VRML approach. The notebook can display the model in a VRML browser and the user has a high degree of interactivity. If the Pocket PC is used, the agent chooses the 3-D server approach if the browser is Java-enabled, otherwise the 3-D servlet method. We use two different HTML browsers on the Pocket PC: Access Netfront 3.0 (without Java) and Pocket Internet Explorer 2003 with the Insignia Jeode Java plug-in. With the server approach, about 1 fps can be achieved on the iPAQ. The framerate is independent of the model complexity. If the servlet method is used, the user has to click on navigation buttons to reload a new view of the model. The completion of such a request takes about 1.5 seconds. Note that the servlet approach has very low requirements on the client, only a simple HTML browser is needed.


Figure 2: Process monitoring and visualization.

## 5 Conclusions and Future Work

In this poster abstract we have presented a scalable information visualization system, which can be used with mobile devices. The described demonstration scenario is settled in the area of environmental engineering. Until now the complexity of unfiltered information is a challenging problem. In order to provide an adequate solution our next step is the integration of additional artificial intelligence methods, like case based reasoning, to improve the decision-making processes when operating a WWTP. Furthermore, it is planned to integrate methods for augmented reality which are applicable if a complex unit has to be disassembled or if the user must enter an unknown underground building.


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