CONTEXT-AWARE VISUALIZATION ON THE WEB

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Abstract

For presentation of a digital map, an application like a portrayal service (e.g. based on (OGC 2007)) interprets specific portrayal rules in order to get the symbology for a selected set of geodata, creates a map according to these rules and sends it back to the client. However, users usually come from various domains and have different tasks, but current portrayal services do not present the geodata specific to the users' needs in a standardized way. Every user can benefit from individualized geodata views and context-based symbolizations. For that reason, the visualization of the geodata has to be adapted to the user's context. This paper focuses on a model approach to present specific geodata views to different user groups in a web environment. The usage of spatial data from a variety of providers requires a standards-based approach. To support these requirements, a more general model for context-aware visualisation is introduced, which is based on the 'Open Geospatial Consortium (OGC) portrayal pipeline' and different models and adaptation rules have been developed. The concept is tested in a web-based environment. The proposed portrayal workflow improves the usability of a portrayal service and supports decision-making activities for different user groups according to their context. Because of a standards-based approach the usage of different data sources is feasible.

1 INTRODUCTION

Depending on the task, the necessary geodata and some parameters of the visualization normally differ. An example for a context-aware visualization from the military domain is the 'march planning'. Therefore the soldiers and heavy equipment are to be brought from point 1 to point 2. One user task is the 'march planning for soldiers'.

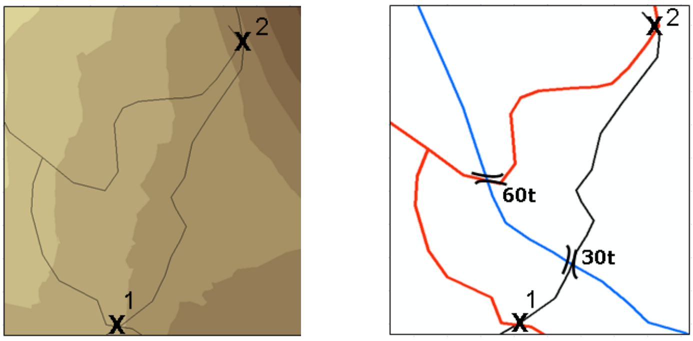


Figure 1. Example for context-aware visualization

Therefore requirements like accessible routes and as less vertical elevation as possible should be fulfilled. For this reason the map shows the start and end point, routes and colour-shaded elevation ranges to support situational analysis (Figure 1 left). Another user task is the ‘march planning with heavy equipment’ from point 1 to point 2. To handle this task, geo-objects like roads, possible obstacles e.g. rivers and bridges with their maximum load rating have to be displayed (Figure 1 right). Further, the users’ situation can vary for example from day to night and thus the map display has to be modified to support this circumstance. The goal of the investigation is the adaptation of the geodata view in a web environment depending upon the user and his situation. In order to use data from various sources, this concept is based on standards to support interoperability. In a nutshell, a standard-based and web service-based concept for context-aware geodata visualization is required.

2 CONTEXT-AWARE GEODATA VISUALIZATION COMPONENTS

The goal of the investigation is to portray user specific geodata views, which are generated by a web service-based environment within a specific domain and with respect to a given task. To get a specific user geodata view, an adaptation process is necessary.
The adaptation process takes in two input models and generates one output view (Figure 2). These are:

- Portrayal model (input)
- Context model (input)
- User geodata view (output)

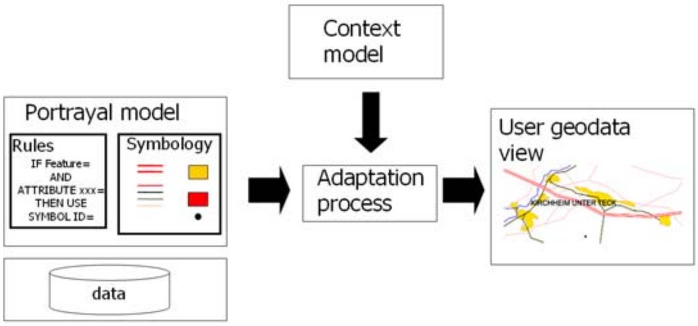
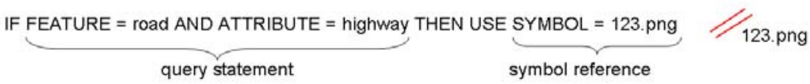


Figure 2. Adaptation process

- Besides the geodata selection, the adaptation process makes use of two input models (portrayal model and context model) and generates an output view (user geodata view). In the next sections, the input models (portrayal model and context model) and the adaptation process are described in more detail.

2.1 PORTRAYAL MODEL

Portrayal is a term used in ISO 19117-Portrayal for the "presentation of information to humans". The creation of digital maps mainly requires two components: geodata and a portrayal implementation. The portrayal implementation defines how the data should be presented e.g. on a digital screen. It contains default portrayal rules and the symbols for defining how the data should be displayed in an initial *portrayal model*. An example of a portrayal rule is shown here:



A portrayal rule consists of a rule expression with a query statement and a reference to a symbol. If the ‘query statement’ is true, the portrayal application like a portrayal service executes the drawing with the referenced symbol. In (Wiebrock & Reinhardt 2007) the portrayal model is explained in detail.

2.2 CONTEXT MODEL

(Dey 2001) defines the *context* as "any information that can be used to characterise the situation of an entity (person, place, or object)." *Context-aware systems* were first defined by (Schilit & Theimer 1994). Their definition limits the system functionality to the adaptation based on the context and does not consider the storage or the view of the context. For this reason, a system is context-aware, "if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task" (Dey & Abowd 2000). Besides the authors define characteristics, which a context-aware system should support "presentation of information and services to a user; automatic execution of a service; and tagging of context to information for later retrieval". Not satisfied by such a general definition, many researchers have attempted to define context by enumerating examples of contexts (e.g. (Chen & Kotz 2000)). This approach was also applied to specific user applications like historical study of natural hazard risks ((Moisuc et al. 2006)), to GIS Systems ((Petit, Ray & Claramunt 2006)) and to the mobile user area (e.g. (Reichenbacher 2004), (Sarjakoski & Nivala 2005)). These approaches can be used only as a base for our use case as we have to consider specific requirements; e. g. the model has to be suitable for usage with a standardized portrayal web service, where only certain adaptations are possible and useful. The *context model* describes users in certain situations. In our case it includes static elements like ‘user roles’ (users’ activities within a certain task) or ‘system’ (parameters of the device) and dynamic elements e.g. ‘physical condition’ like weather or day/night effects. The different aspects of a context model are defined in (Wiebrock & Reinhardt 2008). Information to generate the context model can be extracted from the user in different ways. An approach for acquisition of context information is proposed by (Weakliam, Wilson & Berlotto 2008). Here map actions (e.g. zooming or toggle features on/off) executed by users are captured implicitly in log files and are used to infer user preferences. The user models are then created and updated dynamically based on user interactions.

In (Baldauf, Dustdar & Rosenberg 2007) various context modelling approaches are described e.g. *markup based scheme models* (also found in (Saidani & Nurcan 2007)), *graphical models*, *logic-based models or ontology-based models* (e.g. (Tran, Cimiano & Ankolekar 2008)). However it is very important to develop a suitable model which allows a description and consideration of user groups’ specific requirements. Such a context model can be based on the approach from (Saidani & Nurcan 2007) which is formulated in a three-dimensional space S=<ASPECTS,FACETS,ATTRIBUTES>. Table 1 shows an example. In our case, this concept is translated into XML schema implementations so that the context information can be handled in a web service environment.

Aspect	Facets	Attributes
System	hardware	device type
		screen width
Situation	location	coordinates
		user environment (indoor, outdoor)
	Time	Date
		hour of the day

Table 1. Context model example

3 PORTRAYAL PIPELINE, ADAPTATION PROCESS AND PROTOTYPE

The adapted portrayal pipeline is based on the ‘Open Geospatial Consortium (OGC) portrayal pipeline’ (OGC 2008) and is divided into five representation components (data source, features, portrayal model, user portrayal model, user geodata view) with three units of adaptation processing (arrows) (Figure 3).

The *adaptation process* with geodata selection and symbolization according to the context is necessary in order to get a specific *user geodata view*. The adaptation comprises different adaptation rules to adjust the default portrayal model and the data to a user portrayal model and the selected features (e.g. river, road, bridge). The adaptation rules include basic operations like filtering (e.g. of geo-objects) and selection (e.g. of domain specific presentation rules and symbols). Therefore we have identified which context model elements influence which part of the adaptation process. More details can be found in (Wiebrock & Reinhardt 2008). The adaptation process evaluates the information with the help of rules defined in object and application; portrayal and graphic adaptation rules. The source models (portrayal model and data) are regulated by these adaptation rules, which are influenced by the context model. In the adaption process, first the object and application rules influence the geodata filtering (data -> features). Then the portrayal adaptation rules regulate the portrayal filtering (portrayal model -> user portrayal model).

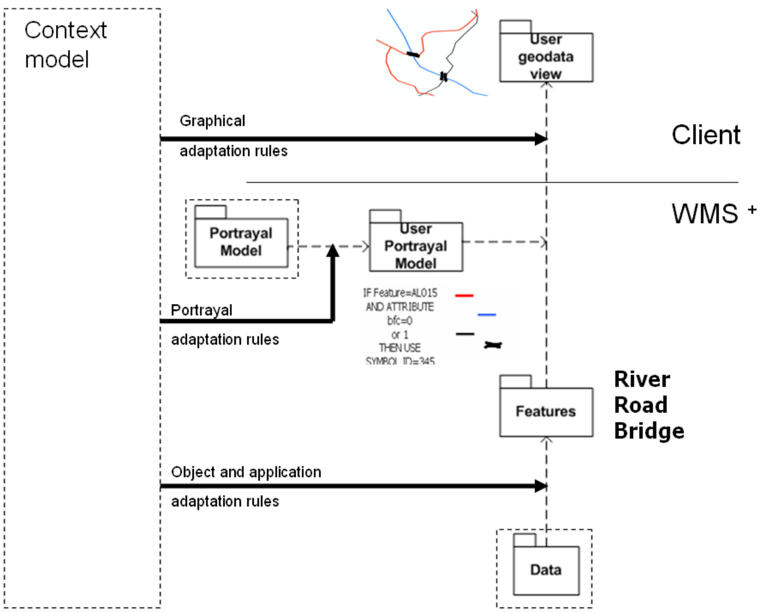


Figure 3. Extended workflow with models and adaptation rules based on “OGC portrayal pipeline”

With the help of the user portrayal model, the application produces a user specific geodata view. This can also be influenced by graphical adaptation rules (like display brightness). The user geodata view is rendered based on the adapted content via portrayal service and displayed on the client screen.

The adaptation process is done via portrayal context service, which is realized as an extended WMS (WMS^+), and a client. Therefore the WMS "GetMap"-Request are extended with a "user context id"-parameter instead of layer and style list parameters to get a context-aware visualization. Besides, two new WMS^+ Requests are introduced. In order to get the context schema a "DescribeContextType"-Request is defined. On the basis of a "Transaction"-Request with insert, update and delete operation for context elements, the user can submit and update the user context information.

To prove the described concept, a prototype has been implemented. The geodata, the context model and the portrayal model with its rules and symbols are defined in XML and managed in an oracle database. The adaptation rules are stored within the service. The user portrayal model and the features can be rendered and displayed on the screen as an SVG file at the client side (user geodata view). Figure 4 shows the results of two user requests based on different user roles. The various geodata selection and requirements on the portrayal are visible. The figure left shows built-up areas in general for an overview. The figure right shows a land-use plan in more detail with industrial and residential built-up areas, grassland, and transportation information like streets.

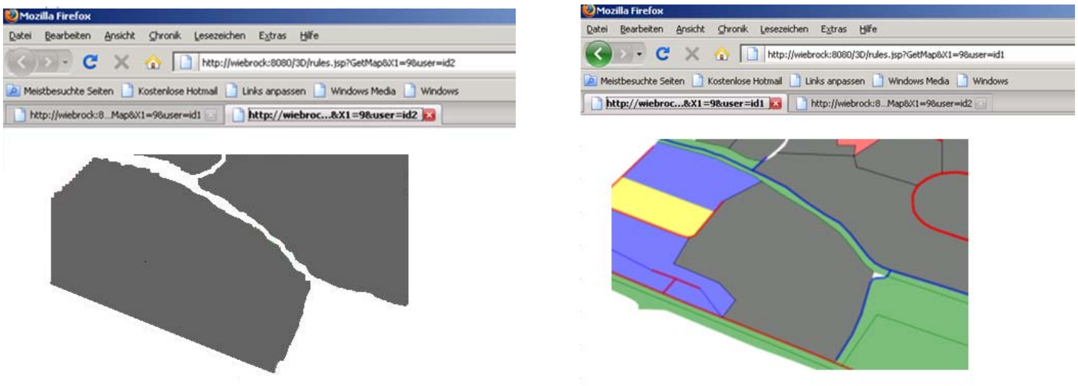


Figure 4. Result of different views

4 CONCLUSION

An adaptation process for context-aware visualisation is introduced which is based on the ‘Open Geospatial Consortium (OGC) portrayal pipeline’. Different models and adaptation rules have been developed. As a result, an extended standardized portrayal workflow to customize geodata views for different contexts is defined and validated through a prototype. The proposed portrayal workflow improves the usability of a portrayal service and supports decision-making activities for different user groups according to their context.

ACKNOWLEDGEMENTS

This work has been financially supported by the BGIO (Bundeswehr Geo Information Office) which is gratefully acknowledged here.

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