Features of the MVC Architecture for Working with Observational Data Series

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Abstract. The paper describes a technology based on the use of an ontological approach and designed to develop systems that take into account heterogeneity, distribution, the continued growth of experimental data and unstructured information in the form of publications, reports, images and other types. The information system (IS) created on this technology is based on the Model-View-Controller concept.

Keywords: intelligent scientific Internet resource, ontology, service, external data storage, data access system.

1 Introduction

A wide class of environmental problems requires the creation of information systems designed to store, process and present time series of spatially distributed data of instrumental observations of the state of the surrounding atmosphere. Information systems focused on environmental monitoring tasks should be based on a data model, tools for working with time series of observational data and data import and editing programs. It is necessary to develop subsystems responsible for the presentation of time series of data and their processing.

The creation of such systems is an important, relevant and complex task. We focus on technologies aimed at developing systems with the above properties. In their development, they have gone through several stages, providing tools and techniques for the development of knowledge portals [1], intellectual scientific Internet resources (INIR), intellectual information and analytical Internet resources (IIAIR) [2]. This approach has been successfully used in active seismology [3], in the study of thermophysical properties of substances [4], decision support and research in energy. The initial reference point was aimed at the representation of semantic dependencies of concepts and systematization of heterogeneous information. As a rule, this approach was supplemented by means of processing this information and solving problems typical for the field of knowledge (KB) under consideration. In order to fully represent the areas of knowledge in which there are large amounts of numerical experimental data stored in distributed sources, the technology must provide a means of managing these data.

2 Monitoring of the state of the atmosphere of the environment

The atmosphere of a large industrial center is polluted by the exhaust of motor transport and emissions of industrial enterprises located in the city. The most common pollutants whose concentrations, in accordance with who recommendations, should be controlled are dust, soot, sulfur dioxide (SO_2), ozone, carbon monoxide (CO), nitrogen dioxide (NO_2), nitrogen oxide (NO), hydrogen sulfide (H_2S), phenol (CH), hydrogen fluoride (HF), ammonia (NH_3, formaldehyde (CH_2O), etc. [6]. A wide class of environmental problems requires the creation of information systems designed to store, process and present time series of spatially distributed instrumental observations. Information systems focused on environmental monitoring tasks should include a data model, tools for working with time series of observational data, subsystems for importing and editing data. An important addition is the subsystems responsible for the presentation of time series of data and their processing. These subsystems and developments can be integrated into a single intellectual scientific Internet resource. It is a system with a web interface that contains systematized information related to the field of knowledge (KB), focused on the information obtained in the study of characteristics reflecting the state of atmospheric aerosols and provides meaningful access to both information and methods of its processing. The main component of INIR is the ontology of OZ. Ontology is a conceptual system that is the basis of a particular field of knowledge. Ontology is the specification of conceptualization. And conceptualization includes objects, concepts of essence that exist in the considered area, and are related to each other. On its basis, the systematization of the information of a particular OZ and the functioning of INIR is carried out.

3 Technology development and research

INIR is a system with a web interface that is focused on MVC (Model-View-Controller) - representation and contains systematized information focused on a specific KB and provides meaningful access to this information, methods of its processing and methods of solving problems adopted in this field of knowledge (KB), as well as related Internet resources [1].

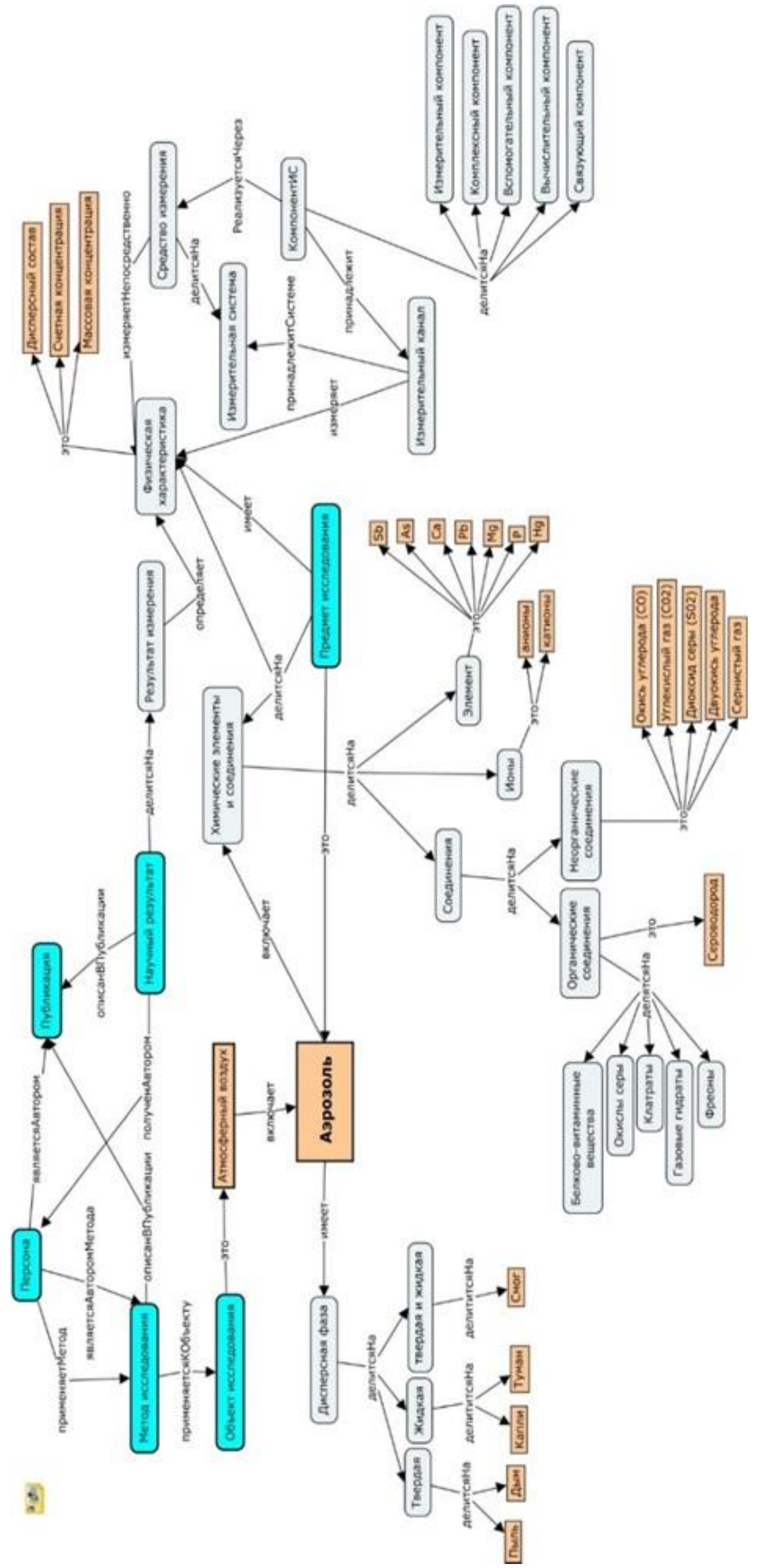

Figure 1. Aerosol ontology.

The ontology of measuring systems is an essential addition to KB [5]. On its basis the systematization of information of this KB and functioning of INIR is carried out.

3.1 The ontology of measurement systems

When measuring any physical quantity, it is important to know not only the measurement result itself, but also its spatial and temporal reference, the conditions in which the measurements were made, the characteristics of measuring instruments, etc.in one form or another, any system that makes measurements stores such metadata along with the measurement results.

The process of measuring physical quantities is well studied and regulated within the framework of Metrology. Its main provisions are set out in standards and regulations, so at the stage of modeling the subject area should be based on them. GOST P 8.596-2002 [8]. Metrological support of measuring systems defines a *measuring system* as a set of components (measuring, connecting, computing), forming measuring channels. *Measuring channel* is a logical entity that combines the whole complex of measurements and transformations to obtain the measurement result of a given physical quantity.

On the basis of this metrological standard the ontology of measuring systems (OIS) was developed. The General scheme is presented in figure 2, and its basic concepts are presented below.

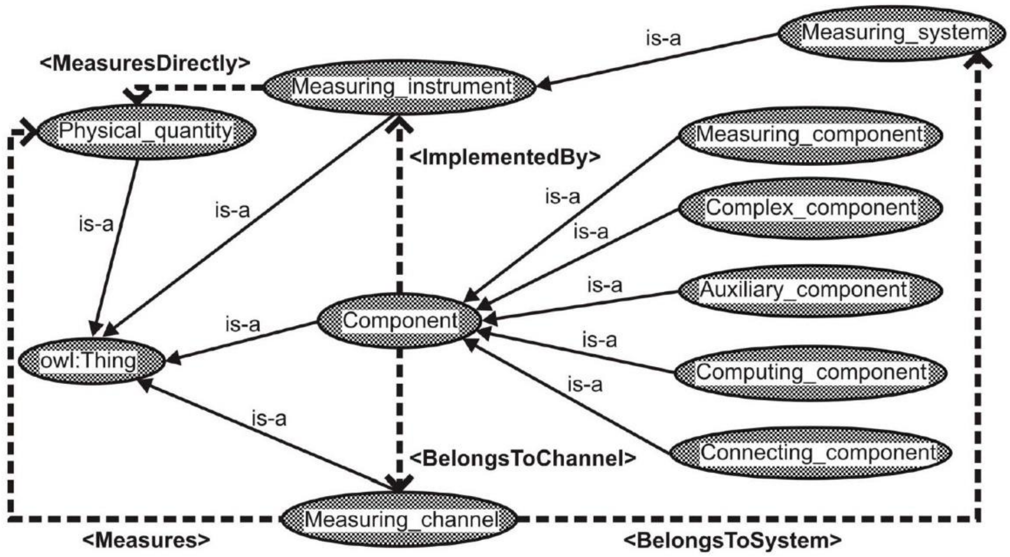

Figure 2. The ontology of measurement systems.

Measuring system has all the features of measuring instruments and is their difference (in ontology, this fact is reflected by the relation is-a. note that the relation is-a means that all instances of one class must also be examples of the second (one of the types of inheritance).

Physical_quantity – the measurement object of the measuring system. Either it is an instantaneous temperature or an integral mass concentration of particles in the atmosphere. These values can be measured by direct measurements or calculated by calculated components based on indirect measurements.

Measuring instrument is an entity that directly measures a physical quantity. In ontology, this relationship is reflected by the relation *MeasuresDirectly*.

Component − a technical device included in the system that performs one of the functions depending on the type of component. Components are divided into measuring, computing, binding, auxiliary and complex. The component of the measuring system can be implemented with the help of a measuring instrument, so the *ImplementedBy* relation is provided in the ontology. The components are part of the measuring channels. This relationship is reflected by the *BelongsToChannel* relationship.

Measuring component is a device that collects primary measurement results. These are: measuring instruments, analog computing devices.

Computing component calculates the results of direct, indirect, local or aggregate measurements based on the data of measuring instruments or measuring components.

Connecting component is designed to transfer measurement results from one component of the measuring system to another. It can be a wired or satellite communication line, radio channel, optical fiber.

Auxiliary component − a technical device that is not involved in the measurement process. It ensures the normal operation of the measuring system.

Complex component − a set of components that completes the measurement transformations, computational and logical operations provided by the measurement process and algorithms for processing the measurement results.

Measuring channel − structurally or functionally allocated part of the measuring system, performing the whole complex of transformations to measure the physical well-being. It is a collection of components. This relationship is reflected by the *BelongsToChannel* relationship defined for the measurement channel component. The measuring channel measures a physical quantity reflected in the ontology by means of the Measures relation. The channel belonging to the measuring system is reflected by the relation *BelongsToSystem*.

Measuring system − a set of components that are combined into measuring cells. It is used to measure a set of time-varying and space-distributed physical quantities, record and process measurement results.

The development technology provides a methodology for constructing an ontology, a set of basic ontologies, an INIR shell, means of user interface specification, data editors and a set of services that provide the functionality of the resource.

To develop the ontology, the Semantic Web tools [9], the Protégé editor [10] and the methodology proposed by the authors of the INIR technology [1, 2] are used. This technique is focused on the use of basic ontologies and patterns of ontological design [2].

When developing the INIR shell, a service-oriented approach was used, based on the technology of separating application data, user interface and control logic into three separate components: model, view and controller-MVC [3]. We use ontology as the basis of the model [3]. According to this approach, all INIR functionality is implemented using services – local or distributed, loosely coupled, replaceable components equipped with standardized interfaces for interaction over standardized protocols. This approach allows resource developers to create various services for processing information stored both in INIR content and in external storage, as well as to use third-party services.

4 Architecture of external data access system and scheme of its functioning

Access to external data is provided by a system that provides INIR users with the following functionality:

1. Organization of interaction with external data sources. These can be third-party databases (DB) or DB created by developers of specific INIR.
2. Description of information objects with values from external databases.
3. Import property values of specified objects from external sources. Visualization of object property values as tables or graphs.
4. Starting services analysis of the imported data.
5. Use imported data to solve problems.

Figure 3 shows the architectural components of the data access system and the scheme of their interaction.

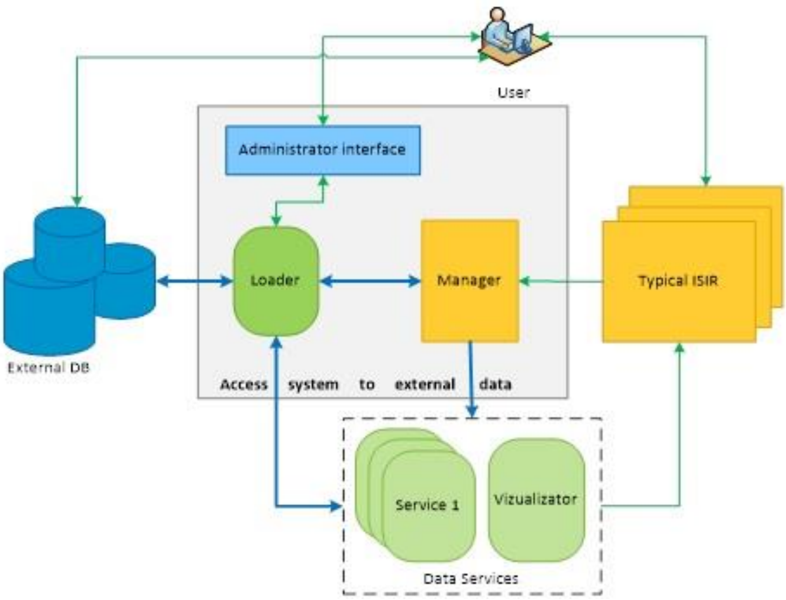

Figure 3. Architecture of data management system from external sources.

The main component of this system is the data download service – zagruzchik. It interacts directly with external data stores (databases). To connect to the system of specific databases, the administrator panel is used, which has a web user interface that allows you to register new data sources and create query templates for accessing them. The loader has its own database, which contains the addresses of the databases registered in it and the information necessary to build a query to a specific resource. Both templates of SQL queries to relational databases and other query formats (REST API, SOAP, SPARQL, etc.) to external resources can be used here. To build specific queries, the necessary parameters are passed to the Loader, which are extracted from the INIR ontology.

Services for working with data allow to show them to the user, to perform their analysis or to use for the solution of problems of KB of a resource. To organize the interaction of INIR with the Loader and Services for working with data, a special plan-Manager was developed. This plugin is designed to extract from the INIR ontology the parameters necessary for the Loader to build a query to an external database. The Manager passes parameters to the loader, receives the request ID from It, which then passes it to the required Service.

Consider the scheme of functioning of the system of access to external data. In order to be able to use external data in INIR, it is necessary to register in the database Loader the template of the query that makes a selection of the necessary data through the administrator Panel. In this case, each triple (template, string, type of database) is assigned a unique identifier, which is reported to the knowledge engineer. The knowledge engineer must define a class of objects in the KB ontology, whose properties will take values from the external database, and associate the resulting identifier with this class. In addition, he should take care to associate the properties of such objects with the parameters of the query template to the external database (their names and order in the template).

For the resource information system, "Atmospheric aerosols", presented in figure 1, was developed data visualization service (Visualizer), which allows you to display some of the parameters of the atmosphere: temperature, nitrogen dioxide, wind speed and dust density, obtained in the summer of 2007. The result of the Visualizer is shown in the figure. 4.

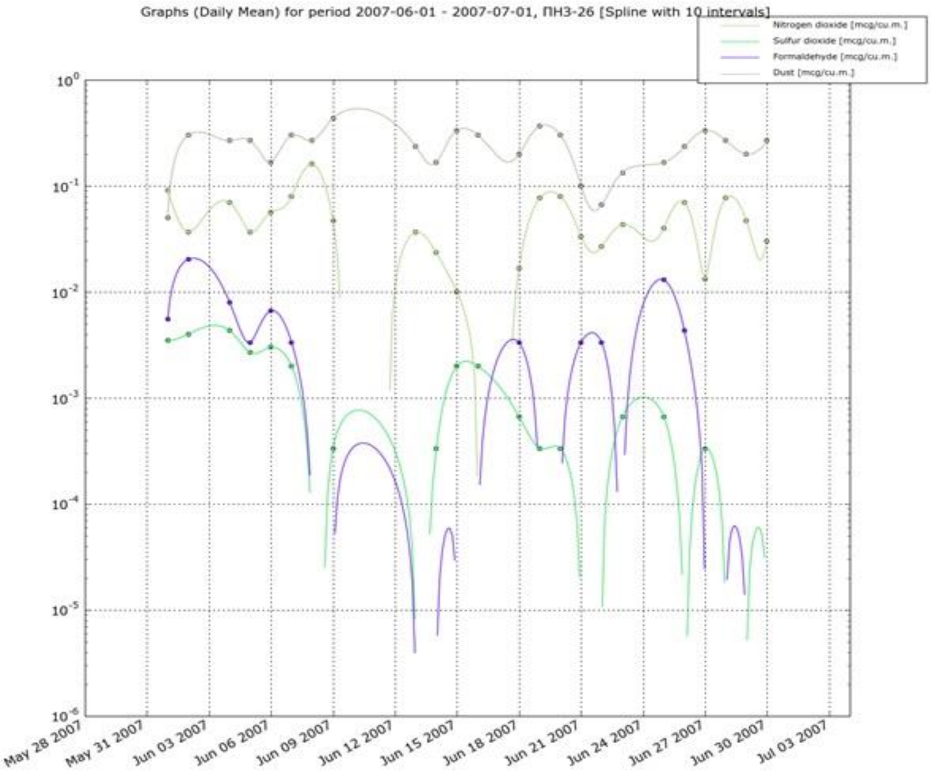

Figure 4. Graphical representation of data.
Logarithmic scale, the approximation using a cubic spline.

5 Conclusion

As part of the technology for creating intelligent scientific Internet resources, a system was developed for access to atmospheric air measurement data stored in databases on external sources. The use of Semantic Web technology and tools made it possible to simplify the establishment of communication between INIR content objects and the values of their characteristics stored in external databases as much as possible. When implementing the system, a service-oriented approach was used. The idea of communicating INIR and services using unique identifiers makes it easy to scale the system and increase the functionality of INIR without making changes to its code. When developing services, special attention was paid to the optimization of the proposed architecture.

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