Interface Model for Spatial Objects Monitoring Task Setting

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Abstract. The research is devoted to the study of human-computer interaction in the context of interaction of end users (EU) and multi-purpose remote monitoring systems (MRMS) for spatial objects. The study is aimed at the formation of conceptual aspects of building graphical interface for setting monitoring tasks. It defines a global structure for communication between end users and multi-purpose remote monitoring systems (MRMS) in the form of a dialogue and target parameters for the quality of the dialogue tools. The task setting interface has been tested in practice on the basis of the ISIT SFU remote monitoring system. An example of task setting for grain crops growth monitoring has been reviewed.

1 Introduction

The research of "human - information system" communication is an integral part of information science. The research focuses on building communication between users and data processing systems (DP-systems) which require data processing chain management. DP-systems can include various processes depending upon the application of such systems which makes the development of a unified approach to dialogue interaction quite a challenging task.

The research focuses on the analysis of spatial objects remote monitoring systems used for Earth remote sensing data processing. At present, there is a growing demand for information products based on Earth remote sensing data [1]. The users of such systems are state administrative authorities and commercial entities, as well as individuals. Users from all these groups shall be considered end users, i.e. task setters and results consumers. The number of information requests from end users tends to increase which require certain interface solutions [2]. Processes for solving satellite monitoring tasks are often of combined type with one part of data processing operations automated and the other part requiring the involvement of programmers which substantially restricts task setting for end users. In connection herewith, the structuring of available data processing algorithms which

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allow using unified dialogue patterns by the end user on its own shall be a well-grounded solution for remote monitoring systems development.

2 Global dialogue structure model

Dialogue shall be a process with an end user pursuing a certain goal which can be analyzed at various levels. The global structure [3] is the highest level for dialogue structure analysis. It shall be the same for the whole class of tasks solved and shall not depend on specific features of separate tasks solved. The global structure is characterized by a general sequence of interaction stages which can further specify dialogue model with the help of subject-specific and local structures' terms which very much depend on the type of the task solved.

Figure 1 contains global structure for spatial object monitoring task class.

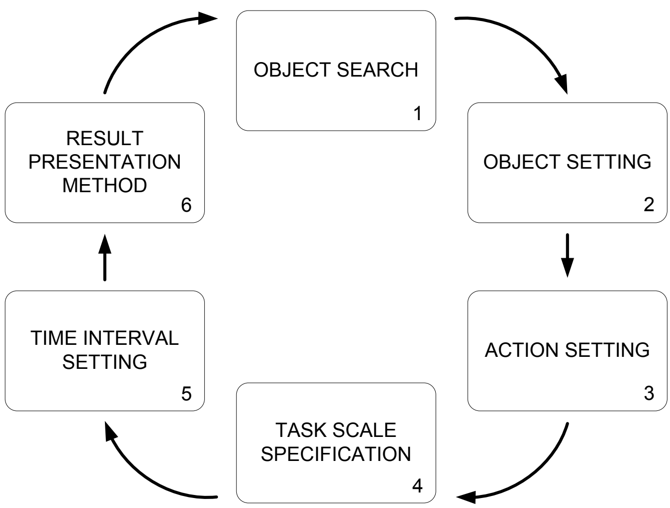

Fig. 1. Global dialogue structure model for spatial objects monitoring task setting.

The structure includes six stages which can be described as follows.

1. Object search shall be used to identify relevant information in the system data describing the target object. Data structure contains factual information about geospatial objects in the form of geospatial tiers, as well as data about the objects represented in the form of taxonomies [4]. The display of the searched spatial object contours on the map or a list of objects matching the request shall be a successful search result.

2. Object setting can be of two types. The first type shall include the use of the object found at the previous stage. In this case the user shall select object specialization and localize it with the help of geographical coordinates by highlighting the object at the map (Fig. 2). The second option is used in case the target object is absent in the system data structure. In this case the user can set the target object coordinates on its own by means of visual outlining.

3. Task setting (*or operations with the object*) shall depend on the specific type of the object defined at the previous stage. E.g. if the found or newly created object is a crop rotation field, the system shall suggest preset monitoring algorithms for vegetation heterogeneity or conditions based on vegetation indices. Actions shall be single or cyclic. Single actions shall include one processing iteration, e.g. object area calculation, while cyclic actions shall include a number of measurements at a specified time interval which

corresponds to the term “monitoring”.

4. Task scale specification shall specify the information request and generally shall be an optional stage of the global dialogue structure. Task specification shall define the object with account of semantic characteristics. E.g. vegetation heterogeneity monitoring shall be required for the specified crop rotation field in case of wheat growing. Semantic characteristics shall be set in the form of classifiers based on taxonomy, with the spatial object connected by numerous relations to other objects of various types expanding the knowledge about it.

5. Time interval setting shall allow setting the time period for making operations with the target object. The following two aspects depending on step 1 and 2 shall be accounted for. Shall the object be found in the system, the database can contain information on its lifecycle, including on its active cycle. Shall there be no information about the object lifecycle in the database or shall the object be newly created in the process of task setting, then the user can set the monitoring interval at the timescale or define a set of time points on its own. The difference between the two approaches to time interval setting shall be the number of monitoring iterations which shall be directly proportionate to the number of the relevant Earth sensing data receipt iterations in the first case or shall depend on the number of time points and data availability as at the set date in the second case.

6. Setting the results presentation method shall define the method for measurement results storage and visual presentation to the user. In general, the results of measurements shall be represented in the form of diagrams or bar charts, and parameters analyses shall be presented in the form of schematic maps with map legend. Table sheets which can be downloaded as files can also be used for visual presentation of results.

3 Model testing in practice

A brief description of implementation of certain key steps of the global dialogue structure is given below (Fig. 2).

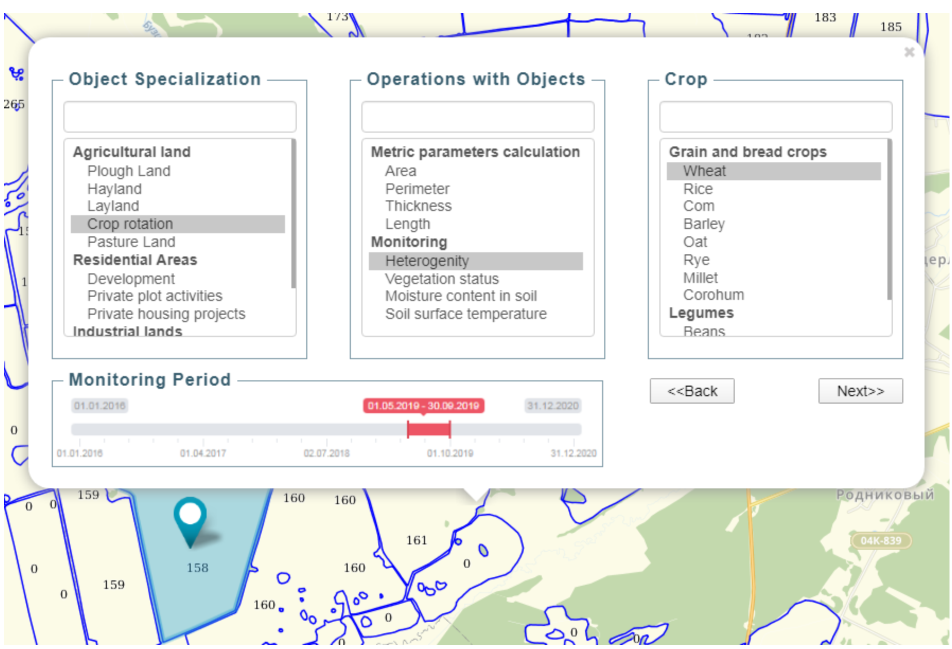

Fig. 2. Monitoring task setting interface for the specified spatial object.

Let us assume that the aim of the user is monitoring of changes in vegetation structure [5] of object “Crop rotation field No.158”. Given that the information on the target object is present in the coordinates structure and the user has localized it in the coordinate space, the system shall suggest setting object specialization and selecting admissible action with the object, specifying the object parameters in the semantic space, e.g. by setting agricultural crop, as well as specifying the monitoring period from May 01, 2019 to September 30, 2019.

4 Conclusion

The analyzed dialogue structure model is based on ISIT SFU multi-purpose remote monitoring system (MRMS) and is currently at the testing and debugging stage. The key target parameters which define the quality of dialogue interaction and are prioritized in this research shall include the following: advanced system functionality with minimum amount of dialogue steps taken by the end user for task setting; flexible interaction which shall mean non-strict step sequence and can be present in various task setting dialogue paths; a possibility for the end user to specify the request more precisely in case of disagreement with the results which shall be considered by the system as the next problem solution iteration followed by the assessment of results.

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References

1. E.A. Lupyan, I.V. Balashov, M.A. Burtsev, V.Yu. Efremov, A.V. Kashnitsky etc., *Conference: Modern problems of Earth remote sensing from Space*, **12**, 53 (2015)
2. V.I. Drakin, E.V. Popov, A.B. Preobrazhenskiy, *End users interaction with data processing systems* (M. Radio and Communication, 1988)
3. C. Traynor, M.G. Williams, *Interactive Technologies*, 115 (2001)
4. Yu. A. Maglinets, K. V. Raevich, G. M. Tsibulskii, *Procedia Engineering*, **201**, 331 (2017)
5. R.V. Brezhnev, Yu.A. Maglinets, K.V. Raevich, G.M. Tsibulski, *CEUR Workshop Proceedings*, **2210**, 316 (2018)