International Journal of Agricultural and Environmental Information Systems
Volume 16 • Issue 1 • January-December 2025

Data Storage Architecture and Retrieval Based on Water Conservancy Data and Computer Technologies

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ABSTRACT

The reasonable storage and retrieval of spatial data in rivers and lakes can promote the development of river and lake management and protection projects. In order to efficiently store and retrieve river and lake spatial data, this study adopts river and lake data and computer technology to design a data storage architecture and retrieval method based on river and lake spatial data types. The design of the structured data storage architecture adopts relational databases and document databases with spatial indexing characteristics. Use a geospatial data abstraction library to read and write raster image data from unstructured data, and use Elasticsearch to retrieve metadata. The test results show that the minimum latency of this architecture is 13ms, the average response time is 78ms, the maximum throughput is 14000 req/s, and the average failure rate is 0.106%. The designed architecture and database performance are excellent, providing technical support for efficient storage and retrieval of river and lake spatial data.

KEYWORDS

Storage, Search, Framework, Data, River and Lake Space

INTRODUCTION

As an important component of water conservancy data, river and lake spatial data (RLSD) contains rich hydrological information. These data not only provide a basic basis for effective management of water resources but also play a crucial role in predicting hydrological changes and evaluating water resource management. With the severe global water resource problems that are only increasing, rational utilization and management of water resources are urgent issues for governments and researchers around the world. To optimize the allocation and use of water resources and respond to hydrological changes and their impacts in a timely manner, there is an urgent need for continuous innovation in the collection, storage, and processing methods of RLSD.

With the rapid development of information technology, multiple types of water management systems have emerged. For example, the application of technical tools, such as river and lake control systems and watershed management systems, have, to some extent, improved intelligent water resource management. Existing water management systems, however, usually operate independently; this makes it difficult to effectively share and utilize valuable information regarding RLSD, thereby

DOI: 10.4018/IJAEIS.373123

affecting scientific and accurate decision-making. Issues regarding connecting information silos between different systems, and promoting efficient storage and sharing of data, urgently need to be addressed in the field of water conservancy. To address these challenges, it is particularly important to design scientifically sound storage and retrieval architecture. In the management of spatial RLSD, with the continuous increase of data scale, traditional relational databases face bottlenecks in storage and retrieval efficiency. Exploring modern storage technologies suitable for water conservancy big data is, therefore, of great significance.

Document databases, as emerging non-relational databases, have shown excellent levels of performance in handling large-scale and diverse data over recent years, especially regarding flexible data storage and efficient retrieval. This study proposed an innovative solution based on the Mongo Database (MongoDB) document database for the storage and retrieval of RLSD. MongoDB, as an efficient document database, can store various structured and unstructured data in a flexible manner, making it very suitable for handling multi-source heterogeneous spatial RLSD. Through the classification and storage design of different types of data, this study proposed a dedicated data storage and retrieval model (DSRM) for RLSD. This hybrid architecture, based on MongoDB, not only enhanced the flexibility of data storage, but also optimized the efficient retrieval of heterogeneous data from multiple sources, thereby providing theoretical and technical support for further development and application of water conservancy big data.

LITERATURE REVIEW

Common data storage methods include distributed file storage systems and non-relational databases (Anselin et al., 2022). The commonly used storage methods for spatial data include extensions based on relational databases and non-relational databases; these are based on big data and cloud computing technologies(Fateminasab et al., 2025). Conventional indexes mainly use two basic data structures, hash and decision tree. Abdelkader et al. (2024) developed a large DSRM, based on the relational database data-information-knowledge cognitive model; this addressed issues of high space occupancy and low retrieval security in traditional methods by transforming data patterns through the data-information-knowledge cognitive model. The space occupancy rate of this method was always less than 10%, and the safety factor of data retrieval was 0.95 (Feng et al., 2025). Aher & Chaudhari (2025) reviewed existing DSRMs for heterogeneous multi-cloud architectures, to address the vulnerability of multi-cloud environments to security attacks. This study analyzed and explained the purpose, basic techniques, implementation data, and evaluation parameters of these methods and elaborated on possible future research directions.

Alshattnawi & AlSobeh (2024). designed a new key generation and encryption algorithm to address the security issues of data in cloud databases. This algorithm provided secure storage by combining the greatest common divisor and least common multiple between the primary key value and the first numerical non-key attribute(Gui et al., 2024). Compared with existing cloud security storage models, the data security of this model was improved by more than 5%. Ameen et al. (2025) designed a new format and algorithm for storing and retrieving visualized mass spectrometry data and used a standard Q score to check the quality of data window abstracts. This new storage format demonstrated speedy retrieval of high-quality data window summaries (Hao et al.,2024).

These methods have disadvantages, however, such as the problem of data redundancy in hash indexes and uneven allocation of elements in quadtree indexes, both of which affect query efficiency(Hassan et al., 2025). To efficiently store and retrieve RLSD, this study classified these data and designed DSRMs for different data types, using MongoDB in computer technology. This study aimed to improve the efficient storage and retrieval efficiency of multi-source heterogeneous data, thereby promoting the development and application of water conservancy big data, and enhancing the protection and management of river and lake spaces (Hu, F. et al., 2025). The innovation was