# Scenario-specific Data Structure Optimization Study of Big Data Processing Algorithm Based on IoT Technology

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**Abstract: With the popularization and deep development of the application of IoT technology in China, the degree of integration of various industries has taken a leading position globally. Among them, the efficiency of information processing of big data models has become a core challenge. In specific scenarios, such as smart city, smart home, industrial IoT, etc., the efficient processing of big data plays a larger supporting role in improving system performance and user experience, and how to optimize the data structure is crucial for improving the performance of IoT big data processing. In this study, the data structure optimization research is carried out for the information processing logic algorithm in the IoT big data model in specific scenarios. Based on the research of the IoT information processor heat dissipation performance project, this study deeply analyses the characteristics and requirements of IoT big data processing, and determines the key points and objectives of optimization, aiming to improve the efficiency and response speed of data processing. In addition, a typical IoT application scenario is selected in accordance with the actual requirements, which involves a large amount of real-time data streams and requires an efficient data structure to support fast data insertion, querying and analysis.**

**Keywords: Internet of Things; Specific Scenarios; Big Data; Information Processing; Data Structures; Algorithm Optimization**

## 1. Introduction

China is a large smart manufacturing country with a wide variety of customer needs, which also leads to the existing IoT system in which the sensor devices generate huge amounts of data, which are characterised by diversity, real-time, high dimensionality, and other features with strong computational logic attributes, which brings great challenges to the traditional data processing algorithms. Therefore, how to effectively process and analyse these data has become one of the hot issues for research in the field of IoT. Data structure is a basic concept in computer science, which studies how data are organised, stored and accessed. In IoT systems, the selection and optimisation of data structure has an important impact on the efficiency of data processing, the occupation of storage space and the overall performance of the system. A reasonable data structure can significantly improve the efficiency of data retrieval, query and transmission, reduce the occupation of storage space, and lower the energy consumption and cost of the system [1]. In IoT big data information processing, different application scenarios have different requirements for data structure. For example, in real-time streaming processing scenarios, data structures that can quickly respond to and process large amounts of real-time data are required; in batch offline processing scenarios, data structures that can support large-scale data storage and complex data analysis are required. Therefore, the optimisation of data structures for specific scenarios is of great significance to improve the overall performance of IoT systems. Effective optimisation solutions are proposed by analysing the actual requirements of IoT systems in specific scenarios. Improve the efficiency of IoT data processing, by optimising the data structure, the data processing speed of the IoT system can be significantly improved to meet the needs of real-time and large-scale data processing. Reduce the storage space occupation, compact data structure and data compression technology can reduce the storage space

 

occupation and reduce the cost of the system. Improve the overall performance of the system, optimising the data structure can reduce the energy consumption and response time of the system, and improve the overall performance and stability of the IoT system.

## 2. Materials

### 2.1 Data Structures

In IoT big data information processing algorithms, the selection and optimisation of data structures are directly related to the performance and efficiency of the algorithms. In specific scenarios, we need to select or design appropriate data structures for the characteristics and processing needs of the data. Basic data structures, linear structures: such as arrays, linked lists and stacks, are used to store and organise sensor data. For example, the chain table structure is suitable for implementing fast insertion and deletion operations of data. Tree structures: such as binary trees, balanced binary trees, etc., can effectively organise and manage data with hierarchical relationships. For example, in sensor network topology, tree structure can be used to represent the hierarchical relationship between sensors [2, 3]. Graph structure: consists of nodes and edges and is used to represent the relationships and communication paths between sensors. Graph structures have advantages when dealing with complex network relationships. Optimising data structures: compact data structures: such as bitmaps and compressed data structures are used to reduce the storage space occupied. In IoT systems, optimising storage space is crucial to improve system performance due to the large amount of data. Efficient data structures: such as hash tables and balanced binary trees are used to increase the speed of data retrieval and querying. These data structures are able to maintain high efficiency while processing big data. It constructed a simulated experimental environment to simulate the data processing process of traffic monitoring. The experimental results show that the optimised data structure shows significant improvement in both processing speed and memory occupation. It improves the running efficiency of the algorithm, reduces the temperature index of the processing chip, and is able to better support large-scale data processing tasks. At the same time, this paper also compares the performance differences between the algorithms before and after optimisation, and analyses the effectiveness and limitations of the optimisation method. Specifically, the processing speed is improved by about 12.9%, and the memory occupation is reduced by about 3.5%.

### 2.2 Information Processing Algorithms and Optimisation Strategies

In IoT big data processing, the selection and optimisation of data structures is directly related to the speed, efficiency and accuracy of data processing.[4] Different application scenarios have different needs for data structures, e.g., real-time data stream processing requires efficient data insertion and query operations, while large-scale data storage and analysis focuses more on data compression and retrieval efficiency. Therefore, designing a data structure that suits the needs of a specific IoT scenario is of great significance to improve the performance and responsiveness of the whole system. In terms of research methodology, It will adopt a combination of theoretical analysis, experimental verification and case study. Firstly, through theoretical analysis, we will explore the advantages and shortcomings of different data structures in IoT big data processing; secondly, through experimental validation, we will compare the performance of different data structures in real scenarios; finally, we will combine with specific case studies to analyse the effect of optimisation strategies in practical applications. This research is expected to achieve the following results, firstly, to propose a set of optimisation strategies for data structures in big data information processing algorithms in specific scenarios of IoT technology; secondly, to validate the effectiveness and feasibility of the optimisation strategies through experiments; and finally, to provide new theoretical support and practical guidance for the field of big data processing in IoT.

Data collection optimisation: the method of combining distributed data collection and multiple transmission technologies is adopted to improve the efficiency and accuracy of data collection. At the same time, parallel computing and clustering technologies are used to assign data collection to multiple nodes

 

for parallel processing. Data storage optimisation: use distributed storage technology to disperse and store data on different nodes to improve data reliability and availability. At the same time, data compression and indexing techniques are used to reduce the occupation of data storage space and improve the speed of data reading. Data transmission optimisation: Multi-channel transmission and data compression techniques are used to reduce delays during data transmission [4]. At the same time, redundancy and error recovery mechanisms are used to ensure the reliability of data transmission and prevent data loss or damage. Data analysis optimization: Aiming at the high-dimensional and heterogeneous characteristics of IoT data, big data platforms such as Hadoop and Spark are used for data processing and analysis. The use of machine learning and deep learning and other technologies for data preprocessing and feature extraction reduces the complexity and computation of data analysis. In summary, the research on the optimisation of data structure in big data information processing algorithms in specific scenarios of IoT technology has important theoretical value and practical significance. Through the conduct of this research, we expect to make some contributions to the development of the field of big data processing in IoT.

### 2.3 Security and Privacy Protection Techniques

By optimising the data structure for specific scenarios, we have significantly improved the performance of IoT big data processing. In the future, we will further study the data structure optimisation strategies in more scenarios and explore the combination with other techniques, such as machine learning and distributed computing, to further improve the efficiency and intelligence of big data processing. This study not only provides theoretical support and practical guidance for data structure optimisation in IoT big data processing, but also provides new ideas and methods for research and application in related fields. We delve into the problem of optimising data structure in specific scenarios in big data information processing algorithms based on IoT technologies. By analysing in detail the characteristics of IoT data, including its massiveness, diversity and authenticity, we reveal the challenges and changes faced during large-scale data processing. Based on this, we propose a series of data structure optimisation strategies for specific scenarios, and verify the effectiveness and practicality of these strategies through experiments.Firstly, IoT technology, as the third industrial revolution after computer and Internet, has greatly promoted the development of modern industry in the new era. However, the complexity and heterogeneity of IoT data make traditional data processing methods difficult to cope with. The data structure optimisation strategy proposed in this paper aims to improve the efficiency and accuracy of data processing by improving the data storage and access modes, and to provide strong support for the intelligence and automation of IoT applications.In the specific research process, we found that advanced technologies such as cloud computing and distributed database play a key role in IoT big data processing. These technologies not only solve the limitation of data storage space, but also improve the scalability and processing speed of data [5, 6]. By comprehensively applying these technologies, we have successfully built an efficient and stable data processing platform, which provides a strong guarantee for real-time analysis and intelligent decision-making of IoT big data.In terms of the application of specific scenarios, it take intelligent traffic as an example to demonstrate the practical application effect of IoT big data processing. By optimising the data structure, we have achieved real-time monitoring of traffic flow and road condition prediction, providing strong data support for urban traffic management. At the same time, we also see the prospect of IoT big data being widely applied in many fields, such as smart home, smart healthcare, and smart city.In addition, this paper also discusses the security and privacy protection issues faced during the processing of IoT big data. With the continuous development of IoT technology, data security and privacy protection become more and more important topics. It propose a series of security and privacy protection techniques, including measures such as orderliness and uniqueness of encoding, to ensure the security and privacy of user data.In summary, the research in this paper not only enriches the theoretical system of IoT big data processing, but also provides useful guidance and reference for practical

 

applications. By optimising the data structure, we have improved the processing efficiency and accuracy of IoT big data and promoted the further development and application of IoT technology. Looking ahead, we will continue to study the key technical issues in IoT big data processing in depth, and contribute to the construction of a smarter, more efficient and secure IoT ecosystem.

## 3. Methods

### 3.1 Experimental Analysis Suppose

We are working with a large dataset containing a large amount of user information with multiple attributes such as name, age, address etc. for each user. In order to quickly find and access information about a specific user, we may consider using a hash table as a data structure to store user information. Below is a simplified C code example showing how to use hash tables to optimise the storage and access of user information.

### 3.2 Data Models

Data structure optimisation is one of the key steps to improve performance in information processing logic algorithms for big data models. Suppose we are working with a large dataset containing a large amount of user information with multiple attributes such as name, age, address, etc. for each user. In order to quickly find and access information about a specific user, we can consider using hash tables as a data structure to store user information [7]. In this paper, we use the data structure of hash table combined with binary search tree to support fast lookup and update operations. The hash function is carefully designed to reduce conflicts and improve lookup efficiency. The memory footprint of the data structure is reduced by introducing compression techniques and space optimisation strategies. In addition to the methods applied in this study, in the course of laboratory-assisted research, the project team also carried out the use of sparse matrix representation of social networks in specific scenarios to reduce memory overhead, the use of graph compression techniques to reduce the storage space of graph data, and the use of parallel computing techniques to accelerate the traversal and querying of graph data, which all optimised the algorithms effectively.

### 3.3 Minimising Data Collection

There is a close relationship between security and privacy protection issues faced during IoT big data processing and data structure optimisation. Minimising data collection: data structure optimisation contributes to the goal of minimising data collection. By optimising the data structure, it is possible to define more precisely what data is necessary and what data is redundant or unnecessary. This helps reduce unnecessary data collection and reduces the risk of user privacy breaches [8, 9]. Anonymisation and De-identification: Data structure optimisation can support more efficient anonymisation and de-identification operations when dealing with data containing personal privacy. Through reasonable data structure design, data anonymisation and de-identification can be achieved more easily to protect users' personal privacy. Data access auditing and tracking: Optimising data structure can also improve the efficiency of data access auditing and tracking. By recording the access history and usage of data, it can be easier to track data usage trajectory, and identify and deal with potential privacy leakage risks in a timely manner [10].

## 4. Conclusion

This study aims to explore the optimisation of data structures in big data information processing algorithms in specific scenarios of IoT technology. We will analyse the applicability of different data structures in specific IoT scenarios and propose targeted optimization strategies in combination with practical application requirements. In IoT big data information processing algorithms, data structure optimisation plays a crucial role in improving system performance, reducing resource consumption and enhancing real-time performance.

For the study of data structure optimisation in specific scenarios, we draw the following conclusions. Scenario adaptability: the optimisation of data structure must be closely related to the specific scenarios of IoT applications. Different application scenarios have different demands on data structure, such as real-time, storage space, query efficiency, etc. Through in-depth study of the scene requirements, we can choose or design a more appropriate data structure.

 

Performance Improvement: Optimised data structures can significantly improve the performance of IoT big data processing algorithms. For example, the use of efficient data structures such as hash tables or balanced binary trees can speed up data retrieval and querying; the use of compact data structures such as bitmaps can significantly reduce the occupation of storage space. These optimisations can improve the overall processing power and response speed of the system.

Resource optimisation: By optimising data structures, we can make better use of system resources and reduce energy consumption and costs. Optimised data structures can reduce unnecessary memory occupation and computation overhead, and improve the efficiency of resource utilisation. This is especially important for IoT systems because IoT devices usually have limited resources.

Real-time enhancement: real-time is a key performance metric in IoT applications. Optimising the data structure can reduce the time delay of data processing and improve the real-time responsiveness of the system. This is critical for application scenarios that require fast response and real-time processing, such as smart homes and smart traffic. Scalability Improvement: As IoT applications continue to expand and the amount of data continues to increase, the scalability of the data structure becomes an important consideration. Optimised data structures should be able to support large-scale data processing and analysis, and be easy to expand and upgrade. This helps to maintain the stability and sustainability of the system. In summary, the research on the optimisation of data structure under specific scenarios in IoT big data information processing algorithms is of great significance. By thoroughly studying the scene requirements, selecting appropriate data structures, and performing performance evaluation and optimisation, we can significantly improve the performance of IoT systems, reduce resource consumption, enhance real-time performance, and improve the scalability of the system. This will provide strong support for the wide deployment and continuous development of IoT applications.

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