Research on Data Visualization Technology and Application

Jianlong Yao

Research Institute, University of Sheffield, Sheffield, UK

robertloongyao@gmail.com

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Abstract: Under the impetus of the rapid development of social economy and science and technology, all major fields have entered a state of rapid development, many advanced high-tech technologies have been derived, and sound application effects have been achieved in social production and economic development, promoting the progress of the whole society. Data visualization technology is a product of the era of big data. Still, the inevitable result of the rapid development of social economy and science and technology, it has been widely used in many fields, improving digitalization and informatization in significant fields. Compared with traditional visualization technology, data visualization technology can process massive data. It has the advantages of a short response time for data information, high system operation efficiency, and strong operational flexibility. Many Internet companies have actively introduced data visualization technology to improve product performance and meet the various needs of product users, which shows the importance of data visualization technology and should attract attention and attention.

1. Introduction

Nowadays, China has ushered in the era of information networking and big data. Many advanced information technology, network technology, and digital technology were born and are widely used in significant fields to promote the development of informatization, networking, and digitalization in major fields. Data visualization technology is an emerging technology produced in the context of this development. It is continuously optimized based on traditional visualization technology. It is also comprehensively applied to various big data technologies and information network technologies, so it has strong informatization, networking, and digitalization characteristics. It can meet the various needs of the development of the information network and big data era.

The application of data visualization technology can not only intuitively reflect the complex transactions of the natural world to people but also transform massive data into useful information so that people can understand and manage these data to realize the sharing of data information and improve the utilization rate of various data information resources. So let's briefly outline the basic concepts of data visualization; Then, several common data visualization techniques are analyzed, and related technical application tools are discussed. Finally, the challenges and future development directions of data visualization techniques are analyzed.

2. Basic Concepts of Data Visualization

In essence, data visualization is big data visualization technology, which is the product of the development of the era of big data. It is a high-tech technology for data value release, data visualization analysis, data calculation, and processing. It is valuable in developing digitalization and informatization in major fields. Data visualization technology is a combination of big data technology and traditional visualization technology, so it has the advantages of big data technology and traditional visualization technology, which the advantages of big data technology, include large data volume (a large amount of collection, a large amount of storage, and a large amount of calculation), variety of types, fast and time-sensitive, low-value density (a small proportion of valuable data), data online [1]. The advantages of traditional start-up technology include graphical visualization, data visualization,

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and information dynamics. However, there are also some shortcomings between the two, so the data visualization technology combined can make up for each other's shortcomings and realize data interactive visual expression, dynamic data visualization, data mass processing, etc., to meet the data application needs of different users.

Data visualization techniques can also be understood and defined in the following ways; First, defined from the perspective of data space: it refers to a data visualization system composed of n-dimensional attributes and m elements, which can centralize different types of data sets and then form a multi-dimensional information space, and finally realize the application and management of data. Second, it is defined from the perspective of data development: it refers to the deduction and calculation of data with the help of specific algorithms and tools, and finally, quantitative analysis and visual design of data. Third, from the perspective of data analysis: it refers to using relevant tools to slice, block, and rotate multidimensional data, achieve the action analysis of the data, and finally, observe the data from multiple angles and aspects. Fourth, defined from the perspective of data visualization: it refers to the technology that can transform big data into the form of graphic images, which needs to be applied to data analysis software, data development tools, etc., and is a data information processing technology [1-2].

3. Common Data Visualization Techniques

It mainly includes in-situ interaction analysis technology, big data storage technology, visual analysis algorithm, quantification of uncertainty, parallel computing, user interface, and interaction design, etc., as follows:

3.1 In Situ Interaction Analysis Technology

Visual analysis of some large amounts of data in memory is in-situ interactive analysis technology. First, for some extensive data, the disk to store data and then analyze, especially petabytes of data, is highly unsuitable in disk data. Then, the analysis will greatly increase the cost of I/O. When the data is still in memory to expand visual analysis, it can maximize the disk read ratio and data use. However, there are still some problems when data visualization analysis is carried out by in-situ interactive analysis technology [2]. For example, process interruptions due to the inability of hardware execution units to share processors efficiently and process interruptions due to reduced human-computer interaction.

3.2 Big Data Storage Technology

The emergence of big data storage technology is based on cloud service technology, and the primary purpose of its existence is to better solve the problems that cloud services cannot solve, for example, for exabytes of hyper-scale data applications. The importance that large enterprises attach to the research and development, and application of new technologies is directly related to the cost of data storage. The cost of cloud storage per gigabit is much higher than that of hard disk storage in a private cluster. In addition, network broadband directly impacts cloud databases' data transmission, significantly strengthening people's attention to data visualization through big data technology.

3.3 Visual Analysis Algorithm Technology

For the big data visualization algorithm. It is necessary not only to consider the scale of visual data but also to attach great importance to efficient algorithms for visual perception. For example, innovating and increasing methods of interaction with users and visual representation. Moreover, from the user's point of view, meeting the user's needs and preferences requires the visualization technology to have a high output adaptability to ensure the organic combination of automatic learning algorithms and needs. This, in turn, increases the control parameter search space. Not only to reduce the cost of data analysis but also to reduce search time while reducing the exploration difficulty.

3.4 Uncertainty Quantification Techniques

Under normal circumstances, data subsampling is introduced into the data analysis task to meet

the real-time data analysis requirements, improving the uncertainty factor to a certain extent. At the same time, as the scale of data continues to increase, the direct processing ability of the entire data set will also be affected. Therefore, quantifying uncertain elements and factors has become one of the leading research directions in science and engineering. Visualization technology can more intuitively reflect the uncertainty factor view to the user, helping the user to have a more intuitive understanding of the current uncertainty. Improve the user's probability of correct parameter selection, significantly reducing the probability of misleading results [3].

3.5 Parallel Computing Technology

Parallel computing is a concept that visual computing takes up much time and can help users interact with data analysis in real time. With parallel computing, the amount of memory occupied by a single core across the architecture is significantly reduced, and the efficiency of data movement within the system is greatly improved. However, it should be noted that the visual analysis algorithm and data model need to be redesigned to maximize the advantages of parallel computing and give full play to the functions of parallel computing. When necessary, highly innovative means of user interaction and visual representation are also introduced.

3.6 User Interface and Interaction Design Techniques

Through the survey, it's learned that many software and tools for data visualization are set up with user interface and interaction design functions, which has become the leading technology of data visualization, and has achieved good application results in the fields of data visualization analysis and visual design, making up for the lack of the traditional lack of the last scalability visual analysis algorithm design method, and can also realize the calculation and output of complex data, and is used by users to achieve human-computer interaction design and data information sharing [4]. User interface and interaction design can also simplify user-driven data, extend multi-level hierarchies, fuse data, interactive query, and time-varying feature analysis used in design and engineering development.

In addition to several common data visualization technologies and calculation methods mentioned above, there are Highchar ts, Echarts, Charts, D3, and other technologies, which are also widely used in several data visualization technologies. The principles and advantages of these technologies are shown in Table 1.

Table 1 Technical advantages of Highchar ts, Echarts, Charts, D3, and Processing[5]

Type of technology	Technical advantages
Highcharts	High compatibility, simple configuration syntax, support for printing charts
Echarts	Feature-rich, personalized, and visualized rendering capabilities
Chart	Eight visual presentations can mix different charts, out-of-the-box animation effects
D3	It can be run without plug-ins, is flexible and simple, supports large amounts of data, and simplifies writing difficulties.
Processing	Support multiple platforms, accessible for users to get started, simple syntax, image processing, network communication

4. Data Visualization Tools

Including DataV (a data visualization product of Alibaba Cloud), RayData (a big data real-time visualization interactive system), Tableau (a foreign business intelligence software), Sugar (a data visualization product of Baidu), the functions and functions of these tools are shown in Table 2.

Table 2 The role and function of several common data visualization tools[6]

Tool type	Function and function
DataV	Role: Analyze complex data. Functions: geographic analysis, real-time monitoring, report display, graphical interface, multi-resolution adaptation, encrypted release, custom components.
RayData	Function: Real-time graphical visualization and real-time interaction of data. Functions: ultra-high resolution, content modular management, provide end-to-end product solutions, two-way interaction, remote control, and free customization.
Tableau	Role: Data management, data visualization. Features: Quick analytics, intelligent dashboards, automatic updates, instant sharing.
Sugar	Role: Report and data visualization, interactive data analysis. Functions: Page adaptation, public and encrypted publishing, private deployment, permission management, data filtering, and filtering.

5. Application of Big Data Visualization Technology

It is mainly used in the visual design of big data network security, taking the visual analysis design of a white environment worm map as an example. This design increases the amount of data but is more conducive to the user's understanding. The visual analysis of data through the insect map is mainly to comprehensively monitor the abnormal traffic accessing the intranet core server. The focus is on the two aspects of access relationship and intranet assets [7].

Combined with previous experience, the data with relationships are analyzed using force-oriented layout diagrams and chord diagrams. We first choose the chord graph, the host is inside the dots, and the user can find the event correlation from three dimensions. However, after testing practice, it is known that its understanding is relatively low, so finally, the global relationship of the force-oriented layout diagram (bug diagram) is shown at the first level, and the second level is further demonstrated by drilling into the IP or port.

In the stage of graphic optimization, design adjustments were made from many aspects; for example, only TOPN was displayed, mainly considering the user's adaptability to the density of graphic elements; The interface style and element style are consistent; The omitted treatment when the IP name is too long, ensuring the simplicity of the period; For interactive aspects, drill through to individual IP and port information by clicking on it; When the mouse crosses over, the relevant information is highlighted and displayed, mainly from the aspects of the beautiful picture and user recognition memory [8].

In the detection link, after investigation, users understand the internal flow direction of the enterprise very well, drilling information is more convenient, visual guidance is more precise, and optimization of dynamic effects and color helps users locate faster and ensure secure operation and maintenance efficiency.

6. Challenges and Future Development Directions of Data Visualization Technology

6.1 Challenges

Including visual noise, information loss, large-scale image perception, high-speed image transformation, high-performance requirements, etc., as follows:

First is visual noise. When highly correlated data is encountered when separating data, in-situ interactive analysis technology and visual analysis algorithms cannot separate this type of data into independent objects to display so that it will be transformed into a good display, and these sounds form visual noise. Second, information is lost. Data visualization technology itself is based on

traditional visualization technology, information network technology and big data, and other technologies, so these data can also be obtained through the network, which means that there will be information loss in the process of collecting and transmitting various visual data sets using the network [9]. Third, image perception is limited. Because data visualization is affected by factors such as device length ratio, device resolution, and real-world perception, image perception is limited. Fourth, high-speed image transformation. Because fast image transformations make it impossible for users to react to changes in data intensity. Fifth, high-performance requirements. Dynamic visualization has high-performance requirements, and equipment defects will be exposed once the dynamic visualization requirements are not satisfied.

6.2 Future Development Direction

First, the connection with data mining is getting closer and closer. Data visualization technology and data mining technology have many similarities. The ultimate purpose is to mine valuable data information and then realize the processing, management, and application of massive data information, so in the future development of data visualization technology and data mining technology will only become closer and closer. Second, the degree of human-computer interaction is getting higher and higher. User and data interaction is the core content of the application of data visualization technology. It is also the critical link for users to control data, which means that the development of data visualization technology will become more and more human-computer interaction. Third, data visualization technology processes data on an increasing scale, dimension, and types. Driven by the development of the era of big data, there are many large-scale data, high-latitude data, and unstructured data to adapt to these new trends, data visualization technology will continue to upgrade its functions to achieve effective processing of large-scale data, high-latitude data, and unstructured data [10].

7. Conclusion

All in all, China's data visualization technology has gradually matured and has achieved good application results in various fields, accelerating the pace of China's big data development and promoting the development of informatization and digitalization in major fields to a large extent. Therefore, how to efficiently apply data visualization technology has attracted the great attention of relevant technical personnel and attracted the attention of people from all walks of life, which further confirms that the application of data visualization technology has great significance for the times and social promotion role. Data initiation technology is based on the development of traditional visualization technology, which can not only make up for the shortcomings of traditional visualization technology but also derive many new visualization technologies and calculation methods, including in-situ interactive analysis technology, big data storage technology, visual analysis algorithms, etc., which have improved the level of data visualization to varying degrees. Therefore, based on the understanding of data visualization and its tools, the above analyzes the application, technical challenges, and future development direction of data visualization technology, hoping to provide a reference value for relevant scholars.

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