PROCEEDINGS OF SCIENCE

Temporal Data Visualization Technology Based on C#

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The development of computer technology brings the type and function expansion of system software and application software in recent years. Visual data shows that the real-time requirement of software has improved continuously. However, the increase of network bandwidth still can't satisfy modern software development. Since spacecraft vacuum thermal test and control platform demands a fast real-time reaction on collection points collect temperature, current and voltage data. Data security requires the consistency visual data between the client and server. The slow reading speed of visual data may lead a misjudgement on the evaluation of the thermostat operator on environmental conditions in the vacuum vessel. This situation may bring disastrous consequences. This article proposes a compression algorithm which can solve the problem of a large amount; in addition, we design the information visualization technology of Fisheye Lines. This technology displays holistic view of large data sets in quickly way, it is also easy to see the details.

ISCC 2015
18-19, December, 2015
Guangzhou, China

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1.Introduction

In recent decades, computer storage capacity has increased continually, the speed of production and the data acquisition is becoming more and more quickly, thus more and more the quantity of the data. Meanwhile, facing the huge amounts of data, of which can direct access to information is more and more limited. Pure human is hard to do for such a huge amount of data analysis and extract relevant information. In order to solve the contradiction between the data and information, information visualization arises at the historic moment.

Time-series data can be a period, also can points. Time series data is a complex type of data, it consists of a sequence of values or change over time of events. Shneiderman take the time-series data as one of the seven kinds of basic data, and it is very important to time as a dimension [1]. Time-series data of long span exists in many fields such as business, health and production. People take analysis of time-series data on long span to find and master the rule. Information visualization technology based on abstract information provide interactive representation, can strengthen people's cognitive ability of complex information[2], become the power tool which help people explain the phenomenon, find rules, and make decision[3].

Time-series data refers to the time series data. Time series data is the unified index record data column in chronological order. All data must be in the same data column with diameter, require comparable. Put simply, time-series data is related to time. Time is a kind of measure, is also a kind of special dimensions. When visualize the data, must consider the effect of time, to establish a direct and visual correlation with the time line [4-5]. Time lines [6] is one of the most common visualization technology of time-series data visualization, easy to show the relationship between events in a period of time. Life Lines [6] can be used in information visualization analysis of patient records, but does not provide a method to find patterns between multiple entities. A common problem of time lines is that it display large amount of data, difficult to achieve to showing details of all the data at the same time in a screen. In order to solve this problem, Mackinlay et al. put forward the perspective wall technology [7]. Perspective wall technology is a kind of interactive technology combine focus and context, it uses the perspective of information technology to compress boundaries, can visualize a single attribute of multiple entities at the same time, but cannot visualize multiple attributes of entities. McLachlan et al. [9] using ICONS with semantic zoom technology matrix to the time-series data visualization of system management. The multiple view technology can compare multiple attributes of multiple entities. But for browsing data in multiple views, the frequent switching of attention and working memory will lead to lower efficiency.

2.Compression Algorithm

In a control platform, requiring temperature measurement points, the value of current, voltage is accurate to three decimal places, and the temperature is usually in the range between -150.000 ~ 150.000 ℃, the current range between 0.000 ~ 4.000A, changes in the voltage range between 0.000 ~ 100.000V method taking into account the previously stored value accurate to three decimal places and each occupied by a four-byte floating-point number to store the temperature of each measuring point, current, voltage data . The observation that the temperature range is the largest, and the difference between the minimum and maximum values can be up to 300.000, if the maximum change is multiplied by 1000 to become the results of an integer number obtained is 300000, a byte can range integer value representing the integer value ranging from 0 to $0\sim2^{8}-1$ ie 0 to 255, two bytes can represent 0 to 2 ^ 16-1 that is 0 to 65535, three bytes range of integer values can represent 0 to 2 ^ 24-1, which is 0 to 16777215, we can find that when the temperature of the measuring point, current and voltage data are converted into only three byte integer Each desired data can be stored, and the original method using four-byte floating-point data is stored for each comparison, the new algorithm will compress the original data to the original mass of 3/4, which not only saves storage space, and a visual display platform to accelerate data reading speed.

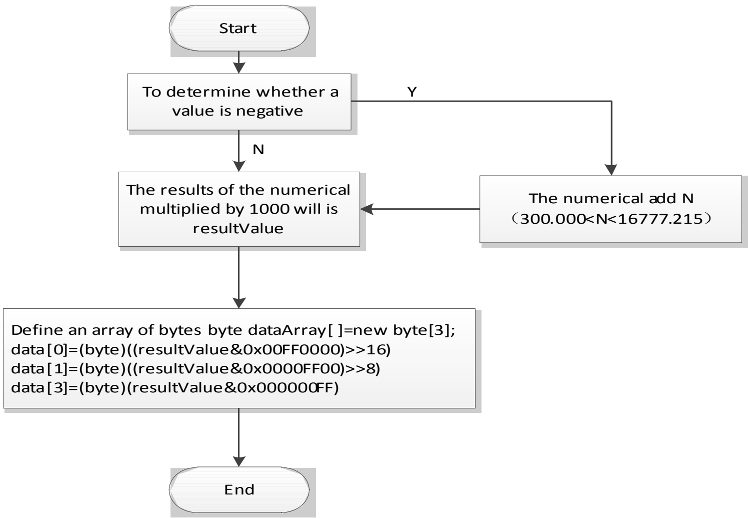
Start
To determine whether a value is negative
Y
N
The results of the numerical multiplied by 1000 will is resultValue
The numerical add N （300.000<N<16777.215）
Define an array of bytes byte dataArray[ ]=new byte[3];
data[0]=(byte)((resultValue&0x00FF0000)>>16)
data[1]=(byte)((resultValue&0x0000FF00)>>8)
data[3]=(byte)(resultValue&0x000000FF)
End

Figure 1: Compression Algorithm Processes

Such as the value of a measuring point in the cycle collected temperature data is 123.345, then 123.345 123,345 multiplied by 1000 to get the results, and then define the byte

```
byte [ ] dataArray = new byte [3];
    dataArray [0] = (byte) ((123345 & 0x00FF0000) >> 16);
    dataArray [1] = (byte) ((123345 & 0x0000FF00) >> 8);
     dataArray [2] = (byte) ((123345 & 0x000000FF));                    (2.1)
```

Then the byte array on the current value of the information stored up. DataArray information is 11110000111010001.

If the value of the collected temperature data is -147.987, take N=400.000, 400.000 plus you will get the results -147.987, 252.013 will be multiplied by 1000, 252,013 get results, then define the byte array

```
byte [ ] dataArray = new byte [3];
     dataArray [0] = (byte) ((252013 & 0x00FF0000) >> 16);
    dataArray [1] = (byte) ((252013 & 0x0000FF00) >> 8);
   dataArray [2] = (byte) ((252013 & 0x000000FF));                      (2.2)
```

Then put the current byte array of numerical information stored up. DataArray information is 111101100001101101.

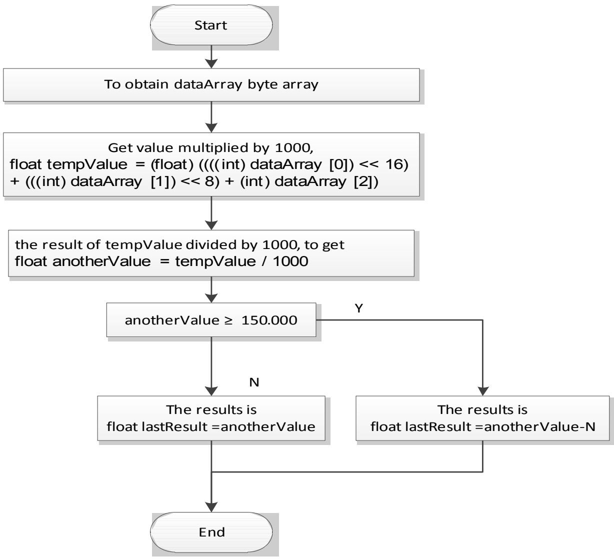
Start
To obtain dataArray byte array
Get value multiplied by 1000,
float tempValue = (float) ((((int) dataArray [0]) << 16)
+ (((int) dataArray [1]) << 8) + (int) dataArray [2])
the result of tempValue divided by 1000, to get
float anotherValue = tempValue / 1000
anotherValue ≥ 150.000
Y
N
The results is
float lastResult =anotherValue
The results is
float lastResult =anotherValue-N
End

Figure 2: Anti-Compression Process

For example, the value of a measuring point in the cycle collected temperature data to be compressed is $dataArray = 11110000111010001$ .Then the definition of temporary float variable

float tempValue = (float) ((((int) dataArray [0]) << 16) + (((int) dataArray [1]) << 8) + (int) dataArray [2]);

Get results tempValue = 123345; define another float variable $anotherValue = \frac{tempValue}{1000}$,

get $anotherValue = 123.345$;its not more than 150.000, so its original value is 123.345.

If the measured value after a certain point in the cycle collected temperature data to be compressed is $dataArray = 111101100001101101$ .Then the definition of temporary float variable

float tempValue = (float) ((((int) dataArray [0]) << 16) + (((int) dataArray [1]) << 8) + (int) dataArray [2]);

Get results $tempValue = 252013$ .Define another float variable $anotherValue = \frac{tempValue}{1000}$;

Get $anotherValue = 252.013$

Its more than 150.000, so its value is equal to the original result is equal to $252.013 - 400 = -147.987$ ·

All data for each measurement point binary compression and will get a length of the measuring point after stitching is all byte array data can be three times the number of the splicing array named binaryDataArray. Then a further use Zip compression algorithms compress it further through binary compression and Zip compression after storage size measurement points collected data reaches the original 0.375, saving storage space, greatly speeding up the time visualization of data read.

3.FisheyeLines

Furmas [10] proposed, FisheyeLines structure should define three essential properties: focus; distance and focus ".": D (. , X) [D,.] = 0; importance, details, resolution a level of LOD (x), however, Furnas in the text is given only tree structure to achieve the function DOI

$$\mathrm{DOI}\ (x\ |.) = (\mathrm{LOD}\ (x)\ -\mathrm{D}\ (,\ x)) \qquad (3.1)$$

For time temporal data is concerned, this is clearly not realize the function describing the level of interest of the user. Below we give the appropriate DOI functions for time temporal data.

Definition 1 (time period). Analysis of time-Temporal data for the user defined time interval, the same time period in the timing analysis of user data will be concentrated. This time interval using two time points, the lower limit, denoted by [Tstart, Tend].

Definition 2 (temporal entities). Over time, a physical change in the properties of their occurrence. Users can Timing entity organized for analysis of time temporal data. Timing entity TE = (T, EAD), where, T is the set time period; EAD is set on the property A1 × ... × Ak k-ary predicate, where, Ai (1≤i≤k) is a sequence of entity TE property.

Part of the definition of time-Temporal data visualization DOI function is as follows:

(1) Focus. "" Timing entity for the current time period of interest, it will be given the highest DOI value.

(2) The distance D (., X) between a point and focus you need to consider the following two aspects: one is from the PD (, x.) Time. In the same period of time points at the same distance, i.e., PD = PD (x1 & x2∈ same time period) (, x1.) (, X2.); PD (., X1) <PD (., X2) <PD (, x3. ...) (& x1∈ same time period, & x2∈ adjacent time periods, & x3∈ non-adjacent time period), this is because the relationship between the time period often weak, and therefore relatively far away from it; in addition, also contemplated the time distance, the time interval is relatively far away from the larger point. On the other hand is the distance timing entity LD (., X). Timing Entity same entity within the same timing distance, i.e., LD (., X1) = LD (., X2) (x1 & x2∈ same timing entity). This is often the need to be analyzed when the same timing as the data entity within the visualization. LD (., X1) <LD (., X2) <LD (., X3) (. & X1∈ same timing entity; . & X2∈ timing neighboring entities;. & X3∈ other timing entities). This is because the timing relationship between entities is relatively weak, and given the distance between them, the more closely related to or need to be viewed at a timing entity arranged adjacent positions, while the other distantly related arrangement at a remote entity timing position.

D (., X) by the two distances, namely D (., X) = PD (., X) + LD (., X).

(3.2)

(3) LOD (x) to take into account the special nature of time-Temporal data. First, the degree of importance, you can define the properties of each sequence analysis tasks in accordance with the requirements of the LOD (x) value; the second is the details: For the focus of data, in order to give more details on data analysis. LOD (x) = - D (f, x) (f x where the time period for the focus timing corresponding entity).

From the above definition is easy to get FisheyeLines the DOI function:

DOI (x|.)= (LOD(x)-D (. , x));

LOD(x) =-D (f, x);

D(.,x)=PD(. , x)+LD(. , x);

$$\rightarrow \mathrm{DOI}\ (x|.)=-(\mathrm{D}(f\ ,\ x)+\mathrm{PD}(.\ ,\ x)+\mathrm{LD}(.\ ,\ x)) \qquad (3.3)$$

Based on these focal length, Fisheye Lines DOI value of each object is calculated by the propagation DOI value, as Card et al [8] described, calculate a DOI value approximately equal to the distance from the focus to each semantic object. DOI value is assigned to each object, and is used to view the visual part of the layout and visual representation of the decision objects.

4. Collective Analysis

First, data sets and test environment described and illustrated; then were to verify the effectiveness of compression algorithms and FisheyeLines, combined with the visual analysis of the effects on the characteristics of visualization methods will be described.

4.1 Dataset Description and Test Environment Description

In this paper, the spacecraft thermal vacuum test and control platform as an example of visualization methods presented case studies, the data sets to simulate spacecraft testing ground space simulation environment to test satellites each device stable in high temperature environments sex, use a vacuum container to simulate the space environment, was introduced into the vacuum container of liquid nitrogen to simulate the space environment of low temperature, heat is generated by the current to simulate the high temperature environment. Then periodically collect temperature, current, voltage, power, information, and store the data into a local database which is used to draw the curve, the data is data intensive 8 million.

This paper on the Beijing satellite environment engineering research institute "spacecraft vacuum thermal test measurement and control platform" project has great significance. Caching mechanism in line with the requirement of the project fast reaction, high real-time performance, and the data quantity is very large, need to read the 8 million or so every time the amount of data to collect, such as temperature, voltage, current curve drawing, because the large amount of data read and require to read faster. Using Zip compression algorithm and the proposed compression algorithm is applied to the "spacecraft vacuum thermal test measurement and control platform" project, can effectively save the data storage space, reduce the waste storage resources as far as possible, to read the stored data and curve drawing speed significantly promoted, use the cache validation algorithm is applied to the "spacecraft vacuum thermal test measurement and control platform" project, can effectively avoid read into dirty data, very well in practice proved in this paper, the use of efficiency and effectiveness of the algorithm.

The data set in line with article requires a data set definitions. Data sets are temperature, current, voltage, power and other information over time, it can be analyzed based on time. Research hardware environment: Inter (R) Core (TM) 2 Quad CPU Q9550 2.83GHz, 7.84GB memory physical address, 500GB hard drive; software environment: Windows7, Visual Studio2013, SQL Server.

4.2 Visual Effects

FisheyeLines Visualization technology is an interactive approach is a direct-to-content interaction. It is a direct manipulation of the mouse on specific information. In this interaction, the concern is currently executing task and content of the current itself.

Users put forward their own proposals after using this method. Most of them suggest the selection of the particles time and the exact time have a direct impact on the performance of software. Therefore, we should enhance the usability of above options. Some users suggest identify the number attribute since it is a important attribute of time sequence.In the existing visual platform, the implementation of a high-performance visualization optimization compared with other algorithm can fast effective real-time transmission and draw the curve and analyzed, to meet the requirements of high performance data of a large amount of data visualization.

Spacecraft data simulation testing ground space simulation environment to test satellites each device stability in high temperature environment, the use of the vacuum vessel to simulate the space environment, to take a period of time the data in Figure 3, the figure shows the overall arrangement intensive, time units intervals greater overall presentation mansard. Figure 3-6 are marked in pic 1 an enlarge view of the red box.

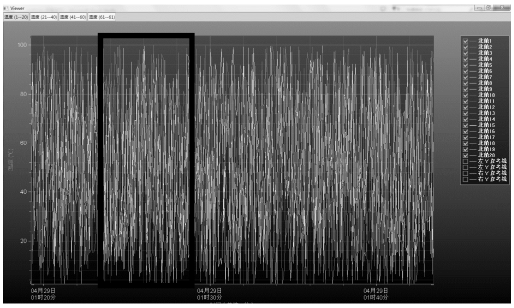

Figure 3: The Units of Hours

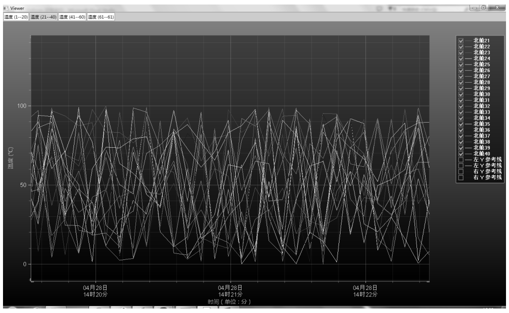

Figure 4: The Unit of Half Hour

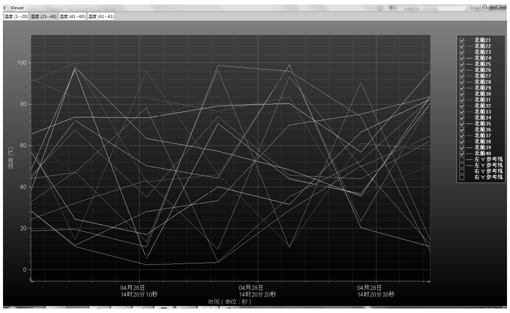

Figure 5 : The Unit of Min

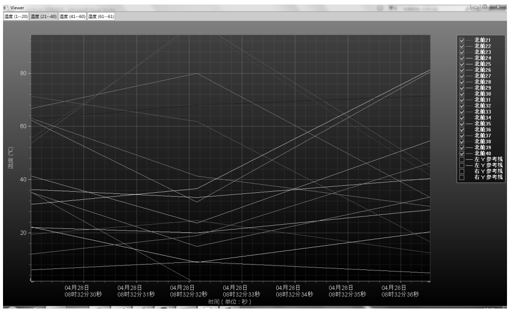

Figure 6: The Unit of s

5. Conclusion

Before launch into space, satellite needs in the space of the ground simulation environment simulation test, to test the various satellite device stability in the high and low temperature environment, using the vacuum container to simulate the space environment, the vacuum container zhongtong into the low temperature of liquid nitrogen to simulate the space environment, using electric current to generate heat to simulate high temperature environment. Periodic information collection temperature, current, voltage, power, and the data of deposit to the local database is used to draw curves and analyzed. Usually draw curve needed time is decided by the following factors:Curve drawing time consumption = load mapping data time consumption + drawing time consumption.

Reading the database of time consumption is the need to look at the measurement point or to be read by the control points of sensors from the start to the current all historical data, collected by the execution is the use of GDI drawing time consumption or DirectX will have been loaded into the data in memory for drawing the time required to.

Temporal data visualization helps people discover the regualrs of the time Temporal data and enhances their cognitive ability. However, the prior art is not a good long span of time Temporal data visualization. This article proposes a compression algorithm and visualization technology of FisheyeLines based on DOI. Our method solves the above problem. This technology evaluates on application examples and verifies the effectiveness and the usability of this technology.

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