Research on 3D Technology Based on Point Cloud

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Abstract. In order to solve the problem on how to visualize the point cloud data in the web front-end domain, this paper proposes and develops a point cloud resolution based on Web technology. The user interface is achieved by opening web technology HTML5 and CSS3, and web interaction function is developed by using JavaScript. The visualization operation and the positional information of the point cloud image data are converted and calculated by the depth-perspective correlation function and applied to the module test. The experimental results show that the system can resolve about 30,000 points of cloud data, the less point cloud data, the faster resolution speed is, which has greater practical value.

1. Introduction

Point cloud is one of the primitive representations of 3D data nowadays [1]. Recently point cloud reconstruction has been witnessed a drastic improvement in scanner acquisition devices [2]. It has the characteristics of quickly obtaining a large amount of point cloud information on the target space [3]. It is created for industries purpose such as point cloud reconstruction, robot recognition [4]. At the same time, the Internet as a platform oriented on multiple tools [5] with its modern features such as convenience, speed and customization, has become an important way for people to obtain information [6], also should be able to provide a mean for the creation of new web based applications [7] for sharing information in all areas of human activity [8]. So how to manage a large number of point cloud resources on the web and visualize it becomes a new challenge. If you can find a way to do not need to pre-install the client or load the component, you can avoid the installation of large components. Users no longer need to wait for a long time, which can greatly improve the experience of them [9]. In foreign countries, Potree [10] as a free point cloud renderer based on open source WebGL, its data needs to be converted locally and then uploaded to the server, and the conversion speed is slow. Alexandre Devaux [11] implemented a web-based 3D map application, using WebGL to interact with images, point clouds and models, but data integration and accessibility still need to be further optimized. In China, there are few related researches on Web-based point cloud visualization. Xun Zeng [12] proposed an airborne lidar point cloud data visualization method based on WebGL, but did not integrate point editing (selection, deletion, change, etc.) functions into the visualization window. Ye Mengxuan et.al [13] proposed the 3d point cloud visualization method based on HTML5 and WebGL. Although the plug-in free 3d point cloud network visualization was realized, there was a problem of slow page loading speed in the reading and display of large amounts of data.

Aiming at the above problems, this paper designs a point cloud analysis system based on Web technology. The system has an image rendering display function, which enables JSON to record all point cloud data, calculate point cloud information, and render it to the user; point removal function allows...
the user removes some points by himself; the multi-view rotation function enables browsing of images, rendering images, viewing image information, and spatial rotation of images, in order to quickly solve the problem of visual rendering of point cloud data in the web front-end field.

2. Point cloud system resolution operation

This operation requires two types of JSON data files, namely the position coordinate information and image information. The DIV element event is selected by the construction of TriggerEvent () function. The coordinates passed into the JSON are converted into information. The JSON file in the database stores all the information in the form of an array. The data type of each array element is an object. The object contains complete information about each display window or image.

The data scheme is to build a JSON file inside the program to save the display window information in the load, for each point that is loaded, a node data is created under the JSON where the display window is located. In order to reduce the size of the image information file and ensure the stability and running speed of the system, the information of the image is read and displayed in real time, and can be arbitrarily deleted after the out of order.

2.1. Point cloud system rotation

The rotation function is still based on the DOM tree. The Structured JSON information is embedded through HTML such as perspective position, etc. then call the rotate() function to construct a rotation transform based on the passed perspective parameters, call the scale() function to construct a scale transform based on the passed depth parameter, and call the perspective() function constructs a displacement transform based on the passed perspective parameters, and selects DIV points to draw different perspectives, and use the layout tree to control the style section. The system also introduces the excellent CSS framework named Pure to speed up the development process.

2.2. Point Cloud System Removal

The point cloud data stored in the system, all non-basic structure variables in the code, temporary output data, etc. are all composed of JSON data, and are mainly used for data processing work. This lightweight data exchange format is relatively easy to machine parsing and generating. The system builds the DOM and the Layout tree at initialization according to the set of "name/value" pairs generated by the initial JSON and the ordered list of values. The algorithm removed after that is no longer related to the original data, but the DOM and Layout tree are trimmed.

3. Point cloud resolution system operation

When the user starts the system, the system reads the information in the data file, loads the data matrix, and then displays the point information recorded therein one by one. After removing the average value of the matrix, the eigenvalues and feature vectors of the covariance matrix are calculated and sorted. Retain n feature vectors in descending order. Transform the data into a new space built by these feature vectors. At the same time, the total number of points and the total number of images are stored and calculated. At any time after the system is started, after the user clicks on the next interface element, the system responds to the click event, and the system displays the image interface. The expected process is to first create a new display window. After opening the system box and selecting the image resource, the system traverses according to the input data to generate one image file to be presented in the display window. Second, edit the display window. Open the display window editing interface to rotate the angle of view of the image. Finally, show the display window. Click on the display window you want to view, then enter the multi-image display page, the interface rotates and jumps, taking into account the loading speed problem, loading with asynchronous data loading form, you can view all the angles through "arrow" and "click point".

After entering the first image interface, load the pre-set angle of view, read the deviation of the current angle from the pre-set angle, calculate the angle at which the depth-dialysis should be offset, and the angle at which each point should be offset by the perspective. After the temporary variable is output,
a result tree is generated to render the image. Then you can jump to the image in the display window, click the up and down arrows to view the image angles of the front and back, click on any point in the figure to jump to the corresponding angle. The system needs to realize image display, image rotation calculation, image point removal, and all processing logic is mainly realized by JSON data change transformation. The specific operation flow is shown in Figure 1.

![Figure 1. Point cloud data processing process.](image1.png)

4. Results and analysis
System test environment consists of Windows 7 Flagship 32-bit the operating system, Intel Core i7 CPU, memory 2GB and solid state drive with hard disk 256GB, display resolution 1024 × 768, colour quality 32-bit and the browser chrome. The test data is constructed by 8000-point point cloud horse and a 15000-point point cloud rabbit.

4.1. Image Module Testing
The image module includes displaying the display window, storing the total number of display window elements for storing the calculated image and the total number of image information, and loading automatically display window and a return image interface when the system is started. When the system is first loaded, the image interface will display the test interface. Then the image will display the point cloud data of the display window and display window just loaded, and calculate the total number of point clouds and the total number of images. The storage calculation information displayed on the display window is shown in Figure 2.

![Figure 2. The display of image storage calculating information.](image2.png)

4.2. Anchor page loading and returning
If close the system, then restart the system, the image will automatically load the display window in the image when the system was last turned off. The interface automatically loaded is shown in Figure 3. At the same time, you can directly return to the previous interface by clicking the direction button. As shown in Figure 4.
4.3. Anchor page loading and returning

The display window module has the functions of establishing display window, displaying display window, rotating display window and deleting part of point cloud data. After clicking on the display window of the image interface, you can enter the display window. The point cloud data displayed in the display window is defaulted to all. The point cloud data in the editing interface can be controlled by the digital button. For the deletion and recovery of the window, considering the efficiency of image loading, the asynchronous loading strategy is implemented.

4.3.1. Delete

After the partial display of the display window is eliminated, the updated image interface is as shown in Figure 5. Before the display window is deleted, only the temporary data variable in the photoinfo.json file exists in the display window directory. After the display window is deleted, the albuminfo.json data file is added into the display window directory. The new file records the temporary information of the deleted point, for example, about one-quarter of the point cloud data is deleted, as shown in Figure 6.

4.3.2. Restore the display window

The deleted image is shown in Figure 7. The interface is reopened, and restarted the display window deleted before. The display window can be reloaded in the image interface as shown in Figure 8, so that all the original information is restored.
4.4. Data processing module

Data processing module aims at not changing any original information of the image in the system. All recorded information can only be stored, viewed and used by the system. The data processing database is composed of two parts, and part of the data file data.json which stores the display window information in the system directory is as shown in Figure 10. After deleting the display window, the data file albuminfo.json for saving the current display window information is created in the window directory, and the data file photoinfo.json for saving all the image information in the current display window can be established in the display window directory shown in Figure 10.

5. Conclusion

This paper took the 8,000-point cloud data request as an example, in order to avoid unnecessary flooding and access of data and maximize the efficiency. The system used the original point cloud data, selected the point cloud data and displayed the image information in real time, and calculated and corrected the CSS position of each point after the depth-perspective transformation before constructing the Layout tree, and realized parsing and display rendering at the front end. The point cloud analysis system operation of the web technology based on parsing and real-time reading and display was completed, which facilitated users to manage their own point cloud image resources on the Web. This system provided a useful reference on the research of the mass service technology of the client distributed mode and the better solution to the problem of point cloud data rendering and presentation of the URL loaded by the browser.

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